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Home Automation Awareness in United Arab Emirates

استبيان لمدى الوعي بنظام التشغيل الاوتوماتيكي للبيوت في دولة الامارات
العربية المتحدة

by

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**A dissertation submitted in fulfilment
of the requirements for the degree of**

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Abstract:

More than ever, we use internet excessively almost everyone access the world wide web daily, from kids to elderlies, even from people with different academic backgrounds we use it to connect, socialize and even perform tasks. By 2020, numbers indicates that 21 billion devices are going to be connected to the internet. In fact every “Thing” can be connected to internet from smartphones, tablets, watches, cars, appliances and even homes, better known as “Internet of Things”. Mega IT companies are investing into researches to combine IoT, Artificial Intelligence, and automation to increase the efficiency and productivity of things around us hoping to make people’s life more convenient.

Internet of things, Home Automation and smart home technologies will transform our homes and the way we live drastically. Home Automation empowers users to control and monitor their houses remotely. The question is; are we ready for this change? Are we aware of the benefits of it? Are we going to think about the risks? But most importantly are we going to adopt this technology?

One of United Arab Emirates strategic goals for 2021’s National Vision is to provide sustainable housing for its national citizens. With full awareness to invest in renewable and clean sources of energy and be less dependent on using nonrenewable sources of energy like fossil fuels and natural gas, moreover preserve water and natural resources. In addition to, investing in the latest telecommunication and IT sectors. The goal is to form a new kind of modern Utopia, which are “Smart Cities”, wither by renovating the existing structure or by totally building a new smart infrastructure from scratch.

This research will highlight the importance of adopting smart technologies in this phase of time into your home. With the aim of conserving electrical power and water as well as increase comfort and security level, it will closely survey the user’s opinion by analyzing the smart home automation technology and the ways of selecting the right energy saving appliances, lighting fixture and water saving tools.

الملخص:

بدون شك ان استخدام الانترنت اصبح من الضرورات اليومية حيث يستخدم الانترنت بلايين البشر من كافة انحاء العالم بمختلف الفئات العمرية و المراحل الدراسية و من جنسيات مختلفة بشكل يومي .في المستقبل القريب و تحديدا في سنة 2020 هنالك تقدير لعدد الاجهزة الموصولة بالإنترنت إلى 21 بليون جهاز, وذلك ليس حكرا على الهواتف الذكية او الألواح الذكية او حتى الساعات الذكية بل "اي شيء" يمكن وصله بالإنترنت و مع بعض لتبادل البيانات و تخزينها , ذلك هو مفهوم لمصطلح "انترنت الاشياء". كبرى شركات التكنولوجيا و المصانع تتسارع لتزويد اجهزتها و خدماتها بهذه الميزة .الفكرة بذاتها حولت البيوت العادية إلى بيوت ذكية بنظام التشغيل الاوتوماتيكي لكي يتم مراقبة و التحكم بالأجهزة المنزلية عن بعد .

العالم حولنا متسارع في التغيير ولذلك تحرص الدول على مواكبة التغيير والاستثمار في تبني التكنولوجيا لتشكل نوعا حديثا من "المدن الفاضلة" وهي المدن الذكية. سواء كان في اعادة تأهيل المنشآت القائمة او تأسيس بنية تحتية كليا.

واحدة من خطط دولة الإمارات العربية المتحدة الاستراتيجية لعام 2021 ان توفر مساكن مستدامة لمواطنيها مع الوعي التام بالاستثمار في مصادر الطاقة المتجددة والنظيفة وتقليل الاعتماد على المصادر الغير متجددة كالغاز الطبيعي والوقود الاحفوري والحفاظ على الموارد الطبيعية كالمياه. بالإضافة إلى كل ذلك استخدام أحدث وسائل تكنولوجيا المعلومات.

هذا البحث سيلقي الضوء على اهمية دمج التكنولوجيا الذكية في هذه المرحلة من الزمن في المنازل لتحقيق هدف خفض الطاقة الكهربائية والمياه وايضا تقصي اراء المستخدمين من خلال استبيان لدراسة مدى وعيهم وتقبلهم لتطبيق نظام التشغيل الاوتوماتيكي للمنازل لتصبح منازل ذكية ويدرس اهمية اختيار الاجهزة الالكترونية الذكية التي تساهم في خفض مدى استهلاك الطاقة الكهربائية والمياه.

Dedication:

I would like to dedicate this research to whoever is interested in the same field.

Acknowledgment:

I always thank Allah for the many blessings I received, after my bachelor degree; I did not consider continuing my master's degree. Now I have a different mindset to never stop learning and pursue highest degrees .I feel that I have a major responsibility to contribute to the development of my own country and hopefully I can return some of the favor of my country on me. I would like to extend my gratitude to my family, my beloved siblings and wonderful friends.

It is a genuine dedication to a great mother for her endless lifetime support; she believes that education is the elegance of mind. Finally yet importantly, I would like to extend my gratitude to my academic professors in BUiD, and dissertation supervisor Dr.Riad Saraiji for the constant encouragement and support, and who inspired me to think creatively.

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List of Abbreviations:

AI-Artificial Intelligence

DEWA-Dubai Electricity and Water Authority

FEWA-Federal Electricity and Water Authority

HEMS- Home Energy Management System

IoT-Internet of Things

PVRS-Pearl Villa Rating System

SEWA- Sharjah Electricity and Water Authority

SH-Smart Home

UAE-United Arab Emirates

UN-United Nation

Chapter 1: Introduction and Background

1.1 Chapter overview:

This chapter asks a research question about Home Automation awareness level in UAE. In addition, why it is important to integrate this technology at homes, seeks to define the problem of implementing this technology and demonstrate the purpose of the study.

Also this chapter aims to get a better understanding of adopting methods to contribute to attaining sustainability goals, after tackling the climatic change issues globally and especially in United Arab Emirates after studying its background, strategic plans and Initiatives to face the global matter.

1.2 Research Question:

The purpose of this study is to understand future and current dwellings modern requirements in terms of adopting trending technologies such as IoT and AI, home automation and so on. What is this system about? How it will make people's lives better? What are the benefits and concerns of Home Automation, what is the role of the government and role of occupants? So many questions to be answered during this research.

They say that "Change is the only constant" ever since humankind existed in this planet they always found away to adapt with change, developed new skills and sometime got ahead with knowledge to create and innovate new things, same goes with sheltering from caves to smart homes!. Engineering and technology are coming together to make things a little bit more easier for people so Home Automation and Smart Homes can be a solution for a better sustainable life style.

The question of this study is: How Home Automation can be used to solve domestic issues; reduce bills and time in doing tasks, however the main question is:

- **What is the significance of Home Automation and how it will fit the context of UAE?**

The key objective of this study is to present the adoption of Home Automation and its usage in local scheme the awareness level and acceptance toward technology for improved living conditions. This study will present the importance of Home Automation in UAE.

1.3 Problem statement and purpose of the study:

As mentioned previously what is the importance of Home Automation and how will fit the context of UAE , is UAE ready to adapt and implement this technology ? are people aware of it , are they willing to invest in it ?or what are the benefits its going to bring to the users and what are the risks or concerns when people start to use this technology efficiently . The purpose is to highlight the importance of following the state-of-the-art technology be aware of it and use it wisely.

1.4 Aims and Objectives:

The aim of this research is to discuss Home Automation technology in UAE also the current issues of sustainability and how will smart automated home contributes in this matter, and bridge the gap between ecology and technology. Furthermore, study the impact of smart sustainable homes on optimizing energy efficiency without compromising resident's comfort and well-being, which will ultimately decrease the ecological footprint and harmful greenhouse emissions such as carbon dioxide, it is all connected.

Also, this research aims to promote and highlight the importance of adopting sustainable lifestyle in everyday bases by proving the benefits of integrating smart systems into homes. In addition, make a smart investment in renewable energy needed for sustainable way of living with the challenge of increasing the standard of comfort and health. Moreover, build strong social network of people who are aware of the environment challenges and take the initiative toward reducing the dependency on nonrenewable sources of energy .The smart sustainable

homes research could be taken later as a prototype for sustainable communities or local government housing programs .The main objectives of this research are to:

1. Identify the concept of IoT, AI, Smart Home and Home Automation.
2. Conduct a literature review by collecting trusted recent scientific data.
3. Recognize barriers of adapting IoT and smart devices from consumer perspective, government approach and market statuses.
4. Analysis the advantages and disadvantages of adopting Home Automation technology.
5. Collect a survey about people's preference and energy consumption behavior.
6. Design strategy or a framework to estimate of the needed resources requirements.

1.5 Climate Change and Global Warming:

The temperature is raising gradually over the years causing a global warming. Climate change is a massive issue where many countries are moving toward solving the problem in holistic manner. The effects of global warming not only tackles the ecological system balance but also disturb the weather conditions to melt the iceberg and threaten to extinguish endangered species. It can lead to catastrophic climate changes of natural disasters like tornadoes and floods.

Moreover, the raise in temperature drives us to use more cooling loads in our buildings and cars this process is consuming huge amount of energy .The production of energy nowadays is mainly dependent on non-renewable sources of energy like fossil fuels and natural gases.

The problem with this energy production ,is the greenhouse gas emission which creates “Greenhouse effect “making the carbon dioxide along with other gases traps in the atmosphere, where the sun longs waves are reflected as short waves warming up the temperature. Ultimately leads to global warming ,so in order to break this cycle renewable sources of energy are taking over progressively like using Solar power ,Wind power and water turbine generators in

addition to using nuclear energy .As with the modern lifestyle we consumes a lot of energy so integrating smart technologies could offer a resolution to optimize energy efficiency.

1.6 Sustainable Future:

In 2016, United Nations developed a strategic plan made out of 17 main goals to be implemented. For each goal there is a target list and progress indicator for which all together should to be achieved by the year 2030(Sustainable development goals - United Nations 2018) as shown in figure number 1.



Figure 1:(Sustainable Development Goals, Source: United Nations2018)

The seventh goal target which is about affordable and clean energy, as to attain universal access to modern energy services of renewable clean energy resources as well as energy efficiency, the challenge is about the governmental policies, acceptance level to integrate new technologies.

According to United Nation statistics shows that 85.3% of the global population had electricity in 2014, which is about 1.06 billion so the rest of people are living without any electricity, they still use traditional ways of cooking with fire and not using clean fuels or electrical cookers clearly.

Goal number eleven draws a plan of sustainable cities and communities, which got the pillars of creating safe, resilient and sustainable cities. If combined with goal number 9, which is about industry and infrastructure preparing cities for smart infrastructure will make a difference in the global goals .And will reflect on goal number 8, which is decent work and economic growth. In 2015, about four billion people lives in the city so by 2030 it is predicted that it will increase to be about five billion people.

1.7 Population Growth and housing demands in UAE:

According to world meters, the latest statistics of United Arab Emirates demographic numbers of 2018 shows that over the past decades there is a significant increase of the population growth rate as 1.50 % (World meters 2018).

The population number estimated to be around 9,538,227, which is about 0.13% of the total world’s population most of this number is due to migrants which is around 88 percent of the total population number. Emiratis make up about only 11 percent of the total number and the median age is 33.5 years, as shown in figure number 2.

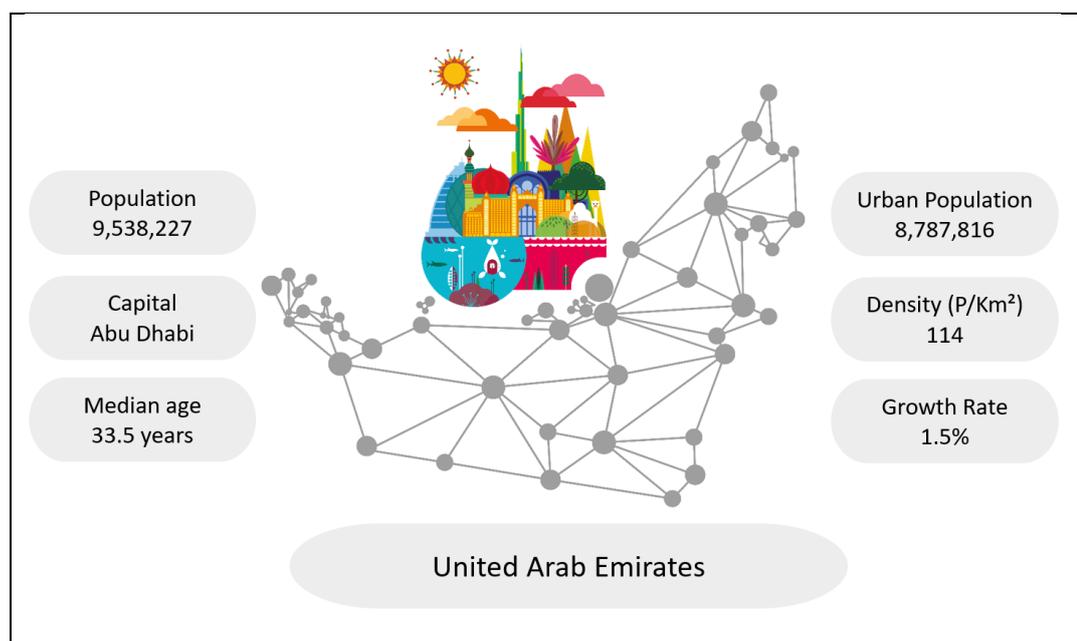


Figure 2:(Population number in UAE 2018, source: World meter)

Attributable to the position of Dubai as a tourism attraction destination it is the densest city among other emirates, followed by Sharjah and then Abu Dhabi. In United Arab Emirates there are several housing program dedicated to design and build homes to UAE nationals like:

Shaikh Zayed Housing Program, which serves the whole country as a federal authority, there is one in Dubai Shaikh Mohammad bin Rashid housing Program, in Sharjah there is Directorate of Housing.

With the increase of population number naturally there is an increase in energy demand to support household activities .It was reported that about 25.4% from total energy is for household consumption ("Energy consumption in households - Statistics Explained" 2018).

All of these energy consuming activities had led to increasing the carbon dioxide emission, affecting the carbon footprint making the UAE as one of the countries with largest ecological footprint challenges house hold activities is responsible for 57% of the total footprint("United Arab Emirates - Global Footprint Network" 2018).

1.8 United Arab Emirates Green Infnitives and Sustainability achievements:

In 2009, United Arab Emirates managed to host the International Renewable Energy Agency “IRENA”, which is located in the capital Abu Dhabi ("International Renewable Energy Agency (IRENA)" 2018).

The main role of the agency is to promote renewable energy in addition to advising and training their members to the best practices regarding how to use and finance renewable energy sources as well as giving them annual performance reports.

In order to better suit the context of UAE , climatic condition and overall circumstances it created it is own local Green Building codes version of LEED (Leadership Energy

Environment Design) Sustainability rating system which is another important green initiative aiming to optimize energy efficiency .

In Abu Dhabi the Department of Urban Planning and Municipalities tailor made “Estidama Pearl Rating System “the main pillars of Estidama are :Environmental ,Economic, Social and Cultural. The rating phases starts with the design phase then a construction phase and last is the operational stage the categories of evaluations system covers villas, buildings and communities.

In Dubai the green building evaluation system is called Al SA’FAT developed by Dubai Municipality the regulations are applied in Dubai existing and under permitting buildings .Both codes made it mandatory for all buildings permitted to apply the regulations in their building to be sustainable and energy saving.

When it comes energy generating projects one of the most promising major projects is “Barakah Nuclear Power Plant “According to Emirates Nuclear Energy Corporation (“Barakah NEP” 2018).

It is predicted that by 2020 the power plant will cover quarter of UAE’s energy demand saving 12 million tons of carbon dioxide emission annually, which eventually will reduce the impact on the environment.

To diversify the renewable eco-friendly sources of energy solar power is utilized in” Shams Dubai Project “by Dubai Electricity and Water Authority (DEWA) which is a program that aims to encourage users to install Photovoltaic panels to generate electricity to their buildings. Another major project is (“Mohammed bin Rashid Al Maktoum Solar Park” 2018) “lunched back in 2012. According to DEWA, it will provide by 2020 a 7% of clean energy to Dubai in the first stage, and in the second phase by 2030, it will cover 25% and by the third stage in 2050 a 75% will cover most of the city need for the eco-friendly source of energy.

2 Chapter 2: Literature Review

2.1 Chapter Overview:

This chapter gives a general introduction of the evolution of internet concept; also, it will highlight the aims and then focuses on the importance of keeping up to the state of the art technology. This chapter is literature review conducted to better understand the technological terminologies and scientific research findings that are relevant to sustainability and smart home automation features. Several recent studies were collected about IoT, Artificial Intelligence and Home Automation. Moreover analyzing the factors of the benefits of IoT and possible concerns of integrating these technologies in homes. Additional factors are considered such as cost effectiveness and energy efficiency.

2.2 History of the internet:

In order to understand the concept of smart automated houses; first, we need to know the basis of the notion that enabled us today to use it, as shown in figure number 3. Dr. Joseph Licklider, a computer scientist from the United States thought of connecting computers through a shared system. Off course it was not a popped up idea it was a study about the “The Computer as a Communication Device “.

In 1962 in this study he anticipated the idea of what we know today as the “Internet “, at first he connected two computers through telephone dial-up wire. After that, the connection of data was used for military to form a network called “ARPANET “(Engard 2018).

Taking after, Leonard Kleinrock a computer engineer known for developing the concept, which was simply a trail of connecting computers from different sites to share and have an access to a data through a linked intermediate.

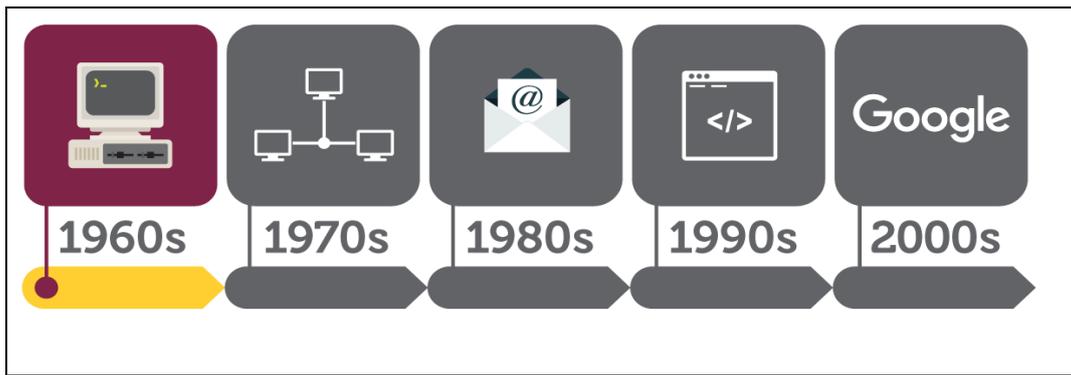


Figure 3:(Evolution of the internet overtime, source: Engard 2018)

In the seventies the concept of ARPANET was applied to transfer the data from Host-to-Host and accessible for public to operate with. In the eighties notifications were sent as an Electronic mails which allowed for instant data transmission and communication between sender and receiver. By the nineties many companies created software for surfing the World Wide Web (www) and was used by many people around the globe as well as producing searching engines like yahoo and Google.

