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MASTER'S THESIS

Evaluating Customers Attitude Towards Using 3D Modeling In Construction Industry In Iran

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Abstract:

Today improvements in globalization and technology have exposed companies to a situation with tough competition. In this new era companies are focusing on managing customer relationships and creating more value to their customers in order to efficiently maximize their revenues. In terms of creating and delivering value to customers and make their shopping more convenient, giving appropriate and comprehensive information about the product or service is a channel for interacting with customers. In order to interact with customers, 3D modeling or image interactivity is used which permits the viewer to view a product's design features, background, viewing from different angle or distances.

3D modeling provides a complete view of the product to the customers in order to increase their information about the product or service, make their experience attractive and enjoyable, and help their decision making process easier and more convenient. Although many industries are currently using image interactivity (3D modeling technology) to attract customers' attention and deliver them full information prior any purchase take place, few researches have taken place in evaluating the customer attitude toward using the 3D modeling. Especially there were no literatures written for evaluating customers' attitude towards using 3D modeling in construction industry, therefore we found it essential to work on this research. The purpose of this study is to evaluate customer's attitude toward using 3D modeling in construction industry in Iran.

We measured the effect of image interactivity function by preparing a questionnaire which includes different variables that were attitude toward 3D modeling, willingness to purchase, willingness to return, reducing the time, convenient, enjoyment and usefulness.

Table of Content

List of Figures

List of Tables

Chapter 1

Introduction

1.1. Introduction

This chapter will provide the reader with an insight to the research area. We will begin by briefly discussing the background that will then be followed by the problem motivation. The problem discussion ends the overall purpose of the study and specific research question.

1.2. Background

The digital technology has been offering new approaches in gathering, presenting and transferring information. The approach is expanding through the passing time and developments are being made in hardware and software capabilities (M.T. Pirbabaei, et al., 2007). In this new era, using the information technology in order to present and introduce products by different companies and industries exceeds the development of text and image in the websites and it is a better and comprehensive way for introducing products.

The present study focuses on 3D modeling or image interactivity which provides the ability for creating and manipulating images of a product or an environment on a Web site. For example, image interactivity helps the viewer to alter a product's design features, background, context, viewing angle or distance, and to simulate the product's operation. Image interactivity also allows the viewer to simulate his/her navigation through an environment, such as a shopping mall (Fior, Jin, 2003) or take virtual tours to historical buildings and museums. Previously consumers were hesitant to purchase online due to the lack of information which was acquired through direct contact with the product (Lee, 2002; Li *et al.*, 2001). While image interactivity does not provide tactile (touch-based) information, but it may help consumers to overcome their hesitancy in order to shop and purchase online because more of the sensory information available during an in-store encounter with the product is now accessible (Katz and Aspden, 1997; Li *et al.*, 2001; Intel Corp., 1999, Cited from Fior & Jin, 2003).

Providing customers with rich information using new technologies such as 3D modeling on their website recently, attracts the concern of most of the marketers. Lack of sensory in the World Wide Web (WWW) environment could lead to difficulties in making decision for shopping online for customers. The Web has drastically changed the buyer-seller relationships recently, tipping the balance of power in favor of consumers through interactive features such as personalization, customized content and virtual communities (Detmer, 2002; Wind and Mahajan, 2002, cited from Kim & Kim, 2004). Reda (2001) and Schaeffer (2000) claim that fast-selling products on the Internet used to be those products which the shopper already had sufficient information about it, such as books,

computer products, travel, health and beauty products (Kim & Kim, 2004), but now owing to the technology of 3D modeling or image interactivity, an extremely competitive marketplace has been created in which consumers have more shopping choices than ever before (Kim & Kim, 2004) and shopping becomes more easier and enjoyable.

Today many marketers in different industries are using 3D modeling to give a complete view of the product to their customers, in order to increase their information about the product, make their experience more attractive and enjoyable, and help them to ease their decision making process. For instance online apparel retailers in the USA and Europe (such as Lands' End, J.C. Penney and Galleries Lafayette) have increased their profits by giving consumers access to interactive try-on sessions such as the "virtual dressing room", "digital supply chain" and "online fit prediction" (Abend, 2001; Direct Marketing, 2001 , cited from Kim & Kim, 2004).

Interactivity of a website can offer facilitated communications, customization of presented information, image manipulation, and entertainment for the customer. Examples for such an interactivity are "24/7" customer service representatives via e-mail, ASP(Active Service Pages) which permits customers to customize what information appears on the web page, take 3D virtual tours, and entertaining contests and games (Fior and Jin, 2003). Factors that are dependent upon website interactivity, such as community building and 3D virtual experiences, have been embraced by online marketers to attract customers in order to visit the site, purchase online, and be satisfied enough to become a repeated visitor or customer(Gehrek and Turban, 1999; Li et al.,2001; Mathwick, 2002, cited from Fior & Jin, 2003).

Despite offering 3D virtual tours to introduce the products features via web pages, these 3D virtual tours are also offered to customers in sales offices of companies. This procedure is used for those types of products or services that are huge in size and takes a long time to be downloaded through website such as construction industry which we have focused on in this research. Loading 3D virtual tours through web pages could be hard and time consuming for visitors/ customers, therefore rather than being online it is preferred that customer visit the sales department of a construction company in order to view the 3D model of the building which is presented by sales people even with extra explanation. These companies usually provide customers with 3D modeling images on their web pages, for those customers who are interested to have brief information about the construction before they refer the sales office to view the complete 3D virtual tour.

In this study we are focusing on image interactivity, which provides the ability to create and manipulate images of a product or environment.

1.3. Motivation

Procter and Kitchen (2002) stated that Modern marketing is different from traditional perspective in several ways. Modern marketing is more than just developing a good product, pricing it, and making it available for customers (Armstrong et al. 2005, cited from Yan & Po, 2006). Giving complete and comprehensive information about product/service to customer is essential, especially that today customers are using the internet to make a complete search about their required product/ services in order to gain more information. Because of lack of sensory in the internet environment, creating 3D model of product and providing customer with virtual experiments motivates online shoppers to shop different products, and their online shopping would not be limited anymore to those type of products that they have sufficient information about, such as books, CD's and etc.

Factors that are dependent upon website interactivity, such as community building and 3D virtual experiences, have been embraced by online marketers to attract customers in order to visit the site, purchase online, and be satisfied enough to become a repeated visitor or customer (Gehrek and Turban, 1999; Li et al.,2001; Mathwick, 2002, cited from Fior & Jin, 2003).

Different industries such as Medical, Automation, Mobile, Tourism and Hospitality, Construction and so forth are using image interactivity to provide virtual experiences for online shoppers. By giving 3D model of a car, mobile, camera, rooms in a hotel or even a house, marketers provide customers with more information and allow them to create and manipulate visual images of a product on a Web site. Through 3D modeling one can decide to purchase a product or reserve a hotel online with more trust, and make sure that it will match his/her expectations. Image interactivity increases online shopper's enjoyment, satisfaction and repurchase intentions.

Although many companies are implementing image interactivity and taking advantage of this technology in their marketing practices, but few researches has been done in this area. Articles that have been accomplished are evaluating the influence of image interactivity in apparel industry. Some other articles have been written in medical area and in virtual museums. It is believed that with the competitive environment in today's marketing, more research in this area should be done.

In Iran 3D modeling has entered some industries such as medical, automation, mobile, construction and so forth. We found it essential to make a research done in this area and we have chosen construction since we thought it could be more tangible for the respondents.

This research will evaluate the customers' attitude toward using the technology of 3D modeling in construction industry in Iran and their returning and repurchasing intentions.

With each business big or small getting their operations online just to make their presence felt with the rest of the internet world the construction industry is no exception. The analysts rightly say that the internet world is rapidly growing and is becoming the lingo of chief resource for many manufacturers and business owners. The theme behind web-enabling the construction industry is to provide construction companies with the tools they need to compete more effectively and to grow their businesses successfully.

1.4. Research Objective

The purpose of this study is to assess and analyze the attitude of consumers toward 3D modeling in construction industry and their shopping enjoyment, willingness to purchase and return, convenience, usefulness, reducing the time of decision making. This research will shed light to understanding how much a virtual tour will help a customer to purchase a house/property and what does the customer think about using this technology. This research has been done to gain a deeper understanding of customer attitude toward image interactivity or 3D modeling technology in Construction Industry.

1.5. Thesis Chapter Structure

In this study Chapter 2 reviews the current literatures about 3D modeling; chapter 3 presents the theoretical foundations of our research model and outlines the research methodology. Chapter 4 describes the data analysis, presents and discusses the empirical results; and finally chapter 5 concludes this research by discussing the implications of the results, limitations and providing suggestions for further research in this area.

Chapter 2

Review on 3D Modeling Technology

2.1. Review on 3D Modeling

In this chapter we will have a review on 3D modeling, its definition, softwares, relevant works, and 3D modeling in Architecture and finally we end this chapter with the proposed hypotheses for this research.

2.2. Introduction

The World Wide Web (WWW) or the Web has been recognized as a new powerful channel for exchanging information in recent years (Lu, Yeung, 1998). Strauss and Frost (1999) stated that marketing has changed dramatically due to the internet development and since its inception online marketing has seen rapid change (Rowley, 2001, cited from Fior & Jin, 2003). Today, an ever-increasing number of businesses have set up Web sites to publicize their products and services (Lu, Yeung, 1998).

The Internet was first originated in 1969 as a special tool for communicating among selected academic and governmental researchers. In the early years, the major Internet applications were e-mail, file transfers, and listservs; but in the last few years, owing to the introduction of user-friendly browsers, World Wide Web (WWW) applications, or simply Web applications have been increasing in an exponential fashion and have become the driving force behind the expansion of the Internet user base (Lu, Yeung, 1998).

With the fast development of the Internet infrastructure new opportunities are being presented which are rarely seen in the world economy. Owing to the latest developments in the communication and information technology, online marketers are rushing to establish positions in new identified niches in order to obtain new competitive advantages. One of these distinctive advantages is the ability to reach a large number of customers who are scattered all around the world in different geographic locations, in a matter of minutes or hours (Strauss and Frost, 1999, cited from Chen & Chang, 2003).

Growing online competition and maturation of the Internet technology have bolstered the expansion of Web site factors, beyond extensive product offerings, customer convenience, ease of navigation, and security, that affect online marketing success (Choate, 2000; *Chain Store Age*, 2000; Liu *et al.*, 2000; Lohse *et al.*, 2000; Lohse and Spiller, 1999; Vijayasarathy and Jones, 2000, cited from Fior & Jin, 2003). However, there is a careful planning and preparation needed to achieve the intended purpose of this new information exchange channel (Lu, Yeung , 1998).

Owing to the great market potential, many academics and businesses are closely studying and monitoring the explosive growth in this marketplace. Since the WWW has become the major instrument of Internet commerce, studies on the WWW as a new channel for

exchanging information (Maney *et al.*, 1996) have been conducted to obtain more insights into how organizations are using Web sites to carry out different activities in Internet commerce (Lu, Yeung, 1998).

There has been a consensus regarding the appealing attributes of Internet shopping in compare to traditional shopping. These appealing attributes of Internet shopping are time- and money-saving; convenience or easy accessibility; the shopper's ability to monitor and select a wide range of alternatives; and the availability of information for making purchasing or ordering decisions (Breitenbach and Van Doren, 1998; Crawford, 2000; Ray, 2001; Schaeffer, 2000; Then and Delong, 1999, cited from Kim & Kim, 2004).

E. Constantinides (2004) argued that some academics and practitioners have identified the "online shopping experience" or "virtual experience" as a crucial e-commerce marketing issue. Cho and Park, 2001 believe that an online customer is not only a shopper but also he is an information technology user. An individual can argue that the online experience is a more complicated issue than the physical shopping experience: the Web experience can be defined as the consumer's total impression about the online company (Watchfire Whitepaper Series, 2000) resulting from his/her exposure to a combination of virtual marketing tools "…under the marketer's direct control, likely to influence the buying behavior of the online consumer" (Constantinides, 2002, p-60, Cited from Constantinides, 2004).

