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ISTANBUL AYDIN UNIVERSITY
INSTITUTE OF SOCIAL SCIENCES

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THESIS

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DECLARATION

I hereby declare that all information in this thesis document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results, which are not original to this thesis.

Chaymaa RACHDI

FOREWORD

Along during the preparation of my thesis, I had to take guidance and support of some respected people, who merit my profound acknowledgment. As the accomplishment of this research gave me much gladness, I would like to show my acknowledgment to my Advisor Assoc. Prof. (Ph.D.) İLKAY KARADUMAN on Istanbul Aydin University for providing me some good guidelines for thesis over numerous consultations, also who introduced me to the methodology of work.

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June, 2019 **Chaymaa RACHDI**

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İNTERNETTEN TÜKETİCİ BEKLENTİLERİ AKILI EV ÜRÜNLERİ ÜZERİNE BİR ARAŞTIRMA

ABSTRACT

In a world where the Internet of Things is becoming a center of interest of all researchers, domotics or smart home products has demonstrated itself as one of the hottest trends to follow. Smart homes are homes equipped with highly advanced systems that monitor and control the multiple functions of the home and that allow the home devices to interact with each other and with the householders at the same time. The purpose of this thesis first is to identify the main important attributes of smart home products, then to investigate the consumer expectations from these products by using the conjoint analysis method.

The findings of this research have shown multiple area of development. The ideal smart home product profile for the 155 investigated respondents was one with high privacy and security, extreme usefulness and reliability, moderate interoperability and low cost. The Marketing Engineering Software for Excel was used in order to estimate part worths for the conjoint analysis and the attribute importance. Respondents had shown a high importance for privacy and security and then usefulness in which they represent more than 50% of the attributes importance, then come reliability and price and at the end interoperability. Market shares were predicted by using the First-Choice Rule for 9 existing product profiles; the ideal product for consumers was the Inseton Hub Central Controller with a high privacy and security, extreme usefulness and interoperability, moderate reliability and a low cost, with 30 % of the market share. The results demonstrate that modifying costing and promotional strategies as well as working on some technical areas of the smart home products such privacy and security and interoperability could increase market share for smart home products producers.

Key words: *Conjoint Analysis, domotics, internet of Things, interoperability, reliability smart home, security and privacy, usefulness.*

ÖZET

Nesnelerin İnterneti, tüm araştırmacıların ilgi odağı haline geldiği bir dünyada, akıllı evler veya akıllı ev ürünleri kendilerini takip edilmesi gereken en yeni trendlerden biri olarak göstermiştir. Akıllı evler, evin birden fazla işlevini izleyen ve kontrol eden ve ev cihazlarının birbirleriyle ve aynı anda ev sahipleriyle etkileşime girmesini sağlayan oldukça gelişmiş sistemlerle donatılmış evlerdir. Bu tezin amacı, önce akıllı ev ürünlerinin temel özelliklerini belirlemek, daha sonra bu ürünlerden beklenen tüketici beklentilerini birleşik analiz yöntemini kullanarak araştırmaktır.

Bu araştırmanın bulguları çok sayıda gelişim alanı göstermiştir. Araştırılan 155 katılımcı için ideal akıllı ev ürünleri profili; yüksek gizlilik ve güvenlik, aşırı kullanışlılık ve güvenilirlik, orta düzeyde birlikte çalışabilirlik ve düşük maliyete sahip bir profildi. Birleşik analiz ve öznitelik öneminin parça değerinin hesaplanmasında Pazarlama Mühendisliği Yazılımı için Excel kullanılmıştır.

Katılımcılar, mahremiyet ve güvenlik için yüksek önem göstermişler daha sonra önemli niteliklerin %50'den fazlasını temsil ettikleri kullanışlılık, daha sonra fiyat ve güvenirlilik ve en sonda ortak çalışabilirlik gelmiştir.

Pazar payları, mevcut 9 ürün profili için İlk Tercih Kuralı kullanılarak tahmin edildi; Tüketiciler için ideal ürün% 30 pazar payıyla yüksek gizlilik ve güvenlik, aşırı kullanışlılık ve birlikte çalışabilirlik, orta güvenilirlik ve düşük maliyete sahip Insteon Hub Merkezi Kontrol Ünitesi idi.

Sonuçlar gösteriyor ki, maliyet ve tanıtım stratejilerinin değiştirilmesinin yanı sıra gizlilik, güvenlik ve birlikte çalışabilirlik gibi akıllı ev ürünlerinin bazı teknik alanlarda çalışması akıllı ev ürünleri üreticileri için pazar payını artırabilmektedir.

Anahtar kelimeler: *Akıllı ev, birleşik analiz, birlikte çalışabilirlik, domotik, güvenilirlik, güvenlik ve mahremiyet, kullanışlılık , Nesnelerin İnterneti*

CONSUMER EXPECTATIONS FROM THE INTERNET OF THINGS: A STUDY ON SMART HOME PRODUCTS

1. INTRODUCTION

Economists have at all times waited for the convergence of national productivity levels. The logic of this theoretical background is strengthful. The income of each individual is mainly standing on the use of the administrative and industrial technology reserve of the Industrial Revolution. This reserve (modern technology) is considered as a public good. The advantages of tapping this reserve is immense, and then nations will put all their efforts in order to understand and work on the modern technology and their incomes will go to those of industrial nations (De Long, 1988). Economists alert that we will live another 20 years of economy crisis which is shown in the productivity and unemployment decreasing, the slow development and the uprising none quality. The economic down turn is enhancing the dissatisfaction among governing institutions and giving birth to new political movements all around the globe. Currently, after about 200 years of industrialization, the climate change has been seen as the main cause of the planet damage, that take humans into the sixth mass life extinction on earth (He, 2014; Wen & Niu ,2019).

Jeremy Rifkin states in his book The Third Industrial Revolution (2011) that the communication internet is now mature, it's been 25 years since the World Wide Web. we have digitalized communication. Now this communication based internet is moving forward with a new, digitalized renewable-energy internet, and currently the two of those internets are moving toward with a nestling, automated, GPS, and betimes driverless rail, road, water and air transport internet for the purpose to bring up three internets: automated transportation-logistic, communication and renewable-energy internets. The goal is to have one initial internet that has the ability to control the power and at the same time fit

the economic life. The later internets are taking their places on top of a platform called the Internet of Things. We're embedding sensors in all of our devices, as you know, so they can monitor the real-time activity and then communicate with other machines and communicate with us. Consequently, we currently have sensors in the agricultural fields and they are actually monitoring the growth of crops, the soil salinity, the moisture in the crops, etc. they are sending that data, we have sensors now in the factories that are monitoring our economic data, we have sensors in smart homes monitoring how the energy is used in our buildings, we have sensors in smart vehicles, warehouses, smart roads. All of them collecting data. But where all of this big data heads? It heads to communication, energy, and transport internets to control power, and get about economic life. As this new system comes in, it's going to be ubiquitous by 2030, connecting everything with everything with everyone. We are essentially creating an external prosthesis "a distributed nervous system" that is going to permit each person on this world, at a very low cost to start immediately engaging each other on a universal Internet of Things and bypassing a lot of the vertical integrated organization and middlemen that kept us away from each other.

Our engagement can be direct now; this is the revolution. This even the playing field. There's been a long discussion among the Millennials, you started this: Occupy movements. The Internet of Things platform is of a different nature; it is a really radical platform; the internet of things is set to be distributed not centralized, it performs better when it is clear, open and transparent, instead of being proprietary and closed. It becomes more beneficial when more people are involved and contribute their talents in the network, which turn to be more beneficial for the network and people. It is set to be scaled in a lateral way, not vertically integrated and eventually makes us switch to a large social entrepreneurialism and global networks expansion.

However, when it comes to define the "Internet of Things", you will not find any available unique one that can be admissible by its users. If you check publications and discussions about this topic, you will find different definitions from different academicians, researchers…etc. However, in 2001, Ashton Kevin in one of his presentations that he made in the MIT Auto-ID center where he

represented his vision of the IoT, he stated the term (IoT), and he explained the relationship between things and people in the real World and the internet as quoted by Perera et al. (2014)

All the existing data on internet now was first captured by human beings. when you think about it, you will find that the internet and computers depend in whole on people for collecting data (Conti et al, 2017). So, the problem here, is that the internet and computers may stay limited because of the limited abilities of human being from time, attention and accuracy. For that reason, we can conclude that people are not efficient in collecting data about things. And since our lives depend more on things than on information, we can mention as a result that “Ideas and information are important but things matter much more”. Therefore, if we have computers that have the ability to know everything and that can gather data from things by itself and without any help from human beings, we would be more optimal and efficient, due to the ability to track and count everything. The thing that will help us to reduce perfectly the waste and cost and save time.

In the same context and by the appearance of the IoT, the SHP becomes smarter, more effective and useful. With the transformation of the households into a digital ecosystem, the smart home is being more and more adopted, which shows a great progress in the smart home market, in its drivers, challenges, opportunities and use cases. Despite the fact that it is new in the market, the sector has its success and failure stories.

In the construction sector, the smart home is a place of living that consist of having the required technologies in order to put systems and devices automatically under control. Aldrich (2003) defined the Smart Home as a house which is technologically furnished and which is able to foresees and responds to the occupants needs, its purpose is to provide them in a first place with security, suitability, comfort and amusement through the home technology management and then to allow them to get connected to the world beyond. From the last sentence “connected to the world beyond”, he wants to explain that the information services existing in the home are interacting and connected to the external world, which means that the residence or the home is not limited to its environment but it is widely intelligent.

In order to make a Home Smart, all the objects in it should be connected to the internet, which means that: windows, door bells, lights, cameras, curtains, air conditioner, appliances, speakers…etc. should communicate and send you information and take your commands by using the technology mentioned and explained in the previous paragraph which is the Internet of Things, and which is also the key element of home automation and smart homes (Hamdan et al, 2019). Home automation refers to the fact of controlling all the objects within the home with a simple click or a voice command (Mishakova et al, 2019).

In 1901, home appliances were an incredible achievement and this has begun with the vacuum cleaner with an engine-power. Then in 1907, it's been revolted to be electricity-powered, and then after two decades, irons, toasters, washing machines refrigerators and so more had been invented. In 1966, the ECHO IV had been invented to be the first smart device, it has the ability to monitor temperature at home and control the appliances and turn them on and off. After one year, the Kitchen Computer had been technologically advanced to prepare recipes, however, none of its new models had been sold. And then between 1998 and the 2000s, the domotics or the domestic automation become more common. They become more approachable and then a technology element for users. Domotics such smart gadgets, home networking and domestic technologies had their potential existence on the store shelves (Drew, 2014).

Due to the world concern about environment, nowadays Smart Homes are made to be more sustainable and energy saver (Zhang et al, 2019; Haarstad & Wathne, 2019). Also smart homes are dedicated to solve the security issues, (Reddy et al, 2019), they can be your eyes when you are not home, consumers can be informed directly if there are any doubtful actions happening around the home and can send alerts to alarm the consumers if there are any trespassers.

The purpose from doing this research is to study the consumer expectations regarding the Internet of Things more precisely the smart home products. Consumer expectations will be studied by using the conjoint analysis method since it is one of the practical methods to imitate real-life scenarios and help researcher to understand more the consumer preferences, also it is the most generally used method for studying the consumer trade-offs (Green et al, 2001).In Turkey, US$124m is the amount of revenue in the Smart Home Market

in 2019, the revenue is forecasted to show annually a growth rate of 31.1% outcoming in a market volume of US$365m in 2023 (CAGR 2019-2023), household is at 2.5% in 2019 and is forecasted to get to 8.7% by 2023 and the average revenue per installed Smart Home currently amounts to US$271.33 (Statista, April 2019). These statistics shows the importance of this market for Smart Home companies and the opportunities that may be created for the other related-companies such energy providers, security providers, Telecom companies, cable, media, content and hardware suppliers…etc. It is not weird that all the companies concerned about the sale of domotics – from producers to retailers – want to know what pleases most their consumers. To keep up with the ever-changing demand of Smart Home Products, SHP companies should provide their customers with the products that consist of having the most preferable group of attributes. However, basically, the issue to be solved is that those Smart Home Products' companies do not specifically know what consumers expect from their products and what are the variables that may fill the existing demand gaps among the consumer and give him a rational push to make a purchase. This research has the purpose to answer these questions, because understanding the consumer behavior and intentions toward a product, will allow the companies to provide the adequate product which benefit all the parties concerned and lead to their satisfaction.

2. LITERATURE REVIEW

2.1 Internet Of Thıngs

2.1.1 Definitions

While coming to give a definition to the internet of things (IoT), you cannot find a unique one (Thibodeau, 2014) and most researchers and articles say that, this later is still blurry and can be a debate subject for philosophers (Uckelmann et al, 2011).The large number of the IoT definitions is such an output of the fuzzing technologies and products involved in it, such as ambient technology, sensor network, Wireless Sensor Network (WSN), Object Naming System (ONS), Radio Frequency IDentificiation, etc. Also it can be due to the geographic or the national boundaries. In China and Europe for example, it is acceptable to call it Internet of Things, while in the US, it is commonly called a smart grid, smart object, cloud computing or data grid (Kranenburg, et al, 2011).

The phrase “Internet of Things”, has been first coined by Kevin Ashton in one of his presentations at Procter & Gamble in 1999, and thanks to the Auto ID-Center, that made from it a commonly used term by the world (2001). According to (Gubbi et al, 2013; Whitmore et al, 2015), the basic idea of the Internet of Things is that all the things surrounding us will be connected to the internet (Huang & Li, 2010). In addition to being connected, the entire appliance and devices connected to the objects surrounding humans will be connected to each other and will give the ability to people to interact with the digital world (Sarma et al, 2009).

The internet of things gives the ability to people and things to communicate whatever the time, place or thing. Basically using any service or network or path. This divulges the addressing components just like Computing, Convergence, Content, Connectivity, Collections and Communication in a

frame where people and things and/or things and things are interacting in a free-flowing way (Vermesan et al, 2011).