Nowadays the concept evolved further to connecting even “Things “to each other, better known as “IoT” the internet of things or “IoE “ the internet of everything ,the transition started with having smart phones ,smart tablets ,smart TV , smart watches ,smart cars and smart appliances .

Artificial intelligence “AI”, helps users to control and filter the massive amount of the information flow and assists people with performing tasks in short time or in efficient approach by machine learning or deep learning techniques with time the machine will understand the users need and start to make more sense and decision making.

Developed countries success is measured by the technological advancement and creative innovations, which provides luxury and convenience to its users. More importantly the invention of intelligent home appliances that uses electrical energy and water in efficient way by using Home Energy Management system (HEMS) which has sensors to monitor the

consumption rating and system's efficiency process and interacts with residence to give them the latest performance information through their smart phones or tablets ("Redefining Home Energy Management Systems" 2018).

If we consider the "smart sustainable community" as an energy self-sufficient cell that will build up in the community, it will result in not only having a smart city, but will also contribute in being more environmentally friendly. Moreover, raise the awareness of people to share the concern of climatic change issues and collaborate to face it.

The GCC countries are racing to be leaders in sustainability field. According to Smart Dubai Government that is working on a lot of smart initiative related to data storing, block chain management and smart living and clean energy. It is predicted that it will generate 33.8 billion AED in three years and by 2020 around 18 billion AED ("Dimensions | Smart Dubai" 2018).

2.3 The Internet of things (IoT) Definition:

In 1999, Kevin Ashton developed IoT (Internet of Things), which connected "Things" to each other to perform tasks assigned by users. Which allowed for exchanging data in many ways from the user to the machine or directly between machines with less human interaction. The data exchanged is saved in a common iCloud server.

The concept of IoT can be utilized in many areas the options are endless, wither in retail ,education sector, manufacturing sectors ,health care sectors, automotive ,smart cities , energy and power sector etc. as shown in the figure number 4.

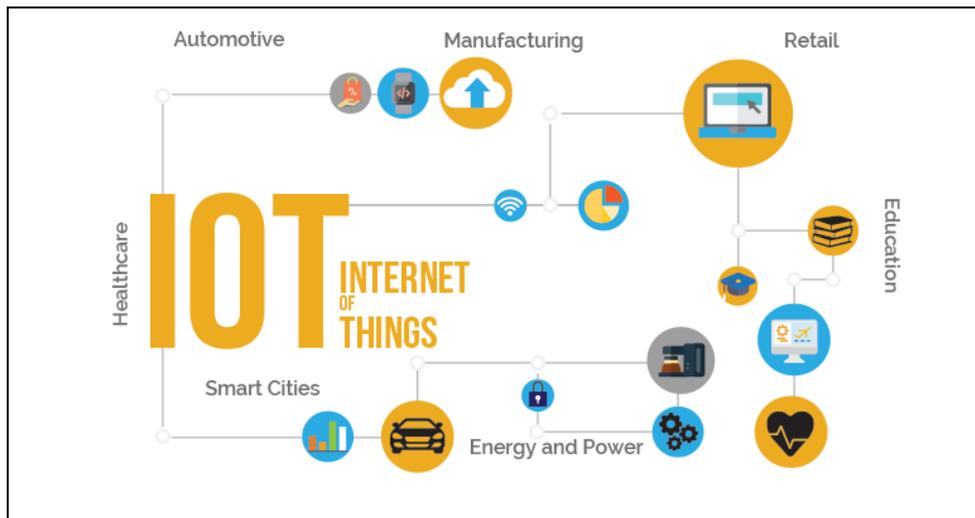


Figure 4:(IoT life domains, source: Georgia Technologies 2018)

Home Automation is a major trending topic because it can create a smart convenient environment, if any house installs Energy and water management system to monitor and control the consumption to more efficient way; it can help in reducing the energy demand rapidly. The system is integrated with “Smart Meters “, it takes the data from HVAC, lighting, appliances smart power outlets which are all equipped by sensors of different types like: motion detection sensor, sound sensor, light sensor or even temperature sensor. Which gives the user a real-time feedback and the ability to control the system remotely regardless of their physical location a possible benefit is the real time pricing for the water and electricity bills.

2.4 IOT in Smart cities and buildings:

Population is denser in cities, statistics shows that more than 50% of world’s population are living in cities, and nearly 70% of world’s population expected to live in cities by 2050 (Sun et al. 2016). Condensed cities struggles with issues like the constant high demand for energy and water supply, traffic, large amount of waste which needs a lot of resources and manpower to face all of the challenges. The concept of sustainable cities did exist in the past, however today people and government will not settle for sustainability standards and regulations alone they thrive to work in the present for a “smarter” future.

Using Internet of things in major city scale from connecting all the dots together of all sectors to share the data and find a solution for the energy demands, traffic, and waste management and so on could reflect possibly on people's live and wellbeing. IoT is widely applied in smart transportation, conservation of the eco-system, government work, security, Home Automation, medical sector etc. (Li & Yu 2011).

As stated by (Georgios L. et al, 2017), it is hard to imagine a future smart cities without smart buildings. Smart building control system, can lead to building energy conservation based on the internet of things from design to construction to operation, IoT can play a key role in sharing data of buildings and makes communication direct between engineers and potentially clients. It is not only about connecting things and systems to each other but also about saving in cost with better data management.

Modern smart buildings can do more than just switching the lights on and off (Matthew B. et al, 2016). As a case study done by (Zeliang L. et al, 2017) in a smart city of Jiujiang city, the study concluded that creation of a smart city need to reflect the full end-to-end information exchange. Smart cities should not conflict with economic, political and cultural values. According to (Andrezej M. et al, 2015), it's not possible to predict the exact future of a system that is as large and vibrant as the smart building IOT ,but it could be advisable to study development scenario. (Andrezej M. et al, 2015) mentioned that ambiguity is one of the problems in construction, which always estimated in the beginning of the construction phase and continues during whole project life cycle.

The availability of new technologies is altering the delivery and operation of services in building management and in many other sectors (Prashant K. et al, 2016).

According to (Geng L. et al, 2017) IoT has achieved good results in construction related fields. In order to cope with the risks that may arise during the future development, it is necessary to

further optimize the hardware and software of the system. As a published case study done by (Bo W. et al, 2014) in the smart residential district in china, smart technologies can be used to guide the construction and evaluation of smart residential district in order to avoid low-level construction. The usage of the new technology system in smart residential district in china can lead to positive results for an easier life. According to (Andreas P. et al, 2018), cost reduction, safer environment, comfortable and friendly applications could be achieved through a system, which can exploit all the abilities of the technologies studies.

2.5 IoT in other domains of life:

IoT can be applicable in many domains of life to achieve higher productivity, comfort, and cost reductions. According to (Koo et al. 2016); the application of internet of things has positive results in increasing bathrooms safety of for older people. IoT can decrease the hazardous conditions and injuries in bathrooms by plugging different kind of sensors like leakage sensor, which detects the water leakage especially when old people are unable to move.

In a study about fog computing and the IoT done by (Flavio B. et al, 2012), the smart traffic light node interacts locally with a number of sensors, which detect the presence of pedestrians and bikers and measure the distance and speed of approaching vehicles.

A study conducted by (Zhang Y. et al, 2013) mentioned that fire IoT could be used in firefighting departments by firefighting facilities to perceive latent dangers of fire. By installing IoT smoke and gas detector sensors at home, occupants can monitor home, get an alert if there is any smoke or gas leakage, and possibly contact the firefighting department immediately.

In healthcare Internet of things can be useful, a case study done on balcony with IoT by (Yoshisumi N. et al, 2017), IoT balcony functions can sense the risk of falling also recognize children presence adult supervisor. IoT Handrails works on estimating a walking speed of elderly at home.

In education sector research done by (Wang 2014), the architecture of IoT psychological health platform is divided into three layers: sensing, network and the application layer. IoT based psychological health education platform is used in order to solve.

A case study done safety in road maintenance works, done by (Rita Yi Ma Li, 2017), Robots can replace labours in road construction due to the high number of road labour accidents, and Robots can solve the problem of labour shortage. For safety issues, robot arms can be used instead of labors in road works despite of the high value of the robots comparing to the labour salary.

Regarding the Management and Internet of things, (Mayra S. et al, 2016) mentioned that IoT usage in network management introduce virtual resources as a recommended option for management.

A case study in IoT in food supply chains control and management by (Riccardo A. et al, 2017). A preliminary panel of performances allows the real time analysis of the Food supply chain possibility not to waste food. IoT in food supply chain leads to solve the challenging issues like costs, emissions and social impacts.

For manufacturing sectors IoT, There is no concept of a business model that is supportive of the company passing on the digital market. Companies will change the existing business model (Sylwia Gieriej, 2017). Industrial Internet of things is trending and will flourish in the near future. Moving to the educational domain, remote education by IoT owns has positive results on students and teachers as well which enhance the data communication & processing ability (Yuqiao Y. et al., 2016).

A case study done by (Xu Jianguo, 2014) for a weak current system of the Mass media building and the impact of IOT on it, The intelligent buildings has the advantages of a lower cost, a faster, more reliable and intellectualized system, more comfortable environment and richer

imagination. Internet of things can be applied to the buildings to provide comfortable and smart methods for more effective works.

IoT can be used in library books organizing system and share information and data. The connection between people and devices through IoT, can empower librarians and provide library users with a unique, personalized experience (Jonathan B. et al, 2018). Also mentioned that the long-term cost savings of more efficient buildings and the detailed data about building use provided technologies that can help offset the increased costs and the relative longevity of the typical library building. There will be years to realize the benefits of these technologies.

2.6 Artificial Intelligence definition:

Artificial Intelligence (AI) means replicating human intelligence, senses, behavior into machine by coding algorithms or deep learning techniques, and train the machine to have logical thinking so that the machine starts to assist human to make decision or perform special missions.

Tasks can be assigned to the machine by voice command, which recognizes the voice of the user and type of request and perform it accordingly. Occupants can control their houses remotely by using smartphone applications to control lights, AC system, appliances and security.

Over time, machines with AI technologies can predict the behavior of people recognizes the family members or guests or spot thieves, which can increase safety measures on a domestic scale .The downside of depending on AI is laziness and lack of physical motion because even when occupants are at home they will use tablets or phones to control their home .Another issue is system corruption, or invading the privacy of occupants or delay in doing tasks.

2.7 Artificial Intelligence in UAE:

The UAE desires is to become a leading country of Artificial Intelligence by 2031. According to his Excellency Omar Sultan Al Olama UAE'S Minister of the AI.UAE's sees the potential of combining the National vision and advanced technology of the telecommunication sector and AI and leverage on that.

This is going prepared the country for the next wave of Digital revolution. "We should not just legislate in line with the changes in the world, but we have to change the world first," Said Omar. UAE seeks be the hub of AI of the world, and to reach to remarkable achievements in AI .It will prepare an aware a generation of AI programmers who can face the challenges, suggest innovative solutions to improve the quality of living.

2.8 Telecommunication in the world and in UAE:

According to Hootsuite, numbers of Digital around the world and in UAE reports that shows multiple reports of digital and related statistics, for example the number of internet users compared with the total population. Those reports are useful to understand the number of internet users, the hours they spend online, and the kind of tasks they perform, the preferred device used to access the internet and so on. This means that if people already use connected device adding Home Automation technology management and integrating it in their daily routine should be easy because they have the basic requirements, which are smart device, and internet connectivity.

The total population of the world in 2018 is estimated to be around 7.593 billion with 55% of urbanization. The internet users are about 7.593 billion, while the active social media users are estimated to be 3.196 and 2.958 socially active by using mobile phone applications, see figure number 5.

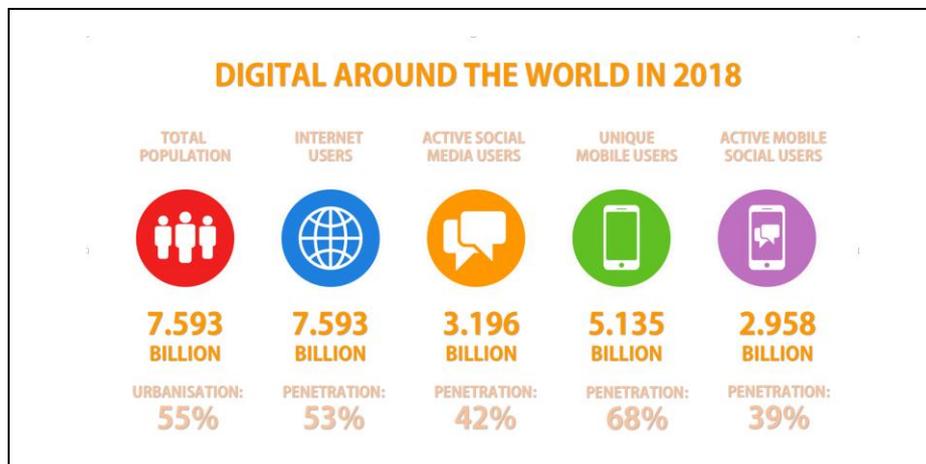


Figure 5:(Digital around the world, Source: Hootsuite, 2018)

According to (Gfk.com, 2016), statistics ranked the most connected populations in the world, Hon Kong came first, followed by North America and from the middle east the third place was for UAE, see figure number 6. It combined the connectivity of several gadgets (Tablet,

smartphone, videogames, TV, desktop, connected cars, smart home etc.). This means that UAE probability to have smart automated homes will be easier in application and integration.

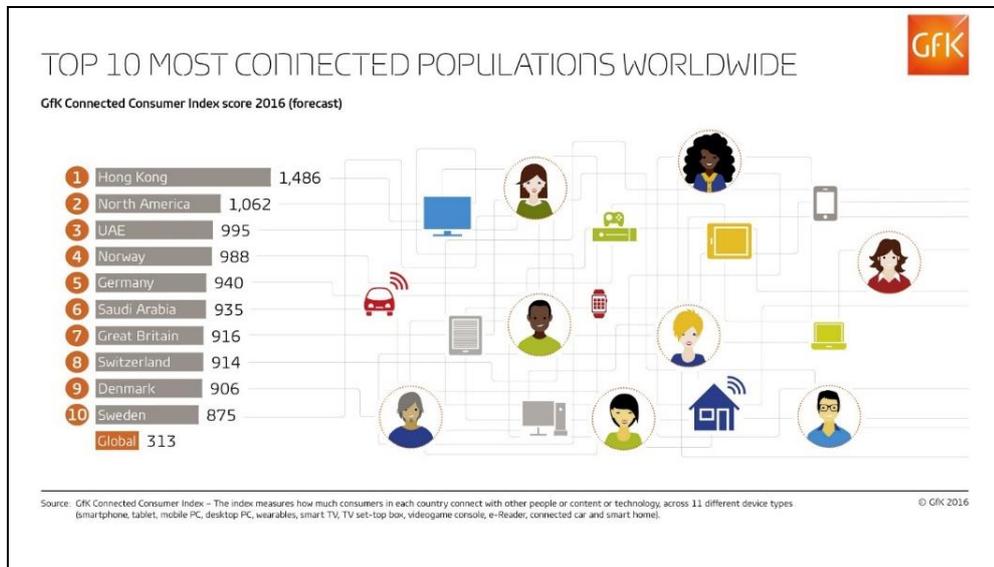


Figure 6 : (Top 10 most connected population worldwide, source: GfK 2016)

In United Arab Emirates out 9.47 million, the internet users are 9.38 million with percentage of 99 penetration. The same number is for active social media users and 8.70 million uses their mobile to get social, see figure number seven.

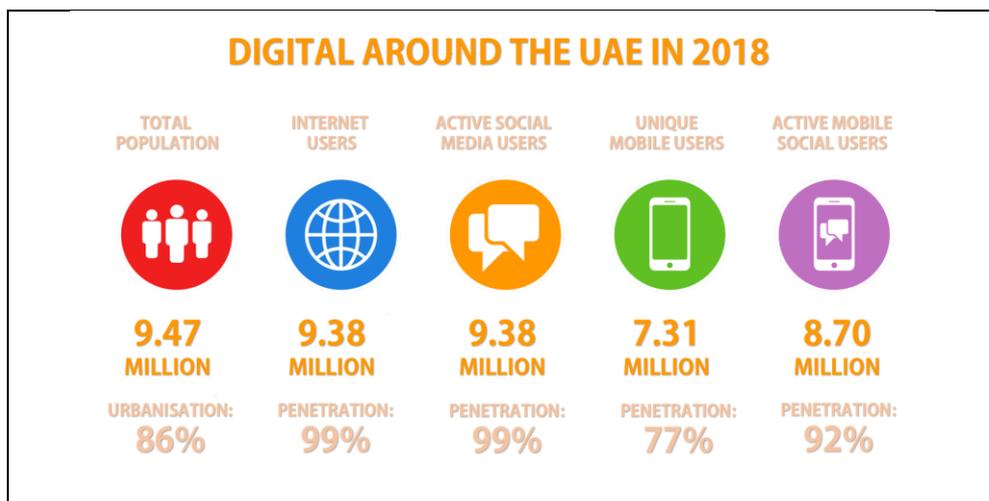


Figure 7 : (Digital around the UAE in 2018, Source: Hootsuite, 2018)

A recall of the statistics, see table number 1:

Statistics	Number in Millions	Percentage
Internet Users	9.38 M	99%
Active Social Media users	9.38 M	99%
Unique Mobile users	7.31 M	77%
Active Mobile Social users	8.7 M	92%

Table 1:(Statistics of internet users in UAE)

According to statistics based on a survey, results show that the internet users in UAE spend 7hours and 49 minutes per day on the internet by any devices. The average daily time spent using social media by any device is almost 3 hours, watching TV can last to 2 hours and 18 minutes on average and one hour is spent on listening to music, see figure 8 below.

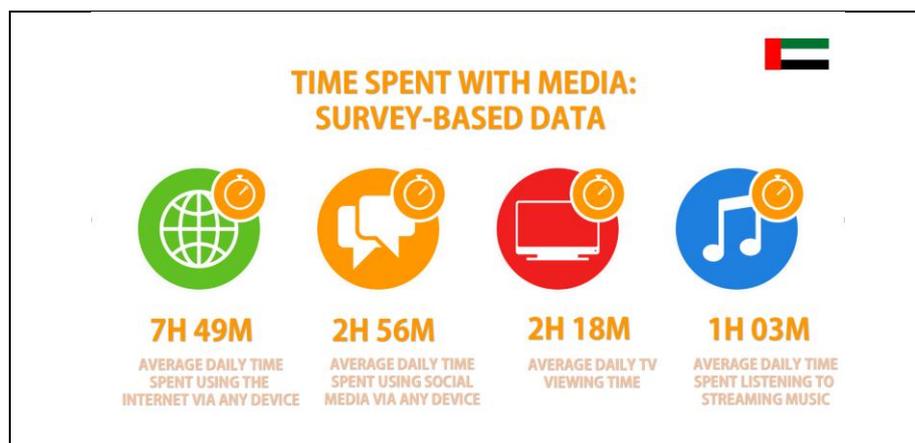


Figure 8 :(Time spent with media, Source: Hootsuite, 2018)

As for the annual digital growth there is a growth rated with 2% of internet users and increment with active social media users of 2% and noticeably from using mobiles they are increased with 6% since 2017,see figure 9 below.