The Web experience is including elements like searching, browsing, finding, selecting, comparing and evaluating information as well as interacting and transacting with the online firm. The virtual customer's total impression and behavior is influenced by design, events, emotions, environment and other elements which are experienced during the interaction with a given Web site, elements that induce customer goodwill and affect the final outcome of the online interaction (Constantinides, 2004).

Many retailers have noticed the Internet's inability in attracting a wide range of senses. (Harrison-Walker, 2002; Srinivasan et al., 2002). Stockport et al. (2001) claim that especially for sensory products like clothing, jewelry or accessories, which are usually experienced through one or more of the five senses (e.g. touch, sight, smell), the consumers' ability to examine merchandise before purchasing is substantially limited through the internet, even if an online shopping site has video or audio-capacities (Kim & Kim, 2004).

Some online retailers depend on image interactivity functions producing photo-realistic rendered images, three-dimensional images that rotate, and close-up images of a product to provide desired sensory information (Li *et al.*, 2001; Intel Corp., 1999). These images

enrich the information available to customers and help them estimate the visual and tactile qualities of the product (Fior & Jin, 2003).

Fior and Jin (2003) have stated that the interactivity of a Web site offers facilitated communications, customization of presented information, image manipulation, and entertainment for the customer. Some examples of such an interactivity that they have offered are customer service representatives via e-mail, ASP (active server pages), permitting customers to customize the information that are appearing on the Web pages, 3D virtual tours, and entertaining contests and games. The factors which are dependent upon Web site interactivity, such as building communities and 3D virtual experiences, have been accepted by online marketers to entice the consumer to visit their web site, purchase online, and be satisfied enough to become a repeated visitor/customer (Gehrke and Turban, 1999; Li *et al.*, 2001; Mathwick, 2002, cited from Fior & Jin, 2003).

One issue that makes a website more interactive is using 3D modeling or image interactivity in order to introduce products or services in a better way to customers who intend to purchase online. This technology gives the customer a good opportunity to browse different web pages, view the 3D model of products, compare easier and decide to purchase. In the following we intend to explain more about 3D modeling or that image interactivity.

2.3. Definition of 3D Modeling

Fior and Jin (2003) have argued that image interactivity or that 3D modeling permits the viewer to alter a product's design features, background, context, viewing angles or distance, and to simulate the product's operation. Image interactivity also allows an individual to simulate his/ her navigation through an environment like a shopping mall.

Mian, Bennamoun & Owens (2005) stated that 3D modeling constitutes an important part of computer vision or robot vision. There are numerous applications of 3D modeling in different areas ranging from the entertainment industry to industrial automation. Some of these applications are computer graphics, virtual reality, medical imaging, reverse engineering and 3D terrain construction. Curless, 1999 claims that 3D modeling consists of data acquisition, correspondence, registration, integration and reconstruction (Mian, Bennamoun & Owens, 2005).

It is worth mentioning here that there is an alternative approach to registration that avoids the process of correspondence. The idea of 3D modeling is tracking the relative

movement of the object and the sensor from one view to another and applies the reverse transformations to these views. This would register all the views in the coordinate frame of the reference view (Mian, Bennamoun & Owens, 2005).

Despite few articles which we found about using 3D modeling, we did not find more explanation about 3D Modeling; therefore the explanations coming below are gathered from different websites not articles.

3D computer graphics are the works of graphic arts that are created with the help of digital computers and softwares. The term could also be referred to the process of creating such graphics, or the field of study of 3D computer graphic techniques and related technology.

3D modeling is the process of preparing geometric data for 3D computer graphics, and is dependent to sculpting or photography, whereas the art of 2D graphics is analogous to painting. In spite of these differences, 3D computer graphics rely on many of the same algorithms as 2D computer graphics. In computer graphics software, the distinction between 2D and 3D is occasionally blurred; 2D applications may use 3D techniques to achieve effects such as lighting, and 3D may use 2D techniques as well.

2.3.1 Creation of 3D Computer Graphics

The process of creating 3D computer graphics can be sequentially divided into three basic phases as below:

- Content creation (3D modeling, texturing, animation)
- Scene layout setup
- Rendering

2.3.1.1 Modeling

We can describe the modeling stage as shaping individual objects that are later used in the scene. A number of modeling techniques exist, but are not limited to the following, including:

- Constructive solid geometry
- NURBS modeling
- Polygonal modeling
- Subdivision surfaces
- Implicit surfaces

Modeling processes may also include object surface or material properties editing (e.g., color, luminosity, diffuse and specular shading components - more commonly called roughness and shininess, reflection characteristics, transparency or opacity, or index of refraction), adding textures, bump-maps and other features. Modeling may also include different activities that are related to preparing a 3D model for animation (although in a complex character model this will become a stage of its own, known as rigging).

2.3.1.2 Scene Layout Setup

Scene setup includes arranging virtual objects, lights, cameras and other entities on a scene which will later be used in order to produce a still image or an animation. If it is used for animation purpose, this phase usually makes utilizing a technique called "key framing", which facilitates the creation of complicated movement in the scene. With the help of key framing, instead of having to fix an object's position, rotation, or scaling for each frame in an animation, an individual needs just to set up some key frames between which states in every frame are interpolated.

2.3.1.2 Rendering

Rendering is the last process of creating the actual 2D image or animation from the prepared scene. This process can be compared to taking a photo or filming the scene after the setup is finished in real life.

Rendering for interactive media, such as games and simulations, can be calculated and displayed in real time, at rates of approximately 20 to 120 frames per second. Animations for non-interactive media, such as feature films or video, are rendered much more slowly. Non-real time rendering permits the leveraging of limited processing power to gain higher image quality. Rendering times for individual frames may differ from a few seconds to several days for complex scenes. Rendered frames can be stored on a hard disk then can be transferred to other media like motion picture film or optical disk.

Since human eye sees three dimensions, the mathematical model that is represented inside the computer must be transformed back so that the human eye can correlate the image to a realistic one. The fact that the display device - namely a monitor - can show only two dimensions means that this mathematical model must be transferred into a two-dimensional image. Often this is done by using projection; but mostly using perspective projection. The basic idea behind the perspective projection, which unsurprisingly is the way the human eye works, is that objects that are further away are smaller compared to those that are closer to the eye. Thus, to collapse the third dimension onto a screen, a corresponding operation is done to remove it - in this case, a division operation.

Orthographic projection is used mainly in CAD or CAM applications where scientific modeling requires precise measurements and preservation of the three dimensions.

In 3D computer graphics, a 3D model is a mathematical representation of a three-dimensional object. It can be displayed as a two-dimensional image via a process called 3D rendering or be used in a computer simulation of physical phenomena.

Today, 3D models are used in an extended variety of fields. The medical industry uses detailed models of organs. The movie industry uses 3D models as characters and objects for animated and real-life motion pictures. The video game industry uses them as assets for computer and video games. The science sector uses them as highly detailed models of chemical compounds. The architecture industry uses 3D models in order to demonstrate proposed buildings and landscapes. The engineering community uses them for designing new devices, products, vehicles and structures as well as a host of other uses. In recent decades the earth science community has also started to construct 3D geological models as a standard practice.

3D models are sometimes animated for some uses. For example, 3D model are heavily animated for use in feature films and computer and video games. They can be animated by the 3D modeler that created them or externally. Often extra data is added to the model in order to make it easier to animate. For example, some 3D models of humans and animals have the entire bone systems so they will look more realistic when they move and can be manipulated via joints and bones.

2.4 Investigating Relevant work In the 3D Modeling

In the past few years, massive progresses are done in computer hardware and software that triggers many novel sciences, which could not be accomplished decades ago. Computer assisted drawing, design, engineering, manufacturing, or even tele-operation surgery; adopt the research powers in computer geometric modeling. (Fang, Liao, 2005)

Previously fast-selling products on the internet used to be those products that the online shopper already had enough information about , like books, computer products, travel, health and beauty products (Reda, 2001; Schaeffer, 2000). However, by improving technology, other products which were previously thought to be saleable only in a touch-and-feel environment (e.g. apparel, jewelry) are enjoying more widespread sales and could be offered through web pages (Kim & Kim, 2004).

In 1989, a research group at the University of Geneva worked on the research of virtual human dressing simulation. Their work (Hadap et al., 1999; Volino and Magnenat-Thalmann, 1997) focused on the phenomena of wearing effect of a virtual garment on a virtual human in mixed realities (Fang, 2003).

In the 21st century human's life has become much more convenient and comfortable than before. Owing to the ability of 3D computer animation in real-time, relevant studies has been widely expanded in apparel industry (Fang, 2003).

In order to provide full information about the product an increasing number of apparel Web sites has incorporated image interactivity (My Virtual Model™, 2001a). For example, researchers have developed a user friendly interface where a customer can upload his/her body measurements in order to build a 3D model for "virtual wearer trials" that supplies visual information of how a company's products will look on his/her body (Stylios *et al.*, 2001). Some websites have recently incorporated My Virtual Model™ "dressing room" function that permit the customer to create a model by selecting body features, facial features, and hair features similar to those of his/her own (Fior, Jin, 2003).

Then and Delong, in 1999 argued that there are three important visual aspects for successful Web sites for apparel shopping: 1. Images of the online product in its closest representation of end use, 2.Displays in conjunction with similar items and 3. Viewing from different angles such as front and back. (Kim & Kim, 2004).

Researches indicate that 3D virtual product presentations provide a stimulating experience due to the vivid sensory information and the psychological sensation of being present in the online environment (Li et al., 2001). Abend, 2001 states that the ability of simulating the product on one's body using a 3D virtual model could be also an important interactive feature for apparel Web sites because consumers frequently claim that the inability to try on the product leads to hesitation in purchasing apparel online (Kim, Fior and Lee, 2007).

Various apparel retailers have adopted this virtual model technology in order to increase the online shopping experience. Currently, Lands' End, Sears, L.L. Bean, Adidas, Speedo, H&M, and iVillage use My Virtual Model™ technology on their Web sites (Go shopping, 2005). For example, one of the largest online apparel retailers, Lands' End, have claimed that the updated version of My Virtual Model™ that permits customers to use their specific body measurements when creating the virtual model makes shopping for Lands' End apparel online shoppers even easier and more accurate through providing size recommendations (Lands' End, 2004). Klein, 2003; Schlosser, 2003 claim that researchers have found that simple technologies that is providing interactivity have positive effects on consumer responses (Kim, Fior and Lee, 2007).

Some other few researches have been done in the area of medical, here we just mention one of these researches which is written by A. Odgard that is about " Three Dimensional method for quantification of cancellous bone architecture" in 1997. He believes that the recent developments in 3D imaging are a significant improvement in the tools available for studying and understanding the mechanical function of cancellous bones.

Three other researchers (M.T. Pirbabaei, F. Pour Rahimian and R.Ibrahim, 2007) have written a research named" The Development of Virtual Musuems in Iran, Presenting Historic Buildings of Azarbaijan Province, Iran, In 8 Historic Complexes, combination of Different Models and Materials".

As mentioned before other industries have also started using 3D modeling to give a better view of their products to the online shoppers in order to allow customers decision making process become much easier. Mobile industry (for example www.Nokia.com), automotive industry (such as www. Ford.com and www.Caterpillar.com …), Tourism and Hospitality industry and so forth are few examples of implementing 3D models for better introducing a company's product. Although many companies are entering this kind of marketing but few researches have taken place in this field. Literatures that we found were mostly written in the areas of apparel and medical industry but unfortunately the impact of using 3D modeling in other industries has remained unknown.