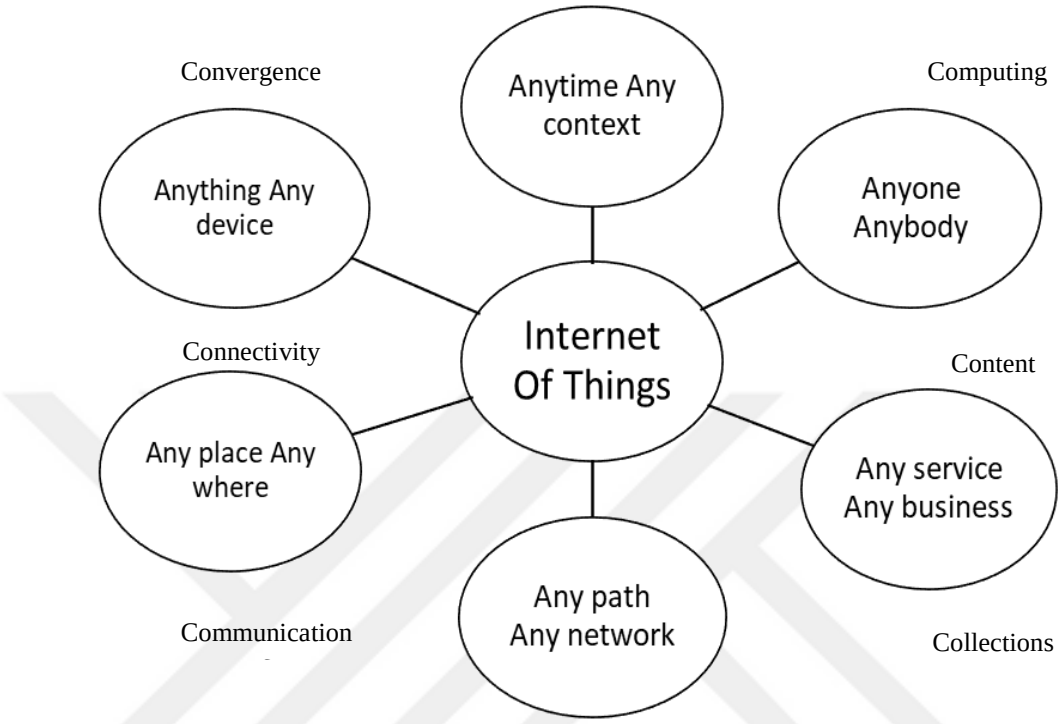

Figure 2.1: Internet of things adapted scheme from Vermesan, (Ovidiu et al, 2011)

2.1.2 2 IoT: Enabling technologies

The aim of the IoT is to bring the technology into our daily life, such as movement detectors, smart cameras, audio receivers, etc. and connect them to the internet, in spite of the fact that their original design doesn't have that capability (Fan et al, 2010), the internet of things had promised another important advancing change which is concluded in the incorporation of networks in those devices and make each of them reachable via internet. The RFID used for tracking can be giving as an example for that. The RFID tags can be used in order to track the history of the product throughout the supply chain. Yet, at the point where the product lives the warehouse to a retail store, was lost for the manufacturer. Eventually, consumers were not being able to have information about the lifecycle of the purchased products. The IoT came to give the traceability ability throughout the lifecycle of the product, and this is by dispatching a unique identifier to each product and make its data available

through the web (Whitmore et al, 2015). When networking, sensing, processing and identifying capacities are integrated into things, the ordinary object becomes a smart object (Kortuem et al., 2010; Whitmore et al., 2015).

The enabling element of the IoT, is the incorporation of different collaborative and communication technologies that help to make an extensive data collection (Atzori et al, 2010). IoT stands on different technologies such hardware, software and architectures, like any other information system (Tan et al., 2010, Gubbi et al, 2013; Whitmore et al, 2015).

2.1.2.1 Sensors and actuators

When talking about converting a physical signal into an electrical signal, we're talking about Sensor devices. Sensors are considered as a part of the interface between the electrical devices and the physical world. Actuators represent the other part of this interface, that turn the electrical signals into physical ones (Wilson, 2004). A smart sensor should be able to communicate with its environment just like monitoring temperature, tracking humidity and movement. Generally, Wireless Sensor Network (WSN) refers to the existence of more than one sensor that work together and interact between each other. In the industrial electronics, sensors that has the potential to communicate with a microcontroller are in a continuous raise of demand. According to (Powner & Yalcinkaya, 1995), the essential intent of intelligent sensor designers and researchers is to install a memory element into the intelligent sensor in order to create a revolution in the control systems and measurement. As stated before, sensors are made in order to sense the objects surrounding us and the environment, whereas actuators are performing actions to affect the environment or objects. Actuator's role is to emit radio waves, light, sound or even smells, these potentials are for the purpose to allow IoT objects to communicate with people (Whitmore et al, 2015). Sensors are mostly combined with actuators to give out sensor-actuator networks. For example, when there a diffusion of gas in a room, sensors are used in order to detect the diffusion of carbon monoxide in the area and the actuator comes to give the reaction by triggering an alarm to alert the individuals in the room that there is a dangerous gas leak. The goal of this combination is the interaction of the environment with people which is already the goal for the IoT.

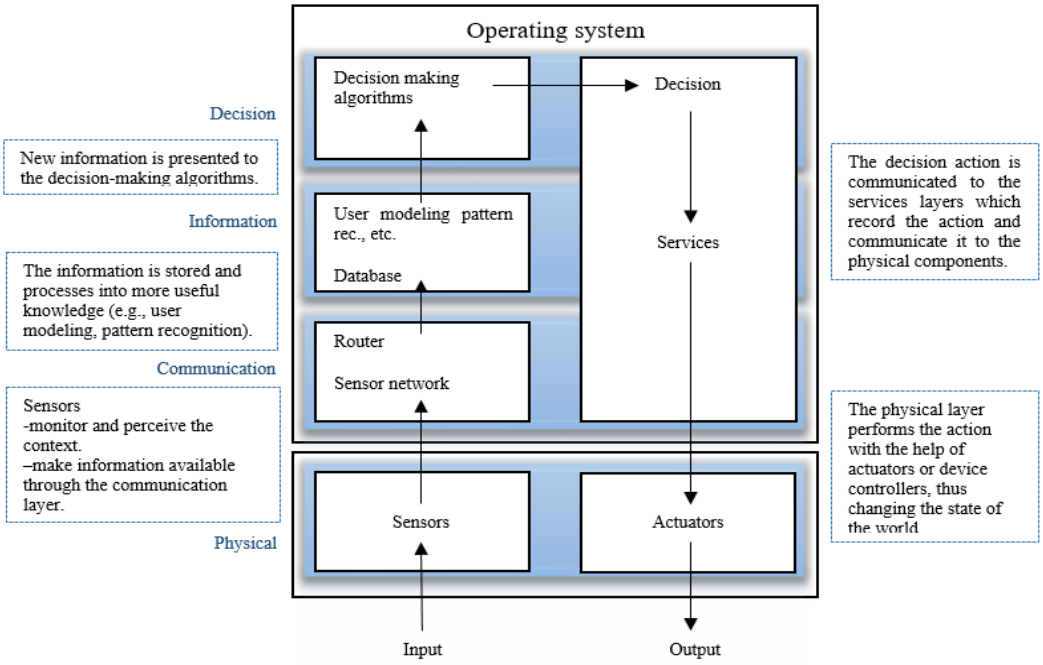

Figure 2.2: The physical and software interface of the smart home products, adapted from Cook and Das (2007)

2.1.2.2 RFID

Radio Frequency Identification is taken as one of the most important technologies in the IoT. The RFID technology is considered as the foundation and the networking infrastructure for the IoT (Li & Yu, 2011). RFID is generally used in order to identify assets, to track and locate them (Weber & Romana Weber., 2010). Radio-Frequency Identification or as it is shortly called RFID is considered as a short term communication, in such a communication the RFID tag uses RFID electromagnetic fields in order to connect with the RFID reader (Whitmore et al, 2015). The RFID system contains a RFID tag, RFID reader, antenna, access controller, software and a server (Madakam et al, 2015). The RFID reader enables its users to identify, track and monitor any things connected with RFIDS tags systematically (Jia et al., 2012). For that reason, RFID system is progressively used by different industries, for example, it's used to track products throughout the supply chain in order to get the full history of the product, it is also used for healthcare service monitoring and in logistics as well (Jia et al., 2012; Lim et al., 2013).

RFID tags, generally have small radio antennas, which transmit information over a short range. RFID technology may use both powered and non-powered

means to activate the electronic tags. Powered devices use batteries to actively transmit data to more distant readers. Electronic highway toll systems are good examples of active RFID tags. Passive RFID devices typically use inductive coupling from an active reader to both power the tag and transmit the data (Brock ,2001). Other advantages of the RFID system contain the simple business process, the raise in the inventory information's accuracy level, labor low cost, the improvement of the business efficiency, and the supply of a specific real-time information about the involved devices (Da Xu et al, 2014). These advantages encourage manufacturers, distributers and retailers in many industries to efficiently use the stated system (Ngai et al, 2008; Sun, 2012). Yet, the tracking potentials that the RFID have, are commonly taken to be a pioneer to the IoT (Ngai et al. 2008).

2.1.2.3 NFC

Based on the Radio Frequency (Sinan et al., 2007; Weber & Roaman Weber ,2010) technology and Internet technology, the Near Field Communication (NFC) (Pavel et al., 2007; Weber & Roaman Weber ,2010) is built. This later supports the communication within 20cm and it is more advanced than RFID technology (Wang & Zhou, 2012). And according to (Whitmore, et al, 2015) NFC is considered as another important hardware technology for the IoT. Technically, NFC stand on inductive coupling between the receiving and the transmitting devices. With a 13.56 MHz operating frequency and within few centimeters up to 10 cm, the communication occurs between two compatible devices (Haselsteiner & Breitfuß, 2006; Michahelles et al., 2007; Kneissl et al., 2009; Coskun et al, 2012). The NFC is a technology based on a message and a reply concept, which means that a device A sends a message to a device B and the device B sends back a reply. In this context, the device A is called the initiator and it is the one that starts the data exchange and the device B is called the target and it is the one that responds to the requests made by the initiator. In general, the target device can never send any data to the initiator without first receiving some message from the initiator, to which it could reply (Haselsteiner & Breitfuß, 2006; Chavira et al., 2007). The NFC protocol operates in several modes. In a context where the both devices can create their own RF field by using their own power to send the data it is called the active mode. While, when

the RF field is generated from only one device, it is called a passive mode (Table 2.1) (Haselsteiner & Breitfuß, 2006; Cho et al., 2007). The active devices usually use a power supply, while the passive don not.

Table 2.1: Communication Configurations, adapted from Haselsteiner et al. (2006)

Device A	Device B	Description
Active	Active	When a device sends data it generates an RF field. When waiting for data a device does not generate an RF field. Thus, the RF field is alternately generated by Device A and Device B
Active	Passive	The RF field is generated by Device A only
Passive	Active	The RF field is generated by Device B only

In order to make the human environment easier in term of its interactions with the several service domains, the NFC technology enables its users with an only touch to set off intelligent services such as healthcare services, smart environment applications, mobile payment, ticketing and loyalty services, entertainment services, social network services, educational services, location based services, work force and retail management services (Ozdenizci et al., 2013). Furthermore, different other devices and technologies such as smart phones, barcodes and cloud computing are contributing to form an extensive network that support the IoT (Uckelmann et al., 2011; Li et al., 2012a; Tao et al., 2013; Li Q et al., 2013; Wang et al., 2013).

2.1.2.4 WSNs

The wireless sensor networks (WSNs) is considered as another foundational hardware technology for IoT (Weber & Roaman Weber., 2010). The smart environment is in need for sensor networks to collect information, this later is required because it is fast and easy to install and maintain (Lewis, 2004). The role of sensor networks is to monitor the environment or other things such as movement, quantity, humidity, temperature, pressure, noise levels, the current characteristics such as direction, speed and size of an object, etc. (Akyildiz et al., 2002). When we have a set of sensors that interact with one another, they are called wireless sensor network (WSN). WSN include a group of sensors and it can as well include gateways which collect data from sensors and send it to a server (Whitmore et al, 2015). The WSNs can be applied in the healthcare

monitoring, industrial monitoring, environmental monitoring, traffic monitoring, and so on (Figure 2.3) (Uckelmann et al., 2011; Da Xu et al, 2014);

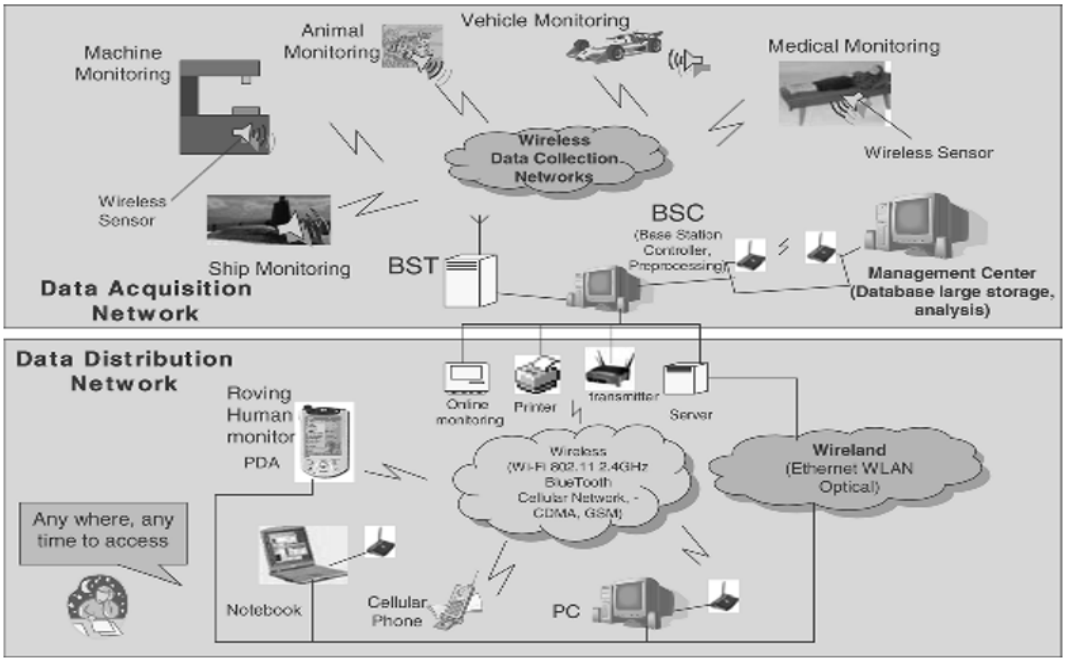

Figure 2.3: Wireless sensor networks (Lewis, 2004)

2.1.2.5 Middleware

The middleware is generally considered as software that takes place between the operating system and the applications running on each node of the system.

The middleware is supposed to hide the internal workings and the heterogeneity of the system (Chatzigiannakis et al, 2007). In order to create and deploy new IoT services, developers will use IoT middleware to gather a multitude of devices and data, instead of having various codes for every type of device and data format (Whitmore et al, 2015). According to Grieco et al. (2014), cloud technologies, centralized overlays or peer to peer systems can be used to implement the middleware in order to access to the virtualized resources and services easily.

Many researchers agreed that the major technical challenges that need to be addressed by middleware solutions for the IoT are interoperability, abstraction provision, spontaneous interaction, unfixed infrastructure, multiplicity, security and privacy (Chaqfeh & Mohamed, 2012); Li X et al, 2015; Ngu et al, 2017).

The IoT middleware is actively developing by researchers. There have been a lot of researches that aim to build up the middleware addressing interoperability over the heterogeneous devices that serve a variety of domains of applications, device discovery and management, context awareness, adaptation, scalability managing huge data volumes, security and privacy aspects of the IoT environment. The use of the semantic middleware has been proposed by many researchers in order to interoperate the various categories of devices that communicate over various communication shapes (Gómez-Goiri et al., 2010; Huang & Li, 2010; Song et al., 2010).