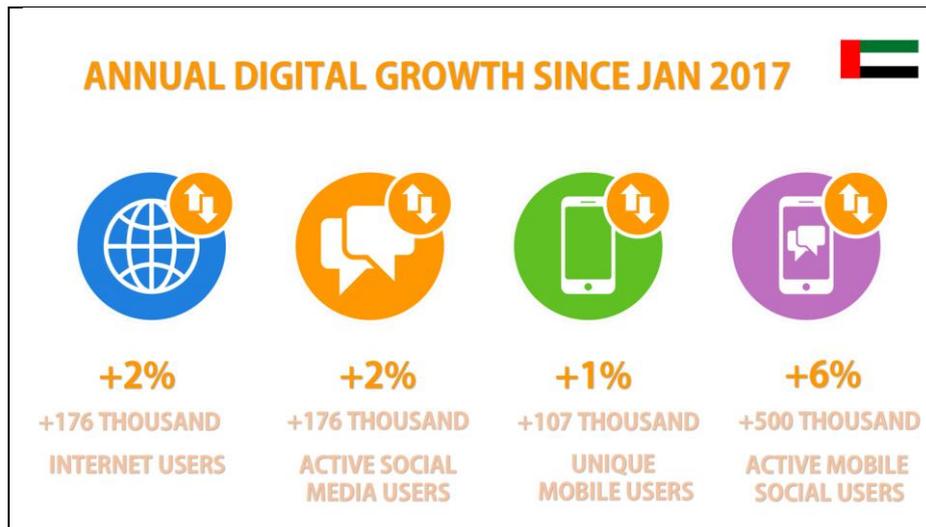


Figure 9:(Annual Digital Growth since 2017, Source: Hootsuite, 2018)

Global web index data based on a survey of internet users aged 16-64, see table number 2.

Statistics	Number in Million	Percentage
Active Internet users	9.38 M	99%
Mobile Internet users	9.13 M	96 %

Table 2 :(Global web index of internet users from 16-64 years old age range)

When it comes to how people react with digital, people have different attitudes and values. Most of the people are optimistic about technology and feel that it offers more chances than risks. In addition, they tend to prefer doing tasks digitally if they can rather than traditionally. Privacy is important to people in UAE 80% voted for it that is why 40% of them deletes cookies for extra protection or use blocking tools to stop spam of unsecured web pages and so on , see figure 10.

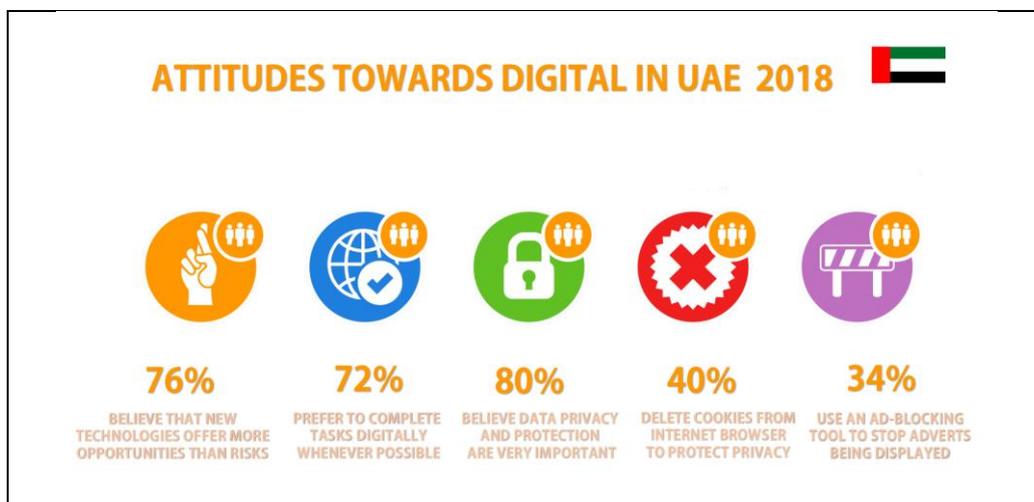


Figure 10:(Attitudes toward digital in UAE, Source: Hootsuite, 2018)

See table number 3 for numbers details:

Statistics	Percentage
New Tech offer more opportunities than risks	76 %
Prefer completing tasks digitally	72 %
Thinks that Data privacy and protection are very important	80 %
Deletes cookies from internet browser to protect privacy	40 %
Use AD-blocking tools to block advertisements	34 %

Table 3:(Attitude toward digitals of the survey whom age is between 16-64 years old)

A survey for the device usage done among the internet users aged 16 to 64. Smartphone users are 96% this will translate the ability in downloading Home automation application also smartphones got more options tools and phone assistant to control by voice command and most importantly can be connected to the internet. Home occupants can still control and monitor their home while using laptops so 71% uses laptop and 28% uses tablets, see figure number 11 below.

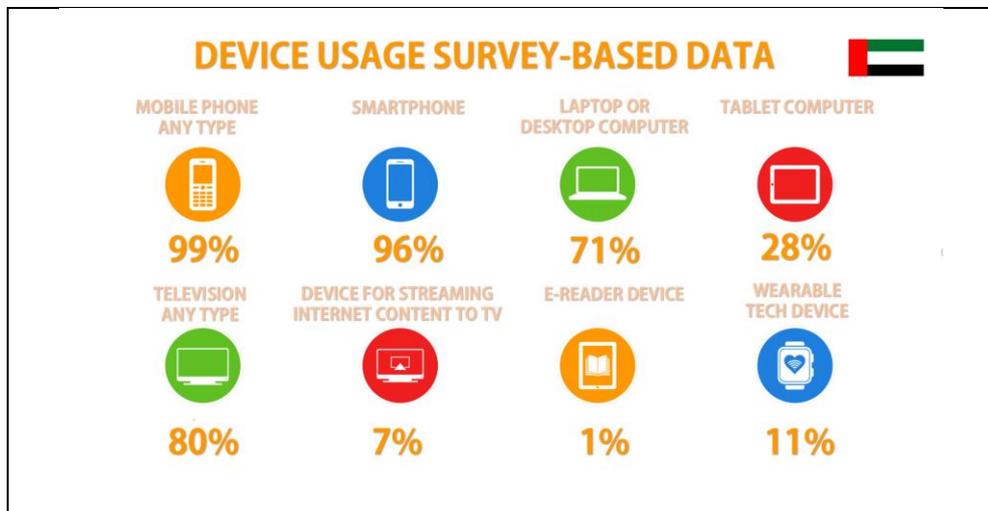


Figure 11:(Device usage survey-based data, Source: Hootsuite, 2018)

See table 4 for detailed results show that:

Statistics	Percentage
Use any type of mobile phones	99 %
Use smart phones	96 %
Use laptops or desktop computers	71 %

Use Tablet computers	28 %
Use any kind of TVs	80 %
Use devices for streaming internet on TV	7 %
Use E-reader devices	1 %
Use Wearable Tech devices	11 %

Table 4:(Device usage)

The percentage of people who access the internet frequently every day is 93%, while 6% at least once per week and no one access it ones per months .This means that most of the time they are connected all the time which assures getting notification of Home Automation events and real time data exchange, see figure number 12 below.

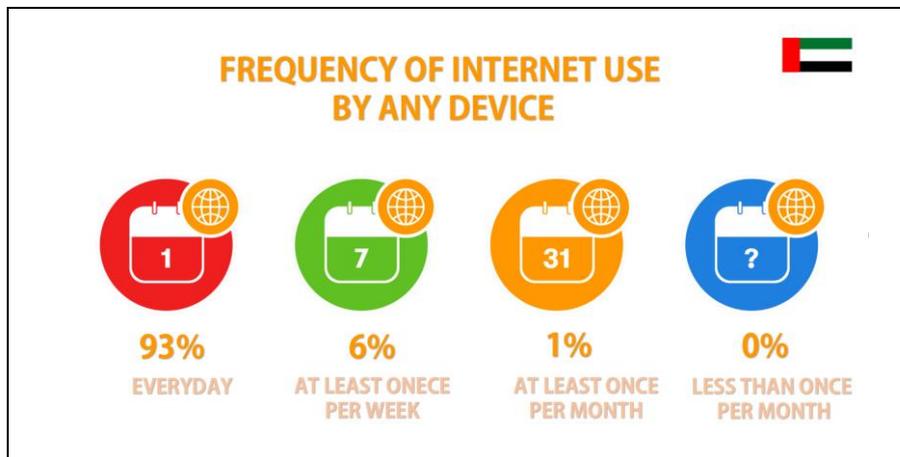


Figure 12: (Frequency of internet use by device, Source: Hootsuite, 2018)

The frequency of internet use as the following, shown in table 5:

Statistics	Percentage
Use internet everyday	93 %
Once per weak	6 %
Once per month	1 %
Once per year	0 %

Table 5:(Frequency of Internet usage)

To recap 99% of the 9.38 million UAE’s population uses the internet, 9.13 are active internet mobile user with 96%, see figure number 13 below.

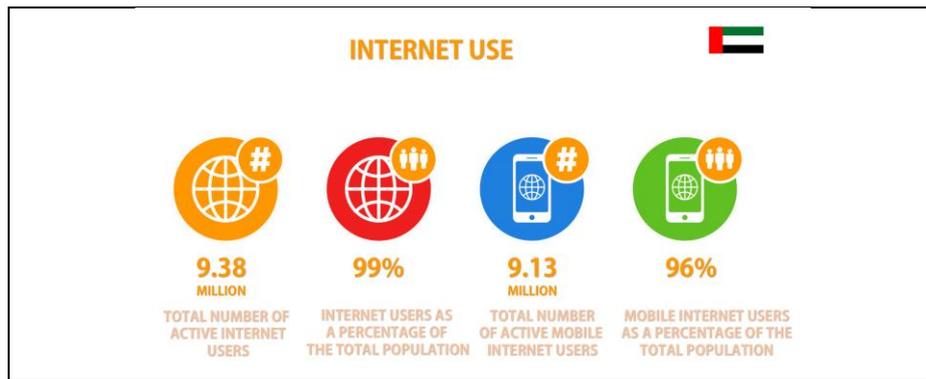


Figure 13 :(Numbers of internet users in UAE, Source: Hootsuite, 2018)

In connectivity higher internet speed of the connection is very important to assure doing tasks in efficient way, so the average speed via fixed connections is 25.69 megabit per second .From mobiles the speed is higher the average is 50.20 MBPS and people prefer to access the internet more using smartphones , see figure number 14 below.

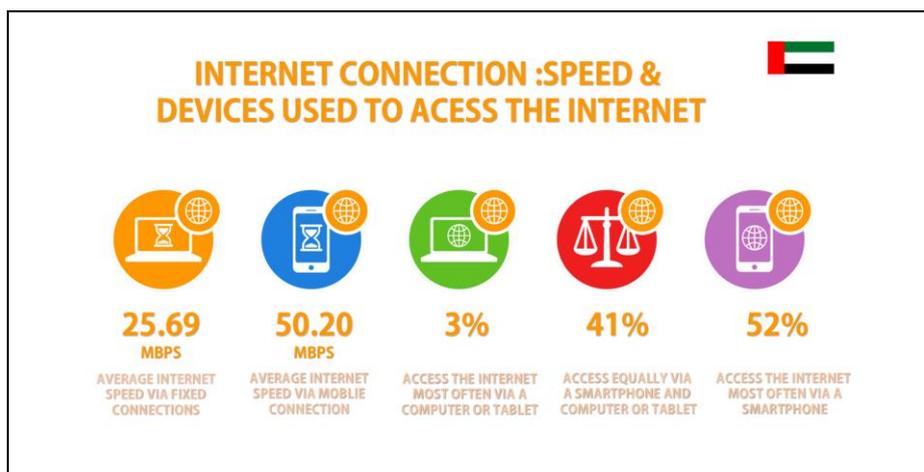


Figure 14:(Internet connection and speed, Source: Hootsuite, 2018)

A snap shot of the average internet connection speeds and the device that people use most often to access the internet, as shown in table 6.

Statistics	Speed in MBPS
Average Fixed connection	25.69
Average mobile connection	50.2

Table 6:(Average internet speed on devices to access the internet)

Another questions targeted to know the preferred device to access the internet through, see table number 7, as shown in table 7:

Statistics	Percentage
Via Computer or Tablets	3 %
Equally via Smart Phones, Computer and Tablets	41 %
Via Smart Phone	52 %

Table 7:(Internet access by devices)

The most growing share of WEB traffic by device is mobile phone with annual year-on-year change of +6% while other devices drop in rate, see figure 15 number below.

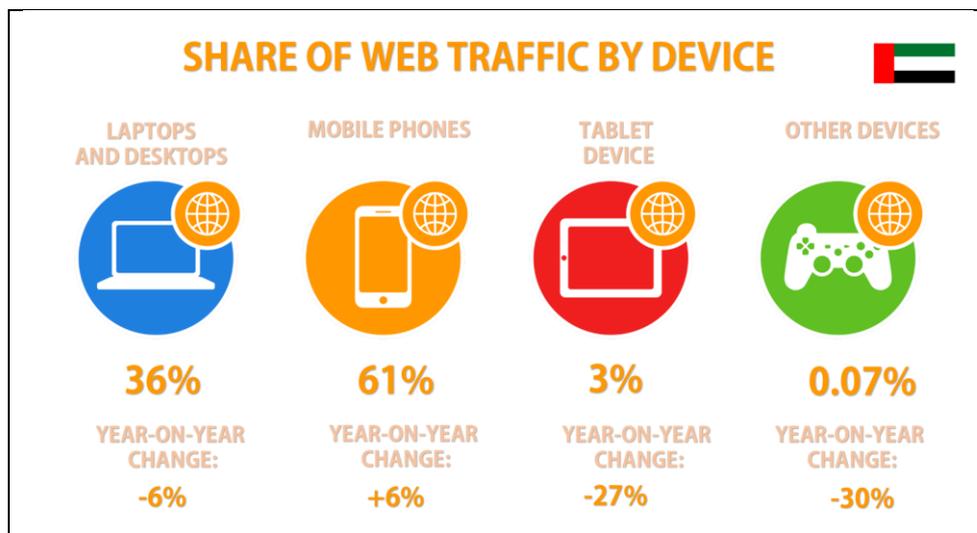


Figure 15(Share of web traffic by device, Source: Hootsuite, 2018)

Weekly online activities by device by smartphone or computer , people use search engine the most ,then for a social network ,then watch videos and play games and less often they look for products or shopping for example , see figure number 16 below .

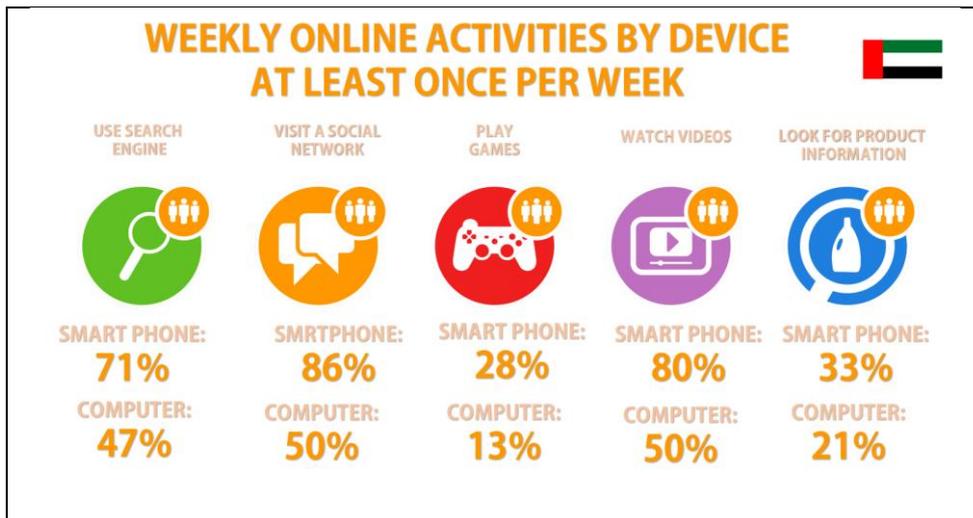


Figure 16:(Weekly online activities by device at least once per week, Source: Hootsuite, 2018)

As for Social media use 99% of the population is active on social media , if people are active using social media application notification of Home Automation can be sent to their phone while they are online , see figure number 17.

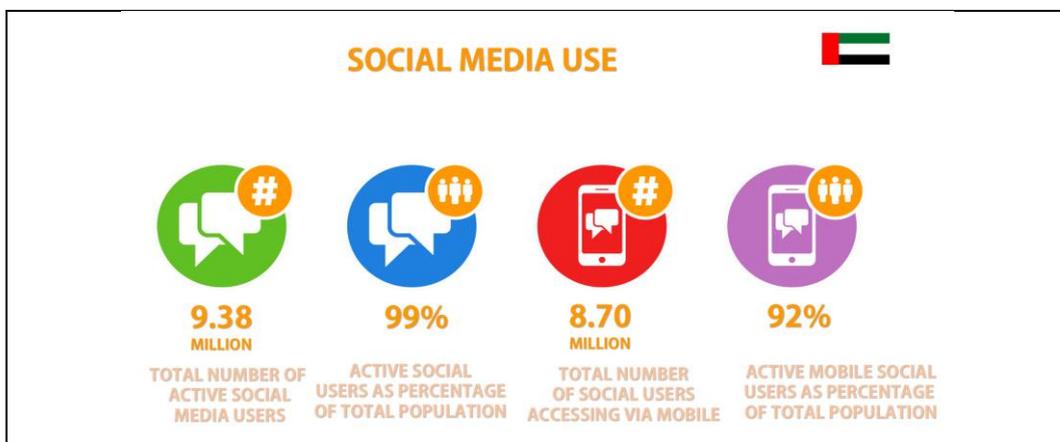


Figure 17(Social media use in UAE, Source: Hootsuite, 2018)

The most performed task by smart phone is taking videos or photos then setting the alarm, then checking the news then weather conditions and less frequently read , it translate in that people prefers visual interaction so a user-friendly application with pictures and visuals can help them with imagining the consumption rate of energy, see figure number 18.