2.5 3D Graphics and 3D Modeling Software

Engineers have always managed to achieve creative and inventive solutions for designing problems. However computerized tools, such as CAD/CAM applications, have helped designers to achieve their goals in designing problems. The soft wares which are used for 3D modeling and rendering are as follows (The softwares introduced below have been gathered from different websites):

1. **3ds Max (Autodesk),** that is originally called 3D Studio MAX. 3ds Max is used in many industries that utilize 3D graphics. It is used in the video game industry for developing models and creating cinema cut-scenes. 3ds Max is also used in architectural visualizations because of its high compatibility with AutoCAD— which is also developed by Autodesk.

2. **AC3D** (Inivis) is a 3D modeling application that began in the 90's on the Amiga platform. While it is used in some industries, Math Works actively recommends it in many of their aerospace related articles because of its price and compatibility. Additionally it is the first commercial 3D modeler to integrate full support for exporting models to the meta verse platform Second Life. Although AC3D can not

feature its own renderer, it can generate output files for both Render Man and POV-Ray among others.

3. **Auto CAD** with the availability of CAD/CAM tools, designers are now able to sketch a far bigger number of alternative designs under an electronic format; it is also possible to reuse previous solutions (partially or entirely) by just reloading the previous electronic data. In modern CAD systems, designers take bottom-up approaches to 3D modeling. They have to set the goal state of what to build in mind and then decompose it into a series of smaller pieces before turning it into a set of modeling commands.

4. **Autodesk** (makers of AutoCAD), acquired Alias--the original creator of Maya. Maya comes in two versions: Maya Complete and Maya Unlimited. There is also Maya Personal Learning Edition, which is for non-commercial use and puts watermarks on any rendered images.

5. **Blender** (Blender Foundation) is a free, open-source, 3D studio for animating, modeling, rendering, and texturing offering a feature set comparable to high end and mid range 3D animation suites such as Maya, 3ds Max, or Cinema 4D. It involves features like multi-resolution sculpting and retopology painting. Additionally it supports 3D view texture painting; stack based modifier system; flexible particle system with particle based hair; cloth/soft body dynamics, rigid body dynamics and fluid simulation; node based texturing and node based compositing; an integrated non linear video editor; and integrated game engine. Blender is developed under the GPL and is available on all major platforms including Windows, OS X, Linux, BSD, Sun, and Irix. It is currently the only 3D animation suite that is supported both on super computers as well as handheld computers such as the Pocket PC (Pocket Blender).

6. **Cinema 4D** (MAXON) is a slightly lighter package than the others in its basic configuration. This software is claimed to be artist-friendly, and is designed with the less-technical user in mind. It has a lower initial entry cost due to a modular a-la-carte design for purchasing additional functions as users need them. For instance, a module that is called Body Paint permits artists to draw textures directly onto the surface of models. Originally developed for the Commodore Amiga it is also available for Mac OS X, Windows and Linux.
7. **Cult3D** technology is software, multi-platform rendering engine that delivers real-time interactive 3D graphics of unprecedented quality and speed. Cult3D permits

fully animated 3D scenes, ranging from simple sequences of motions to complete interactive 3D presentations, without any special hardware support. Whether the final goal is educational, commercial, or technical, most compelling Cult3D worlds have certain characteristics in common: A Cult3D world is immersive. The user should enter the 3D scene on the computer screen and explore it as she/he would explore part of the real world. It is the user, not the computer, who controls the experience. The local browser allows the user to explore the Cult3D scene/world in any way s/he decides. A Cult3D world is highly interactive. Objects in the world can respond to each other and the external events caused by the user. A Cult3D world blends 2D and 3D objects, animation, and multimedia effects into a single medium. Due to the advantages and the features described above, Cult3D appears to be a very suitable tool for sharing 3D models across the WWW, in conjunction with e-manufacturing concepts. The further developments in this area will be focused on linking such models with manufacturing simulators in order to link a process to its 3D representation in a highly interactive way.

8. **Electric Image Animation System** (EI Technology Group) is a 3D animation and rendering package which is available on both Mac OS X and Windows. This package is mostly known for its rendering quality and rendering speed but it does not include a built-in modeler. EIAS features the ability to handle very large polygon counts.

9. **Form-Z** (autodessys, Inc.) is a general purpose solid/surface 3D modeler. Its main usage is modeling, and it also features rendering and animation support. Form-Z claims users involved in architecture, interior design, illustration, product design, and set design. Its default renderer uses the Light Works rendering engine for ray tracing and radiosity. Form-Z also supports Plugins and Scripts and has rendering support through Next Limit's Maxwell Renderer. It has Import/Export capabilities and it was first released in 1991. It is currently available for both Mac OS X and Windows.

10. **Houdini** (Side Effects Software) is used for visual effects, and character animation. Houdini uses a nonstandard interface that it refers to as a "NODE system". Commercial licenses of Houdini include unlimited copies of Side Effects Software's hybrid micropolygon-raytracer renderer, Mantra, but Houdini also has built-in support for commercial renderers like Pixar's Render Man and mental ray. For non-commercial users, Side Effects Software offers the free Houdini Apprentice personal learning edition that places a small watermark on images.

11. **Light Wave 3D** (NewTek) was originally developed for the Amiga, Light Wave 3D was originally bundled as a part of the Video Toaster package and entered the market as a low cost way for TV production companies to create quality CG for their programming. It first gained public notoriety with its use in the TV series. This software is available for both Windows and Mac OS X.

12. **Massive** is a 3D animation system for creating crowd-related visual effects, targeted for use in film and television. It was originally developed for controlling the large-scale CGI battles in the Lord of the Rings, Massive Software has become an industry standard for digital crowd control in high end animation. Recently, the software has been utilized for blockbuster feature films including *Happy Feet*, *King Kong*, and *I, Robot*. It is available for various Unix and Linux platforms as well as Windows.

13. **Maya** (Autodesk) is currently used in the film and television industry. Maya has a high learning curve but has developed over the years into an application platform in and of itself through extendibility via its MEL programming language. A common alternative to use the default is built in rendering system named mental ray is Pixar's Render man. In 2005,

14. **Modo** (Luxology) is a subdivision modeling, texturing and rendering tool. Recently, version 301 added animation capabilities for camera motion and morphs / blend shapes. It is available for both Windows and Mac OS X.

15. **Silo** (Nevercenter) is a subdivision-surface modeler available for Mac OS X and Windows, with a Linux version in development. Silo does not include a renderer and is the bundled in modeler for the Electric Image Animation System suite.

16. **Sketch Up Pro** (Google) is a 3D modeling package that features a sketch-based modeling approach.

17. **Solid Thinking** (solid Thinking Ltd) is a 3D solid/surface modeling and rendering software that features a Construction Tree method of development. This is defined as the history of the model construction process which permits real-time updates when

modifications are made to points, curves, parameters or entire objects. Solid Thinking is available in four versions: MODELER, MODELER XL, DESIGN, and VANTAGE.

18. **True Space** (Caligari Corporation) is another 3D program that is available for Windows, and the Caligari Company first found its start on the Amiga platform. True Space features are modeling, animation, 3D-painting, and rendering capabilities.

19. **Vue 6** (E-on Software) Vue 6 is a tool for creating, animating and rendering natural 3D environments. It was most recently used to create the background jungle environments in the 2nd and 3rd Pirates of the Caribbean films.

20. **ZBrush** (Pixologic) is a digital sculpting tool that combines 3D/2.5D modeling, texturing and painting tool available for Mac OS X and Windows.

Most of the soft wares which are used for creating 3D images are mentioned above, but as much as we have determined and asked experts, Auto CAD and 3ds Max is currently used in 3D modeling in Iran.

2.6 3D Modeling In Construction Industry

I. de Sola Morales (1997) states that having abandoned the discourse of style, the modern times architecture is characterized by its capacity to take advantage of the specific achievements of that same modernity: the innovation which is offered by present-day science and technology (B. Kolarevic, 2003, P-3).

Digital technologies are changing architectural practices in ways that few were able to anticipate just a decade ago. In the conceptual realm, computational, digital architectures of topological, non-Euclidean geometric space, kinetic and dynamic systems, and genetic algorithms, are supplanting technological architecture. The processes of digitally driven design, characterized by dynamic, open-ended and unpredictable but consistent transformations of three-dimensional structures, has given a rise to new architectonic possibilities. The generative and creative potential of digital media, together with manufacturing advances already in automotive, aerospace and shipbuilding industries, has opened new dimensions in architectural design (B. Kolarevic, 2003, P-3).

The advances in computer-aided design (CAD) and computer-aided manufacturing (CAM) technologies have started within the last few years to have an impact on building design and construction practices. These technologies have opened up new opportunities by permitting production and constructing very complex forms that were very difficult and expensive to design, produce and assemble until recently by using traditional construction technologies. New digital architectures are emerging from the digital revelation, architectures that have found their expression in highly complex curvilinear forms that will gradually enter the mainstream of architectural practice in the coming years (B. Kolarevic, 2003, P-4).

Historically the building industry was among the last to change and adopt new technologies. The question is why this sudden interest and fascination forms? Three-dimensional digital modeling software based on NURBS (Non- Uniform Rational B-Splines), such as parametric curves and surfaces, has opened a universe of complex forms that were very difficult to conceive, develop and represent, until the appearance of CAD/CAM technologies (B. Kolarevic, 2003).

For centuries, being an architect also meant to be a builder, since architects were not only the masters of spatial effects, but were also closely involved in the construction of building. The design information was the construction information- they implied each other. All the master builders from the Greek tekton (builders), to the master masons of the Middle Ages were in charge of all aspects of buildings, from forming to production techniques which was used in their construction. The history of architecture's disassociation from building started in late Renaissance by using the most celebrated invention which was perspective representation and orthographic drawings as a medium for communicating the building's information (B. Kolarevic, 2003, P-57).

The medieval architects used few models and drawings in order to test or communicate ideas, and just relied on direct verbal communication with craftsmen instead, which this leaded to continuous presence on site. In the mid-nineteenth century the rifts between architecture and construction started to extend dramatically, when "drawings" of the earlier period became "contract documents". There were other developments as well, such as the appearance of a general contractor and a professional engineer (first in England), which it was particularly significant in the architectural developments as we know it today (B. Kolarevic, 2003, P-58).

The twentieth century brought increasing complexity to building design and construction, since new materials, technologies and processes were invented. When complexity increased, specialization increased as well, and there was an emergence for various design and engineering consultants for different building systems, code compliance and etc. With the increasing complexity of buildings, the designing time decreased, architects

sought the need for limiting their liability exposure (B. Kolarevic, 2003, P-58). The newfound ability for generating construction information directly form design information, and not the complex curving forms, is what defines the most profound aspect of the contemporary architecture. The close relationship that once existed between architecture and construction potentially remerged as an unintended but fortunate outcome of the new digital production process (B. Kolarevic, 2003, P-57).

2.6.1 Digital Production

One of the first projects that was developed and realized digitally was frank Gehry's design for the large Fish Sculpture at the entrance to a retail complex called Vila Olimpica in Barcelona, Spain (1992). The project's financial and scheduling constraints led Gehry's partner Jim Glymph to find the 3D modeling and manufacturing program developed for the French aerospace industry, called CATIA, an acronym that stands for Computer Aided Three- dimensional Interactive Application. This software which was made for designing and manufacturing airplanes was used to develop and construct a built structure. 3D digital models were used in the design development, for structural analysis, and a source of construction information, in a radical departure from the normative practices of the profession. Hence, the bellwether of digital revolution for architecture had finally arrived (B. Kolarevic, 2003, P-31).

Developments made in the field of computer graphics have dramatically extended possibilities for representing landscapes and environmental information (Orland, Budthimedhee, & Uusitalo, 2001). However, the extent to which private and public landscape planners have adopted the new technology and the suitability of current 3D simulation software for their professional needs, are subjects that are open to debate. Sheppard (2001) predicts that there will be a growing number of people that turn to or require 3D landscape simulations, though precise data is hard to ascertain (Paar, 2006).