(Katasonov et al., 2008) believe that the automatic integration, orchestration and composition of complex systems on the IoT will not be possible in a centralized way because of the scalability and other issues. Semantic technologies are appealed to be a qualitatively stronger approach to interoperability than contemporary standards-based approaches (Lassila, 2005).

2.1.2.6 Architecture

Because of the broadest and vast concept, the IOT has, it is difficult to find a uniform architecture for it. The idea of IoT consist of an assortment of network, communication and computing technologies, sensor, etc. (Gigli & Koo, 2011). The IoT architecture is a debate point for researchers, as mentioned before, there is no special single architecture that better matches the internet of things. Many articles have suggested different designs for the IoT conceptual architecture, when some others have suggested evaluation standards of the suggested architecture (Främling, 2008), like a conceptual architecture to be compatible with smart objects exigency (Kortuem et al., 2010).

According to (Miao et al., 2010; Ying, 2011), the architecture of the IoT consist of 3 layers: The perception layer, the network layer and the application layer. *The perception layer* plays the role of the 5 sense organs, it is mainly responsible of the objects identification and the data collection by using RFID tags and reader-writers, sensors, cameras, GPS, 2-D bar code labels and readers, etc. *The network layer* plays the role of the brain; it is mainly responsible of the data transmission and process obtained from the perception layer by using network management center, intelligent processing center, information center and convergence network of communication and internet network, etc. *The*

application layer is the mediator between the IoT and the users, it is combined with the industry demand and realizes the intelligent application the IoT. The application layer acquires data storage, data mining and decision making for all kinds of application by using mainly a variety of data processing soft wares such as *the middleware*. This later is a stand-alone system software or a service program that has the capacity to manage the communication, control the equipment and positioning. Furthermore, it is needed to be between the network layer and the application layer (Ying Zhang, 2011)). The middleware is considered as a layer (Debasis Bandyopadhyay · Jaydip Sen, 2011), and not only a software that links the network and the application layers (Ying Zhang, 2011).

W. Chun-lei, et al., (2011) add that after the *perception layer*, there is an *analysis layer* that is mainly responsible of repairing and selecting all data information collected from the perception layer, transmitting the useful information and deleting the repeated one, in order to reduce the data processing loading, prevent the damage and loss of information and increase the transmission speed. Followed by a *transmission layer* which plays the same role as the network layer stated before, then comes another layer called a *processing layer*. This later consists of categorizing, storing, retrieving and uploading the transmitted data, and only transmit useful data of the application layer instead of all data package, in a view to make the system in application layer restore the useful information. Eventually, there is an *application layer* which is responsible of gathering, exchanging and analyzing the collected data. This later can supply application user interface (UI) of the IoT for the user, comprehensive user equipment (mobile phone, PC, etc.), client, etc. It comprises also the cloud computing function which can help using network capability to put into action intelligent processing for massive information, just like management center and information center of the IoT.

2.1.3 Privacy and Security

In the Internet of Things every ‘object’ is connected to the internet and ‘objects’ are communicating with each other, which results a complex network that by the end cause a new kind of security and privacy issues such as authenticity, confidentiality and integrity of the data that has been sensed and exchanged by

‘objects’. The privacy should be ensured for humans and objects to avoid any hacking or unauthorized identification and tracking. It includes the fact of hiding the personal information of users as well as the potential to control what happens with this information (Weber, 2010). Then, one of the most important concerns that should be highlighted in the Internet of Things, is how to ensure an easy and safe user control. Consumers need a fully trust to embrace the IoT to enjoy its benefits and keep off any risks to their security and privacy. The privacy of users and confidentiality business processes are the two main issues in the IoT. Due to their mobility, the scale of deployment and sometimes their proportionally low complexity, the cloud[1] of things is difficult to be controlled (Guillemin & Friess, 2009). Furthermore, in order to achieve a full acceptance by users, it is compulsory to define valid security, privacy and trust models that are suitable for the IoT application context (Weber, 2010; Feng et al., 2010; Miorandi et al., 2012; Roman et al., 2013; Anderson et al., 2014).

By going through different literatures regarding IoT, the privacy and security issues had drawn the attention of different researchers in different cases. (Atzori et al., 2010) claimed that users will resist the IoT since there is no public confidence which will not be a cause of serious threats to privacy, and he considered privacy and security as an open issue together with standardization, addressing and networking ones. Weber (2010) treated the privacy and security as challenges for the IoT form a legislative point of view, also he drew a special attention to the European Commission directives. Miorandi et al. (2012) discussed the IoT vision, applications and challenges, he dealed with data confidentiality, privacy and trust as requirement for security (Figure 2.4)

[1]A computer network where files and programs can be stored, especially the internet (https://dictionary.cambridge.org/dictionary/english/cloud)

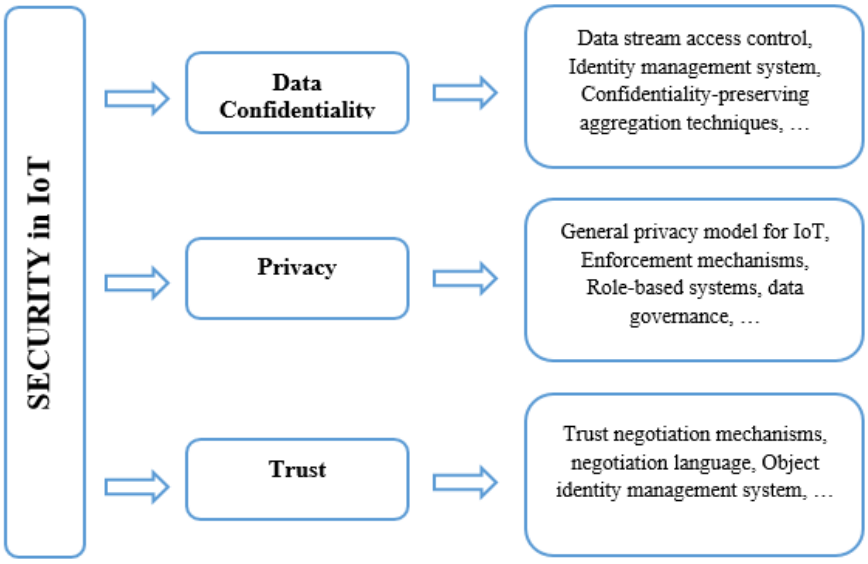

Figure 2.4: IoT security challenges: A graphical representation, adapted from Miorandi et al, (2012)

Domingo (2012) had hint the security issue while analyzing and discussing the way how the benefit from the Internet of Underwater Things, in order to learn from, to exploit and to preserve the natural resources existing underwater. Roman et al. (2013) talked about the privacy and security of a distributed IoT, he claimed that to understand the exact security issue of a distributed IoT, it is important not just to analyze the impact of the distributed IoT principles among the existing attacker and threats models, but also to study the impact if these principles in the integration of the several security mechanisms. Gubbi et al (2013) put up a general vision on different IoT aspects, such as the involved technologies, the applications, the cloud platforms, the architecture, the security issues and energy consumption, the quality of service and data mining implications. Finally, Yan et al. (2014) brought into focus only the specific issue of trust management in IoT.

2.1.4 Applications domains

The internet of things has huge capacities for developing new intelligent applications for approximately all the fields, such applications has for objective the improvement of the quality of every-day life, and will absolutely have a deep influence on the economy and society. These applications as well will cover several aspects starting from the personal aspect passing by social,

societal, medical, environmental arriving to the logistics aspects (Borgia, 2014). This later claimed that the different applications can be categorized in three major domains: Industrial domain, smart city domain and health well-being domain. According to (Whitmore et al, 2015), the application areas and domains of the internet of things are limited only by imagination at the moment.

While reviewing the literature for this research, it is found out that different researchers have discussed the domain of application areas for the internet of things. Starting by (Atzori et al., 2010) who claimed that with the power of the IoT and the potentialities offered by this later, the quality of our lives can be improved by applying them in different domain of applications like at home, when sick, at work, while traveling, at the gym and when jogging just to cite a few. Currently, the environment we are living in is full of different objects that are generally having a primitive intelligence and which is mostly not equipped with any communication capabilities. When giving these objects the ability to connect to each other and to elaborate the information perceived from the surroundings connote having different environments where a very large range of applications can be deployed (Figure 2.5).

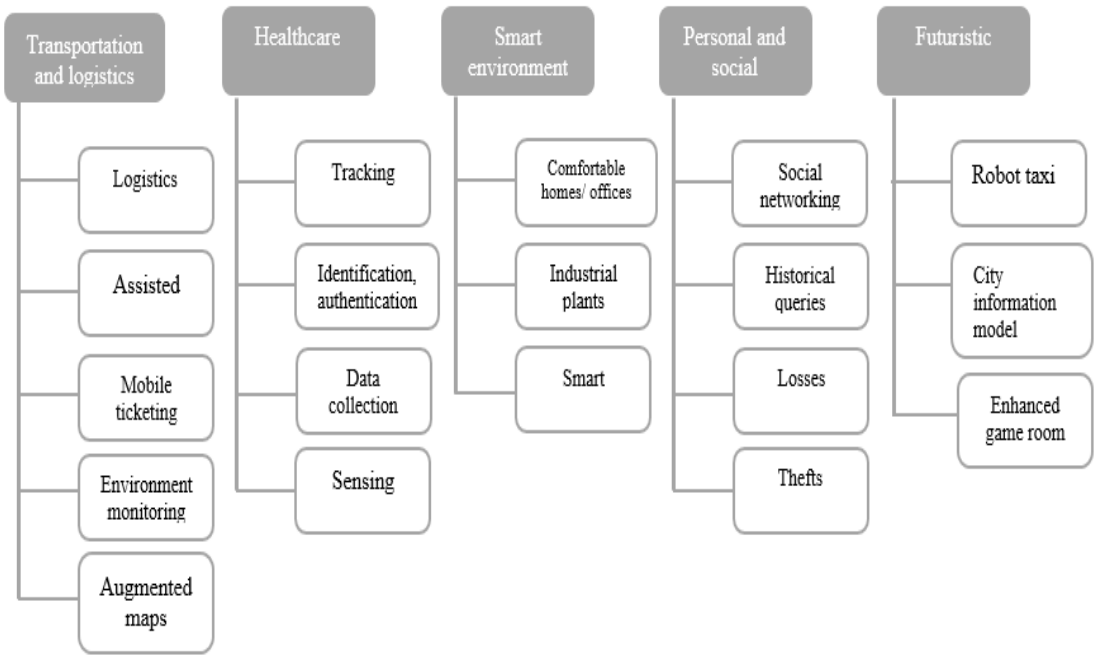

Figure 2.5: the domains of application for the Internet-of-Things and its relevant major scenarios, adapted from Atzori et al., (2010)

Then, Miorandi et al. (2012) discussed the IoT application domains for an Internet-Connected Things vision. He claimed that the different capabilities and form factors of this later can boost the ICT role as a mean of innovation in the different application markets. The estimated market value of the number of RFID tags sold in 2011 which was valued at $ 5.84 billion (source: www.idtechex.com), showed the increase in the RFID usage. This later is not a simple result of a technological push for the IoT, it is also driven by the market pull, since companies are aware of the increasing commercial benefits of the IoT technologies based applications. He added also that the adoption of IoT technologies can give a birth to new business ecosystems that has new actors and value chains characteristics. While talking about application fields and market sectors regarding the IoT solutions he identified six application domains that he believes that they play a leading role in the adoption of the IoT technologies: environmental monitoring; smart business/ inventory and product management; smart cities; smart homes/smart building management; health-care and surveillance and security.

In the same rail Gubbi et al (2013) claimed that there are many application domains that can be influenced by the IoT. they agreed with Gluhak et al. (2011) while talking about the classification of the applications, they said that these later can be classified according to the type of network availability, coverage, heterogeneity, scale, repeatability and user involvement and impact. Gubbi et al (2013) categorized the applications into four domains: personal and home; enterprize; utilities; and mobile (Figure 2.6).

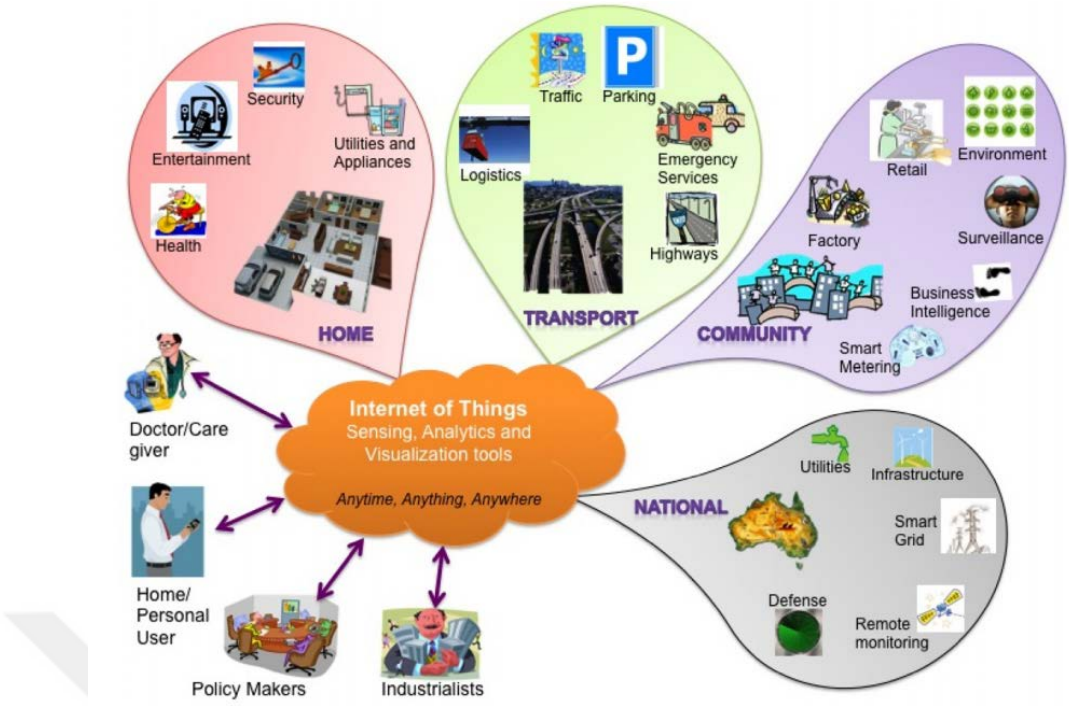

Figure 2.6: Data based applications areas and end users for the Internet of Things, adapted from Gubbi et al., (2013).

Since each domain is not isolated from the others, there are too many intersections in applications and the data usage among domains (Gubbi et al., 2013; Borgia, 2014). One example is when the Personal and Home IoT produces the data of electricity usage in the house and makes it available for the electricity company (utility) which by its role can optimize the supply and demand in the Utility IoT. Another example is when tracking products, which is in common between the health well-being and the industrial domains as it can be used for controlling foods or cargos, but it has also the ability to control the delivery of pharmaceutical products. Multiple business opportunities can be created because of the fluid interchange of data between the different service providers. It is also important to mention that not all the IoT applications have presently the same scale of maturity. Some of them are already part of our daily lives, some others are still in an experimental stage and finally others that are more futuristic and are at an early phase.