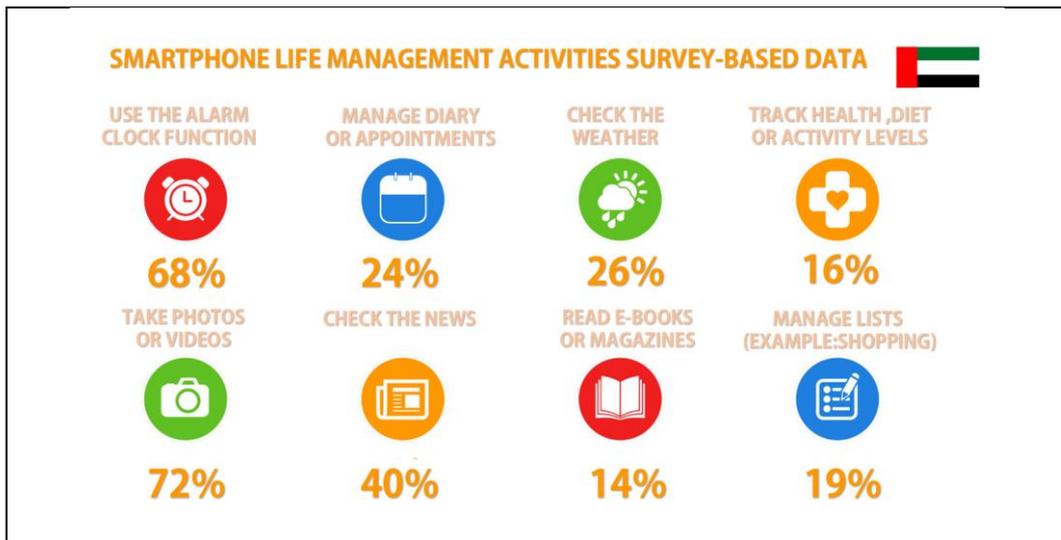


Figure 18(Smartphone life management activities survey-based data, Source: Hootsuite, 2018)

Mobile Activities like using the messenger, watching videos, playing games, use it for banking or map services. People use it the most for message, see figure 19 below.

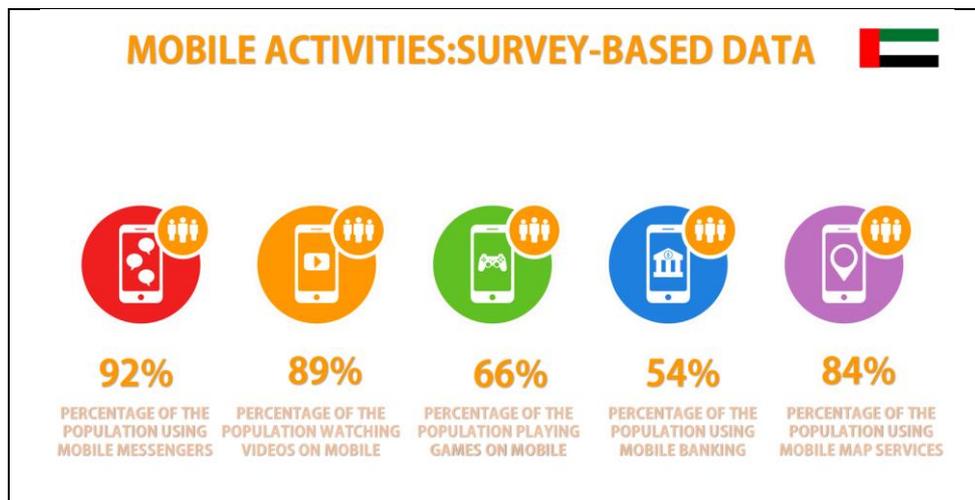


Figure 19(Mobile activities survey based, Source: Hootsuite, 2018)

Out of maximum possible score of 100, 81.88 shows that devices and services are affordable in UAE, see figure number 20. Therefore, also Smart appliance could highly be affordable to UAE residents.

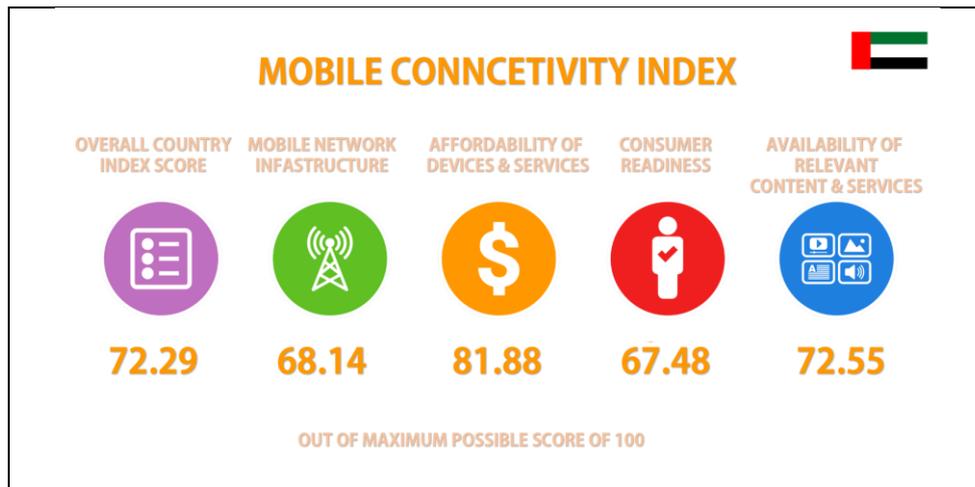


Figure 20:(Mobile connectivity INDX, Source: Hootsuite, 2018)

2.9 Smart Home:

Internet of things (IoT) along with Artificial Intelligence (AI) had made it possible to shift standard homes into intelligent homes .It is also affecting the lifestyle of users in completely different way it is not only about luxury and convenience but also about efficiency with using home energy and security to the family members. Smart home can also be called automated home or intelligent home or even adaptive home.

A fully smart automated home is now mostly in experiential phases due to high expenses ,but as the technology advances the cost of it will be more affordable and it will be more available in the market and easy to apply to most homes or buildings.

The main element that makes the home smart is internet connection, devices can be connected to each other and to a “Smart meter “as a central monitoring system to manage and control the consumption rates but as a smart system it reports information and data to the users to take action and control of the whole home system and appliances .

Not only does it control the energy consumption but also controls the indoor environment of air temperature and humidity and sets the mood for relaxation and comfort. If the user is on vacation and away from home they can pre-program the appliances to work remotely for

example irrigation system can work according to fixed timings and weather conditions. Also another important feature when the user is away they can get a notification from surveillance cameras if there was any suspicious intruding of the house the user can switch the lights on to create fake presence and increase the security standers.

2.10 Home Automation by IoT:

Home Automation is simply the technology that permits users to monitor and have a control over the operation of home appliances and equipment from entertainment system such as smart TV and to lights, HVAC and appliances to assists with everyday chores.

Home appliances are plugged with sensor devices connected to the internet by “IoT” technology ,they are connect to the internet in single or mash connection as explained previously, the user can per-programed so it is automatically runs based on the home user preference and daily habits or even by real time automation remotely due to the context awareness spatiality.

Smart and automated houses concept is trending, occupants wants to have a better quality of living where things around them do tasks without much of human interaction but only commanding and monitoring. Home automation gives the user the power to control security, recycling, lighting, appliances, temperature, renewable sources of energy etc., as shown in figure number 6.



Figure 21:(Home Automation, source: PNG download 2018)

2.11 The benefits of IoT in Home Automation:

Nowadays the availability of the smart phones and smart gadgets and smart appliances opened up huge opportunities for technological companies and factories to create products and innovative services for customers with the help of IoT and Artificial intelligence technologies.

When it comes to Home Automation, the benefits are as the following:

- Increasing the awareness and motivation of occupants to optimize the energy consumption.
- Assign tasks for machines to increase productivity and provide convenience to the user for example: automatically set a timer for rice cooker and washing machine to non-peak hours.
- Increasing security by fixing surveillance internet connected cameras and motion sensors to report any suspicious behavior or any accident.
- Improve security by installing automated door locks and get rid of traditional keys.
- Increasing safety of children's by switching off electric oven and stove.

- Improving the quality of life when appliances are easy to use and be remotely controlled by a dashboard with simple tabs for example closing all lighting at night from one single place.
- Saving energy by using “Smart Meter” for monitoring consumption rates more efficiently which leads to cost saving.
- Some appliances are easy to use and available in the market.
- Adds thermal comfort and convenience through room temperature controlling.
- Helps with multitasking and saving time to do daily chores for example using robotic vacuum cleaner.
- Personal identification can provide peace of mind.
- It is user friendly specially to people with physical limitations it provides easy approach to doing tasks.
- The freedom of customization of the system to saves time.
- Easy installation.
- Ease of use when there is an interactive display of statistic and figures of consumption and home automation.

2.12 Concerns about IoT in Home Automation:

When it comes to the concerns of adapting IoT in Home Automation, first it is important to discuss the topic in wide spectrum in order for the system to work properly. Smart grid should be built which must be compatible with individual smart meters.

The government has an important role in managing and controlling the open big data (cloud computing), it should also preserve the national security by blocking any unwanted access or hacking to their cloud storage .In smaller scale ,to individuals privacy is a sensitive manner so some of the concerns of utilizing “IoT” technologies to home automation application are :

- Invading the privacy, users should agree to terms and condition of manufacturing companies just like smartphones for example, sometime they do not have a data ownership rights and their information goes to commercial purposes or sell it to a third party users in order to improve their service and products.
- Hacking smart TV or surveillance cameras.
- Encrypted data failure.
- Bad internet connection or lost in connection means that the system is not as reliable.
- Some systems are complex to use.
- Technology is ever changing this means some updates are always necessary to improve the system, which might not last for long period, or old devices might not be compatible with latest appliance.
- Programing all devices needs expert fixing and maintenance for better performance.
- In order for the appliances to work in automated system, it must always be plugged to the internet and electricity, which is causing some electricity consumption.
- Systems are subjected to failure and error with potential lack of accuracy adding to that smart appliances efficiency drops with time.

2.13 Cost effectiveness:

Clearly not all homes have the same amount of energy consumption rates, also the energy bills is not the same. It is different from home to home because of the different number of family members, number of electrical devices and behavior pattern fluctuation of occupants, different life style as well. Moreover, the consumption in summer time is different from wintertime so to compare the difference it should be according to the annual consumption and energy improvement strategies.

For example according to US Environmental Protection Agency, a smart thermostat saved up to from 10-30% of total electricity bill (Energy Star, 2018).

Therefore estimation of the cost vary depends on market status , priorities of the designed automation system ,prices of the appliances , cost of the internet connectivity, prices and the rating of water and electricity is also different according to different authorities pricing.

2.14 Energy efficiency improvement:

When it comes to energy, buildings consumes a huge amount of energy during construction and operational phase. The operation of home using appliances in traditional ways also leads to huge loss of energy resources it all can be changed if more technological solutions were integrated to enhance the usage of electricity and water resources. Raising the efficiency standers is not an option anymore since the population number is constantly increasing and our lifestyle demands for household activities to run daily without any delay.

Implementing IoT technology and adopting Home Automation strategy can be a wise sustainable decision, it is an investment to reduce cost in long term and increases the quality of life when it is comfortable, convenient, and most importantly safe to use and increases home security.

One way of accomplishing that goal is to have a Smart Home Energy Management System (SHEMS) along with smart meter as a dashboard to get data about the electricity and water consumption rates, get real-timing feedback by prescheduling the home automation process to avoid peak hours and switch off any unnecessary running appliances. Smart Home Environment (SHE) is similar in concept by using sensors and actuators to run the appliances on low power status.

It is critical to have motion detection sensors to turn on lighting and HVAC system when someone is present in the space and switch off if they leave the room. Furthermore, a smart

system is programmed with prediction algorithm capability to anticipate and react to human behavior .By using context awareness power management system , the reduction of using HVAC consumption went down to 14% but the percentage difference is depending on the user's behavior .

3 Chapter 3: Methodology

3.1 Chapter Overview:

In the previous chapter, the literature review explained some of the technological terminologies as well highlights the advantages and disadvantages of integrating home automation system to homes.

This chapter will demonstration various methodologies to know the awareness level Home Automation in UAE and if they are interested to apply it to their home, also evaluate the performance, workability and efficiency of home automation system. However, each methodology has its own advantages and disadvantages, which are going to be evaluated later in order to justify the suitable methodology that fits this research to achieve its goals and aims. Numerous relevant researches has been carried on aiming to understand the procedure and requirements to transform standard homes into smart energy efficient ones around the world but rarely in the GCC region and notably in UAE.

Prior to proceeding with this study, it is necessary to have a sufficient realization of the appropriate research methodology for the sake of reaching the goals of this dissertation. Plus, to establish a complete understanding of the limitation of the adopted methodology. Methodology constrains consist of time, research resources, the level of complexity also the validation of the method.

Now the different approaches to conduct a research is either by Qualitative measures basically exploring case studies or assume hypothetical situations with open –end questions, or Quantitative measure which deals with statistical and numerical analysis by surveys and experiments, finally a mixed methods measures which combines quantitative and qualitative approaches and results.

The research will start with a question, and then collect information by conducting a literature review to know the previous used methods. Next step, select the most suitable research methodology that better fits the nature of the question and use this method to collect data and

analyze to come to a result and then recommendation for futures researches interested in the same field, see figure number 22.



Figure 22: (Research process, source: Author, 2018)

3.2 Defining the parameters of the research:

This research will analysis the awareness level of new technologies, AI, IoT and Home Automation in UAE, know the opinion of the local people who might be interested to transform their homes to more smart and energy efficient one.

3.3 Comparison of research methods:

Several studies investigated Home Automation, the different methodologies are Literature review, field experimental measurement, and computer simulation and modeling approach.

3.4 Literature review approach:

Literature review is about building knowledge and database from previous researches in the same field or topic and then make a valuable contribution to the same selected field or topic. Literature review also considered a qualitative research methodology that includes a survey. The survey questions must lead to answers of the question of the research and the targeted

objectives .The purpose of it, is to get a clearer understanding of the research topic so that the following researcher continue to add educational value and valid findings. The observations normally varies according to local conditions and circumstances. However, some findings can be similar if the facts are constant or the parameters are standardized.

In literature review, there are many methods to save energy in buildings using technologies that are smart. A journal about “Building sustainable smart homes” (Blumendorf, 2013) found out that homes can act in a smart way. By installing a system, which is works with AI. Growing usage of technology and the growing need for sustainable life style are two conflicting ideas the question is how to combine these two trends to serve domestic purposes. However, there exist several publications about ways to make smart homes more sustainable, either by enhancing the sustainability in technology itself or by using smart home machinery. One of the challenges is to let users be more aware of their routine and behavior.

Another study a survey conducted in Singapore for “Energy conservation through Smart Homes in Smart City”. Based on the conducted survey, respondents were aware of the appliances that consumes the most energy (like air-conditioners).Most of the participants would invest in smart technologies to conserve energy in their households. Survey results show that 67 Singapore households either strongly agree or agree, “smart home “is associated with energy efficiency (Bhati, Hansen & Chan 2017).

A study aimed to evaluate the risks of Smart Home technologies, confirmed that the market of smart home technologies depends on the user. Based on a survey collected in United Kingdom, 86% of consumers linked the technology to energy management (Wilson, Hargreaves & Hauxwell-Baldwin 2017). Most of the respondents 83% believes that the purpose of smart home is for convenience and 71% believed it enhances security while 60% said for entertainment and communication.

The market of smart home technologies depends on user’s awareness the benefits of the system.

The survey conducted in UK presents, 86% sees smart home with energy management lens. 83% of respondents believes that the purpose of smart home is for convenience and 71% for enhancing security, finally 60% to enhance entertainment and communication (Wilson, Hargreaves & Hauxwell-Baldwin 2017).

A Smart Home is the block for Smart Cities (Hui, Sherratt & Sánchez 2017).The major requirements for building Smart Homes in Smart Cities supported by IoT technology are: :(Sensor network, Heterogeneity, Self-configurable, Extensibility, Context Awareness, Usability, Security and Privacy Protection, Intelligence)

To sum up, the previous papers, which used the literature methodology, can indicate users life style with technology and home automation in terms of comfort and security and energy saving.

3.5 Experimental approach:

Observation research such as experimental method in laboratory or field measurements can assist in investigating Home Automation effect on energy performance as real case scenario. The results of the experimental approach; can be controlled under set of conditions, variables, as well as standard parameters and leads to effective conclusions. Depending on the local context, climate, and resources results can be different or modified accordingly. The downside of using this method is that it is costly and require several things such as special equipment measurement, instrument, sensors, smart meters, advanced smart appliances to either fully integrate the homes with it or partially automate it. In addition, it takes a lot of time to extract the data and accomplish the study goals. Moreover, it involves human resources and system experts.

In 2016, a study about Home Automation by (Asadullah & Raza 2016) ,the study compared different types wireless Home Automation system in terms of price, speed, real time. As a

result it was found out that Bluetooth wireless is flexible with lower cost but works with short range only. Also mentioned that voice recognition feature is useful for older people.

Another study conducted by (Kao & Yuan 2012) about User-Configurable semantic home automation. The paper introduced (USHAS) concept which is user semantic Home Automation System. They designed a prototype of basic home automation configurable by user to meet their requirements it can be customized. And with that they discussed the design issues and listed system assumptions and multiple scenarios .The system identifies the device type, events, location and time , in addition it consisted of several management layers such as process layer, service layer, notification layer and device layer.

As noticed from the previous papers, and as mentioned earlier, the experimental approach demands time, it is expensive, and requires constant observation .As a result, this method is not going to be utilized entirely however some aspects can be applicable. Also the experiments took one element in Home Automation to test and not the whole system the aim of the research is to test people's awareness of Home Automation.

3.6 Computer modelling and simulation approach:

Computer modelling and simulation is trending in academic and professional fields .it is becoming a convenient tool and ideal solution to test hypothesis and scenarios of the case studies before actually transforming it to reality. Computer simulation programs and tools is proving to be effective to any application or test prototype or project.

Architects for example uses software like Autodesk Revit Architecture ,IES ,ECOTECH or Energy Plus to model and simulate Buildings digitally ,also select the project's region ,weather condition ,sun path and can get a review of the predicted total energy performance before construction begins, which reduces the risk of error or compromising people thermal comfort

and wellbeing. In addition to that, it is cost effective and flexible to create several improved design schemes based on accumulated data, select material type and their thermal capacity.

The weakness of this research type is that any inaccuracy in the input data that will reflect on the validation rate and doubts the results. The software simulations can only reduce the gap between concepts and reality, sometimes the researches uses more than one program due to software limitation and errors, which is not convenient. Using this method is a good option to early stage of design that will be help reduce risk and other factor but it cannot predict end users behavior toward energy consumption or other probabilities.

According to the research on Smart Home based on component technologies and Internet of Things (Li & Yu 2011). Using SOA (Service Oriented Architecture) software, which assist with the design on smart home system based on IoT, it helps with realizing changing dynamic. SOA allows for designing family oriented services such as :(Security, Medical services, Family data services, Entrainment and family business services).As for the network selection from smartphones like 3G or homes network base like Wi-Fi and Blue Tooth , see figure number 23.