The 3D modeling technology is also used in Iran recently in building industry. Due to the increasing rate of inflation in housing in Iran, purchasing properties is a very important fact for customers. The fact is that 3D modeling is currently used for pre-sale buildings in Iran, and it is obvious that the price of pre-sale buildings are lower and have the advantage of using good loans, therefore viewing the 3D model of the house and having a better imagination of what is being purchased could help a lot in ones decision making process and could be embraced by many people. Because of lack of experts in the area of creating 3D models of buildings not all construction companies have entered this market. Entering this market requires honesty, assurance and respect to customer's rights. What may frighten customers is lack of honesty and respect from the construction company.

Most of the construction companies in Iran are also offering 3D model slides and images on their website but for two main reasons customers are forced to visit the sales offices of these companies: first they can take a 3D virtual tour into the building and gain much more information than visiting the website due to low speed of internet in Iran for downloading large size files and band width problems, second that companies prefer to be visited by customers in their own company in the case that they believe since this technology is new in Iran, their architectural plans could be stolen by their competitors if they put the entire 3D model on their website, so in their view the 3D images are sufficient enough for attracting customers. In our interviews with experts we have understood that the cost of creating 3D modeling for buildings is very high due to its huge size of work and the few experts in this field.

2.7 Theoretical Development and Research Model

In this study we have focused on the customers' attitude toward using 3D modeling in construction industry in Iran. Many retailers have noticed the Internet's inability to attract a wide range of senses (Harrison-Walker, 2002; Srinivasan et al., 2002, cited from Kim & Kim 2005). Especially for sensory products like clothing, jewelry or accessories, which are usually experienced through one or more of the five senses (e.g. touch, sight, smell), the consumers' ability to examine merchandise before purchasing is substantially limited through the internet, even if an online shopping site has video or audio-capacities. Online retailers of fashion sites have attempted to capitalize on the advanced unique virtual shopping environment using 3D Flash sites, electronic dressing rooms and fashion-conscious virtual personal shoppers to guide users (Stockport et al., 2001, cited from Kim & Kim, 2004).

Some online retailers depend on image interactivity functions producing photo-realistic rendered images, three-dimensional images that rotate, and close-up images of a product to provide desired sensory information (Li *et al.*, 2001; Intel Corp., 1999). These images enrich the information available to customers and help them estimate the visual and tactile qualities of the product (Fior & Jin, 2003).

Recently owed to the developments in technology, creating 3D models of products are used to introduce the product to customers in order to help them to have a better view about the product before purchase. 3D is being used in construction industry as well, and has taken the place of physical model which were used previously to introduce a building to customers. Buying a property is very important in customers view, considering the fact that they are choosing a place to live or work and also the amount of money paid for this issue is much more than buying apparel online using image interactivity. Therefore it was very important for us to understand people attitude towards using this technology in order

to choose or purchase a property. In order to understand this issue we have proposed some hypotheses which we will explain in the following.

The theoretical development of our research model is based on the theory which Fior and Jin have used in their research which is "Influence of image interactivity on approach responses towards an online retailer". These hypotheses are: 1. Attitude toward the online store, 2.willingness to purchase from online store, 3.willingness to return to online store, 4.likelihood of spending more time than planned shopping on the site, and 5.likelihood of patronizing the bricks-and-mortar store.

In this research we have proposed seven hypotheses which we have used some of the above hypotheses such as: 1. Attitude toward 3D modeling, 2. Willingness to purchase via 3D modeling and 3. Willingness to return and use the 3D modeling again. We also have used other hypotheses from the research of Lee , Fior and Kim in the research of "The role of technology acceptance model in explaining effects of image interactivity technology on consumer responses", which are 4.shopping enjoyment through using 3D modeling and 5. Ease of use which was changed to Convenient in our research and 6. Usefulness and the last hypotheses is 7. Reducing the time of choosing a property which was proposed by us and in interviews with experts this last hypothesis was confirmed.

Since using 3D modeling in construction industry is almost new in the world and also in Iran and it is used only for buildings before or under construction and many people haven't used this technology yet, so we omitted the fourth and fifth hypotheses which Fior and Jin have proposed.

H1: Customers' attitude toward using 3D modeling in construction industry is positive.

Consumer's attitude toward the using 3D model in construction industry can be an significant determinant for using internet in searching product information. Helander and Khalid (2000, cited from Kim & Park, 2005) found that a positive attitude toward e-commerce has an important influence on shopping through the internet. Klein (1998) has proposed that the internet can influence information search behavior due to its greater convenience and accessibility (Kim and Park, 2005). Customers' attitude toward using 3D modeling could be very important for construction companies. By understanding customers attitude construction companies will put all of their effort to make the customers virtual tour much more convenient and enjoyable. In this study we are evaluating customers' attitude toward 3D modeling in construction industry in a general way, not only customers' attitude toward using 3D modeling and purchasing online.

H2: Willingness to purchase a property through 3D modeling is positive.

Purchasing a product by viewing its 3D model could be a little strange at first, especially if an individual wants to buy an expensive and also a large size product such as a house or office. However we want to measure this variable and understand the willingness of customers for buying a property via viewing its 3D model.

H3: Willingness to return/repurchase from 3D modeling in construction industry is positive.

After understanding the willingness to purchase it is important to understand the willingness to return as well. A customer might prefer buying a property through visiting the place instead of taking a virtual tour. Most customers might be uncertain about returning back due to the uncertainties they have in buying a house, they are not sure they whether the property they are purchasing is the same as the 3D model they have seen or there might be cheatings. Some customers might be eager to use this way of purchasing again and they even may suggest this to others.

H4: Using 3D modeling for buying a property is more convenient than before.

Wolfinbarger and Gilly (2001) suggest that convenience is referred to the ease of shopping and sometimes includes elements of accessibility, comparison shopping and ease of shopping. The access to internet 24 hours a day and 7 days a week is an important item for online customers. Availability of rich information about different products, different brands and the ability to compare and select could be another reason to make customers satisfied enough to shop through the web. Convenient in viewing the 3D model of a property before choosing and purchasing could be more for customers than visiting different properties in order to choose and buy one of them which is very time consuming.

H5: Using 3D modeling for buying a property is useful.

Image Interactivity Technology (IIT) has been credited with improving consumer responses towards an online retailer or a product (Fior and Jin, 2003; Li et al., 2001; Wu, 1999). These positive responses may be because of the usefulness of this technology in providing complete information similar to what it is found in a brick and mortar store with out expending physical effort in order to shop in the store (Lee, Fior, Kim, 2007).

Image interactivity technology permits the viewer to simulate his/her navigation through an environment (Fior and Jin, 2003), such as walking through a building, view different aspects of that building and to gather more sensory information about that place. Image interactivity technology close-up images enrich product search attribute information (for example color and texture) and virtual model technology enriches visual information

about the product (Fior and Jin, 2003). Also this technology could be a very useful tool for those Iranian's who are not living in Iran and want to buy a property in their own country, so instead of traveling to Iran and visit different places for choosing a property they can easily choose and buy one on the internet so easily by viewing its 3D model (Perhaps this needs a higher band width of internet for providing this technology).

H6: Reducing the time needed for choosing/buying a property through using 3D modeling is more than before.

As mentioned in the previous hypotheses this technology could also reduce the time of choosing and buying for both those customers in Iran and all around the world. Visiting different places for choosing a property to buy could be very time consuming especially for those customers who have difficult tastes in choosing something.

H7: Shopping enjoyment by using 3D modeling is more than before.

Enjoyment may arise from the entertaining and creative process involved in developing images (Mehrabian and Russell, 1974) in construction industry by viewing the construction from different angles and views. Mehrabian and Russell (1974) believe that the resulting experience is more vivid; the function provides more of the visual sensory information (e.g. how products look) and behaviors (e.g. checking the side and back views of the product) found when shopping for the actual product. An enjoyable and involving experience should enhance approach responses toward the environment (Fior & Jin, 2003). Despite the convenience and usefulness customers might feel more enjoyable by viewing 3D models of different properties.

The results of these hypotheses are explained in chapter 4 with details.

Chapter 3

Research Methodology

3.1 RESEARCH METHOD

In this chapter the research method will be evaluated and commented and we will discuss the characteristics of the study. We will focus on the discussion of the method chosen in our research study. The chapter will end up by a discussion on reliability and validity of the research instrument.

3.2. Research process and design

When research problem has been identified, the research objectives and questions started, it is necessary to indicate how the research objectives would be achieved (Williman, 2001).

The marketing research process consists of six steps as shown below. This process is a general one and can be used for conducting research in any functional area for example marketing, finance, accounting and so fourth (Malhotra and Peterson, P-9).

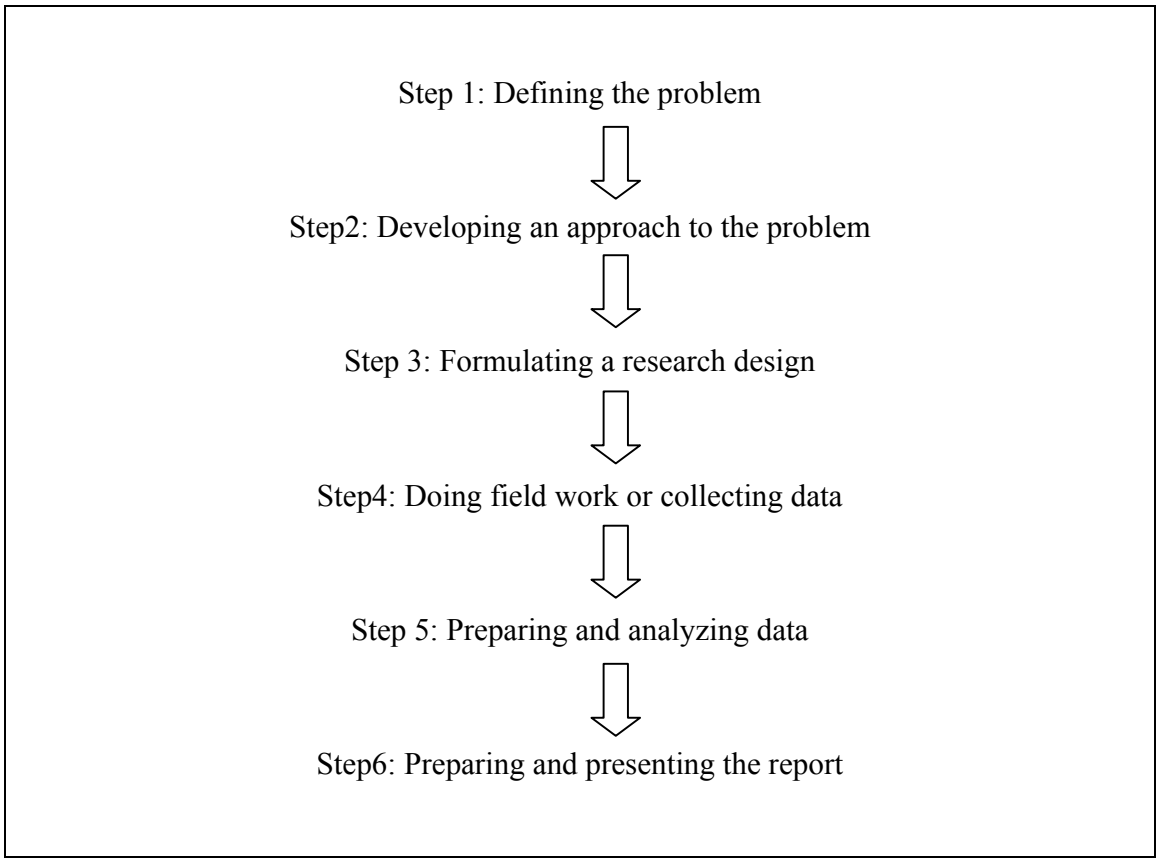

Figure 3.1 Phases of research process, source: Basic Marketing research, Malhotra and Peterson

Developing an approach to the problem includes formulating an analytical framework and models, research questions and hypothesis and the information needed. A research design is a framework or a blueprint for conducting the marketing research project. A research design details the procedures needed to obtain the required information (Malhotra and Peterson-P10). Yin (2003) believes that a research design should include five components which are 1- study questions, 2- its proposition, 3- its units of analysis, 4- the logic linking the data to propositions and 5- the criteria for interpreting the findings. In this study we have presented the research design, sampling and data collection methods. We would analyze the data and state conclusions, limitations and further researches in the chapter coming after.