2.2 Smart Homes Framework From An Iot Perspectıve

Getting connected with anyone, anytime and anywhere is becoming such a routine for humans. In other words, the internet has changed everybody's life.

As many improvement technology has had, the transmitters, processors, sensors, receivers, etc. are currently available in a very cheap rate. Therefore, all these things can be used in our daily life (Agrawal et al, 2011). In case of need of the expansion of the internet of services, then the internet of things can be considered like so (Singh, 2014). Yet, the internet of things is not just a long run deep vision. It already exists and it is influencing not only the technological development but even everything surrounding us. These connected objects and things that used to communicate only with the internet, now they are able to configure themselves independently and they are being able to operate without human intervention (Vittorio & Dario, 2014).

In the same context, we have the smart homes which are considered as one of the internet of things applications. Smart homes are living environments or homes that owns that technology aspect which permit to the whole home appliances or devices to be controlled automatically and can be controlled remotely (Bing et al., 2011). In smart homes, households can easily control and monitor the whole home appliances and devices through internet. Home devices connect in a predefined specific network architecture and using standard protocols.

In the Figure 2.7, only four household's devices have been considered to show the basic idea for Smart Home System using IoT: Light, Fan, Television and Gas outlet. However, in reality the consumer can use different connected devices as much as needed, and all these household devices will connect to the switch modules. Any type of module can be contained by the switch module, which changes its state once the signal is received. The switch module is connected to the home device in a way that when it changes its state, the state of the home device connected to it will also change (Agrawal et al, 2011; Bing et al., 2011; Wu et al, 2013; Wang et al., 2013).

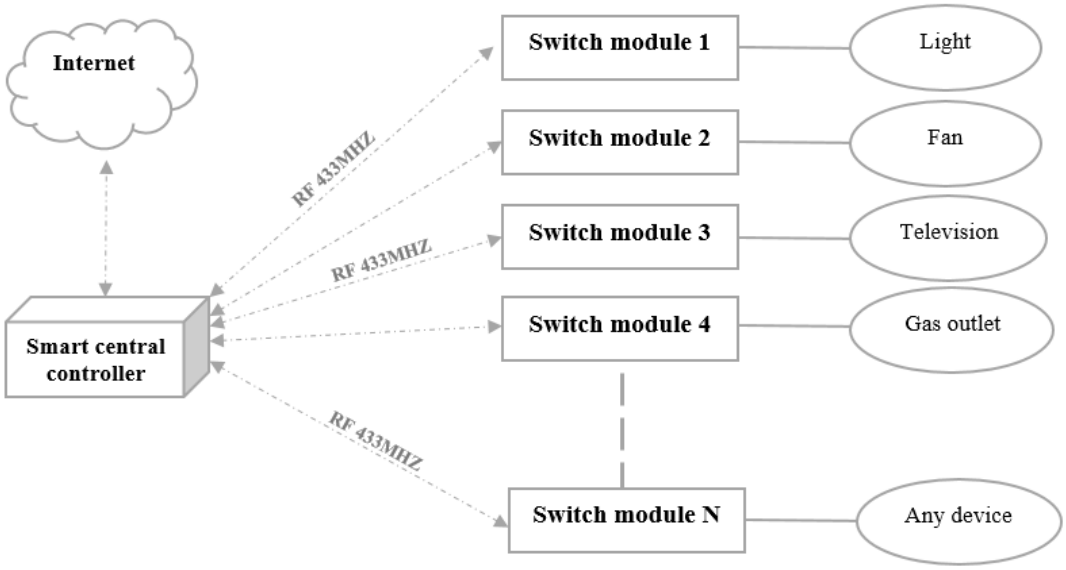

Figure 2.7: A basic schematic showing the staple idea of the SHS utilizing the IoT, adapted from Wang et al., (2013)

2.3 Smart Homes

2.3.1 Definition

A smart home is a place of living which is equipped with communication networks, domestic appliances and devices linking sensors, that can be remotely accessed, monitored and controlled (King, 2003) and which is able to respond to its inhabitants by supplying the services needed (Taylor et al, 2007; Chan et al., 2008). Mainly, the term “Smart Home” can be used or refer to any kind of residence, whether it is an apartment, a villa, a standalone house, a unit in a social housing development.

In the current definition, sensors are devices used in order to detect motions, locations or objects or even for the purpose of collecting data about states such as, temperature, energy usage, open doors or windows, etc. Home appliances refer to white goods such as refrigerators and washing machines, etc. While devices can refer to electronics such as, televisions, phones, computers or can refer to electrics such as kettles, light bulbs, simple toasters, etc. The network of the connection and coordination of the different technological features such sensors, devices and appliances with information, is the key to the concept of the smart home (King, 2003; Li J et al, 2004). What differs the smart home from a regular home is the existence of a such home network (Scott, 2007).

Among the different branches of ubiquitous computing, we find Smart Homes. This later, requires incorporating smartness into accommodations for security, energy conservation, healthcare, comfort, and safety. The most common components of smart homes are the remote monitoring systems, they use web technologies and telecommunication to supply remote home control and help patients remotely from specialized assistance centers. By introducing assistive services and automated appliance control, smart homes enhance the life's quality of households (Alam et al, 2012).

The World Health Organization (2018) claims that by 2050, the proportion of the world's population that will be aged over 60 years will nearly double from 12% to 22%. This group of age is generally willing to face problems with living alone and is more likely to have long-term chronic diseases. According the same organization (2011), more than a billion of people are estimated to live with some form of disability, in other words, about 15% of the world's population (based on 2010 global population estimates). The most known causes of disability contain chronic diseases just like cardiovascular diseases, diabetes, cancer, injuries due to road traffic accidents, falls, land mines, conflicts, mental impairments, malnutrition, birth defects, HIV/AIDS and other diseases. For medical centers or nursing homes, it is not logical or even possible to help all these patients for an indeterminate period of time. The solution for it, is to provide the assistive technologies and the healthcare services in the home environment of the patients (Alam et al, 2012).

Among the newest surveys written on smart homes was written by Chan et al. (2008), which discusses the international selection of leading smart home projects which are arranged according to country and continents (The US, Asia, Europe, and Australia), as well as the associated technologies of wearables and implantable devices and assistive robotics.

The awareness of location is an essential condition in order to create an intelligent environment in smart home. Hightower & Borriello (2001) outlined the location detection techniques and discussed multiple location detection system taxonomies. The survey they have conducted, categorized the location detection systems properties according to symbolic location, physical position, and absolute and relative measurements. However, they have considered

different issues such as accuracy, precision, measurement scale and cost, in order to help researchers to make better choices by comparing different location systems.

Manley et al. (2006) emphasized the current state-of-art of localization and tracking on algorithms and systems used in sensor networks. They categorized location and detection systems based on the tracked objects and the sensor networks technologies and the application environments. Yet, there work is more affiliated with object tracking than tracking people.

Home automation technology is the most effective way to alarm the households of any problems occurred. However, the conventional security systems protect householders, and their property and keep them safe from any intruders. Robles and Kim (2010) discussed the smart home and security, also they reviewed the context-aware tools for smart home security. They gave a short overview of rule-based smart home architecture, networked robots, aware community systems, and context-aware gateways. They provided a comparison between different smart home protocols such as, Zigbee, Z-Wave and WiFi. Yet, the overview didn't attack the algorithms points, which are considered as the components of context awareness. Pishva and Takeda (2008) examined some related security issues that have happened and identified different existing challenges from a social, technical and practical aspects. Yet, they discussed some countermeasures that can be taken in a case where there is a security violation.

2.3.2 Attributes

2.3.2.1 Privacy and Security

Domotics are generally equipped with different types of actuators, tracking devices and sensors so as to provide context-aware services. Whereas in one hand, householders want to have a comfy lifestyle with an added value of personalized context-aware services, privacy and security becomes a serious concern on the other hand (Sang-Hyun et al., 2013). According to Balta-Oskan et al. (2014), for the purpose of creating a good system to best assist the householders' lifestyle, a smart home may be a good way to collect information about them, just like: their bills, energy use, their movement, their schedule,

purchases or even music preferences. Among the challenges faced by this industry is the insurance of an adequate saving for the householders' personal data. Likewise, with the ability of the remote controlling of the security services (turning lights, opening the garage door or even heating on or off by using a mobile phone), it is so important to make sure that the network's sensitive systems are well controlled and that they will not be easily compromised.

In order to keep the householders and their properties safe from intruders, the existence of conventional security systems is important. By the use of the home automation technology (Figure 2.8), the householders can be easily notified and then investigate in any emergency case. Yet, the householders' habits are kept tracked by the artificial intelligence programs, and other important information, and when necessary the emergency personnel are automatically being notified (Nicks, 2009).

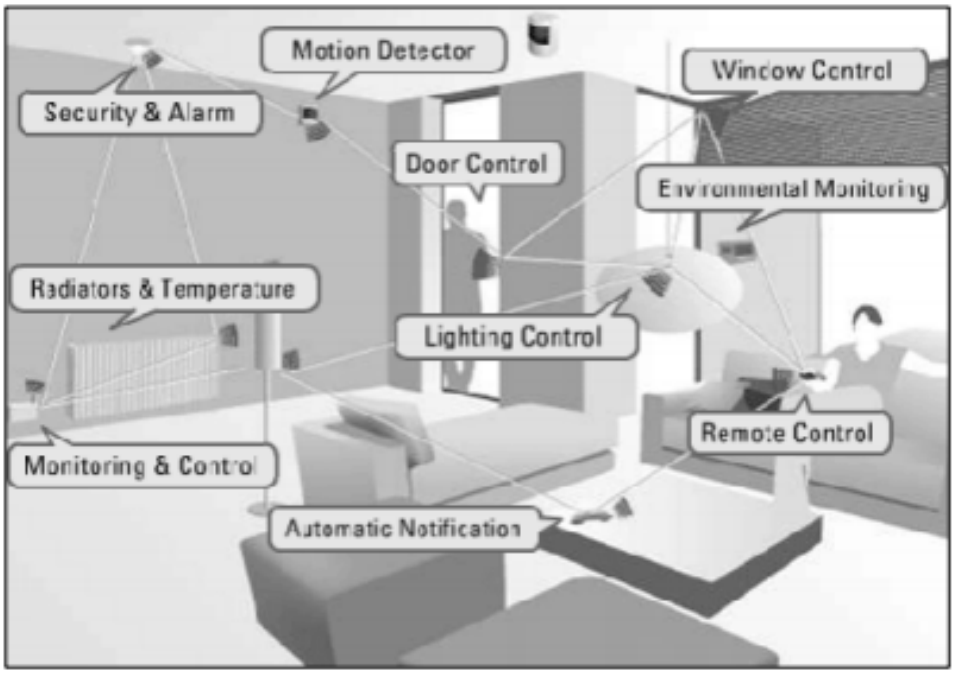

Figure 2.8: Smart home technology automation (Robles et al., 2010).

According to Demiris et al. (2004), in order to research the significance of privacy in the smart homes context, a quantitative study must be run. They conducted a study regarding this issue with 14 persons residing a retirement home asserting that the most important problem is privacy, precisely the use of home surveillance cameras. Kotz et al. (2009) came with a comparison between the various standing privacy scopes and suggested a group of privacy policies

for smart home systems and mobile healthcare applications. The aim of these policies is to make people informed about the problems related to data collection and storage; to help them always access their own data; to provide them with the easy-to-use interfaces; to make them aware that the data collection and storage is restricted only for the monitoring purpose; to make them aware about the insurance of the data quality while talking about the accuracy, completeness and authenticity; and to show them that the personal data and people's identity should be protected against any unauthorized access.

Dewsbury et al. (2001) explains that safety is so important while talking about smart homes. In order to avoid any critical problem, smart home system must be provided with safety measures, especially in vulnerable people' cases. So far, the safety requirements must be essentially considered while designing and developing the smart home system, because in case of lack of this later, the well-being of householders can be affected.

While talking about security in smart homes, Hupperich et al. (2012) came with a proposition of the use of security architecture in healthcare organizations. The main problem that they try to address was the importance of having a secure and flexible architecture at the same time. A completely distributed peer to peer system was proposed by Castiglione et al. (2013) that enables healthcare organizations to share their medical or non-medical data in a safe way. This system has nodes and every node has the ability to access readily and swiftly in a safe way to a large number of data. Consequently, the system performs rapidly while providing clinical evaluation during a care' dialogue. Physicians were questioned about the use of the system with artificial data. In order to assess the experience of participants, they questioned them concerning how the system impact and develop the current ones. The answers to inquiries in all cases were constructive. Instead of typing alphanumeric strings, graphical passwords are operating by clicking on images. As these authentication methods are simpler and safer in comparison with standard passwords they possess a big chance to be employed in healthcare systems. In the same rail, in order to provide more security, a two-factor graphical password scheme have been proposed by Catuogno & Galdi (2014), by then they analyzed the usability and security for an authentication mechanism based on it.

2.3.2.2 Reliability

Reliability is considered as one of the supreme concerns of the smart home technologies occupants. Reaching predicted levels of reliability, mainly when combined with the ad hoc accumulation of devices that may be predicted in smart homes, is a paramount challenge (Jiang et al., 2004). Reliability is considered as the principal challenge as this attribute is going to support the user-conviviality and empowerment (Friedewald et al., 2005). Smart homes shouldn't fail or do unexpected things. Edwards & Grinter (2001) called attention to the various sides of the reliability issue, covering: Identifying and removing errors from domotics produced "accidently" by technologies gradually inserted; fixing and controlling domotics via self-healing systems that eliminate the requirement for third party or household system administrators; and deducting occupation activity from sensor information that could be fuzzy and not reliable. Reliability is essential in domotics for assisted living in which defeats to sense or make erroneous deductions about the nature of householders' behavior may have dangerous outcomes. According to Orpwood et al. (2005), concerning sufferers from dementia: "verdicts made [on human behavior] are always going to be probabilistic, and the designer has to integrate means of dealing with errors, especially in safety critical situations".

As Friedewald et al., (2005) noted that in the integrated domotics, the communication between different devices with various technical errors tolerances show a source of concern. An example could be, the home computers developers that operate in different hypothesis about the suitable breakdown tolerance level. In other respect, unimportant breakdowns in home automation are more likely to lead to life-threatening crashes in the boiler which is connected to. They have designed domotics systems to be strong and reliable.

The real-time monitoring and the network performance control can improve the smart networks reliability at a global and a local level, prompt fault diagnosis and response, 'self-healing' or switching automatically under fault conditions, 'local intelligence' automatically segmentizes to limit blackout, local generation supplying alternatives to the main generation in the major perturbations, better interconnection, decreasing the entire cost of energy production as the demand

is decreased and peak demand loads are decreased, thus decreasing the need for additional infrastructure (Ahmad, 2011).