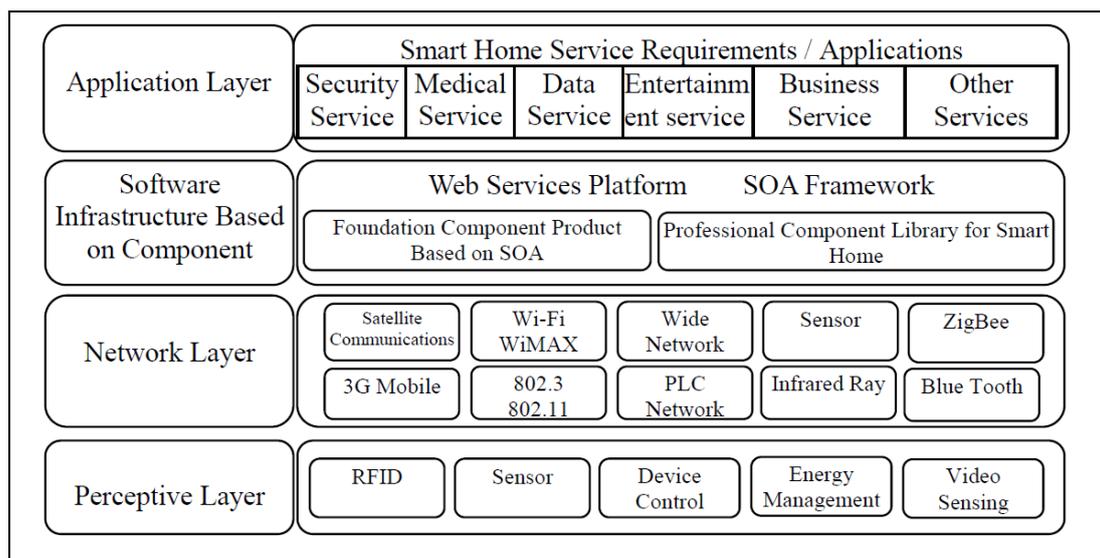


Figure 23 : (The architecture of SH application based on IoT and component technologies, Source: Li & Yu, 2011)

Based on the research conducted to test the integrity of uploaded data of Home Data Network and propose a secure data-uploading medium to validate data security (Shen et al. 2018). It proposed an efficient scheme for a home gateway-assisted for smart device data uploading with integrity and security that consisted of phases such as :(System setup, Key establishment, Data integrity verification with device participation, Device addition and cancelation).

In 2017, a study was conducted to emulate Home Automation installation through component-based web technology. Emulating devices behavior in Home Automation system aims to test the validation before installation to avoid drawbacks. After that by using virtual and physical devices connected to the web to check the performance and compare them to each other (Asensio et al. 2017).

For this research computer simulation option is eliminated because the aim is to get direct people reaction and opinion and willingness to adopt Home Automation technology.

3.7 Methodology selection and Justification:

After going through the pervious different research methods and look at some cases to compare between them and know the advantages and disadvantages of them. Computer simulation option is eliminated because of the validation issue of the software and lack of software's that are capable of involving different parameters and can is reliable.

The reach will concentrate on the qualitative side with combining different elements of each method, conduct literature review to study relative cases, then conduct a survey to analyze people's awareness level and motivation to adopt Home Automation technology to save energy demand and achieve better living standards.

Again conducting a survey, the preferred method to investigate the awareness level impact of home technology on people, plus the survey will closely analyze the local community acceptance and awareness level and how are they willing to invest on Home Automation

technology. Also will lead to propose a design strategy for automation implementation. Field measurement for such approach is not practical, the data needs to be collected over long periods to measure the effect of home automation on occupants like getting their water and electricity bills over a period of time before and after installing Home Automation system and compare changes .Furthermore, there will be a need for complex equipment and special appliances as well as the high costs.

In addition, field measurement could require human specialized resource like IT experts and so on; it needs a sponsorship to a have a prototype home that is not applicable in this scope of academic research. Further, computer simulation approach is eliminated for such system is not guaranteed to be valid.

3.8 Research methodology summary:

According to the previous various research methodologies, this paper is going to focus on data gathering by collecting survey and interviews people in UAE. The data will be analyses via graphical representation of the results to compare. Importantly, designing a framework to implement Home Automation technology. The summary of the methodologies as shown in table 8 below:

Methodology: Literature review approach			
#	Journal Title	Reference	Lessons learned
1	Building sustainable smart homes	(Blumendorf et al. 2013)	<ul style="list-style-type: none"> ▪ Smart Home is a network of systems ▪ Smart Home works with Artificial Intelligence ▪ Smart Home technology can contribute to enhancing sustainability
2	Energy conservation through smart homes in a smart city: A lesson for Singapore households	(Bhati, Hansen & Chan 2017)	<ul style="list-style-type: none"> ▪ To better use smart home technologies, first we need to <u>understand consumer’s behavior</u>. ▪ Based on the conducted survey, respondents <u>were aware of the appliances that consumes the most energy</u> (like air-conditioners). ▪ The majority of the participants <u>would invest in smart technologies to save energy in their households</u>. ▪ Survey results show <u>that 67 Singapore households either strongly agree or agree that “smart home “ is associated with energy efficiency</u>.

3	Benefits and risks of smart home technologies	(Wilson, Hargreaves & Hauxwell-Baldwin 2017)	<ul style="list-style-type: none"> ▪ The market of smart home technologies <u>depends on user's awareness the benefits</u> of the system. ▪ The survey conducted in UK presents, <u>86% sees smart home with energy management lens.</u> ▪ 83% of respondents believes that the purpose of smart home is for convenience and 71% for enhancing security, finally 60% to enhance entertainment and communication.
4	Major requirements for building Smart Homes in Smart Cities based on Internet of Things technologies	(Hui, Sherratt & Sánchez 2017)	<ul style="list-style-type: none"> ▪ <u>A smart home is an important block for smart cities</u> ▪ The paper listed Smart Home requirements for stronger application such as :(<u>Sensor network, Heterogeneity ,Self-configurable ,Extensibility, Context Awareness, Usability, Security and Privacy Protection , Intelligence)</u> ▪ In reality, Smart Home technology <u>adoption rate is low</u> as people sees it more hyper than a necessity.

Methodology: Experimental approach			
#	Journal Title	Reference	Lessons learned
1	An Overview of Home Automation Systems	(Asadullah & Raza 2016)	<ul style="list-style-type: none"> ▪ The study aims to compare different types wireless Home Automation system in terms of (cost , speed , real time) ▪ Bluetooth wireless is flexible with low cost but works with short range ▪ Voice recognition is handy for elderly people
2	User-Configurable semantic home automation	(Kao & Yuan 2012)	<ul style="list-style-type: none"> ▪ The paper introduced (USHAS) which is user semantic Home Automation System ▪ Design a prototype of basic home automation configurable by user to meet their requirements ▪ Discussed the design issues and listed system assumptions and scenarios ▪ Suggested management layers such as :(Process layer , service query layer , service layer , notification layer, device layer) ▪ The system identifies the device type , events ,location and time

Methodology: Computer simulation approach			
#	Journal Title	Reference	Lessons learned
1	Research and application on Smart Home based on component technologies and Internet of Things	(Li & Yu 2011)	<ul style="list-style-type: none"> ▪ Using SOA (Service Oriented Architecture) software, which assist with the design on smart home system based on IoT, it helps with realizing changing dynamic. ▪ SOA got family oriented services such as :(Security, Medical services ,Family data services , Entrainment and family business services)
2	Secure data uploading scheme for a smart home system	(Shen et al. 2018)	<ul style="list-style-type: none"> ▪ It is important to validate the integrity of uploaded data for smart home system. ▪ The paper proposed a scheme consists of phases such as:(System setup,Key establishment,Data integrity

			verification with device participation, Device addition and cancelation)
3	Emulating Home Automation installations through component-based web technology	(Asensio et al. 2017)	<ul style="list-style-type: none"> ▪ Emulating devices behavior in Home Automation system to test the validation before installation to avoid drawbacks ▪ After that By using virtual and physical devices connected to the web to check the performance and compare them to each other

Table 8:(Summary of methodologies, Source: Author, 2018)

The research will be survey-based to be collected randomly in UAE aiming to test the awareness of participant’s level about Home Automation, in addition to know if they are going to take action and adopt Home Automation. There will be three questions parts of the survey. Methodology map explained below in figure 24.

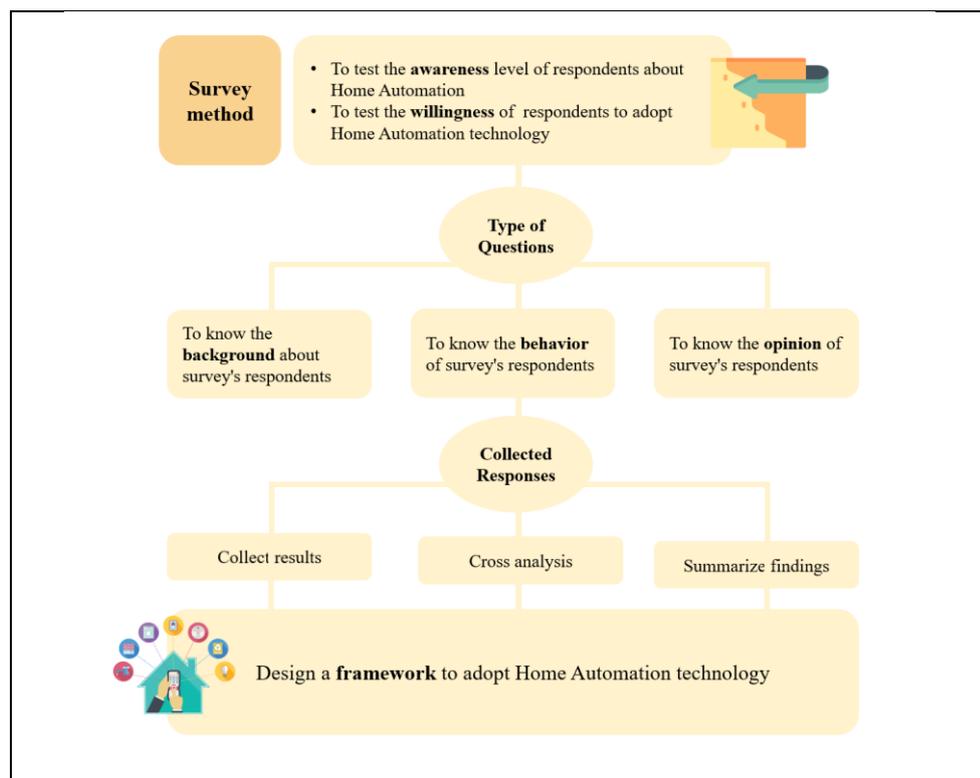


Figure 24:(Methodology map, source: Author 2018)

So the type of questions are divided into three main categories as shown below table 9.

A. Background about the survey's respondents

Questions	Aim behind questions
What is your nationality?	To filter data based on local and non-local differences in many aspects of living like (income, property etc.)
What is your age?	To know the age group of respondents
In which city you are currently living in?	To filter data based on cities and electricity and water consumption rate
What is your education level?	To know their educational background
What is your current resident type?(local and non-local)	To know the different residents types which ultimately will difference in number of home facilities
What is your property type? (local and non-local)	To know if they are permanent residents or living in the city temporarily
How many bedrooms are there in your house? (local and non-local)	To estimate the size of property which will affect the energy consumption rate
How many bathrooms are there in your house? (local and non-local)	To estimate the size of property which will affect the water consumption rate
How many adults are living in the house? (local and non-local)	To estimate the energy consumption rate by number of adults
How many kids (below 17) are living in the house? (local and non-local)	To estimate the energy consumption rate by number of kids
Do you have a housemaid? (local and non-local)	To estimate the energy consumption rate by number of housemaids
Do you have a private garden?	To know the water consumption rate
How often do you irrigate the garden?	To estimate the water consumption rate
What is your monthly income? (local and non-local)	To compare results with energy bills and how much will they invest in Home Automation adoption
What is the average monthly cost of your electricity bill in AED?(local and non-local)	To know the average of electricity consumption rate and cost
What is the average monthly cost of your water bill in AED?(local and non-local)	To know the average of water consumption rate and cost
Do you have a renewable source of energy to support your home energy demand?	To know if respondents are aware of environmental and sustainability

B. Energy consumption behavior and preferences

Questions	Aim behind questions
How many hours do you usually spend at home?	To know how many hours they stay at home which will translate in potential over energy consumption
What is the most important thing you are looking for when you buy home appliances?	To understand the preferences in selecting home appliances
What type of Air-conditioning system does your home have?	To know the current AC types

What is the indoor air temperature degree (Celsius) that makes you feel comfortable in summertime?	To know respondents thermal comfort
What is the indoor air temperature degree (Celsius) that makes you feel comfortable in wintertime?	To know respondents thermal comfort
How many times per day you adjust the thermostat of the air-condition system?	To know the frequency of controlling the AC
Do you use natural ventilation when the weather is nice outside?	To understand respondents behavior toward energy conservation
Do you prefer to use automated smart curtain system?	To know smart technology preference
Would you want to control the air-conditioning system when you are away from home using an application on your smart phone?	To know smart technology preference
Do you turn off the lights when you leave the room?	To understand respondents behavior toward energy conservation
Would you want to control remotely the lighting when you are away from home using an application on your smart phone?	To know smart technology preference
An intelligent system is equipped with lighting sensors to turn on, off and dim the lights, would you buy this system?	To know if respondents are interested in controlling the lights via Home Automation technology
Would you want your appliances to be connected to the internet?	To know if respondents are interested in connected appliances
If your answer to the pervious question was “No”, please explain why you are not interested?	To know why respondents are not interested in connected appliances
An internet-connected appliance can be controlled remotely, and its energy usage can be analyzed, would you want to use the internet-connected appliances?	To know smart technology preference
Would you want to irrigate automatically your garden?	To know smart technology preference
Are you generally interested in technological products?	To know if respondents are into technologies
Do you know what “IoT” internet of things means?	To know the respondents
IoT sends and receive data, what do you think about this technology?	To respondents opinion about IoT ability to send and receive data
Are you aware of Home Automation system?	To know if respondents awareness about Home Automation
Home Automation controls lighting, heating, ventilation and appliances to provide improved comfort, convenience, energy efficiency and security, Would you be interested to shift your home to a smart automated home?	To know smart technology preference
Do you have a smoke detector at your home?	To know if respondent are taking action to increase home safety
How much are you willing to pay for Home Automation system?	To know if people take action to adopt Home Automation technology and see if it is affordable based on their monthly income.

C. Opinion toward energy conservation and Home Automation

Questions	Aim behind questions
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Do you think it is important to save household electricity consumption?	To know the awareness level of energy conservation importance
Do you think that you can contribute into saving the environment?	To know the awareness level of energy conservation importance to save the environment
Do you think it is the government responsibility to save the energy?	To know the awareness level of energy conservation role of the government
Do you think you have the responsibility to use electricity more efficiently?	To know the awareness level of efficient use of energy as a responsibility of occupants
Do you conserve energy just to reduce electricity bills?	To know the motive behind saving energy
Do you agree, “Saving electricity is not convenient to my own life style”?	To know the priority of Home automation between energy saving or comfort
Are you willing to avoid using appliances in energy consumption “Peak hours” to save energy?	To know if people take action to save energy
Are you willing to replace your appliances to more energy efficient types?	To know if people take action to save energy
Are you willing to turn up the AC temperature even if it is not comfortable for you just to save energy?	To know if people take action even if it is not convenient to save energy
Do you think that using the latest smart home device will help you save energy and time?	To know if people trust smart home technology to save energy
Do you think that Home Automation will invade your privacy?	To know if respondents feel unsafe with Home Automation technology Which may let them hesitate to adopt it
Are you willing to download and use smart electricity monitoring application to track your home energy consumption?	To know smart technology preference
Are you interested in purchasing a monitoring system that remotely control your Air-conditioning system?	To know smart technology preference
Are you willing to purchase security system that monitors your home?	To know smart technology preference
A smart home recognizes your arrival to the house; set the air-conditioning at the temperature you like turns on the light in the areas you occupy will you be interested in systems like this?	To know smart technology preference

Table 9:(Survey question types and aims, source: author 2018)

4 Chapter 4: Results

4.1 Chapter overview:

Survey is a descriptive research method seeking a tangible feedback of people's awareness level when it comes to home automation related matters through a survey collected in UAE, as a cross-sectional study to measure the percentages in the questions that close observation hints to acceptance of the local community to integrate the auto-system.

In order to understand the awareness level of home occupants toward adopting technology and transferring their normal home into smart home by integrating home automation technology. A questionnaire was designed to take an in-depth view to the topic, then search further to get a better insight, the total number of the survey respondents were 60 people ,the survey was conducted online using survey monkey website ,and the answers were collected from October 2017 until April 2018. In addition to that, in the survey it was clearly mentioned that the information of the respondents are confidential and the answers are only used for academic purposes. The survey's replies were collected randomly in United Arab Emirates, to get a tangible data that shows two main points first the awareness level of home automation and second is to test the interest and willingness of people to take real steps to implement Home Automation technology. Since that UAE is considered to be an advanced educated country, it is predicted that the responses will indicate positive acceptance of Home Automation technologies adaptation to increase the comfort of occupants, as well as, conserving energy out of being concerned about the environment and having a balanced eco-system.

Furthermore, the aim of the survey is to evaluate respondent's perspective toward domestic energy consumption and how they can contribute in using energy more efficiently using latest technologies supported by Artificial Intelligence and Internet of Things technology, whether by changing their behavior or invest in purchasing smart automated appliances .

The survey combined multiple questions to know about personal information's like the background of the respondents, age, nationality , academic background, number of occupants,

their resident and property type, monthly income, an estimation of their energy monthly bills of electricity and water .

Other questions were about knowing their behavior pattern toward energy consumption, like for example :how many hours do survey's respondents spend at home, their thermal comfort using air-conditioning system in summer and winter , their attitude toward lighting as well as garden irrigation routine.

In addition to that, other questions were targeted to know in general their opinion about energy efficiency, Home Automation adoption, the role of people and government to save energy, controlling energy and home security using smart applications and appliances.

The survey question divided into three main parts as the following:

A. Background about the survey's respondents

B. Energy consumption behavior

C. Respondents opinion toward Energy conservation and Home Automation

4.2 Background about the survey's respondents:

Among the 60 participants, 44 respondents are Emiratis with the rate of 73%, the rest 16 people with 26% are not locals, and come from different nationalities see figure 25.