3.3. Research Purpose

Research strategy depends on the author's willingness, meaning what the author wants? In other words the research purpose is co-related with the researcher's desire (Eriksson & Wiedersheim-Paul, 1997, cited from khoshoie, 2005). Zikmund (2000) divides research into three different categories; exploratory (ambiguous problem), descriptive (aware of problem) and explanatory or casual research (clearly defined problem).

3.3.1. Exploratory Research

According to Gali (2003) exploratory research is characterized by its flexibility, when a problem is broad and not specifically defined, the researchers use exploratory research as a preliminary step. Yin (1994) stated that an explanatory study should be designed by stating a purpose and stating the criteria to judge the exploration successful (khoshoie, 2005).

3.3.2. Descriptive Research

Descriptive research's main objective is description of something, usually market characteristics or functions. A descriptive study tries to discover answers to the questions who, what, when, where, and sometimes how (Malhotra and Peterson- P76). Zikmund (2000) explains that descriptive research is done when the research problem is known but the researcher is not fully aware of the situation.

3.3.3. Explanatory Research

Yin (1994) argues that an explanatory research approach is used when the study aims to explain certain phenomena from variety of perspectives or situations with given set of events. Cooper and Schindler (P-11) stated that an explanatory research goes beyond

description and attempts to explain the reasons for the phenomenon that the descriptive study only observed. In explanatory research, the researcher uses theories or at least hypotheses to account for the forces that caused a certain phenomenon to occur.

Table3.1 Comparison of basic research designs (Malhotra and Peterson, P-74)

	Exploratory	**Descriptive**	**Explanatory or Casual**
Objective	*Discovery of ideas and insights*	*Describe market characteristics or functions*	*Determine cause and effect relationships*
Characteristics	*Flexible, Versatile*	*Marked by the prior formulation of specific hypotheses*	*Manipulation of one or more independent variables*
Methods	*Expert surveys* *Pilot surveys* *Secondary data* *Qualitative research*	*Secondary data* *Surveys* *Panels* *Observational and other data*	*Experiments*

In this study our research purpose and research question reveal that this research is explanatory.

3.4. Research Approach, Quantitative and Qualitative Approach

An approach is a particular kind of perspective on research that is conducted by scholars who are trying to examine a phenomenon, develop insights and report these insights to others (Potter, 1996). In social science there are two types of research approaches to choose for conducting a research which are quantitative and qualitative (Yin, 1993; Holme & Solvang 1991). Holme & Solvang (1991) describe quantitative approach as selectivity and distance to the object whereas a qualitative approach is characterized by nearness to the object of research (Rasooli, 2005). Both of these approaches have their own strengths and weaknesses and neither one of the approaches can be held better than the other one. The best research method that is used in a study depends on that study's research purpose and the accompanying research questions (Yin, 1994, cited from Rasooli, 2005).

Quantitative research approach transforms the information to numbers and amounts that later will be analyzed statistically. Quantitative studies tend to be more structured and formulized. This approach is also characterized by studying few variables on a large

number of entities **(**Holme & Solvang 1991, cited from Khoshoie, 2005). Quantitative research is usually associated with natural science mode of research; data is quantitative, obtained from samples and observations looking for relationships and patterns that can be expressed in numbers rather than words (Tull & Hawkins, 1990, cited from Rasooli, 2005).

Qualitative research approach goal is reaching a better understanding of the phenomenon being studied, they also tend to be relative flexible using this approach the researcher tries to separate the specific or odd and strive in order to create a more complete understanding about the situation (Yin, 1994). Patel & Tebelius (1987) explained that a qualitative research is the search for knowledge that is supposed to investigate, interpret and understand the phenomena by the means of an inside perspective (Rasooli, 2005). Characteristic of qualitative approach is that they are largely based on the researcher's own description, emotions and reactions. It is also in closeness to respondents or to the source which the data is being gathered from (Holme & Solvang 1991, cited from Khoshoie, 2005).Differences between both of these approaches is shown in the following table:

Table 3.2 Qualitative vs. Quantitative research, (Malhotra and Peterson, 2006, P-151)

	Qualitative Research	**Quantitative Research**
Objective	*To gain a qualitative understanding of the underlying reasons and motivations*	*To quantify the data and generalize the results from the sample to the population of interest*
Sample	*Small number of non-representative cases*	*Large number of representative cases*
Data Collection	*Unstructured*	*Structured*
Data Analysis	*Non-statistical*	*Statistical*
Outcome	*Develop a richer understanding*	*Recommend a final course of action*

In this study we are interested to know more about customer's attitude toward using 3D modeling in construction industry in Iran. Therefore, it is revealed that we must use quantitative methods and address a sufficient population in order to understand and evaluate customer's attitude toward using 3D modeling.

3.5. Data Collection Method

Yin (2003) argues that there are six available sources that can be the focus of data collection. These six sources of evidence are: documentation, archival records,

interviews, direct observations, participant observation and physical artifacts. The table below explains how to select the data collection source. Table shows how to select the source of data collection.

Table 3.3 Data collection sources

Source of Evidence	***Description***
Documentation	The different types of documents are for example, statistics, registrations, official publications, letters, diaries, newspaper, journals, branch literature and brochures. Documents are mostly used for collecting secondary data.
Archival Records	Theses can be, for example, service records, organizational records, maps and charts, survey data, and personal records. Archival records are often used in computerized form, also for collecting secondary data.
Interviews	The interviews mostly take the form of an *open-ended nature*, in which an investigator can ask key respondents for the facts of a matter as well as for the respondents' opinions about events. The interview can also take the form of a *focused* interview, in which a respondent is interviewed for a short period of time, an hour for example. Moreover, the interview can entail more structured questions, along the times of a formal *survey.*
Direct Observation	This can involve observations of meetings, sidewalk activities, factory work, classrooms and the like. Observational evidence is often useful in providing additional information about the topic being studied. To increase the reliability of observational evidence, a common procedure is to have more than a single observer making an observation, whether of the formal or the casual variety.
Participant-Observation	Participant-observation is a special mode of observation in which the investigator is not merely a passive observer, instead, the investigator may take a variety of roles within a case study situation and may actually participate in the events being studied.
Physical Artifacts	A final source of evidence is a physical or cultural artifact- a technological device, a tool or instrument, a work of art, or some other physical evidence. Such artifacts may be collected or observed as part of a field visit and have been used extensively in anthropological research.

Source: Yin, 1994, pp.85-f

As the table above indicates, in a case study where an organization is investigated to understand how the organization works, and why the organization works; data can be collected from a person of that particular organization or directly from an organization. During collecting data from the individuals of an organization interviews can be used (Yin, 2003). Sekaran (2000) stated that the collected data can be further grouped into primary or secondary data. In collecting primary data the purpose of the researcher is specific and respondents' specific ideas on specific issues are sought, whereas the purpose of collecting secondary data is different. Examples of secondary data include company records, government publications, academic journals, industry analysis which is offered by the media and websites (Khoshoie, 2005).

A survey is an appropriate strategy for collecting primary data. Because of the quantitative nature of this study, using a survey for collecting data is an appropriate way. The methodology of this research consist an interview with nine experts before preparing the questionnaire (see Appendix A) and a survey study with 200 respondents. This questionnaire includes 41 questions which it came in two parts. The first part includes 11 questions for gathering demographic information of the respondents and introducing 3D modeling in construction industry, which 4 of them were taken exactly from literature review[30,55] and the 7 other questions were prepared due to the sensitivity of the topic and were confirmed by the experts. This part includes Simple category scale, multiple choice single- response scale and multiple choice multiple-response scale questions.
The second part includes 30 questions with seven- point scales prepared to obtain accurate answers. Some of the questions were changed a bit due to the difference of topic from apparel to construction industry. There were 20 questions which the word clothing was changed to property and the word online store was changed to using 3D modeling as well [21, 37]. There are 3 questions which needed more change. For instance the question for willingness to return was: "I would like to visit the online store again" [20], and it was changed to "In future I would like to view & evaluate the 3D model of suggested properties" in this research. There were some questions that needed to be asked in the construction industry due to the sensitivity of the product being purchase in the price and size and usage and we couldn't find them in any paper. Therefore 7 questions were prepared by asking construction engineers and expert's opinions and were confirmed by them. These questions are as follow:

1. Questions number 3 and 4 in the usefulness section.
2. Questions number 2, 4 and 5 in the Convenience section.
3. Question number 2 in the reducing time section.
4. Question number 2 in the willingness to purchase section.

156 out of 200 questionnaires were returned back, 8 of them were incomplete, so they were useless. A total of 148 out of 200 respondents in four cities of Iran (Tehran, Esfahan, Karaj and Sanandaj) who were asked to answer the questionnaire answered the questionnaire completely, which is a response rate of 74 percent. For each respondent we

gave them a brief explanation about what 3D modeling is and how it is used in construction industry, the respondents were also shown a digital 3D image drawing of a building and a building plan so that they can compare and understand the difference, therefore it took two month to distribute and collect the questionnaires.
In order to understand customers' attitude toward using 3D modeling in construction industry in Iran we have developed several questions related to the seven hypotheses which were mentioned before, and measured different variables which were attitude, willingness to purchase, willingness to return, convenience, usefulness, reducing the choosing and decision making time and shopping enjoyment. The questionnaire has been followed in Appendix A.

3.6 Sample Selection

Sekaran (2000) argues that a sample is a subset of population and sampling is the process of selecting a sufficient number of elements within a sample. There are two types of sample selection which are probability sampling and non-probability sampling. In probability sampling there is some known chance or probability for the subset in being selected as sample subjects. While in non-probability sampling there is no such predetermined chance of being selected as subject is known to the subset. Non-probability sampling is used when the data has to be gathered in an expensive way (Khoshoie, 2005).

For a survey-based research, probability sampling is most associated where the researcher wants to make inferences from the sample about a population in order to answer the research questions or to meet the research objectives (Khoshoie, 2005). In this study the most suitable type of the subsequence for selecting the research sample based on our data collection methods is probability sampling. Due to the increasing rate of inflation in construction industry in Iran most Iranians are familiar with architecture and constructing Industry. Our conducted research survey includes 148 respondents in Iran who were selected randomly. Results indicate that 66.22 percent of the respondents were male and 33.78 percent were female.

3.7. Validity and Reliability

The best way for evaluating the quality of a research is to check it on two basic criteria which are validity and reliability. Validity means that how the research has been conducted within the outlined measures i.e. if it has measured what it was supposed to measure. Chisnall (1997) claims that validity is the way that a specific research measures what is intended to measure. Merriam (1998) states that validity measures whether the

obtained information is the information that meant to be received if there is a misunderstanding question, the information is said to have low validity (Khoshoie, 2005).