2.3.2.3 Usefulness

The smart home is considered as a growing and potentially important field of research and development. In order to discuss its usefulness, it is needed to go through the three different views in its literature.

First of all, a functional view is provided, it considers domotics as the best way to control the daily living requirements through the technology usage. A lot of technologically oriented literatures on smart homes introduces their advantages for end-users as both evident and forked: security, convenience through automation, comfort, scheduling tasks, efficiency and energy management; and for particular end-users, assisted living and health (Rashidi et al.,2009; Cook, 2012). The research of user-centric is obviously confirming the development of the existing services not the supply of new ones: “the aim of technology is not to change experiences that we already relish today with our families… [but to] underpin and develop experiences you already enjoy… but in different ways” (Heath & Bell, 2006). The functional view indicates a large choice of duties and actions that domotics may support users to reach: reminders and recalls better via automatic alarms, improving security via simulated occupancy when there is nobody at home, using remote controls for particular appliances, and so on (Park et al., 2003; Orpwood et al., 2005; Cesta et al., 2011). According to Aldrich (2003), this is matching in a wide way with what the consumer perceives from enhanced convenience, security, comfort, and environment. Specifically, security is considered as the most attribute that to be enhanced for consumers (Koskela et al., 2004). The most evidently determined functional view of “better living” is indicated by researcher in the social care and health field. Yet, domotics may “participate in the help of the elderly, disabled people who are living alone at home, people with chronic illness… (by enhancing the variety and quality of information conveyed to the clinician” (Chan et al., 2008).

Then, there is the instrumental view which is provided in order to emphasize domotics’ ability for controlling and decreasing energy consumption by users as part of a broad switch to future with a low-carbon. The instrumental view

perceives the domotics as a remarkable technological way to convey an approachable low-carbon energy transmission or sustainability more widely (Chetty et al., 2008). In the instrumental view, main elements of domotics are using smart energy-using, smart meters and energy management functionality in order to allow microgeneration, user-control and scheduled optimization of device usage (Paetz et al., 2012). According to Hrgreaves et al. (2010) & Wallenborn et al. (2011), customized, adapted and real-time information and feedback on the energy usage and prices through smart meters and in-home displays aid to make energy visible. Domotics will unlock new gates for households in term of energy management that weren't possible, such as enabling energy cut, reduced, improved, shifted or switched (Pierce et al., 2010). Wide-scale trials of in-home displays and smart meters in the UK shown around 3% energy saving on average (AECOM and OFGEM, 2011). Energy utilities are the main advocates of the instrumental view but less concerned in household-level energy savings and more on the smart meters' rollout. These will supply utilities with real-time information on both demand and supply allocated across the millions of the distribution network nodes (Palensky et al., 2013).

Finally, there is a socio-technical view which perceives domotics as an emerging area of improvement in the actual digitalization and electrification daily routine, in different words, it perceives it as the latest chapter of a co-progress link between society and technology. The socio-technical view underlines the meaning and the use of technologies will be built in a social way and associatively bargained, in place of being unavoidable result of supposed practical advantages (Axsen et al., 2012). The main technology of the actual round is the micro-chip, that has given the ability to the crawling digitalization of nearly all daily life aspects. The visions of the technology developers feed this sociotechnical explanation. According to Park et al. (2003), for instance, smart pens' original working design, dressing tables, doormats, sofas, windows, and so on, with identically wide group of services, from smelling, sounding, connecting, remembering, recognizing and energizing. Taylor et al. (2007) assert the ability for nearly all "surface" (bowls, windows) to turn into "smart" digital displays in "surfaces' ecology" with and via which there is an interaction

among users. The importance of smart homes exists exactly due to those possibly changing but unidentified impacts. The daily life at home and the social practices possibly be united or programmed in new forms (Nyborg et al., 2013). Technologies used in domotics also may change the way how users understand experiment, and build a concept about their domestic life and homes ordinarily (Davidoff et al., 2006; Baillie et al., 2008).

2.3.2.4 Interoperability

Interoperability is considered as one of the most important challenges for smart homes. According to Edwards & Grinter (2001) & Jiang et al. (2004) Without this a priori agreement whether on a syntax or semantics side, interoperability is considered as difficult if not impossible. The key to open new markets to competitive solutions in IoT is definitely the interoperability (Lu et al., 2011; Misra et al., 2015). Currently, the main objective for the leaders in the smart devices manufacturing, is to achieve a full interoperability that will ensure easy integration with the existing internet.

Smart homes must have the option of being adapted and evolved to any changing preferences, needs and demands (Edwards et al., 2001; Fitzpatrick et al., 2006). At the same rail, the system should have the ability to easily integrate any new device slowly inserted to the smart home network, in addition to its technologies that need to have the ability to intercommunicate. Yet, with the different preferences for each device manufacturers in term of types of communications protocols and network media, generally this is not the fact. So this is the interoperability issue, shaping a challenge for dealers of consumer electronics as to the operation and thus the appeal, supply of domotics services, and the demand for them (Perumal et al., 2011; Perumal et al., 2008).

Interoperability can be defined as the possibility of intercommunication between different soft wares whatever the technical differences they have. In case where there is no direct link, electrical devices' interoperability could be obtained by transformers and adapters (Wegner, 1996). Interoperability can go through different levels; it can go from a system which is not interoperable at all to a system with an extreme high interoperability through different technical levels (Tolk & Muguira, 2003). Recent literature showed up two ways by which the interoperability between smart home systems can be reached, which are the

universal standards for communication protocols and Central network hub or ‘gateway’ (Balta-Ozkan et al., 2013).

2.3.2.5 Cost

While buying smart home appliances, devices, etc., it is important to watch out the cost related to it, along with cabling and installation costs. These costs show that domotics systems are likely only possible for the rich social class. Meyers et al. (2010) assert that concentrating on management services and energy consumption, high level costs of demand response technologies such as automated refrigerator and hard consumer mediators are pointed out as main limitations in the literature. Yet, people are more likely to get expensive stuffs when it comes to technology the same as the iPhone success story, which is a more expensive comparing to the other brands. However, when taking every characteristic of the good or service, making sure that every phone’s function is advanced and also not perplexing the consumer, in that case the product distinguished itself. In case where smart home designers follow the same approach, the costs shouldn’t stop the domotics market improvement (Holroyd et al., 2010). Despite this optimistic view, benefits of management services and energy consumption are prevented also because of the unclear nature of energy (Warde et al., 1998). In view of that people are not only consuming energy per se, however, they are associating goods with energy in order to provide new services, e.g. integrating electricity to the washing machine in order to have laundry, affect the development of the costs and benefits of smart home services and technology. As a consequence, as indicated in behavioral economics, people who are not investing in future will be less probably to invest on technologies with elevated primary costs as well as they are not taking benefits such as potential savings in the energy bills into mind (Balta-Ozkan et al., 2014).

2.3.3 Smart Home Products

Each individual has his own needs, but when it comes to elderly people, those needs becomes special and harder to achieve due to health problems, so in place of moving to a nursing home to reach the full self-care needed, it is preferable to depend more on smart home appliances. An intelligent interface that keep under surveillance the householders’ movements, and that has the ability to

learn their habits, can inform the closest persons if the habits are changed or broken. Furthermore, a smart home is able to monitor the vital signs of householders. In case where an elderly person has a medical problem that has to be reported, the appropriate medical facility will be automatically informed with the vital signs. The smart home supplied with artificial intelligence (AI) will be able to distinguish critical readings, and send an alert to the medical personnel promptly (Nicks, 2009).

Smart home products or more precisely appliances are a sort of smart objects that have the ability to sense, actuate, process data and communicate, in this order they require to perform A/D and D/A conversations (Byun et al., 2012). Theses appliances are periodically carrying sensing out and sending sensed data to the hub. Therewith, if protocols permit it, sensed data can be automatically transferred to the cloud. If feasible, smart appliances have to carry out basic data processing before they transfer the sensed data (Stojkoska et al., 2012; Viani et al., 2013).

When talking about actuating, we found out that it is possible to be also controlled remotely. While talking about dynamically schedule machine (DSM), smart home appliances can be split up into three categories: flexible, non-flexible and dual nature appliances (Erol-Kantarci et al., 2010). The flexible appliances are appliances that are coupled with orderly loads or preventive tasks e.g. air conditioning or heating, and that the system can automatically operate them. While the non-flexible appliances are appliances that are coupled with baseline loads or non- preventive tasks e.g. TV, hair drier, PC, light, where the system cannot control them (Ullah et al., 2013). When appliances can be sometimes flexible and other times non-flexible, they are called dual nature appliances e.g. laundry, dish washer, washing machine. The dish washer can be a good example, when sometimes the consumer doesn’t care about the specific time the dish washer will do its operation, as long as it is within a predetermined time frame. These appliances most of time introduce blast loads (Ullah et al., 2013; Khan et al., 2014). The smart home products whether they are flexible or dual nature, they are equipped with smart power outlets which are giving the possibility to measure the power of their consumption and to control their operation in real-time.

According to the life wire website (2018), among the best smart products for 2018, we can find the ***Lenovo 10***; it is a display for kitchen which can help householders to build up their daily life inquiries list, to adjust reminders, watch useful cuisine stories and videos, sometimes even showing you the steps to prepare a recipe. It has also the capacity to help householders to control any other appliance that can interact with Google Assistant and control the house, it is also offering smart cameras, it as well adjusts temperature in case where it is coupled with appropriate thermostats.

Another device is the ***Ring Stick-Up***; it is a smart home camera for home security, it concentrates generally on smart doorbells with the functionality of video surveillance. It has the ability of recording high definition videos with 1080p and it offers a two-way talk option in order to connect with anyone standing next to the camera. It comes with an application which operates very well, as it gives the possibility to set up motion-activated notifications. Which is also good about this camera and that is rare to be found elsewhere is that it can work both via the app or on a desktop computer. Another good thing about it is that it can be placed on any flat surface whether outdoors or indoors. Regarding the power options, the consumer has a variety of choices, he can wire it through Ethernet or standard outlets or battery-powered in order the place it out of reach of your outlets. This camera has more functions that allow her to connect via Alexa, to customize motion zones and the it is able to view, save and also share videos if desired.

Adobe Essentials is considered as one of the best security systems for smart homes, it is interoperable with most of the domotics systems (***Nest, Alexa, etc.***) consequently it can be readily incorporated. It is DIY system which is easy in term of installation, it is also flexible with a reasonable price. This kit contains a central hub, a motion detector, a door/window sensor, and a remote keychain fob. The hardware installation is not hard at all and its design is made in order to work with other appliances like ***Nest Cameras,*** and others. It is also helpful in setting up monitoring for some weeks or days when you are away for coverage purpose.

There are so many other smart home devices to mention just like; Google Home Hub which displays with Google Assistant; Amazon Echo Plus 2G which helps

to get into Alexa voice assistance in order to so researches on the web and ask questions; Nest Learning which is a smart thermostat that learns and gets adapted to your own habits and preferences, Nest Protect is a smoke, carbon, monoxide detector that sends an automatic message to your phone in case where there is alarm sounds or the batteries are low; Amazon Echo Input which connects to the Wi-Fi, then it got plugged into a speaker, and finally it works as Alexa does, etc..

2.4 Consumer Expectatıons

2.4.1 Understanding consumer expectations

Expectations have been come up to have an influence on decision-making in a broad variety of consumption framework. Understanding consumer expectations is important because it helps businesses to be successful in term of winning over its target audience. According to the small business website (Sampson, 2018), consumer expectations point out to the needs and wants of the people you intend to pull to purchase your goods and services and mostly contains understanding customer service as well. The businesses 'marketing must rely widely on the consumer expectations, which signifies that the business had to communicate the qualities that make from its products attractive to the targeted audience. The consumer expectations normally rely on actions they take as important when they interface with a business.

According to Bhattacherjee (2001), expectations define the standard or the reference level for consumers in order to construct evaluative judgments related to the focal good or service. Moreover, Olson and Dover (1979) & Oliver (1980) defined expectations more narrowly as the forecasting or beliefs about the having desired attributes of a focal brand. In order to be kept away from failure, these expectations should be properly identified and constantly boosted (Schmidt et al., 2001).

2.4.2 Expectations Disconfirmation Paradigm (EDP)

In order to evaluate the focal brand performance, expectations are considered as the standard for it. Vroom (1964) has been the first who developed the idea of the expectancy theory and he asserted that the later theory is mainly about the

mental process concerning choice. Moreover, Olson and Dover (1979) & Oliver (1980) defined expectations more narrowly as the forecasting or beliefs about the having desired attributes of a focal brand. Yet, as applied in most communication sciences and disorders research CS/D, a more descriptive name for it, is given as the disconfirmation of expectations paradigm. This disconfirmation of expectations model has been applied the most and has taken a wide empirical support (Oliver, 1980; Churchill and Surprenant, 1982; Oliver and DeSarbo, 1988; Westbrook and Oliver, 1991). Later, the expectancy-disconfirmation paradigm (EDP) became the most used cited framework by researchers in tourism and hospitality fields (Erevelles & Lockshin, 1991; Oh & Parks, 1997; Weber, 1997; Yüksel & Yüksel, 2001).

Essentially, it is considered as a rational approach and a cognitive model for the purpose of understanding the motivation concept incorporates important ideas discovered in other commonly approved motivation theories (DuBrin, 2008). As regards to the expectancy theory, motivation rely mainly on how hard our willingness to have something and on the how possibly we are to get it. Subsequently, it says that if you have the ability to create expectancies in someone, the expectancy can turn into a standard or a fact (Northouse, 2007). According to Daft & Marcic (2008), the relationship between the effort of the individual, his performance and the desirability of outcomes related to the high performance are the basement for the expectancy theory. Expectancy then implies defining if setting effort down a task will head to high performance (E/P); and defining if effective performance will head to the wanted outcome (P/O).

In general, when a consumer wants to buy a product (good or service), at a time *t*, he made a choice for a particular brand (the focal brand). The consumer ordinarily make his choice based on the common hierarchy of effects process that involve his expectations or brand attributes beliefs, intentions and attitudes (Oliver 1980). At a posterior time, *t+1*, an occasion takes place in which the focal brand is utilized. the use experience is evaluated after the fact that the consumer triggers the perception of the brand's performance. Seeing that the evaluation conduct to a comparison between the actual performance and the standard one, three outcomes of this evaluation are possible: Satisfaction,

dissatisfaction or neutral. The satisfaction occurs when the actual performance is better than the standard one and which also leads to a positive disconfirmation. The dissatisfaction occurs when the actual performance is worse than the standard one then this leads to a negative disconfirmation. The Neutral feeling occurs when the actual performance meets the standard one (Oliver 1980). According to the equity theory, when consumers are introduced with an acceptable recovery action, in spite of the failure, consumers' perceptions of satisfaction raise and the recovery action most possibly establishes positive perceptions of the service episode (Goodwin and Ross, 1990-1992).