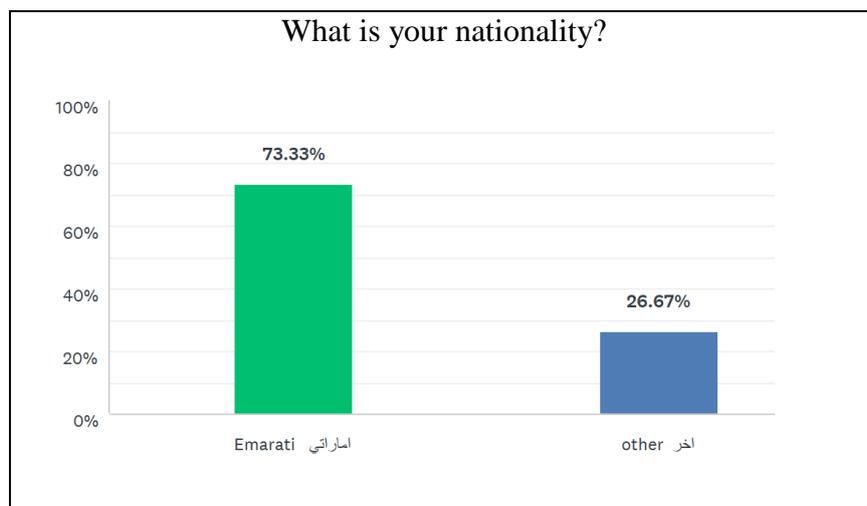


Figure 25 :(Nationality of the survey's respondents)

Age group of the respondents was between 18 and over sixty years old. The majority around 62% are in the age group between 24 to 35 years old. The second age group with 25% are between 35 to 50 years old, around 8% are between 18 to 24 years old and the minority with 5% are above 50 years old, as shown in the figure number 26.

Between the ages of 20 to 40 is considered the age of starting a family and taking care of the household responsibilities, and providing home necessities so information about the monthly bills of water and electricity consumption should be available and known.

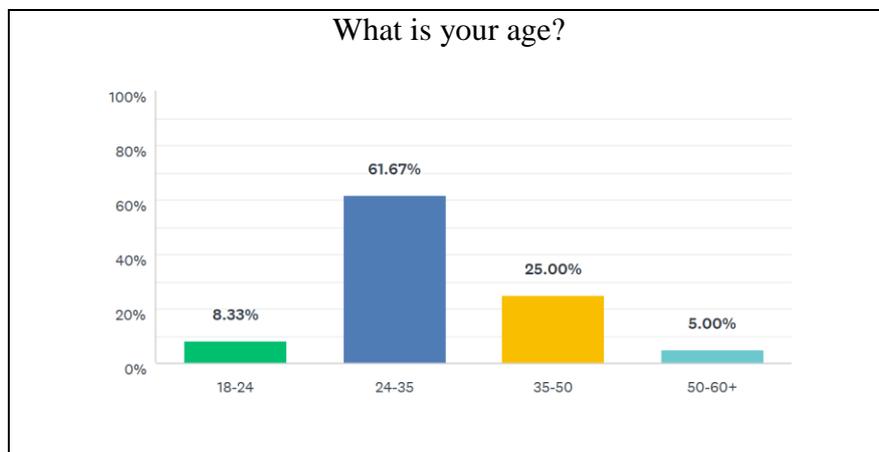


Figure 26 :(Age group of the survey's respondents)

Most of the survey respondents are living in Dubai with 38% of total respondent's number, while in Sharjah it is 35%; those two cities are relatively close to each other. In Abu Dhabi the capital of the UAE 11% of the participants are living there and the others are living in Ajman, Ras Al-Khaimah and Fujairah, as shown in the figure number 27. It is essential to know that each city water and electricity bills are different, due to different local authorities' regulation and energy generation costs.

For example, in the capital Abu Dhabi there is Abu Dhabi Water and Electricity Authority (ADWEA), in Dubai there is Dubai Electricity and Water Authority (DEWA), in Sharjah there is Sharjah Electricity and Water Authority (SEWA), finally the rest of the emirates falls under

Federal Electricity and Water Authority (FEWA) to provide services to rest of the cities, see figure 27 below.

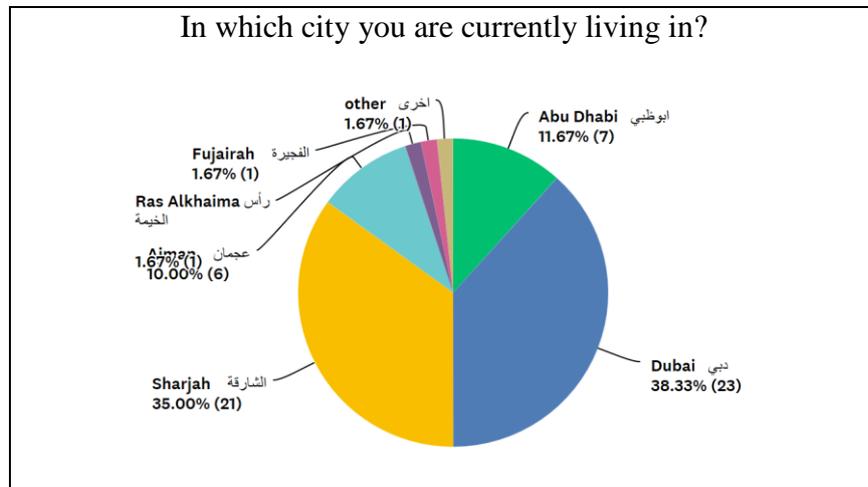


Figure 27:(Residency location in UAE of the survey’s respondents)

The Academic background was categorized to different educational levels, 48% percent almost half of the respondent’s holds a bachelor degree, followed by 40% whom holds a postgraduate’s degree. It is noticeable that the majority are highly educated because only around 7% holds a higher diploma and 5% graduated from High school as shown in the figure number 28. Since that, the majority of the survey’s respondents are highly educated this indicates that they know some basic information about technology in general and using smart devices such as smartphones and tablets.

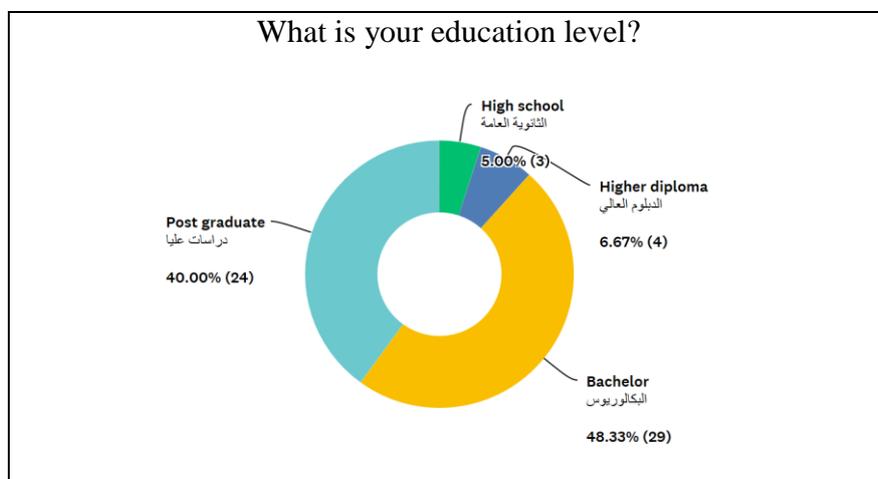


Figure 28 :(Education level of the survey’s respondents)

Furthermore, in order to understand the energy consumption rate it is important to investigate multiple factors. Factors such as: the number of family members and home occupants, number of rooms and bathrooms, the type of residency whether they own a private garden or not ,all of these questions are put into the survey for further investigation of lifestyle and behavior pattern toward consuming energy. The three main resident's types were:

1. Detached villa.
2. Townhouse.
3. Apartments.

Around 77 percent of local respondent's lives in a detached villa, then approximate to 16% lives in townhouse and the minority around 7% lives in apartment .As for non-locals it is different and reversed approximately 69% lives in apartment and 25% in detached villa and 6% lives in townhouse, as shown in figure 29.

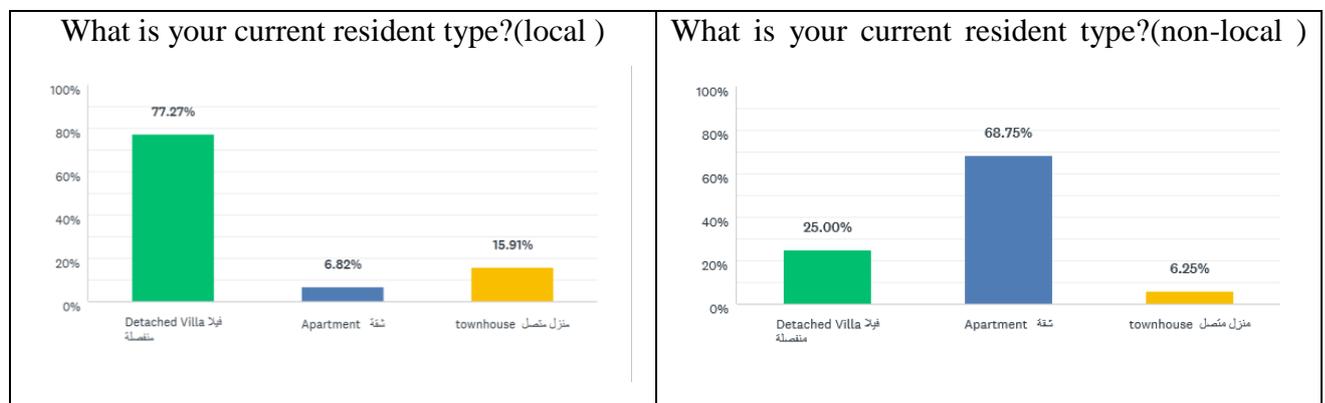


Figure 29:(Resident type of the survey's respondents for local and non-local people)

The percentage of the local survey's participants who own their homes is 56%, and the government owns around 30% homes from housing support authorities like Shaikh Zayed housing program for example. Finally, approximately 14% lives in a rental property.

On the other hand, 81% of non-local property type is rental, and only 18% are owned while they don't get a governmental housing because it is only given to locals with lower monthly

income and other specification and policies as a support from the UAE's government ,as shown in the figure 30.

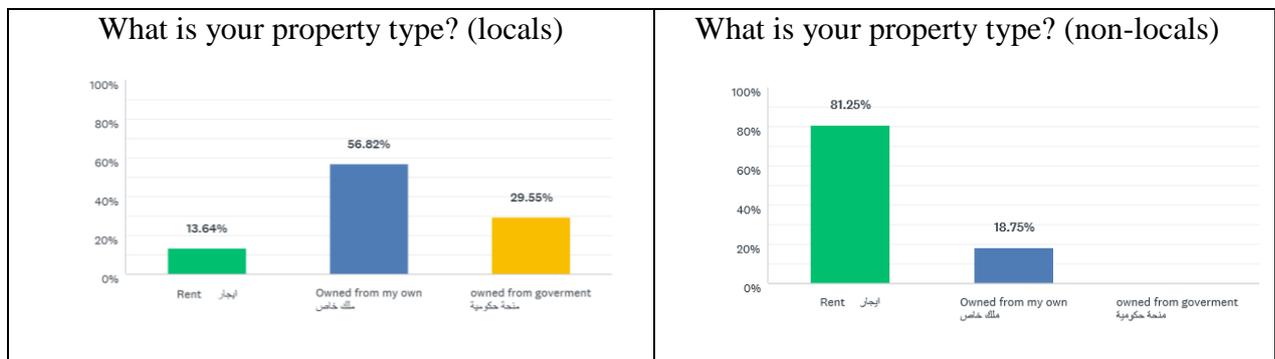


Figure 30:(property type of the survey's respondents for local and non-local people)

When asked about the number of bedrooms, the average is about five rooms in local's home. The maximum was 12 and the minimum is one bedroom, same wise number of bathrooms on average was six bathrooms. The maximum was 14 and a minimum of 3. As for non-local homes the maximum number of bedrooms was eight and the minimum was one and on average of three. While the bathrooms as maximum as 10, the average was 3 and the minimum is 1, as shown in the figure, see figure 31.

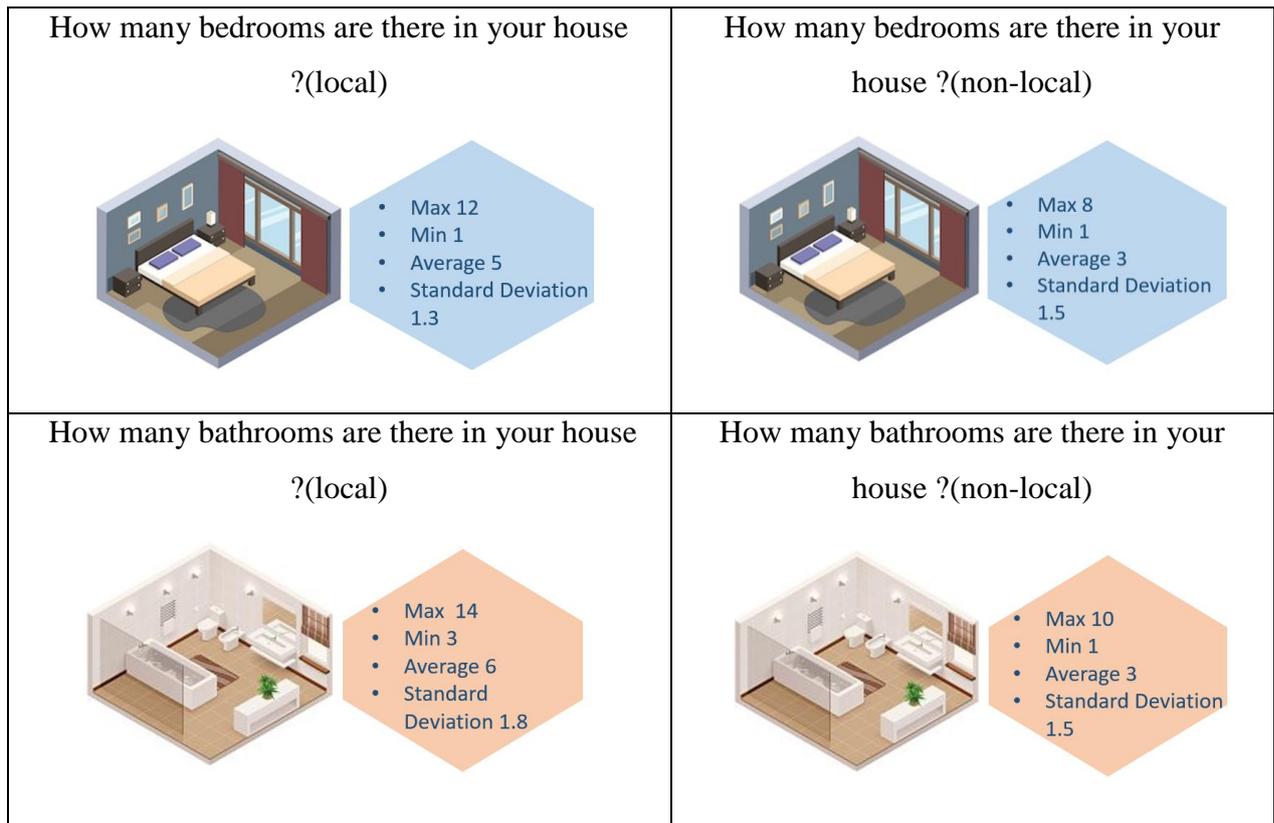


Figure 31 :(Number of bedrooms and bathrooms of the survey's respondents)

It is clear to say that the more family members or occupants are living in the same property chances are that they consume more water and electricity in their daily life than in single or couple living in a house. The findings of the survey showed that number of adults living in the local house from two to five people is 45% and more than half 52% of the respondent's lives in home with more than 5 people, as shown in the figure. As for the non-locals 62% lives with two to five adults' family members and 31% share the living with more than five members, see figure 32.

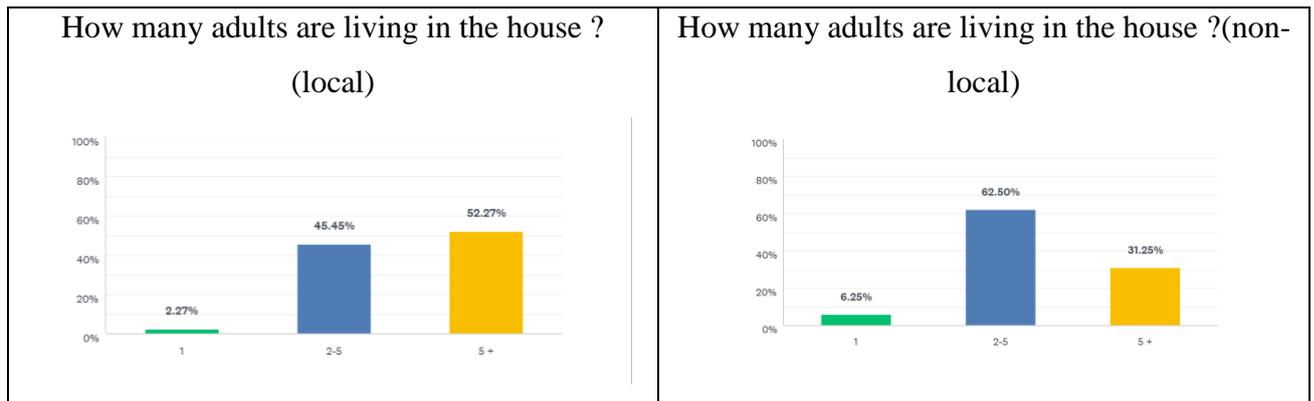


Figure 32 :(Number of adults living in the house of survey's respondents)

There is a difference between adults and kids in behavior when it comes to domestic energy consumption. For example kids tends to use entertainment system such as smart TV gaming and so on more often than adults and they could spend more time at homes, they could be less aware of the benefits of conserving energy and might have a fluctuation in behavior and not switch off the lightings or plugs for example. So the number of Kids living in local house 42% answered to have from 2-5, the other 42% have one kid below 17 and the rest 16% have more than five kids. In non-local case it is a smaller scale family size because 43% answer to have one kid and 57% have from 2-5 kinds living at their homes, as shown in the figure 33.

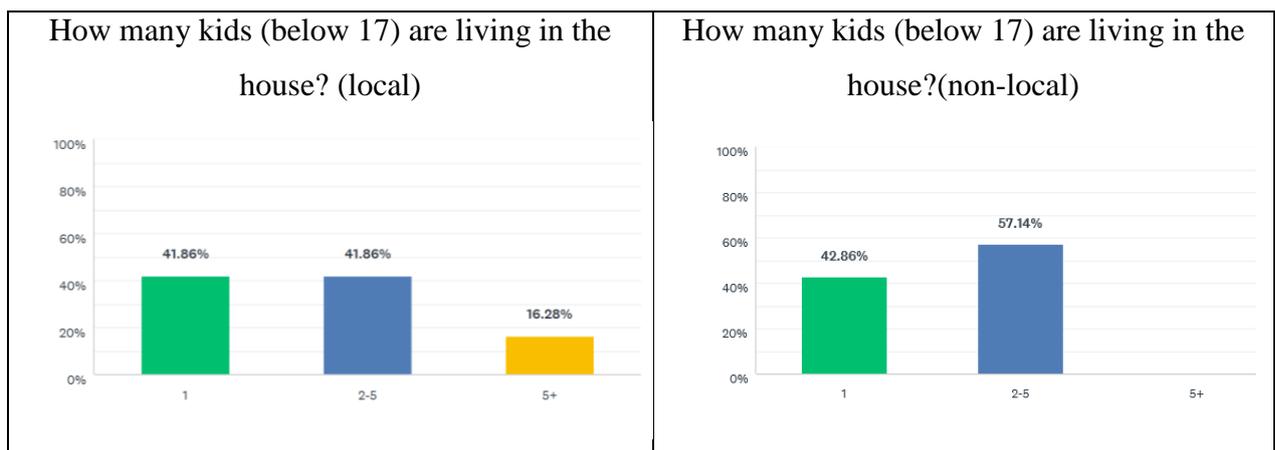


Figure 33:(Number of kids (below 17) living in the house of survey's respondents)

The common status to locals with 68% of the respondents have a house-maid or more than one, on the other hand for non-locals 75% do not hire a house-maid. Some house cleaners are not

educated or have a high school degree they tend to have an over consumption behavior toward energy due to lack of awareness of the benefits of conserving energy, as shown in the figure 34.