In order to ensure the validity of this research study, the questionnaire was formulated and prepared in an interview guide by the help of experts which was mentioned before and the questionnaire was also have been reviewed by some of them in few cases changes were needed. For evaluating the validity, before taking the main sample, a small sample with a suitable size is being taken and then the validity of the questions will be measured with the received information. Since we have formulated the questionnaire with much accuracy, a sample of 50 respondents was chosen, two of them were incomplete so we put them aside and then validity of the 48 remained questions were evaluated and confirmed. In this research for evaluating the validity we have used Cronbackh's alpha value using SPSS software. The Cronbach's alpha value obtained for this 48 respondents was higher than 0.7.

All of the variables had Cronbach's alpha values more than 0.7 making them reliable and appropriate for use in statistical analyses. The values of Cronbach's alpha are shown in the following table:

Table 3.4 variables Cronbach's alpha values

Variable	***Cronbach's alpha value***
Attitude toward using 3D modeling	0.873
Willingness to purchase	0.799
Willingness to return	0.874
Convenience	0.733
Usefulness	0.843
Reducing decision making time	0.710
Shopping enjoyment	0.834

Reliability is concerned with whether alternative researchers would reveal similar information conducting a similar study (Saunders, Lewis and Thornhill, 2003). The reliability of a measure indicates the extent to which the measure is without biased and hence offers, consistent measurement and across time (Sekaran, 2000). Yin, 2003 claims

that it is important to remember that reliability is not measured but it is estimated (Rasooli, 2005).

To insure measurement reliability in this study, we tried to choose the latest and most relevant theories that have been validated in previous researches. These theories were current and appropriate for our research study.

Chapter 4

Research Data Descriptive Analysis & Results

4.1 Research Data Descriptive Analysis & Results

In this chapter analysis of the findings from the results of the survey will be presented.

4.2. Measures

In order to insure the measurement reliability of our research, we tried to choose those theories that have been validated in previous researches.

Customer's attitude, willingness to purchase and willingness to return have been validated by Fior and Jin (2003), usefulness and shopping enjoyment have been also validated by Lee, Fior and Kim (2006). We changed the ease of use to convenient which had been validated by Lee, Fior and Kim (2006). Reducing time for choosing or buying was added considering this fact that this item was considered important to customers in the experts view. We see the present study as the first step in a research program that examines and evaluates the effects of 3D modeling and image interactivity function in construction industry in Iran.

4.3. Data Analysis

In order to analyze this research's theories we used SPSS software. In this study we used both descriptive and inferential statistical methods. Descriptive methods were used to indicate the demographic situation of the respondents in the sample. T-test has been used for analyzing the theories. We have also used the *p-value* to determine the results by comparing this value with the Type I error (i.e. 0.05), if the p-value is less than 0.05 the null hypothesis will be rejected.

4.4. Results and Discussion

The subjects of this study consist of 200 individuals who were asked to answer the questionnaire. We obtained a total of 148 out of 200 usable subjects for testing the hypotheses. The demographics of these respondents are shown in table 4.1. (See graphs in appendix B).

Table 4.1 Demographics of respondents

Gender	Male Female	66.22% 33.78%
Age	20-30 31-40 41-50 Older than 50	37.8% 41.9% 16.2 % 4.1%
Education	Under Diploma Diploma College degree Bachelor Master or higher	2.7% 19.6% 16.9% 35.8% 25%
Occupation	House wife Governmental Co. employee Private Co. employee Manufacturing Co. employee Bank employee Student Business Other	2.7% 31.1% 25% 3.4% 3.4% 24.3% 0.7% 9.5%
Salary	No salary 200-600 USD 600-1000 USD 1000-1500 USD 1500- 2000 USD Over 2000 USD	8.8% 70.3% 11.5% 4.7% 1.4% 3.4%

The results show that 66.22% (98 people) of the respondents are male and 33.78% (50 people) of the respondents are female, most of them have the average age of 31 to 40 years old (41.9%). Only 2.7% of the respondents have the education below diploma and 35.8% of them have Bachelor education which includes the most among the other items, 31.1% of them are employee in governmental Companies. Most of the respondents (70.3%) have the salary of 200 to 600 US Dollars and 8.8% of the respondents claimed that they don't have any salary, which they include the group of house wives and students. 56 out of 148 respondents had seen or heard about 3D modeling in construction industry.

4.4.1. Analyzing The Research Hypotheses

In this part we are about to evaluate the acceptance of research hypotheses by using the collected information from the questionnaires. Each hypothesis will be evaluated separately in below.

H1: Customers' attitude toward using 3D modeling in construction industry is positive.

For evaluating the customer's attitude toward the usage of 3D modeling in construction industry five questions were prepared in the questionnaire. The questionnaire was formulated in a seven-point scale, and the respondents could choose one of the answers from "completely disagree", "disagree", " approximately disagree", " no idea", " approximately agree", "agree", "completely agree" (See appendix A). The answers above were given a scale of 1 to 7 respectively. By getting an average from the five questions that were asked in this part, a scale was obtained that measures the customers' attitude. The large amount of this scale shows that the respondents have chosen the answers with higher scales (scales 5, 6 and 7) and indicates that customers' attitude is positive toward using 3D modeling in choosing and buying a property. In the other hand small amount of this value shows that the respondents have chosen the lower scales. However the scale which is obtained from these five questions is used for accepting or rejecting the hypotheses.

We have defined the hypotheses as below:

H_0: Customers' attitude toward using 3D modeling in construction industry is negative.

H_1: Customers' attitude toward using 3D modeling in construction industry is positive.

Considering that X is the scale of measuring the customers' attitude and μ is its mean, we will have:

$$\begin{cases} H_0 & \mu < 4 \\ H_1 & \mu \geq 4 \end{cases}$$

We have recognized number 4 because the questionnaire was prepared in 7 scale measure and the middle scale is 4. Therefore for measuring whether this variable is positive its

mean should be more than 4. The acceptance results for the first hypotheses are shown in table 4.2.

Table 4.2 the result of t-test for Customers' attitude toward using 3D modeling

Variable	***Number of respondents***	***Mean***	***Standard Deviation***	***t- statistics***	***p-value***
Customers' attitude toward 3D modeling	148	5.95	0.7939	29.86	0.0000

The customer attitude toward 3D modeling had a mean of 5.95, which this large number indicates that the probability of acceptance of the first hypotheses (H1) is high. We will use the *p-value* for evaluating the result. The *p- value* is compared with the probability of the Type I error (which is usually considered 0.05). The amounts lower than 0.05 conclude in rejecting the null hypotheses. As you can see in the table the amount of *p-value* is 0.0000 (since we have formulated that on four decimals, the software gave the above number), and since the *p-value* is lower than 0.05 therefore the null hypotheses is rejected and H_1 is strongly accepted. Therefore we can conclude that the customers' attitude toward 3D modeling is positive.

H2: Willingness to purchase a property through 3D modeling is positive.

There were three questions prepared for this part and the stages for measuring the two hypotheses are as above. The hypotheses were defined as below:

H_0: Willingness to purchase a property through 3D modeling is negative.

H_1: Willingness to purchase a property through 3D modeling is positive.

The results are shown in table 4.3.

Table 4.3 the result of t-test for willingness to purchase a property through 3D

Variable	***Number of respondents***	***Mean***	***Standard Deviation***	***t-statistics***	***p-value***
Willingness to purchase	148	5.63	0.8075	24.49	0.0000

The obtained mean for willingness to purchase is 5.63, and the *p-value* is 0.0000 which indicates that the null hypotheses is rejected and H_1 is strongly accepted. This means that the variable of willingness to purchase a property through using 3D modeling is positive.

H3: Willingness to return to use 3D modeling in construction industry is positive.

There were three questions asked in this section, and the stages for measuring the hypotheses were like the previous hypotheses. The two hypotheses were defined as below:

H_0: Willingness to return to use 3D modeling is negative.

H_1: Willingness to return to use 3D modeling is positive.

The results are shown in table 4.4.

Table 4.4 the result of t-test for the variable willingness to return.

Variable	***Number of respondents***	***Mean***	***Standard Deviation***	***t-statistics***	***p-value***
Willingness to return	148	5.8223	0.8962	24.74	0.0000

The obtained mean for willingness to purchase is 5.8223, and the *p-value* is 0.0000 which indicates that the null hypotheses is rejected and H_1 is strongly accepted. This means that the variable of willingness to return to use 3D modeling again for buying a property is positive.

H4: Using 3D modeling for buying a property is more convenient than before.

There were six questions asked in this section, we took the same stages for measuring the hypotheses. The two hypotheses were defined as below:

H_0: Convenience in buying a property by using 3D modeling is not more than before.

H_1: Convenience in buying a property by using 3D modeling is more than before.

The results are shown in table 4.5.

Table 4.5 the result of t-test for the variable of convenience in using 3D modeling for buying a property.

Variable	***Number of respondents***	***Mean***	***Standard Deviation***	***t-statistics***	***p-value***
Convenience in using 3D modeling	148	5.53122	0.8303	22.43	0.0000

The obtained mean for willingness to purchase is 5.53122, and the *p-value* is 0.0000 which indicates that the null hypotheses is rejected and H_1 is strongly accepted. This means that the variable of convenience in using 3D modeling for buying a property is more than before.

H5: Using 3D modeling for buying a property is useful.

There were five questions formulated for this part. The two hypotheses were defined as below:

H_0: Using 3D modeling for buying a property is not useful.

H_1: Using 3D modeling for buying a property is useful.

The results are shown in table 4.6.

Table 4.6 the result of t-test for the variable of usefulness of using 3D modeling in buying a property.

Variable	***Number of respondents***	***Mean***	***Standard Deviation***	***t-statistics***	***p-value***
Usefulness of using 3D modeling	148	5.88081	0.7742	29.55	0.0000

The obtained mean for willingness to purchase is 5.88081, and the *p-value* is 0.0000 which indicates that the null hypotheses is rejected and H_1 is strongly accepted. We can conclude that using 3D modeling in buying a property is useful.

H6: Reducing the time needed for choosing/buying a property through using 3D modeling is more than before.

There were three questions formulated for this part. The two hypotheses were defined as below:

H_0: Reducing the time needed for choosing/buying a property through using 3D modeling is not more than before.

H_1: Reducing the time needed for choosing/buying a property through using 3D modeling is more than before.

The results are shown in table 4.7.

Table 4.7 the result of t-test for the variable reducing the time for choosing/ buying a property by using 3D modeling.

Variable	***Number of respondents***	***Mean***	***Standard Deviation***	***t-statistics***	***p-value***
Reducing time of choosing/buying	148	5.68268	0.85649	23.98	0.0000

The obtained mean for willingness to purchase is 5.68268, and the *p-value* is 0.0000 which indicates that the null hypotheses is rejected and H_1 is strongly accepted. We can conclude that by using 3D modeling in buying a property the time needed for choosing or buying is reduced more than before.

H7: Shopping enjoyment by using 3D modeling is more than before.

There were five questions formulated for this part. The two hypotheses were defined as below:

H_0: Shopping enjoyment by using 3D modeling is not more than before**.**

H_1: Shopping enjoyment by using 3D modeling is more than before.

The results are shown in table 4.8.

Table 4.8 the result of t-test for the variable shopping enjoyment.

Variable	***Number of respondents***	***Mean***	***Standard Deviation***	***t-statistics***	***p-value***
Shopping enjoyment	148	5.72886	0.9458	22.31	0.0000

The obtained mean for willingness to purchase is 5.72886, and the *p-value* is 0.0000 which indicates that the null hypotheses is rejected and H_1 is strongly accepted. We can conclude that there is a higher shopping enjoyment in choosing/ buying a property through viewing its 3D modeling.

Chapter 5
Conclusions, Limitations & Further Research

5.1 CONCLUSIONS, LIMITATIONS & FURTHER RESEARCH

In this chapter we will summarize our analytical findings with respect to the research question and present our conclusions, as well as remarking the limitations and outline a path for further research on the issue.

5.2. Conclusions

The purpose of this study was to evaluate the customers' attitude toward using 3D modeling in construction industry.