As any other theory, the EDP has its limitations as well. First of all, in the context of pre purchase evaluation, the use of expectations is more meaningful for tangible consumer goods than for experiential services (Hill, 1985). According to the expectations disconfirmation paradigm, customers are going to be satisfied (dissatisfied) of their initial expectations are reached (unreached); yet, this may not be necessarily valid for all consumption cases. Then, at the same rail with the traditional EDP, several studies have adopted predictive expectations as a standard for comparison. Thus, there is inappropriate research proof on if consumers adopt only predictive expectations while doing their evaluations for the post purchase product, if they adopt other standard(s), that they bring into the consumption experience e.g. ideals, desires, etc., or other standards that may appear after the purchase. The processes of satisfaction may vary depends on whether they are goods or services (Churchill & Surprenant, 1982), and the standard adopted may differ depends on the case. The utilization of several comparative standard questions might yield different levels with which the performance is compared, and can give different outcomes in terms of customer satisfaction (Woodruff et al, 1991). In case where the relationship among the disconfirmation and affective outcomes or behavioral outcomes varies, in dependence on the comparative standard adopted, commitment to the traditional EDP may be incorrect. For example, reaching or outrunning predictive expectations might give an indifference outcome (Swan & Trawick, 1980), while the consequent satisfaction and future behavioral intention levels may be different, or likely higher, when consumer desires, ideals and values are

reached. Another limitation is when consumers' initial expectations of a good or service may be basically different from their expectations if evaluated after a service experience that implies different encounters, as in generally in the most hospitality and tourism services' cases. Finally, EDP doesn't look like it is able to give comparative information in competitor's performance, which is important for managers in planning competitive actions.

2.4.3 Consumer choice

Making a decision is defined as the act of choosing one option among different alternatives (Schiffman and Kanuk, 2004). Generally, when decision is involved, the choice come after and vice versa. When the consumer is in the market, he is generally facing a group of substitutes and choices from which he is supposed to make his decision and choose. The decision comes when the consumer decides whether to buy the product or not, or to choose one brand over another. In a monopole market where consumers cannot make a choice and they are obliged to buy that product since there are no other alternatives or to take a specific action, consequently there is no decision to make (Schiffman and Kanuk, 2004). A "Hobson's choice" is generally what is called a no-choice decision.

The right beginning of research about how people do to get to a decision and choose between alternatives goes back to the 17th century, when Pascal, Bayes and Bernoulli had set the probability theory's principles. By utilizing these principles, economists began to be the first professional team to initiate a precise buyer behavior's theory. Consumers are rational this how economists view the core of the economic choice. Theorists also consider the market as a place of perfect competition (Schiffman and Kanuk, 2004), also when consumers make any decision to buy a product they make it rationally and consciously of the economic calculations (Kotler, 1965). Based on what previously stated, the consumer is expected to spend his income on goods and services that he considers having the highest utility depends on his tastes and target prices. Basically, this model stands on the total utility maximization and given some choice set X, a person is supposed to "Max $x \varepsilon X U(x)$" (Varian, 1993, p.66).

The father of economy Adam Smith mentioned that self-interest is the motor that motivates people on all their actions and it is considered as the principle that the economic growth is based on (Smith, 1902). Adam Smith's successors validated the theory and appended that rational people are those who excellently calculate the awaited benefits and costs of every speculated action. In the 1870s, Leon Walras, William Stanley Jevons, and Carl Menger together and independently revealed the marginal utility principle (Beinhocker, 1997). Marginal utility is considered as the variance in the overall utility or satisfaction ensued from a good's one more unit' consumption. The Marginal Utility Theory consists of that the diminishing marginal utility' rule exists. Moreover, it mentions that as much as the good consumed' quantity goes up, as the marginal utility derived from it goes down (Varian, 1993). This broad model, most of times indicated as "Rational Man Theory" or "Marshallian Economic Model", was later elongate into more modern theories just like utilitarian Theory and Rational Choice Theory. According to Scott (2000), Rational Choice theory then was applied into different other models expanded by sociologists and political scientists.

Marketers generally have rejected the Marshallian model (Kotler, 1965) and criticized it for several reasons (Schiffman and Kanuk, 2004). The meaning of value was questioned by Lancaster (1966) while criticizing the rational man theory. He mentioned that "the good... does not give utility to consumers, it possesses characteristics and it is those characteristics that give rise to utility" and gave a proposition of a new model in order to study the consumer behavior that took more into consideration the attributes related to the product than to the product itself. Other researchers from different other majors, or even containing economists, have participated in this turning point from the tradition just like the works of Kahneman and Tversky (1979) and Luce (1977).

Over and above these, the fundamental model assumptions, that affirm that the consumer is completely rational and that the market is perfectly competitive, are perceived as doubtful. According to Schiffman and Kanuk (2004), the model critics, have emphasized that to have a rational behavior in an economic sense, the consumer should (a) be aware of all the alternatives that the product have, (b) have the capacity of accurately ranking each alternative depends on its

advantages and disadvantages, and (c) have the ability to define and select the best alternative among all. Yet, in the daily life, this is generally not the case and consumers usually have limited actions, values and information (Simon, 1957).

In spite of this, the economic view highlights some insights in order to get to a better understood consumer behavior model. The assumptions that the economic theory provides on the consumer choice, just like “the sales increases with the decrease of prices”, sales decreases with the decrease of the substitute products prices and increases with the decrease of the complementary product prices”, and “once the real income increase, once the sales of this product increase, provided that it is not an inferior good” are have to be, at least, fundamental references for behavioral sciences.

Another group of questions are still not enough well absorbed regarding the intricate interaction of memory, attention, and processes of valuation in consumer choice (Lynch et al, 1982). More precisely, because the most of the current consumers are doing their choices based on their previous experiences (memory) or on the other’s experiences (search), and on conclusions standing on researches utilizing special laboratory paradigms, where all the pertinent alternatives are given, can be deceiving (Lynch et al, 1982; Alba et al, 1991).

When exposing to different brands of goods in for example a grocery shop, the consumer generally fails to pay attention to all the available brands, instead he/she takes a look directly on those on shelf at the eye-level, because it is hard and time-wasting for him/her to think about the other possible brands (Shocker et al, 1991; Scheibehenne et al, 2010). In that case, the consumer may have a preference for a brand X, but alternatively he chose another brand when the brand of his preference already is available, but he/she couldn’t realize it (Hausman, 2008). The consumer may not purchase the goods that he needs because he may forget that he run out of them, or he just possibly misremember or misperceive some important attributes concerning those good in need, or maybe mistaking the goods components by one brand for another. The researches about consumer has proven that such misattributions are familiar, and become more usual with age (Skurnik et al, 2005).

Consumer theories focalized on processing phases that supply a strengthful way of typifying the constraints on choice by attention and memory processes (Lynch et al, 1982; Alba et al, 1991). Especially, considerable evidence form laboratory, field, and data from eye-tracking proposes that the consumer first see the available alternatives, filter them and use the simple criteria relatively in order to undertake a detailed analysis of this reduced set (Alba et al, 1991; Chandon et al, 2009). Precisely, the important consumer choice theories have suggested that, filling between the entire universe space of the accessible option and the final choice sits a commonly-called "consideration set", which include the group of alternatives taken into consideration prior to choice (Shocker et al, 1991; Hauser& Wernerfelt, 1990).

Insisting on the same idea that consumers goes for far fewer goods than the total number of the available products, previous studies showed that the consideration sets' size to be in the range of 3 to 6 (Hauser& Wernerfelt, 1990). Moreover, models that include consideration sets are generally explaining the choice data basically better than those utilizing only choice data (Shocker et al, 1991). Broadly, such kind of "phased" decision strategies have been proposed as representative of human decision-making in different contexts where consumers have to overcome with complexity (Bettman, 1970; Wright & Barbour, 1977).

The consumer's choice difficulty relies mainly on such element, for example, choice difficulty generally tends to go up, if the alternatives number and attributes goes up; if some precise values of attribute are hard to process; if there is a big deal of none certainty over the values of many attributes; and if the shared attributes number goes smaller (Payne et al, 1991).

2.4.4 Consumer decision-making

Since we wake up in the morning till we sleep at night, we make hundreds of decisions, from the banal (e.g., choosing what perfume to out) to the highly important (e.g., choosing what career to follow). Yet, consumers continuously make decisions concerning the purchase of goods and services. Some of these decisions are mundane, some others are complex. However, consumer decision

making is considered as a multifaceted process that goes from the automatic to extremely structured problem solving (Kardes et al, 2011).

As stated by Bettman and his friends (1991), for the traditional models of consumer decision-making, consumers will define the suitable attributes of each option they have, evaluate the different attributes and select the one with the best overall utility, standing on their judgments' combination about attribute importance and values. We cope with that this process is not always going to happen in all decision-making cases.

Traditional models of decision-making have succeeded equitably good for familiar, rational and well-structured choices. Yet, these models possibly not be able to depict how consumers make other kinds of decisions for which they do not have much experience, or where emotions are involved, or where the problem is not well-defined. According to Bettman (1979) in his Information-processing and consumers' choice model, the consumer has generally a limited capacity in order to process information. He implies that consumers hardly analyze the decision-making complex alternatives and generally go for very simple strategies. In the decision process step of his model, Bettman (1979) states that various kinds of choices are generally made combined with other factors, the thing that may happen during the decision process. Precisely, this part deals with the rules of thumb (ROTs) or heuristics application, that are applied when it comes to select or evaluate a specific brand. *These rules of thumb defined by Mitch Maidique in one of his talks (www.foxbusiness.com), as a principal that is obtained from the experiences that the person go through and that gives approximately immediate guidance for behavior in certain cases. Generally, most of people, tend to think of it as an intuition or reaction.* Eventually, theses heuristics that the consumer utilizes are impacted by both situational (e.g., how urgent is the decision) and individual factors (e.g., how different is the personality). Consequently, it is not probable that a decision made by a consumer in a situation X can be applied in a situation Y or another consumer can be in the same situation X.

Jacoby and his friends (Jacoby et al, 1974a; Jacoby et al, 1974b), in their observations about the impact of information load on consumers, had consequently changed the number of products given depending on the amount of

alternative brands and the amount of the brand's attributes and studied the impact of information given of the decision making performance. Standing on the researches done, researchers deduced that purchasers "in fact, with the availability of more information they make poorer purchase decisions" (Jacoby et al, 1974b). Yet, critics brought many conceptual and methodological problems (Russo, 1974; Summers, 1974; Wilkie, 1974). The main critics were like: the overall information doesn't have to be determined in terms of the brands amount times the attributes per brand amount; while bringing a comparison between the impacts of the alternatives amount on choice accuracy, one should account for the chance factors effect; they have objected about the choice-accuracy measures that Jacoby applied in his researches, and they rejected its appropriateness; the stimulus variables impacts, just as the choice alternatives' relative attractiveness and the prominence of the information given, have to be also taken into consideration. Subsequently, in reviewing this disagreement, Jacoby admitted that in their research "did not bring any none dubious results" (Jacoby, 1977). Scammon (1977) also studied the information-load paradigm. Scammon (1977) changed the attributes amount and the way how the information was given to the consumers each at two levels. Yet, Scammon's research was limited in term of usefulness, since the brands amount was constant and the attributes amount wasn't variable through an adequate levels amount (Wilkie, 1974). Furthermore, another analysis has been done on the acquired data from these studies, by using a more strengthful analytical procedure, and this new analysis has demonstrated that, in controversy with what these authors claimed, information overload didn't happen in their experiments (Malhotra, 1982). Thereby, if information overload happens or not, the consumer choice still as an open problem (Bettman, 1979).

In order to understand what a consumer's task is, and how it could be possible to characterize a consumer's choice as difficult or easy an initial task analysis for consumer choice is provided by Newell and Simon (1972). The first step to progress is to examine the composing elements of a choice: uncertainties, attributes of value and alternatives. The next step come in order to see how this information is available in the environment in term of structure which means how it is organized and of content which means what is available. Eventually, at

the last step, we check the other factors that may leave an impact on the way how the consumer responds to a choice task.

A representative consumer choice is composed of a group of alternatives and each alternative is described by many attributes. As an example, a car, each one has passenger capacity, different mileage, attractiveness and so on. Some of these attributes' values could be known with reasonable certainty (e.g., another brand's engine size). Yet, the other attributes values are not certain, just like the durability or reliability of a new model car. For several choices, the attributes kinds introduced are the same through the present alternatives (e.g., picking one over different car brands). Yet, the latest research (Johnson, 1980) has concluded that in some situations several attributes may be applied for several alternatives. Provided with an amount of money to spend, one should pick, for example, among a dishwasher, known by its performance in cleaning pans and a vacation, described by attributes like the food quality and the number of sunny days. That kind of choices have been called "non-comparable".

3. RESEARCH METHODOLOGY AND FINDINGS

The origin of the word “Method” is “Methodos” which a Greek word, which means keep following a specific way to reach an aim (Store Norske Leksikon, 2016). In accordance with the social science methodology, the choice of your method represent an important part of the way how you execute your study. A method is supposed to help you define what and how you should collect your data, it also shows you to analyze and interpret the data that you have collected for the conducted study (Johannessen et al., 2011). The methodology application might show the researchers how they can secure validity and reliability of the study and how the make errors minimized. Also, it helps researchers to call attention to different problems and giving awareness and admission with a great hope (Halvorsen, 1993).

In the study in hands, too determine consumer expectations from the internet of things, the following study approach has been used.

3.1 Conjoint analysis

When coming to the literature of the conjoint analysis, Green and Rao (1969) discussed shortly the conjoint methodology in their working paper, the more detailed paper didn’t become visible till 1971 (Green and Rao). After that, a series of articles discussing applications or algorithms appeared in different journals (Green et al, 1972; Srinivasan and Shocker, 1973; Johnson, 1974; Westwood et al, 1974). The multiattribute modeling of consumer preferences’ theoretical justification was supplied in the growing literature on the expectancy-value models and the new economic theory of consumer choice’ Fishbein-Rosenberg class (Lancaster, 1971; Ratchford, 1975).

Due to the considerable number of preferences variation among consumers, conjoint analysis is generally conducted at the consumer level. The preference model form is usually supposed to be the same for all respondents, but the model parameters are allowed. Different alternate ways exist in order to identify

the attributes that are pertinent to respondents in order to form their preferences (Alpert, 1971). An initial data collection effort, asking consumers concerning attributes that are important to them, generally facilitate the identification of those attributes that are most regarded as pertinent (Braun and Srinivasan, 1975). Focus group interviews, or Kelly's (1955) repertory grid, or opinions of product managers, retailers and others who got a good knowledge about the goods and/or services and their use can be applied for this purpose. The hardest task in conjoint analysis is the reduction of the attributes' number to a size that could be managed so that the procedures of estimation are more reliable meanwhile accounting for consumer preferences sufficiently well.