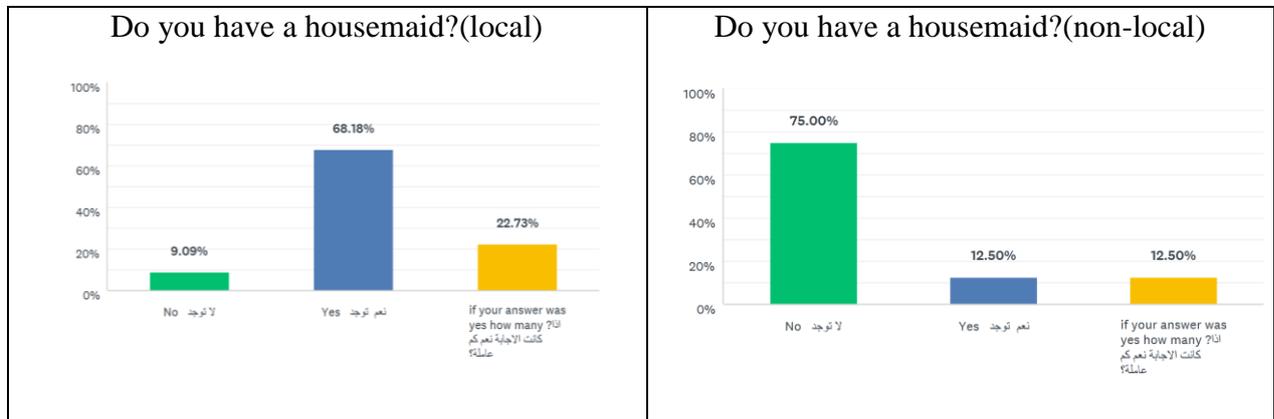


Figure 34:(Number of house cleaner of survey's respondents)

Most of the villa residents from the participants 60 % owns a private garden. About 60% of private garden owners tends to irrigate the plants on a daily basis, due to the harsh hot weather conditions. On the other hand, some participants approximate to 24% reduces the process to every other day and the rest 16% just irrigate their gardens once a week as shown in the figure 35&36.

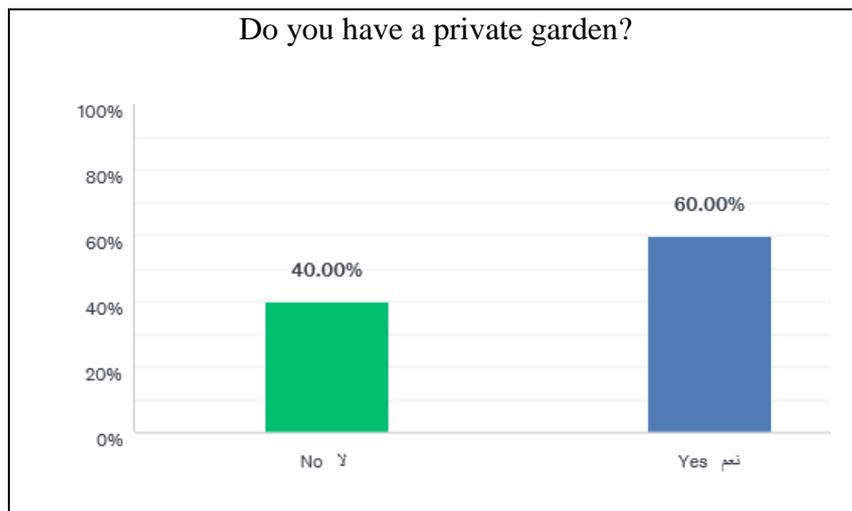


Figure 35: (Owning a private garden)

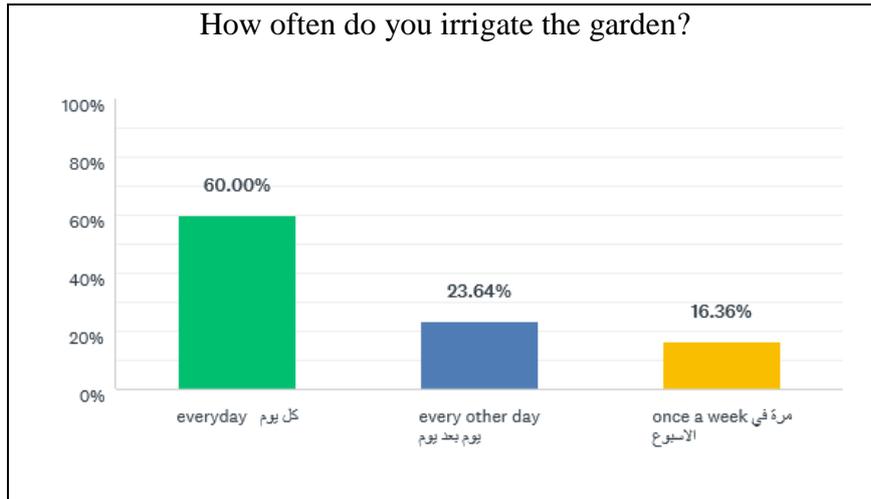


Figure 36 :(The garden irrigation routine of the survey’s respondents)

For native Emiratis and non-local people, the monthly income ranges between 15,000 to 30,000 Emirati Dirhams for most respondents, as shown in the figure number 37. A quarter of Emirati survey’s participants earn more than 30,000 AED and around 14% earns less than 15,000 AED. As for non-locals approximate to 44% earns less than 15,000 AED and only 6% earns more than 30,000 AED per month. Information about monthly income is important to be able to compare it to energy consumption rates of water and electricity monthly bills since it is part of household budget.

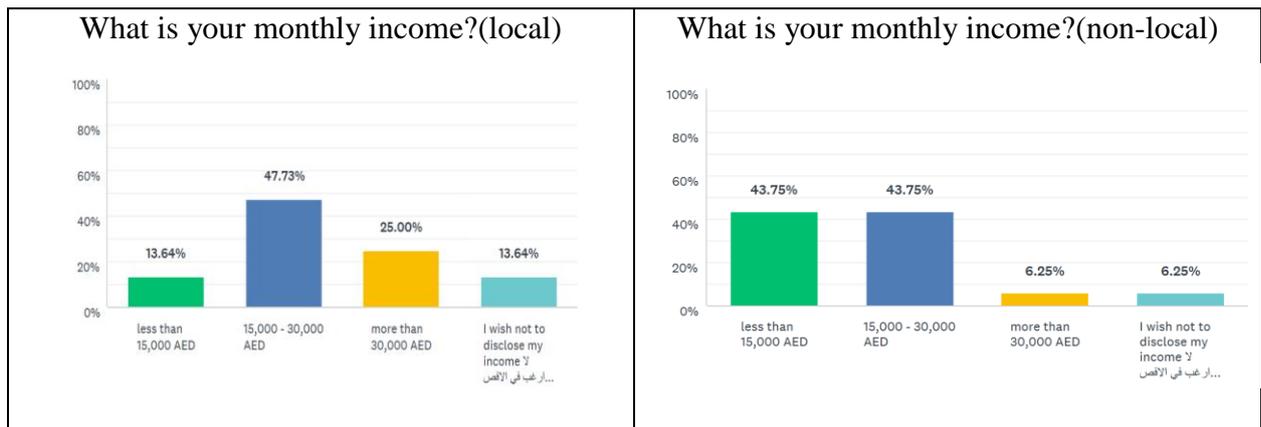


Figure 37 :(Monthly income of the survey’s respondents for local and non-local people)

Compared to participants monthly income, and as found previously the majority have a monthly salary that ranges between 15,000 to 30,000 AED. It was found out that about 10-30% of their monthly income goes to cover water and electricity bills.

So in detail the responses from households' average monthly electricity bill for locals is around 1,500 AED the maximum is 3500 AED and the minimum is 200 AED. As for non-locals, energy cost ranging from 200 AED to 3000 AED on electricity so on average it is about 1200 AED .While, water bills cost about on average 600 AED monthly ,1500 AED maximum and minimum of 200 AED ,as shown in the figure below 38.

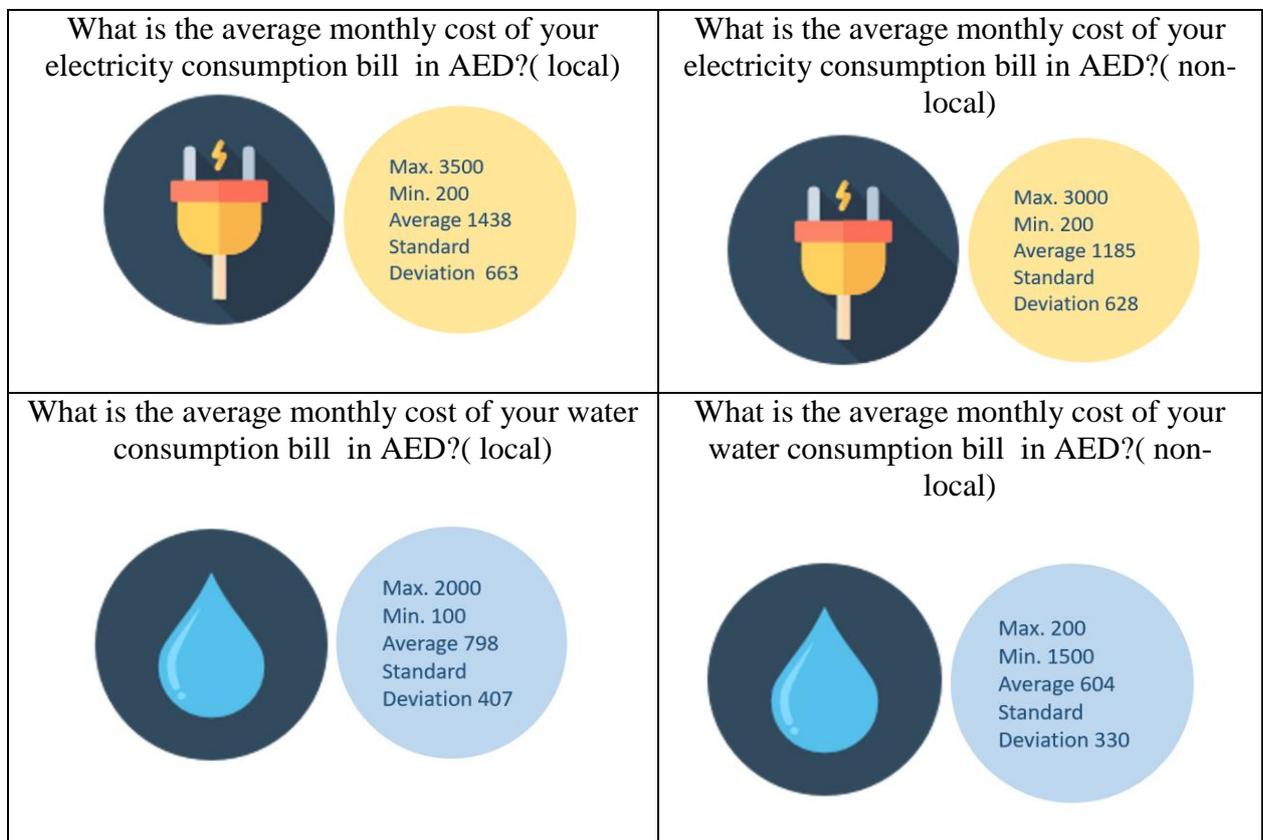


Figure 38 :(Electricity and water bills in AED of the survey's respondents)

It is important to know that according to Dubai water and electricity authority (DEWA), the measurement unit for electricity is (Fils/kilowatt hour) and for water (Fils/ Imperial Gallon).

For DEWA consumption rate per month and slab tariff for residential (villas, flats) and commercial, it is subdivided into four main categories Green, Yellow, Orange, and Red .Green

means lower consumption rate and red represents high consumption rate for both electricity and water, the pricing is higher ,as shown in the table below 10.

Category (consumption/month)	 Electricity(Fils/kilowatt hour)	 Water(Fils/Imperial Gallon)
Green	0-2000 KWh	23 Fils/kWh
Yellow	2001-4000 kWh	28 Fils/kWh
Orange	4001-6000 kWh	32 Fils/kWh
Red	6000 kWh & above	38 Fils/kWh

Table 10 (DEWA Electricity and water pricing, Source: DEWA 2018)

If we calculate the maximum electricity consumption by DEWA rating as the following:

The green category 2000KWh x 0.23 AED=460 AED

The yellow category 4000KWh x 0.28 AED=1,120 AED

The orange category 6000KWh x 0.38 AED=1,920 AED

The Locals in Dubai pay around 1438 AED on average for electricity monthly after dividing cost by rate 32 Fils the result is equal to 4,494 kWh, so the consumption is confirming to be in the orange category.

For the non-locals the average was 1185 AED divided by 32 Fils equals 3,703 KWh that falls under yellow category.

While with Sharjah Electricity and water Authority SEWA, the consumption rate divided into two main categories Green, which represent lower consumption rate, and Red is over consumption rate. The pricing is lower for UAE Nationals, as shown in the table 11.

Tariff consumption rate for villas and apartments	 Electricity				 Water			
	UAE Nationals		Expats		UAE Nationals		Expats	
Green	≤400 KWh	6.7 Fils/kWh	≤200 KWh	26.8 Fils/kWh	≤1540 IG	AED 0.95 Fils/IG	≤1100 IG	AED 3.56 Fils/IG
Red	>400 KWh	7.5 Fils/kWh	>200 KWh	30.5 Fils/kWh	>1540 IG	AED 1.18 Fils/IG	>1100 IG	AED 4.73 Fils/IG

Table 11:(SEWA Electricity and water pricing 1 cubic meter is (219.969 Imperial Gallon)

If we calculate the maximum electricity consumption by SEWA rating as the following:

For UAE Nationals:

The Green category $400 \times 0.067 = 26.8$ AED

The Locals pay around 1438 AED on average for electricity monthly after dividing cost by rate 6.7 Fils the result is equal to 21,463 kWh, so the consumption is confirming to be in the red category.

For Expats:

The Green category $200 \times 0.268 = 53.6$ AED

For the non-locals the average was 1185 AED divided by 30.5 Fils equals 3,885 kWh, which falls under the red category.

If we calculate the maximum Water consumption by SEWA rating as the following:

For UAE Nationals:

The Green category $1,540 \times .0095 = 14.6$ AED

The Locals pay around 798 AED on average for water monthly after dividing cost by rate 1.18 Fils the result is equal to 67,627 IG so the consumption is confirming to be in the red category.

For Expats:

The Green category $1,100 \times 0.0356 = 39.16$ AED

For the non-locals the average was 604 AED divided by 4.73 Fils equals 12,770 IG, which falls under the red category.

From the previous data analysis, we noticed that the rating is lower for UAE nationals in Sharjah but the monthly cost is higher because of residency type they live in villas with many rooms and more occupants number that in non-locals who mostly lives in apartments with less occupants.

Investing in renewable energy in domestic level such as installing solar photovoltaic electricity generating panels, or solar water heater, can be a worthwhile investment. It contributes not only in saving energy that is consumed from generating electricity in traditional methods from non-renewable sources such as burning fossil fuels and so on to feed the housing demands, but it is an eco-friendly way and can reduce costly bills of water and electricity.

Form the survey a question was targeted to know if the respondents have a renewable source of energy to support home energy demand the majority voted “No” with 88%, it can be analyzed that the knowledge about the advantage of using renewable energy to homes is not in optimal stage as shown in the figure 39. However approximate to 12% have a renewable source of energy this is a promising number that indicates a good sense of awareness of the survey respondents toward the environment conservation.

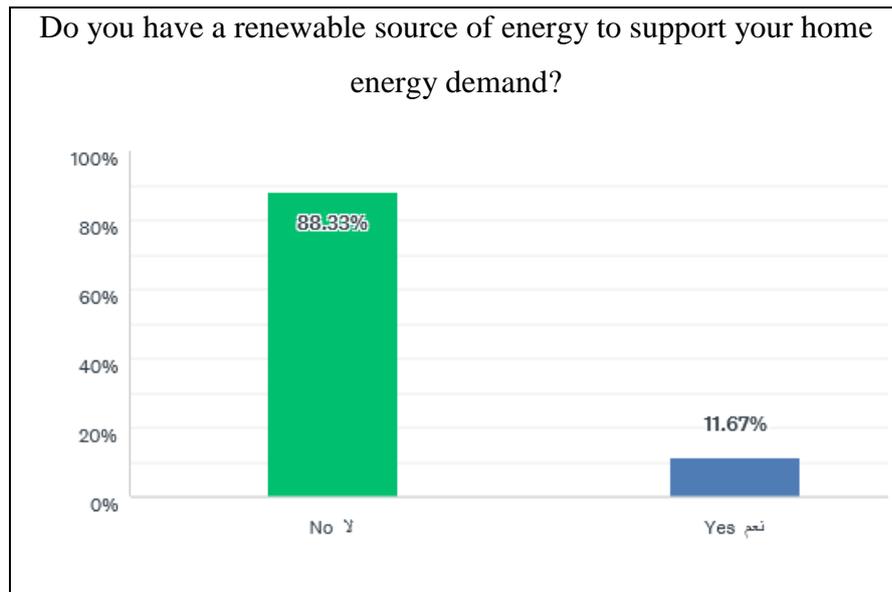


Figure 39 :(Owing a renewable source of energy of the survey’s respondents)

As noticed from figure 39, that the percentage of respondents who have a renewable energy to support home energy demands got a monthly salary ranging between 15,000 AED-30,000 AED is 42% and more than 30,000 AED approximately 43%, most of them holds a bachelor degree, see figure 40.