Enhancing the interactivity of a website is seen as a mean of making a website to be competitive. For attracting and keeping customers, online retailers have incorporated more interactivity, including image interactivity that provides more complete sensory and experiential information about the product as well as enjoyable entertainment (Fior & Jin; 2003). Lack of complete sensory information used to be a major constraint for purchasing online. Image interactivity or 3D modeling is used to overcome this problem (Fior & Jin, 2003). Owed to the image interactivity technology customers are now provided with sensory information before purchase.

In the present research we focused on image interactivity technology (IIT) or 3D virtual model, which provides the ability to manipulate presentation of a product (Fiore and Jin, 2003). 3D modeling or Image interactivity technology method permits the viewer/shopper to view the product from different angles or distances. Viewing the 3D virtual model of a building helps the customer to take a virtual tour into that building, view that building from different angles or distances and decide with a better vision about purchasing that building. Since this technology is modern, it is usually used for new constructed buildings and buildings which are being pre –saled , in which the customer observes the 3D model of the building and can take a virtual tour and therefore decide to whether buy it or not.

The present study provides empirical support that 3Dimensional model of a building has a positive effect on customers' attitude toward using this technology. According to the results of t-tests in this research all of the proposed hypotheses were accepted strongly. Therefore, we can conclude that customers' attitude toward using image interactivity for buying a property is positive. Considering that only 56 respondents had seen or heard about 3D modeling, and the rest without any previous knowledge of 3D modeling, the expectation of the positive effects of 3D modeling in buying a property came as a surprise. Willingness to purchase and even willingness to return to use image interactivity technology again for buying a property was also positive, despite the fact that some respondents were not completely satisfied with the sensory information available online. Most of the respondents claimed that they will recommend others to use this technology.

With the problems that exist in internet connections in Iran and its problems for taking a long time in downloading a 3D virtual model of a building, most companies just put 3D images rather than 3D animations in their websites which brings dissatisfaction for the customers. In order to gain complete information customers are forced to visit sale offices of construction companies so that they can completely take a virtual tour into the construction and gain complete information through the sales people.

Usefulness, convenience and shopping enjoyment were also accepted which means customers believe that using this image interactivity technology is useful, convenient and enjoyable. The respondents believe that using 3D modeling technology reduces the time required for choosing and decision making in buying a property. Considering the increasing rate of inflation in Iran, people invest their money in constructions, so realizing good opportunities is important for them and by using the 3D modeling technology they can view and purchase a property before it is made. Although all of the hypotheses were accepted but the most concern of the respondents was the probability of cheating in buying a property by viewing its 3D model but receiving a property different with what they have been shown. This is a very significant issue that construction companies should consider in order to have satisfied and loyal customers.

Knowing that purchasing properties in Iran, due to the increasing rate of inflation in housing is a very important fact for customers, respondents with the lower range of salaries were more eager to use this technology in buying a house. This relates to the fact that 3D modeling is currently used for pre-sale buildings in Iran, and it is obvious that the price of pre-sale buildings are lower and have the advantage of using good loans, therefore viewing the 3D model of the house and having a better imagination of what is being purchased could help a lot in an individuals decision making process. Over all a large number of respondents were convinced with the advantages of 3D modeling in construction industry and were prepared to view 3D models of buildings in order to purchase a property in the future, women were among those that were fully embraced with using this technology and were very eager to experience it since they believed a 3D model would give them a better imagination of the house they are about to purchase.

5.3. Limitations

There were some limitations for the present study. The most important limitation was that most of the respondents were not familiar with 3D modeling in building industry; therefore it made it a hard work for us to explain and show them some 3D models of buildings in order to give them a complete understanding about the subject, even those who were familiar with this technology, they have never experienced it before. Therefore we think that the results would be more realistic if the respondents had used this technology and then expressed their attitude. Literatures written in the field of 3D

modeling or image interactivity technology especially in construction industry were very few and we faced lots of difficulties for gathering the information about this technology however we think that this research could be a good start point.

Low band width of internet is one of the important limitations of using this technology since it makes it hard for the companies to upload 3D modeling animations on their website and provide a better service for their online customers.

5.4. Further Research

Further research should be done about customers' satisfaction by using satisfaction models. A systematic research should be conducted that focuses on how architects and construction companies increase the customer satisfaction. This is very important because customer satisfaction is a key determinant in attracting and retaining customer. Also by improving transferring of data in internet we expect that customers have a better access to 3D modeling files of buildings in near future than now due to the low band width of internet which creates problems in transferring huge size of data.

By considering the importance of using this technology in providing convenient and usefulness for people and the essential need for using this technology in near future, we suggest that the 3D modeling technology will be taken as an important course in architecture departments in universities.

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Appendix A:

Questionnaire:

Gender:

☐Male ☐Female

Age:

☐20-30 ☐31-40 ☐41-50 ☐Over 50

Occupation:

☐ House wife ☐Private center employee ☐Governmental company employee
☐Manufacturing company employee ☐ Bank employee ☐ Health & Medical employee
☐ Student ☐ Business ☐Other

Education:

☐Under Diploma ☐ Diploma ☐College Degree ☐ Bachelor ☐ Master or Higher

Salary (US dollars):

☐200-600 ☐600-1000 ☐1000-1500 ☐1500-2000 ☐ over 2000

Questions 2, 3, 4 and 5 can have more than one answer.

1. Have you ever been involved in purchasing a property for yourself or others?

☐Yes ☐No

2. The property was bought for the mean of?

☐Residential ☐Administrative ☐Commercial ☐Training ☐ other

3. Your goal of buying this property was for:

☐ Residential ☐Commercial ☐ Investment ☐Other

4. For finding your property which way you have chosen?

☐Real estate ☐ Trustable construction Co. ☐Introduced by friends & relatives ☐other

5. The way you have used for viewing your property was by:

☐Visiting the place ☐ observing the building's plan ☐ observing the 3D model ☐ other

6. Have you ever seen 3D model of a building?

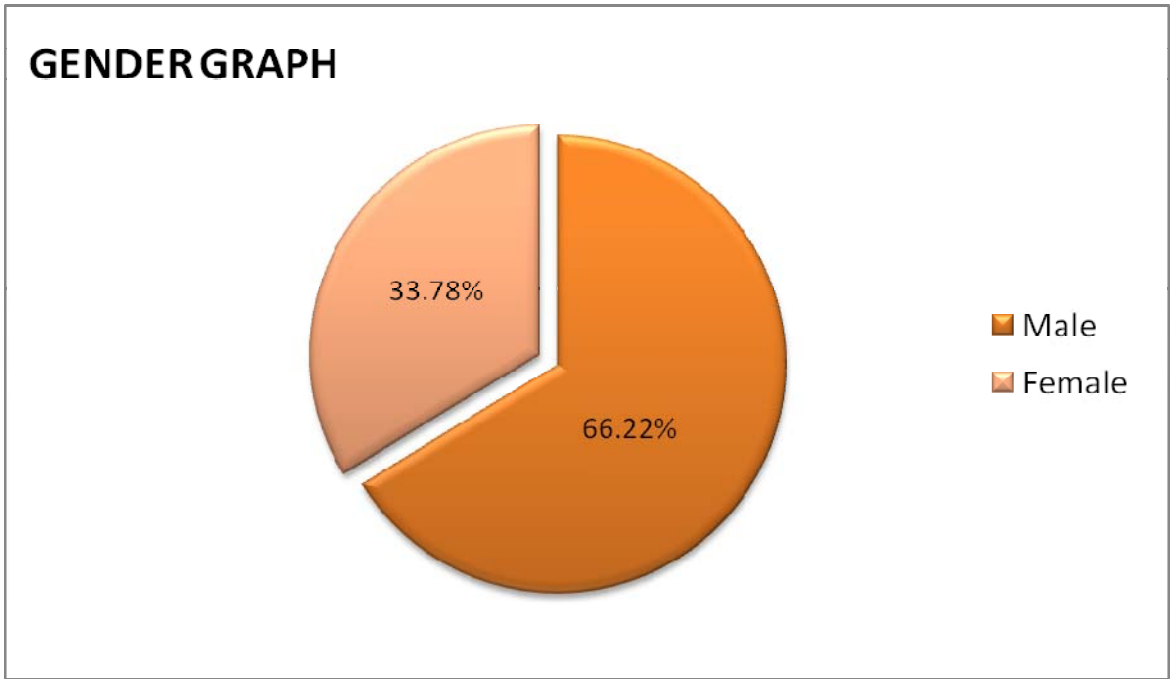
☐Yes ☐No

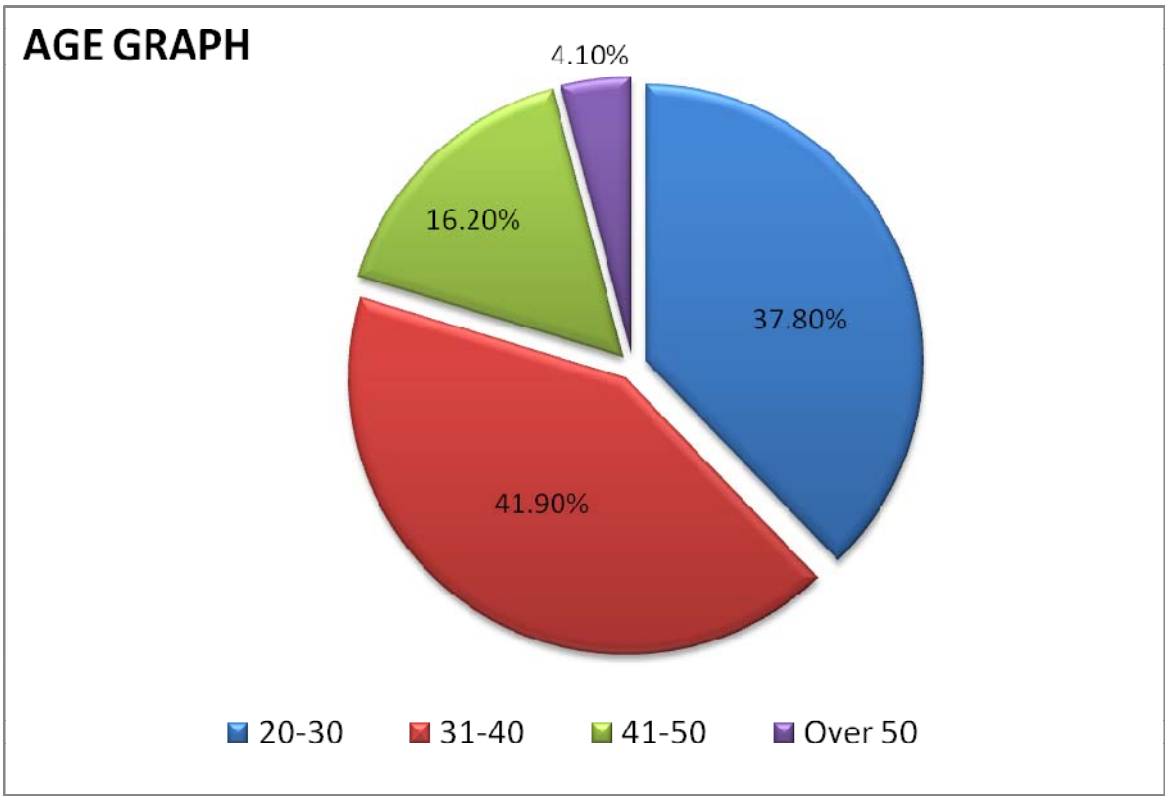
Part one: Beneficial & Usefulness							
	1	2	3	4	5	6	7
1. Using 3D modeling increases my decision making in choosing any property.	☐	☐	☐	☐	☐	☐	☐
2. Using 3D modeling helps me to choose a property much easier.	☐	☐	☐	☐	☐	☐	☐
3. Using 3D modeling helps me to don't loose opportunities & know all of the opportunities that I can use.	☐	☐	☐	☐	☐	☐	☐
4. Using 3D modeling helps me to achieve valuable & on time information about good opportunities in properties.	☐	☐	☐	☐	☐	☐	☐
5. Overall I find it useful to use 3D modeling in buying a property.	☐	☐	☐	☐	☐	☐	☐
Part two: Convenience							
1. Using 3D modeling for buying a property is more convenient for me.	☐	☐	☐	☐	☐	☐	☐
2. In my view visiting different places and then decide to buy is much more time consuming and harder than using 3D modeling.	☐	☐	☐	☐	☐	☐	☐
3. By using 3D modeling I can evaluate different suggested items and decide to purchase in the fewest time.	☐	☐	☐	☐	☐	☐	☐