Conjoint analysis is considered as a multivariate technique that is precisely used in order to understand the respondent's preferences development (Hair et al, 1995), more precisely, the technique in hands is generally used in order to analyze how respondents assess the global profile part worth by supposing that they take all the product's attributes in consideration and pick the one with the more elevated part worth score (Green & Rao, 1971). When doing the analysis for the characteristics of a product in an independent way, the study's reliability can be reduced. However, by using the conjoint analysis, the analysis of factors is done collectively in order to better demonstrate the preference in a smart home product decision analysis. In 1975, a conjoint analysis research has been done on carpet cleaner. They gave a description to the carpet cleaner by specifying five characteristics: brand name, package design, price, a money-back guarantee and Good Housekeeping's seal of endorsement. It's been concluded that the attributes total partworths is the global preference for consumers. A regression analysis has been done in order to assess the participation of every attribute to the global consumer preference (Paul & Wind, 1975). Consumers were demanded to rate or rank profiles, which is named Conjoint Value Analysis (CVA). This method has lost its popularity when the Choice-Based Conjoint Analysis (CBC) have been shown. Then, conjoint analysis and discrete choice modeling were combined and, consumers were demanded to accord their preference by picking between various profiles (called Cards as well) (Louviere & Woodworth, 1983).

The conjoint analysis is a method that is used for the purpose of modeling multilevel dependent variables, in this method, the impact of independent variables on the dependent variables are possibly to be measured (Aktaş et al., 2012; Karaduman & Yilmaz).

A model with different issues that include executing a conjoint analysis into research has been made by Green and Srinivasan (1978). The model steps are demonstrated in Table 3.1. The methodology from this research was pursued in order to design and analyze the conjoint study.

Step		Alternative methods
1.	**Preference model**	Vector model, ideal model, part-worth function model, mixed model
2.	**Data collection method**	Full profile, two-attribute-at-a-time (tradeoff tables)
3.	**Stimulus set construction**	Fractional factorial design, random sampling from a multivariate distribution, Pareto-optimal designs
4.	**Stimulus presentation**	Verbal description (multiple-cue stimulus card), paragraph description, pictorial or three-dimensional model representation, physical products
5.	**Measurement scale for the dependent variable**	Rating scale, rank order, paired comparisons, constant-sum paired comparisons, graded paired comparisons, category assignment
6.	**Estimation method**	Metric methods (multiple regression); nonmetric methods (LINMAP, MONANOVA, PREFMAP, Johnson's nonmetric algorithm); choice-probability-based methods (logit, probit).

Figure 3.1: The conjoint Analysis required steps, adopted from Green and Srinivasan (1978)

The goal of this study is to check what is the combination of characteristics of the smart home products' the most needed by consumers. Therefore, a part-worth utility model is chosen to be used in this ongoing study. This model turned it to be possible to count every attribute's levels as numerical partworths values (Green & Srinivasan, 1990).

For data collection, a Full- Profile approach has been used in order to retain the conjoint factual in a maximum way. By using this method, consumers pick between various products that are having the entire attributes that have been given.

The two-factor-at-a-time method is a different choice in which consumers are supposed to put different factors' sets by order. The full-profile approach provides to the stimuli a more factual designation and this is by identifying each attributes levels and possibly consider the environmental correlation among characteristics in real stimuli (Green & Srinivasan, 1978).

In case if the full factorial design is used, respondents were supposed to be exposed to 243(3^5), which is not possible. For that reason, the orthogonal design is used in this study in order to minimize the number of profiles. Since, it was not obligatory to get outcomes on all the possible sets (Huber et al, 2003). The objective of researchers from finding such a design was the balance that is has, differently saying, each level in each attribute appears the same number of times, and the one that was orthogonal, that is if you get a pair of levels, one from an attribute and one from another one, the pairs appear the same number of times in the array (www.dobneyresearch.wordpress.com). For respondents, orthogonal design is advantageous. First, because it takes less time in order to fulfill the survey. Yet the orthogonal design permits the principal attributes impact in the conjoint analysis to be weighted. Eventually, nevertheless some profile cards remain not realistic, the orthogonal design gives an optimal prediction (Rao, 2013). These combinations are more explained, later in this chapter. The orthogonal design tool of the conjoint analysis module of Marketing Engineering for Excel version 2.1.0. reduced the combinations' number to sixteen (16) bundles. Orthogonal design has been studied since the conjoint analysis' early years. While using it in metric analysis, it remains as a strong design (Carmone et al. 1978).

Respondents may see all the product features as important, and it would be quite difficult for them to give a relative importance of a key product characteristics' number (Moore & L., 2004). For that reason, a choice-based conjoint has been chosen to be used in this study in order to facilitate the task for respondents and rank the bundles from 1 (most preferable) to 16 (less preferable) by preference.

In the choice-based conjoint analysis tasks are generally more alike to the real market place behavior comparing the rating-based conjoint analysis, that possibly may head to a better external validity of CBCA (Elrod et al. 1992). According to Lusk and his friends (2004) CBCA tends to produce less

information compared the rating tasks. The performance of CBCA is better comparing to the rating one because respondents can independently make choices without disquieting about rating scale uniformity over profiles (Moore et al. 1998) and with less mental processing (Næs et al., 2010).

While some choice-based conjoint analysis have been conducted, some challenges have appeared. While evaluating profiles, respondents have to process a load of information; their preference decision has to be made standing on all the shown attributes. Another challenge is that there is a restricted amount of attributes that can be applied. If there are various attributes to be used, consumers may find their preferences based on some attributes instead of all of them (Pullman et al. 1999), also it is advised to not take a number of attributed over than six in a full-profile conjoint (Green and Srinivasan, 1990).

3.2 Attributes

This research's sample concentrated on smart home products, because their revenue in the national market (Turkey) is expecting a real growth from US$303m in 2019 to US$914m by 2023, which is a growth of 31,8% (www.statista.com). Therefore, it was expected that, this IoT segment which are the Smart Home Products, are more likely to be recognized by respondents.

The most common attributes as mentioned in the previous chapter (see: 2.3.2 Attributes) were taken because they are considered as the most important characteristics of a smart home product. The Table 3.2 demonstrate every attribute level mentioned in this study.

Table 3.1: Conjoint Analysis Design

Attributes/ levels	Level 1	Level 2	Level 3
Privacy and Security	Impossible	Moderate	High
Reliability	Not At All Reliable	Moderately Reliable	Extremely Reliable
Usefulness	Not At All Useful	Moderately Useful	Extremely Useful
Interoperability	Not At All Interoperable	Moderately Interoperable	Extremely Interoperable
Cost	Low	Moderate	High

As mentioned before, five attributes were considered: privacy and security, reliability, usefulness, interoperability and cost. The way how smart homes function, allow them to collect data about the householders in order to assist them the best way (Balta-Oskan et al, 2014). However, the insurance of an adequate saving of the householders' personal data is very important. In this study, this attribute had given three level: Impossible for a no privacy and security preference, moderate for a moderate privacy and security preference, high for an extreme level of privacy and security. According to Friedewald and his friends (2005), Reliability is the main challenge as this attribute will support the user-friendliness and empowerment and smart homes shouldn't fail or do unexpected things, in a sort that smart homes are expected to function as they have to. Three levels have been affected to this attribute as mentioned in the Table 3.2. Functionally, smart homes are meant to manage the daily living demands of householders through the use of technology. Smart homes are considered as useful when they are introduced to the householders as evident and forked: security, convenience through automation, comfort, scheduling tasks, efficiency and energy management; and for particular end-users, assisted living and health (Rashidi et al, 2009; Cook, 2012), in this research, three levels are affected to this attribute in order to study the consumer preference. Interoperability is one of the most challenging topics for researchers in the IoT era, it is the key to open new markets to competitive solutions in IoT is definitely the interoperability (Lu et al., 2011; Misra et al., 2015). Currently, the main objective for the leaders in the smart devices manufacturing, is to achieve a full interoperability that will ensure easy integration with the existing internet. Smart homes can be totally interoperable which means they can get connected with any other brand's devices, moderately interoperable with some other brand's devices or not at all interoperable which means It is interoperable only with the same brand devices. Cost is considered as one of the main concerns of the customer, in order to study the consumer expectations regarding the smart home products, three cost levels are affected: low, moderate and high cost.

3.3 Demographics and Findings

In this study, a conjoint analysis has been conducted in order to determine the best profile combination that suites the consumer expectations regarding the smart home products. In combination with it, a demographical survey has been conducted in order to study the demographical factors of the respondents from gender, age, education, marital status and income.

3.3.1 Sample size

The sample size in conjoint analysis is variable. When the conjoint analysis is for a commercial use, the sample size generally varies between one hundred and one thousand respondents. When going for conjoint analysis studies that contain a lower number of variables, the sample size goes mostly between one hundred and one hundred and fifty, with an average of 138 respondents (Cattin & Wittink, 1982). In the current research, five variables are utilized, for that reason and for having a representative analysis the sample size was 155 respondents.

3.3.2 Data source

A survey was conducted using Marketing Engineering for Excel version 2.1.0 for data design for the conjoint analysis. Table 3.3. represents the survey design used in this research. The survey was distributed to 155 respondents between February and March 2019. Those respondents are all Istanbul Aydin University Students. Before the distribution of the survey a 10 minutes' presentation is done in order to explain the topic and the way of fulfillment of the survey. The data collected has been manually entered to the Marketing Engineering for Excel version 2.1.0. after a data collection template had been created. After entering the data, respondents' preference partworths has been estimated and then an analysis has been run and eventually results has been obtained.

3.3.3 Findings

The target group for this survey was students of Istanbul Aydin University, aged between 18 and 54 years. The data was collected by the help of my Advisor Assoc. Prof. (Ph.D.) İLKAY KARADUMAN and Assist. Prof. Dr. NURGÜN

KOMŞUOĞLU. The survey was set up in December 2018 and was handed out between February and March 2019 to 258 students, from which 155 fully responded (response rate of 60%). The incomplete or invalid responses were taken away, so the data set consisted of 155 responses. During the data collection, it was noticed that, in order to give valid responses, the respondents spent between 10 to 12 minutes to complete the survey correctly. Otherwise, when the respondent spent less than 5 minutes on completing it, generally the answers are not carefully done.

About demographics, 69% of the valid and completed surveys were done by males aged between 18 and 54 years and only 31% by females aged between 18 and 34 years only 8% of them are married and the rest is single (Table 3.4, 3.5 and 3.7). Most of the respondents were bachelor students, in which 70% were bachelors and 30% were master students. 46% of the respondents are considered to have a minimum income between 0 and 1603TL, 21% are between 1604TL and 3000TL and the rest are above the 3000's. The tables below summarize the key statistics about the participants.

Table 3.2: Statistics about respondents: Gender

Gender		
Male	**Female**	**Undisclosed**
69%	31%	0%

Table 3.3: Statistics about respondents: Age

Age	# Respondents	% Age
Female	**48**	**100%**
18 - 24 Years old	42	87,5%
25 - 34 Years old	6	12,5%
Male	**107**	**100%**
18 - 24 Years old	77	72,0%
25 - 34 Years old	27	25,2%
35 - 44 Years old	2	1,9%
45 - 54 Years old	1	0,9%
Grand Total	**155**	**100%**

Table 3.4: Statistics about respondents: Education

Education	# Respondents	% Education
Female	**48**	**100%**
Masters	10	20,8%
University	38	79,2%
Male	**107**	**100%**
Masters	36	33,6%
University	71	66,4%
Grand Total	**155**	**100%**

Table 3.5: Statistics about respondents: Income

Income	# Respondents	% Income
Female	48	100%
0 - 1,603 TL	24	50,0%
1,604 - 3,000 TL	8	16,7%
3,001 - 5,000 TL	2	4,2%
Above 8,000 TL	2	4,2%
Undisclosed	12	25,0%
Male	107	100%
0 - 1,603 TL	47	43,9%
1,604 - 3,000 TL	24	22,4%
3,001 - 5,000 TL	6	5,6%
5,001 - 8,000 TL	4	3,7%
Above 8,000 TL	3	2,8%
Undisclosed	23	21,5%
Grand Total	155	100%

Table 3.6: Statistics about respondents: Marital Status

Marital Status	**# Respondents**	**% Marital Status**
Female	**48**	**100%**
Married	2	4,2%
Single	45	93,8%
Undisclosed	1	2%
Male	**107**	**100%**
Married	11	10,3%
Single	94	87,9%
Undisclosed	2	1,9%
Grand Total	**155**	**100%**

3.4 Conjoint Analysis: Findings

The conjoint analysis is considered as a tool that shapes the origin of consumer compromises between different attribute goods or services. It comes with an assumption that substitutional product ideas can be explained as a chain of

defined levels of a common set of attribute. It presumes as well that the global part-worths that the consumer obtains from a good or service is defined by the part-worths or utilities participated by every attribute level. The conjoint analysis begins with the general idea of a consumer regarding a group of complicated alternatives (Green, 1975). After that, it carries out a decomposition of the consumer's main judgments into separate and appropriate part-worths scales, by which the main general ideas can be rebuilt. Having the ability to detach the consumer's general evaluations into components, in this way, can give the producers important data regarding relative different attributes importance of a good or service. It also has the ability to give data regarding the different levels value of an attribute. Thus, the conjoint analysis goal is to define the attribute combination that provide the highest part-worths to the consumer and to set up the attributes relative importance in terms of their participation in the total part-worths. Eventually, a perfect product profile can be evaluated.

In this study 16 alternatives were selected by the help of the Marketing Engineering for Excel (version 2.1.0) (Table 3.8).

Then respondents were asked to rank the bundles or the set of attributes from 1 to 16 depends on their preference (from the more preferred to the less preferred), then the data collected from the 155 respondents were converted to percentages from 0% to 100 %. After the entering of the converted data into the Marketing Engineering software for Excel, the Preference Partworths

Table 3.7: Attribute levels for a full-profile, fractional design Conjoint study

Attributes / Bundles	**Bundle 1**	**Bundle 2**	**Bundle 3**	**Bundle 4**
Privacy and Security	Impossible	Impossible	Impossible	Impossible
Reliability	Not At All Reliable	Moderately Reliable	Extremely Reliable	Moderately Reliable
Usefulness	Not At All Useful	Moderately Useful	Extremely Useful	Moderately Useful
Interoperability	Not At All Interoperable	Extremely Interoperable	Moderately Interoperable	Moderately Interoperable
Cost	Low	Moderate	Moderate	High
Attributes / Bundles	**Bundle 5**	**Bundle 6**	**Bundle 7**	**Bundle 8**
Privacy and Security	Moderate	Moderate	Moderate	Moderate
Reliability	Not At All Reliable	Moderately Reliable	Extremely Reliable	Moderately Reliable
Usefulness	Moderately Useful	Not At All Useful	Moderately Useful	Extremely Useful
Interoperability	Moderately Interoperable	Moderately Interoperable	Extremely Interoperable	Not At All Interoperable
Cost	Moderate	High	Low	Moderate
Attributes / Bundles	**Bundle 9**	**Bundle 10**	**Bundle 11**	**Bundle 12**
Privacy and Security	High	High	High	High
Reliability	Not At All Reliable	Moderately Reliable	Extremely Reliable	Moderately Reliable
Usefulness	Extremely Useful	Moderately Useful	Not At All Useful	Moderately Useful
Interoperability	Extremely Interoperable	Not At All Interoperable	Moderately Interoperable	Moderately Interoperable
Cost	High	Moderate	Moderate	Low
Attributes / Bundles	**Bundle 13**	**Bundle 14**	**Bundle 15**	**Bundle 16**
Privacy and Security	Moderate	Moderate	Moderate	Moderate
Reliability	Not At All Reliable	Moderately Reliable	Extremely Reliable	Moderately Reliable
Usefulness	Moderately Useful	Extremely Useful	Moderately Useful	Not At All Useful
Interoperability	Moderately Interoperable	Moderately Interoperable	Not At All Interoperable	Extremely Interoperable
Cost	Moderate	Low	High	Moderate

were estimated (Appendice 4.2). In the conjoint analysis the part-worth utilities of individual attributes are calculated based on the selection or ranking of a defined set of combinations of attribute values. After this, profiles of the existing smart home products in the market were created and market share was predicted for different scenarios, using the First-Choice Rule.

3.4.1 Preference Part worth

In this research, all the 155 respondents ranked the combinations of attributes (bundles). Then this ranking was converted into percentages. Based on the ranking done, the conjoint analysis software (Marketing Engineering Software for Excel Version 2.1.0), calculates how each attributes contributes to the consumer's preference. The term used for the attribute level's contribution is "Part- worths utility".

By using excel as a tool the mean part-worth utility has been calculated for the 155 respondents for each attribute's level (Table 3.9). Therefore, each level's part-worths were investigated. With regard to the privacy and security, a smart product with a high privacy and security had taken the greater utility while a product without security and privacy had the lowest utility. A smart product with a low cost was more preferred with a higher utility, a smart product with a high cost is the less preferred. When it comes to analyze the utility of the reliability attribute, we find that the utility of the two levels moderately reliable and extremely reliable are so near, which shows that respondents goes more for extremely reliable smart home products, but if they face a smart product with a moderate reliability they would purchase it as well. The same case happened with the cost, the utility of low cost smart home products had approximately the same utility as moderate cost ones. The remaining utilities can be read from table 3.9.

Table 3.8: Mean of Respondents' Preference Partworths

Attributes	Levels	Utility
Privacy and Security	Impossible	8,187
	Moderate	15,897
	High	27,252
Reliability	Not At All Reliable	6,897
	Moderately Reliable	9,832
	Extremely Reliable	9,877
Usefulness	Not At All Useful	3,523
	Moderately Useful	11,690
	Extremely Useful	14,071
Interoperability	Not At All Interoperable	7,239
	Moderately Interoperable	8,000
	Extremely Interoperable	5,445
Cost	Low	9,555
	Moderate	9,206
	High	7,032

Respondents globally felt that the privacy and security is having the highest importance among attributes (33 per cent), then followed by usefulness (19 per cent), cost and reliability (17 per cent), and finally interoperability (14 per cent) (Table 3.10). Privacy and security was approximately two times as important for consumers as cost and as reliability. Privacy and security and usefulness accounted for more than 50 % of the importance that all respondents affected to the smart home products attributes. The interoperability of the smart home products was the attribute the least-valued.

Table 3.9: The mean of Attribute Importance

Attributes/Attribute Importance	Privacy and Security	Reliability	Usefulness	Interoperability	Cost
The Mean of Attribute Importance	33%	17%	19%	14%	17%

The privacy and security attribute utility demonstrates that respondents in this research were privacy and security mindful, obtaining a higher utility from a smart product with the highest privacy and security. They can be somehow judged as being a privacy and security sensitive, because they obtained a higher utility from the smart home products that have a high privacy and security, that are extremely useful and reliable but with a moderate interoperability and a low cost. Eventually as a result, consumers are expecting smart home products with first high privacy and security, products that are extremely useful, moderately to extremely reliable and with a low to moderate cost.

3.4.2 Existing profile products

In this research, we used some existing products in the market in order to run the analysis. These existing product profiles are picked from Smart Home Products market precisely as they are the top sellers. The levels affected to each attribute of these products have been taking into account approximately according to their technical characteristics mentioned in the website (www.smarthome.com).

Following are the nine existing profile products picked and used in order to run the market share simulation by using the respondent's partworths preference results (Table 3.11):

Table 3.10: Existing Product Profiles

Attributes / Existing Product Profiles	Inseton Hub Central Controller	Amazon Echo Spot- Smart Alarm Clock	Inseton Smart Dimmer Switch
Privacy and Security	High	High	Impossible
Reliability	Moderately Reliable	Extremely Reliable	Extremely Reliable
Usefulness	Extremely Useful	Extremely Useful	Moderately Useful
Interoperability	Extremely Interoperable	Moderately Interoperable	Not At All Interoperable
Cost	Low	Moderate	Moderate
Attributes / Existing Product Profiles	LIFX- App Controlled Wi-Fi Smart LED Light	Inseton Remote Control Wall	Arlo Pro Wireless HD Security Camera
Privacy and Security	Impossible	Impossible	High
Reliability	Extremely Reliable	Moderately Reliable	Extremely Reliable
Usefulness	Moderately Useful	Extremely Useful	Extremely Useful
Interoperability	Extremely Interoperable	Not At All Interoperable	Extremely Interoperable
Cost	Low	Low	High
Attributes / Existing Product Profiles	Ring 88LP000CH000 Wi-Fi Video Doorbell Pro	ELK Two-Way Wireless Ready M1	NEST x Yale Lock (Satin Nickel) With Nest
Privacy and Security	High	High	High
Reliability	Extremely Reliable	Extremely Reliable	Extremely Reliable
Usefulness	Moderately Useful	Extremely Useful	Extremely Useful
Interoperability	Extremely Interoperable	Not At All Interoperable	Not At All Interoperable
Cost	Moderate	High	High

3.4.3 Market Share simulations

The market share simulations have been done by using the partworths utilities for each consumer for the all of 155 consumers. The conjoint analysis findings were taken and utilized in order to simulate choices between nine existing products (see Table 3.11). Table 3.12 resumes the predicted market share for a simulation with the nine existing product profiles.

Table 3.11: Predicted market share using the First-Choice Rule

Existing Product Profiles	Predicted Market Share
Inseton Hub Central Controller	30%
Amazon Echo Spot- Smart Alarm Clock	15%
Inseton Smart Dimmer Switch	7%
LIFX- App Controlled Wi-Fi Smart LED Light	5%
Inseton Remote Control Wall	7%
Arlo Pro Wireless HD Security Camera	4%
Ring 88LP000CH000 Wi-Fi Video Doorbell Pro	10%
ELK Two-Way Wireless Ready M1	10%
NEST x Yale Lock (Satin Nickel) With Nest	10%

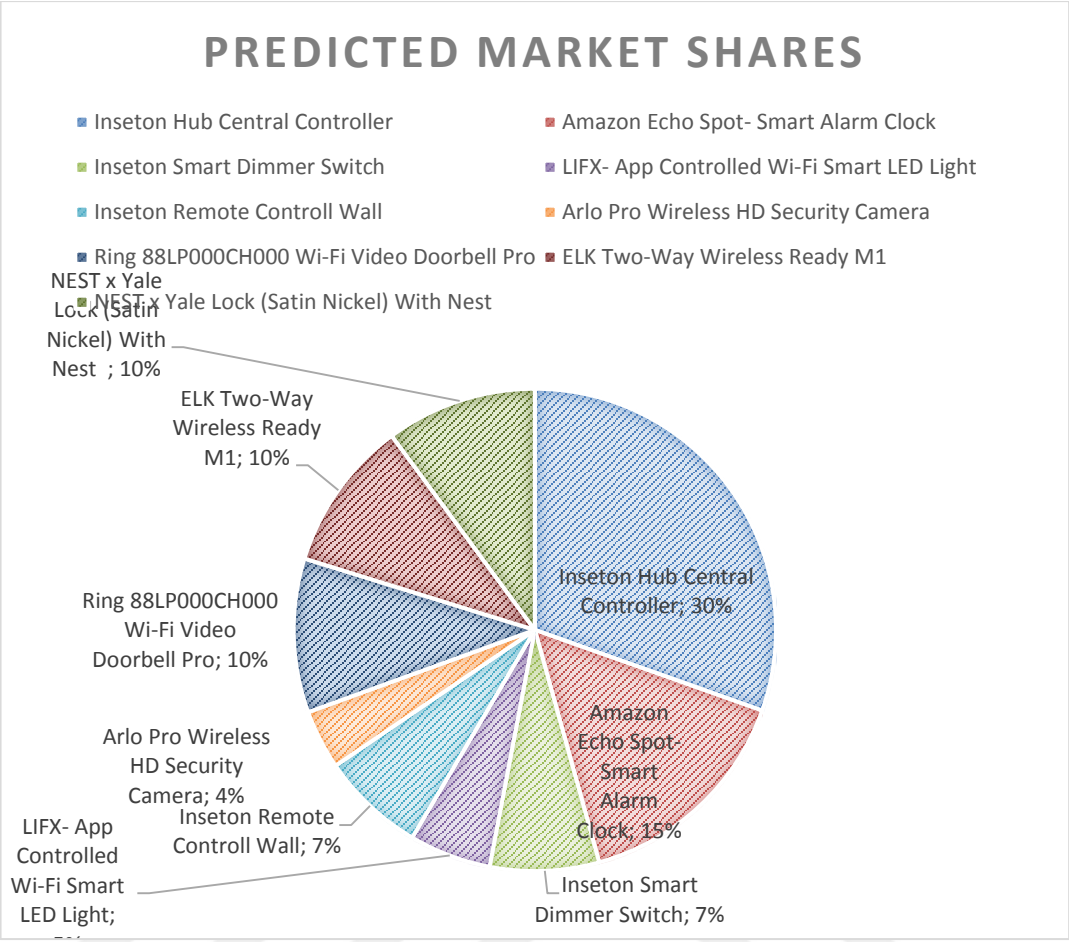

Figure 3.2: Predicted market shares

In the market share simulations, the "Arlo Pro Wireless HD Security Camera" had only 4% of the market share, according to the respondents partworths preference this security camera has to work more on its cost and it can reduce its interoperability in order to improve that later. The "Inseton Hub Central Controller" had the largest market share with 30%, the hub central controller can reduce from its interoperability and improve its reliability in order to maintain its market share. After the Hub central controller comes the "Amazon Echo Spot- Smart Alarm Clock" with a market share of 15%, this only 15% is explained by the moderate cost of the smart alarm clock, the producers need to work more on cost in order to increase their market share. Then, come the "Ring 88LP000CH000 Wi-Fi Video Doorbell Pro", "ELK Two-Way Wireless Ready M1", and "NEST x Yale Lock (Satin Nickel) With Nest" in a same level with an equal market share of 10%, the three products are having high security and privacy and are extremely reliable which is so much expected and needed by

consumers. However, when it comes to usefulness the Doorbell Pro has to improve this in order to survive in the market, otherwise, three of them need to work on their interoperability and costs to meet the consumers' expectations which are moderate interoperability with a low cost. The "Inseton Smart Dimmer Switch" and "Inseton Remote Control Wall" have equally a market share of 7%. This is due to their lack of privacy and security which considered - as mentioned in Table 3.10- as the most important attribute for a smart home product, also by the absence of the interoperability attribute in the product. Finally, for "LIFX- App Controlled Wi-Fi Smart LED Light", comes with a market share of 5%, this market share can be increased by adding the privacy and security feature to the product, the usefulness has to be increased as well and the interoperability can be reduced to be moderate, that way the cost may not be affected as well.

4. CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

Privacy and security and usefulness were preferred to be the most important attributes for the smart home products, comes then the cost and reliability, and finally the interoperability. The utility among attributes has a considerable variation. High privacy and security had received the highest utility, then the moderate privacy and security and finally, no security and privacy. This shows that consumers of smart home products are privacy and security mindful. This is also noticed on respondents' usefulness preference for an extremely useful smart home product rather than smart home products with less usefulness.

An extremely reliable smart home product had a higher utility than a moderately reliable or a none reliable smart home product, also at the same level of importance comes the cost. A low cost smart home product is more preferred by consumers with the highest utility, but a moderate cost can be also acceptable since there wasn't a considerable variation between the two levels, at the end comes smart home products with high cost. A moderately interoperable smart home product was more preferred by consumers, then comes a none interoperable product, and finally an extremely interoperable product which shows that interoperability is not taken a lot of attention by consumers.

The product profile that has the highest possible utility for all the 155 respondents was a smart home product with a high privacy and security, extremely useful and reliable, moderately interoperable with a low cost. the profile that has got the least utility had only an extreme interoperability and a high cost with the absence of the other attributes. Producers who provide smart home products with this utility can use the part-worth analysis of every single attribute in order to find out how they can boost the consumer's utility from the smart home products.

Smart home product producers should take into account these findings; they need to check with technicals in order to improve the privacy and security

attribute of their products since it had taken the highest importance by respondents; they need to highlight the usefulness of the products while devising marketing, pricing or promotional campaigns that strived for rising the purchase of smart home products. They can use niche strategies in order to make the product easily differentiated from other products, and it will have also the possibility to be produced and marketed for special utilizations within its correlated niche market. The definition of the perfect product for consumers helps producers to improve products that have the needed sets of attributes and take into account the best way to target their market. That is considered as one of the advantages of conjoint analysis. In this context, privacy and security and usefulness were identified as taking nearly more than 50 per cent of the attributes importance for respondents. Smart home producers who have consumer satisfaction as a purpose, should highlight their smart home product privacy and security and usefulness in any marketing strategies undertaken by them.

More researches should be done about the cost of smart home products. From one side, standing on the findings cost is taking 17% of the importance among the other attributes which is half important as privacy and security. From another side, cost still always a sensitive aspect for consumers. In this research respondents expect smart home products with low to moderate price. Consequently, smart home product psychological costing research should be done. A study regarding the psychological attribute of cost for consumers would permit smart home producers to target this cost sensitive consumers more effectively.

Research have also to be done to analyze what consumers take as acceptable cost for smart home product. Respondents of this research, in spite of their high expectation regarding the smart home product features from privacy and security, usefulness, reliability and interoperability, they derived a negative utility for smart home products with high cost. the results of the research in hands, propose a cut in costs which may help making their product offerings better for their consumers.

Furthermore, it is preferable to make a conjoint analysis research using segmentation analysis of consumers' preferences and needs which gives more

value to the research. The output segment structure can be taken into account in order to define new products that appeal to defined customer segments. The estimated preference partworths can be used in order to define customer's segments who are having common likes and dislikes and give values to some attributes to nearly the same level.

In this research, an analysis of existing products has been done in order to investigate the market potential of the new offering, which are measured with a reference to what already exists in the market. It is recommended to run a cannibalization effects analysis of the new product on the company's existing products in the market.

Since the current data of smart home products market shares is unavailable, unfortunately, a comparative analysis of this data with predicted market share studied is currently impossible but would have be of a good interest. That kind of analysis would better test the usefulness and accuracy of the methodology used in comprehending and expecting consumer behavior (Batt & Katz, 1997).

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