4. By using this technology I do not need to visit different properties in order to decide better.	□	□	□	□	□	□	□
5. For more convenient I prefer to observe the suggested items via 3D modeling, and then evaluate and visit the chosen items.	□	□	□	□	□	□	□
6. Overall I think using 3D modeling is more convenient.	□	□	□	□	□	□	□
Part three: Reducing the time of choosing/buying a property							
1. By using 3D modeling I can evaluate different suggested items, and decide to buy as soon as possible.	□	□	□	□	□	□	□
2. By using this technology I don't need to spend much time to visit different properties in order to make my final decision for purchase.	□	□	□	□	□	□	□
3. By using this technology the speed for choosing and deciding will increases.	□	□	□	□	□	□	□
Part four: Shopping Enjoyment							
1. I think using 3D modeling can be entertaining.	□	□	□	□	□	□	□
2. I think using 3D modeling can be enjoyable.	□	□	□	□	□	□	□
3. I think using 3D modeling can be interesting.	□	□	□	□	□	□	□
4. I think using 3D modeling can be exciting.	□	□	□	□	□	□	□
5. I think using 3D modeling can be appealing.	□	□	□	□	□	□	□
Part five: Customer Attitude:							
1. I think by using 3D modeling I will feel more satisfied in buying a property.	□	□	□	□	□	□	□
2. I think using 3D modeling is useful.	□	□	□	□	□	□	□
3. I think using 3D modeling is necessary.	□	□	□	□	□	□	□
4. I think using 3D modeling is an interesting idea.	□	□	□	□	□	□	□
5. According to the increasing improvements in technology, I think real estates and construction companies are forced to use 3D modeling.	□	□	□	□	□	□	□
Part Six: Willingness to purchase							
1. I would be willing to purchase a property through viewing its 3D model.	□	□	□	□	□	□	□
2. I prefer to observe the 3D model of a property before purchase.	□	□	□	□	□	□	□
3. If a 3D model of a property suits my taste and need, I would be willing to purchase it.	□	□	□	□	□	□	□

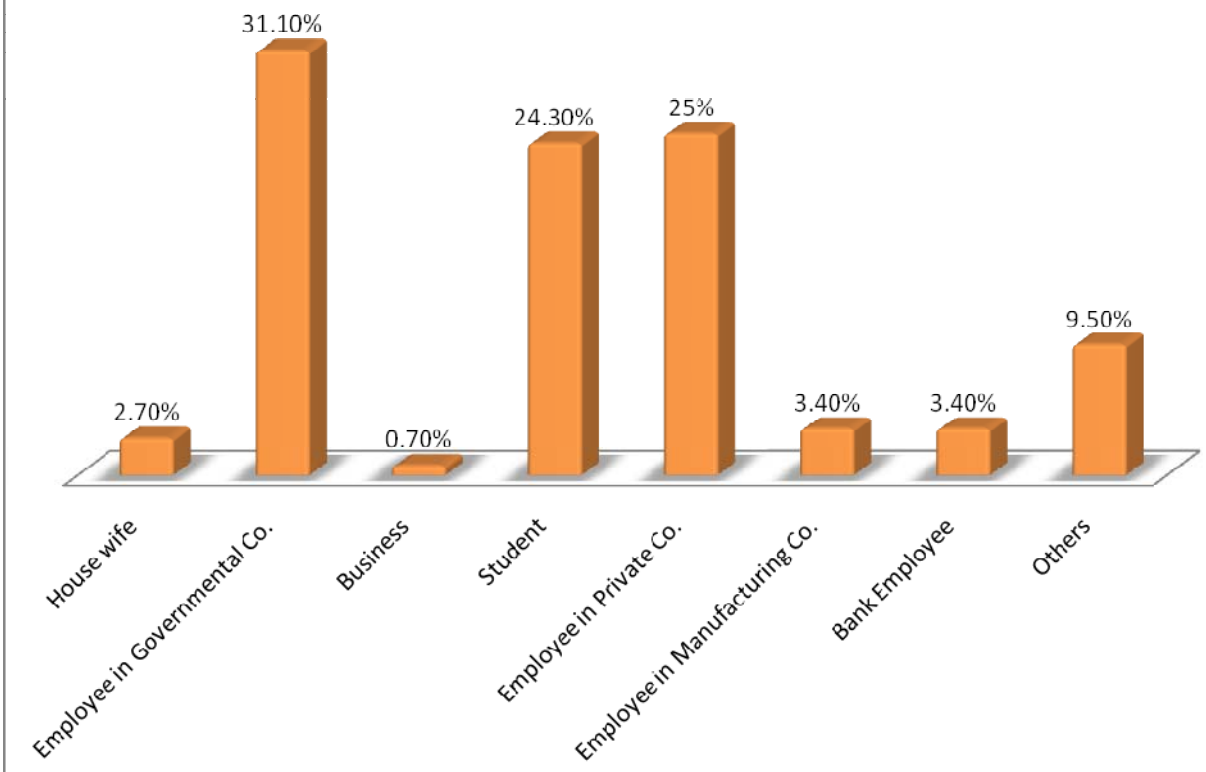
Part seven: Willingness to return							
1.In future I would like to view & evaluate the 3D model Of suggested properties.	☐	☐	☐	☐	☐	☐	☐
2. I am always waiting to receive new 3D recommendations about properties.	☐	☐	☐	☐	☐	☐	☐
3. I recommend others to view 3D modeling for buying a property.	☐	☐	☐	☐	☐	☐	☐

Appendix B:

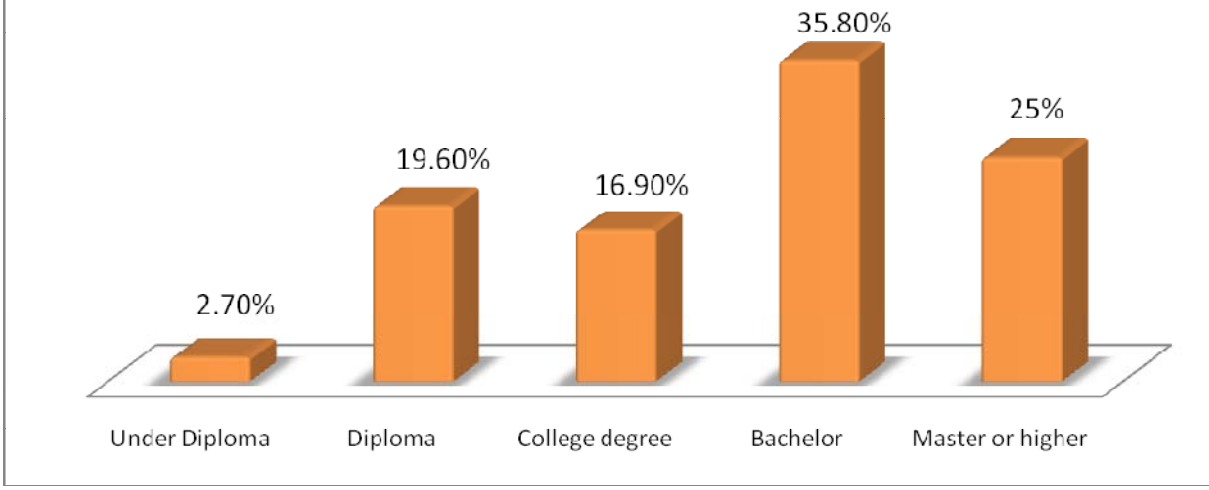

GENDER GRAPH
33.78%
66.22%
Male
Female

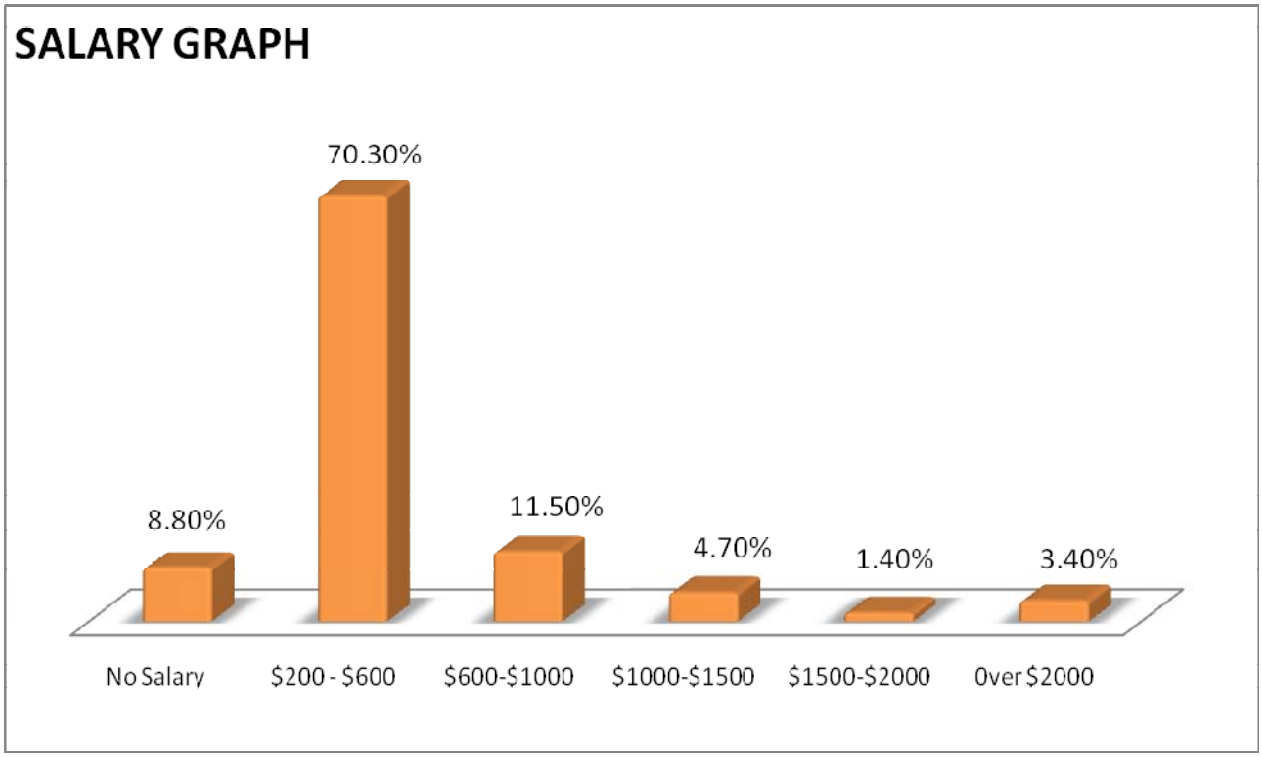

AGE GRAPH
4.10%
16.20%
37.80%
41.90%
20-30
31-40
41-50
Over 50

OCCUPATION GRAPH



EDUCATION GRAPH




SALARY GRAPH
70.30%
8.80%
11.50%
4.70%
1.40%
3.40%
No Salary
$200 - $600
$600-$1000
$1000-$1500
$1500-$2000
Over $2000