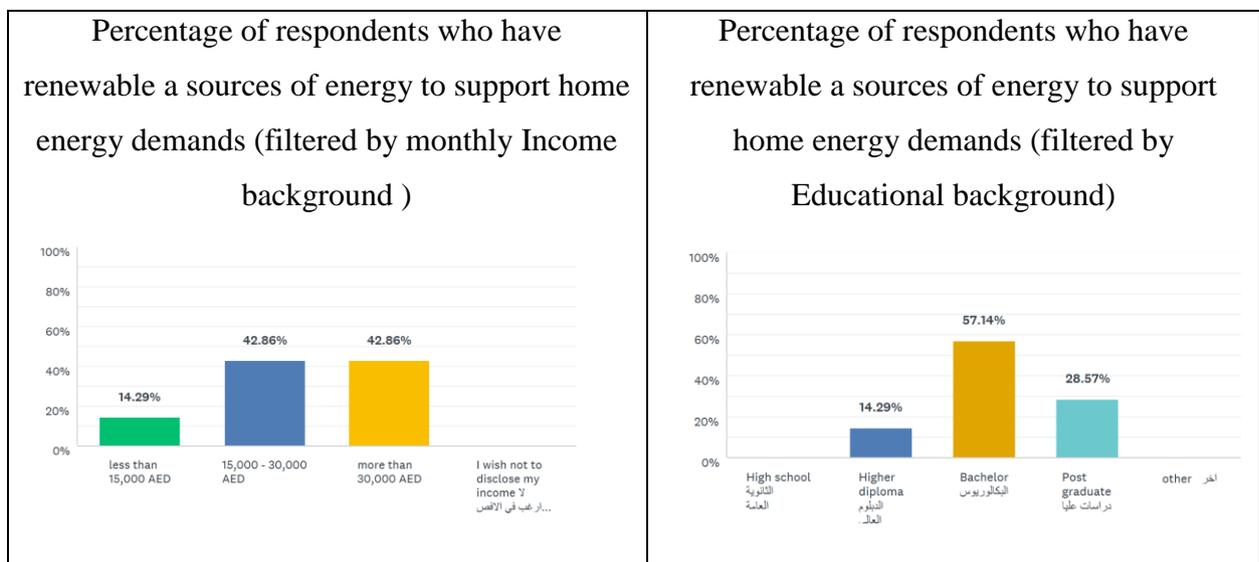


Figure 40 :(Respondents who have renewable energy at their home energy (filtered by monthly income and Educational background)

4.3 Energy consumption behavior and preferences:

Undoubtedly the number of hours spent at home translates also in the amount of time we use home appliances, air-conditioning system and lighting, so around 43% of questioner's participants spend half of the day around 12 hours ,followed by around 25% who spend 8 hours at home this suggest that they are full time workers or students or both . Exactly 20% spend around 16 hours and around 12% stay at home all the time, as shown in the figure 41. As mentioned earlier the more hours stayed at home the more tendency to consume more energy.

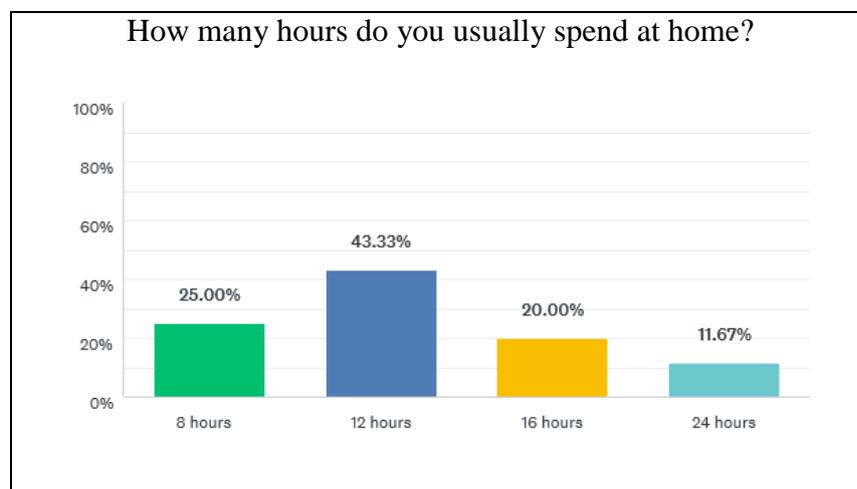


Figure 41: (The numbers of hours spent at home by the survey's respondents)

When it comes to home appliances purchasing, people look for several special features. About 43% of the survey participants prioritizes quality, the second thing that they look for with 23% is energy efficient appliances which indicates sense of awareness toward energy conservation and saving the environment importance to them; the third feature approximate to 17% is related to economic factors to purchase appliances with reasonable cost. Next, is ease of usage with 8% of replies undoubtedly no one prefers a complex machine it should be user-friendly, followed by 8% who looks for new featured , however internet connectivity feature was the least important to the participants in fact no one voted for this feature remarkably at this stage of the survey. As shown in the figure 42.

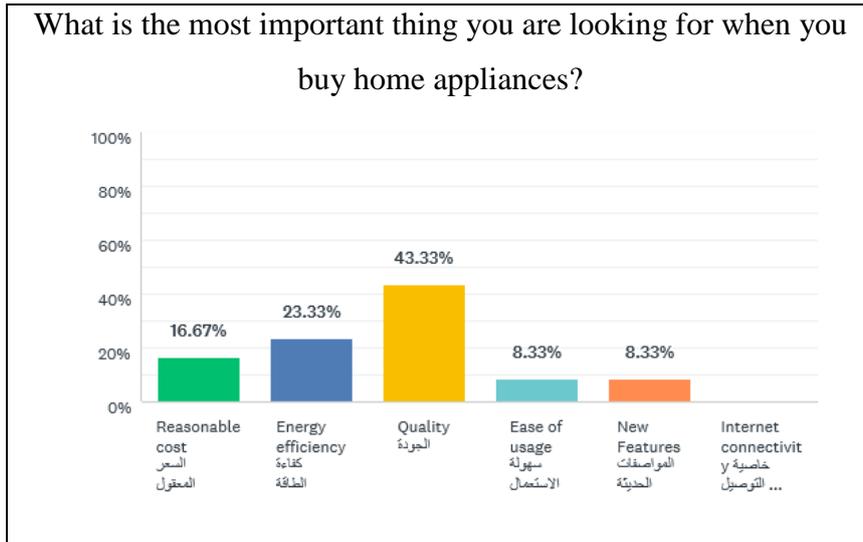


Figure 42: (Home appliances preferred features by survey's respondents)

In the villa, apartments or townhouses, participants have different types of air-conditioning installed or built in systems at their homes .The numbers of the survey found out that 54 percent of them have centralized air-conditioning system. While approximate to 32% have AC split unites, also 9 % got a through the wall AC unites, finally 4% system is rooftop units as shown in the figure 43. When it comes to home automation technology to control AC system, it is easier to install an internet connected sensor to the centralized and split unit than through the wall AC because it is not supported by a remote controller , so occupants can monitor and switch on and off the cooling units from a distance.

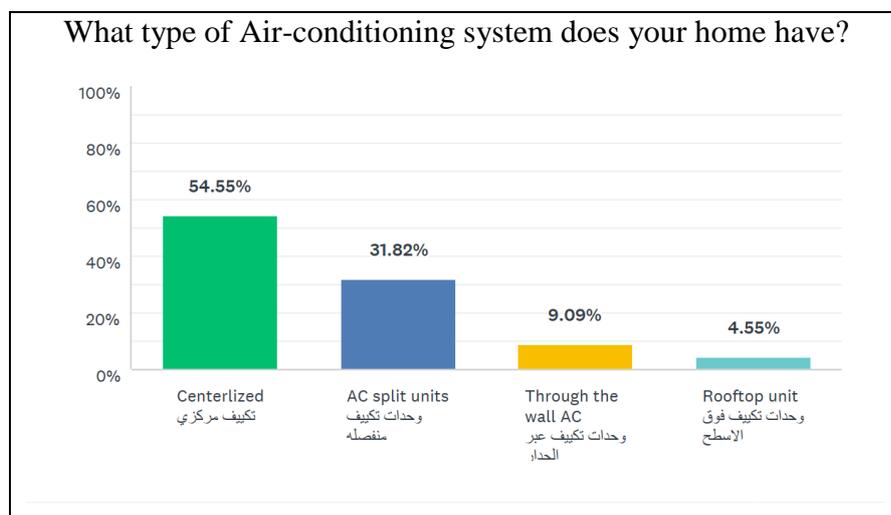


Figure 43 :(Air-conditioning type of survey's respondents)

After knowing the respondents Air-conditioning type, it is needed to know more about the thermal comfort of the occupant in summer and in winter. Therefore, it was found out from the survey that the indoor air temperature degree (Celsius) that makes them feel comfortable in summer time is as average 21.3°C the maximum is 25°C and the minimum is 15°C.

In winter the survey's respondents mentioned the preferred indoor air temperature to be on average 23.9 °C, and as high as 30°C or a minimum of 20°C ,as shown in the figure 44 .

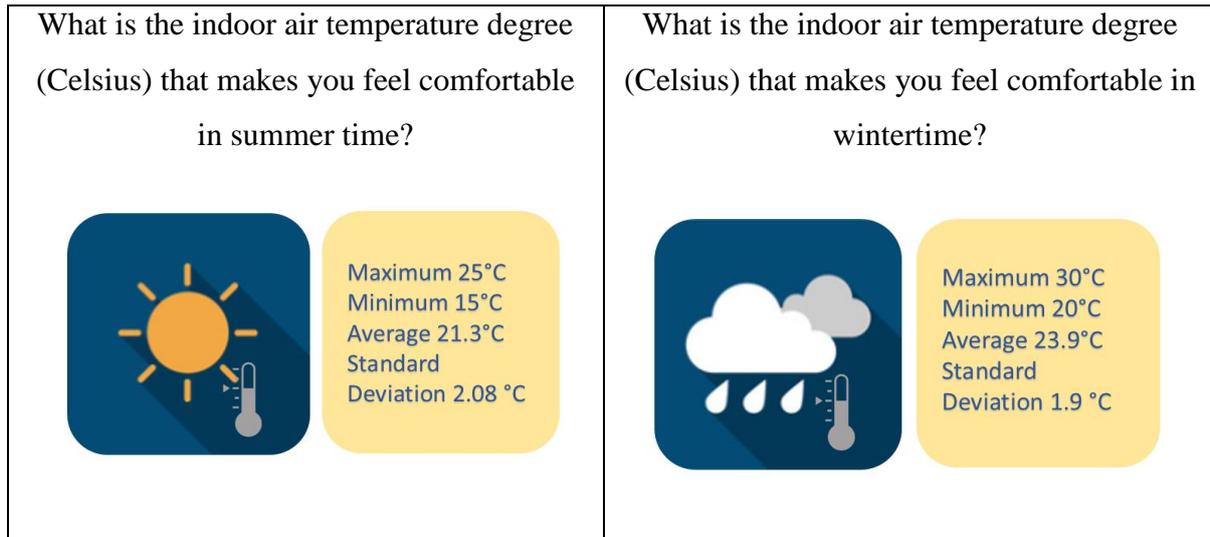


Figure 44:(Preferred comfortable indoor air temperature for the survey's respondents in summer and winter)

Due to indoor temperature variation, people tend to adjust the thermostat to have a convenient thermal comfort, so when the participants were asked about the number they adjust the thermostat of the air-conditioning system, close to 42% replied only before sleeping, whereas 35% never adjust the AC and 23% more than once, as shown in figure 45.

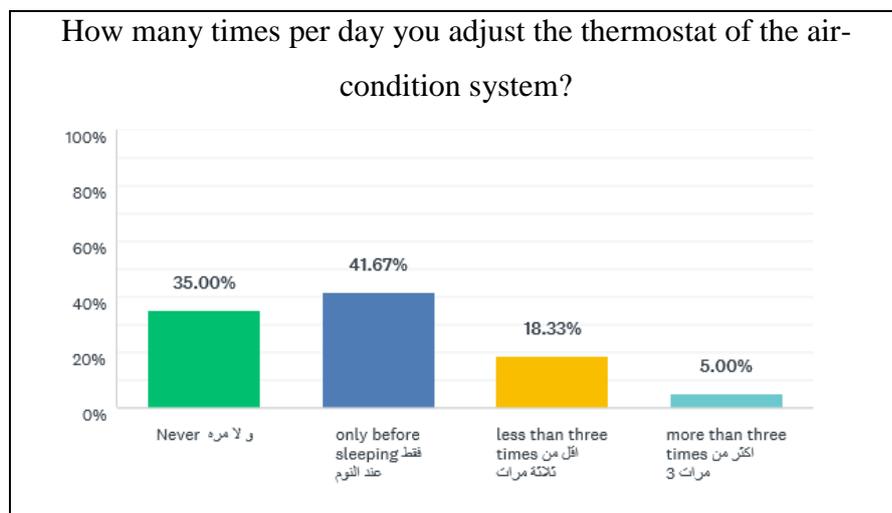


Figure 45 :(Number of times that survey's respondents adjust their thermostat)

Due to the nature of UAE’s climate, the weather gets better between December and March, not only that, but also there is a colder air breeze .This reduces the need of using air-conditioning system to cool down buildings. Therefore, when asked about using natural ventilation, 40% of respondents mentioned sometimes .On the other hand 30% replied always .Next 25% of them uses natural ventilation most of the time .Finally 5% never take advantage of using natural ventilation to cool down their homes and exchange air, as shown in the figure 46.

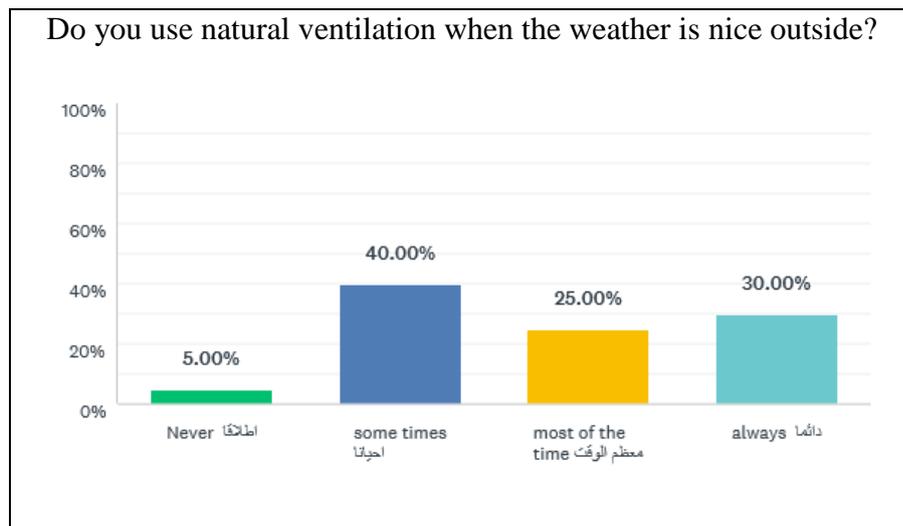


Figure 46: (Natural ventilation preference of survey’s respondents)

Automated curtain system allows opening the curtains and closing automatically when there is a strong daylight it is equipped with light sensor to measure radiance and automatically adjust curtains accordingly .The special thing about it, is that it can reduces heat exchange and lower the need for air-conditioning cooling and reduces cooling loads leading to energy saving. The finding of the survey’s question “if they prefer to use automated curtain system”, 41% were indecisive about using the system, 38% are not interested at all, while 20% showed an interest in the system. As shown in the figure 47.

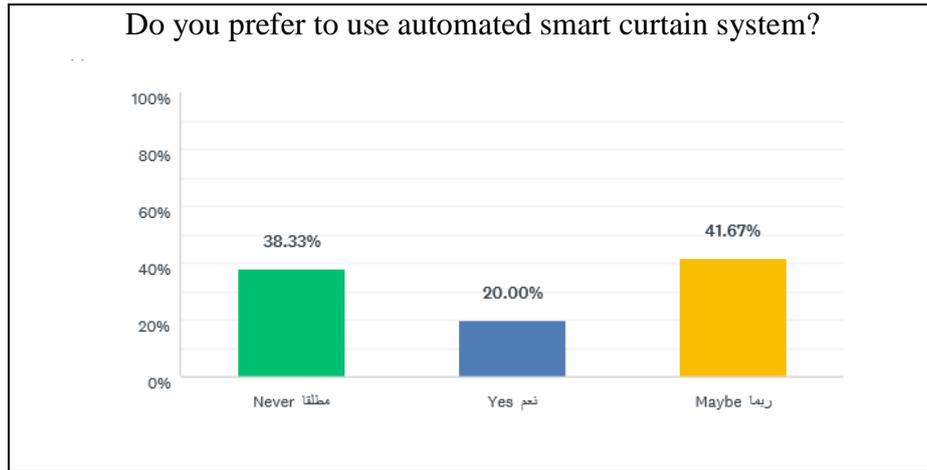


Figure 47: (The interest level of automated smart curtain system)

The finding indicates positive response about controlling the air-conditioning system remotely by using phone application. More than half of the respondents 52% wants to control the air-conditioning system remotely. Alternatively, 22% voted for maybe, last but not least, a quarter of them never wants this feature, as shown in the figure 48.

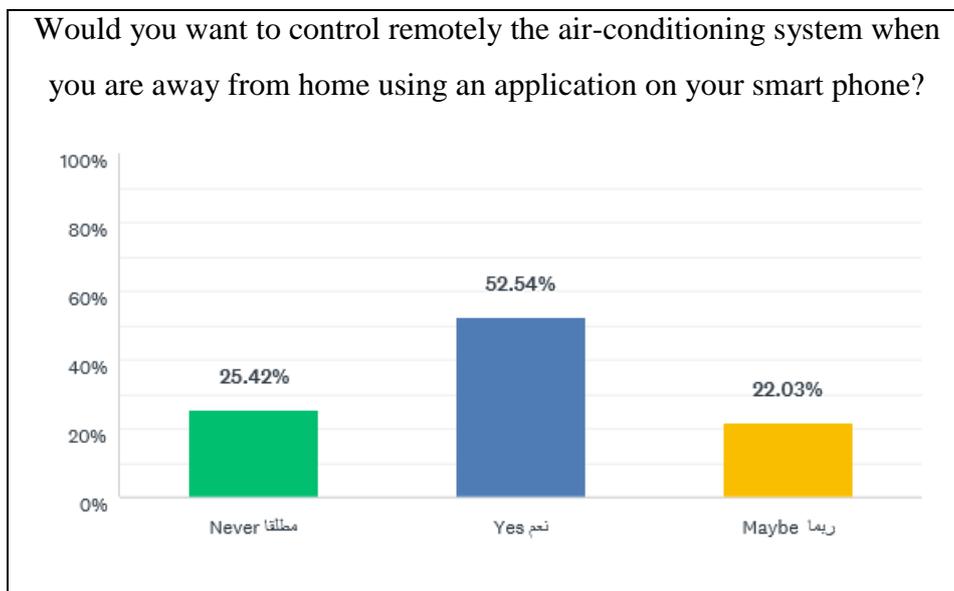


Figure 48 : (Remote control interest level of the survey's respondents)

Respondents who said yes filtered by income and educational background, as shown below in figure 49. It shows that they are highly educated and can afford the automated system.



Figure 49 (filtered answers by “Yes”)

The majority of the participants 86% switch off the light when they leave the room, around 11% often do and few of them 2% keeps the lighting on even if they are not in the room, as shown in the figure 50.

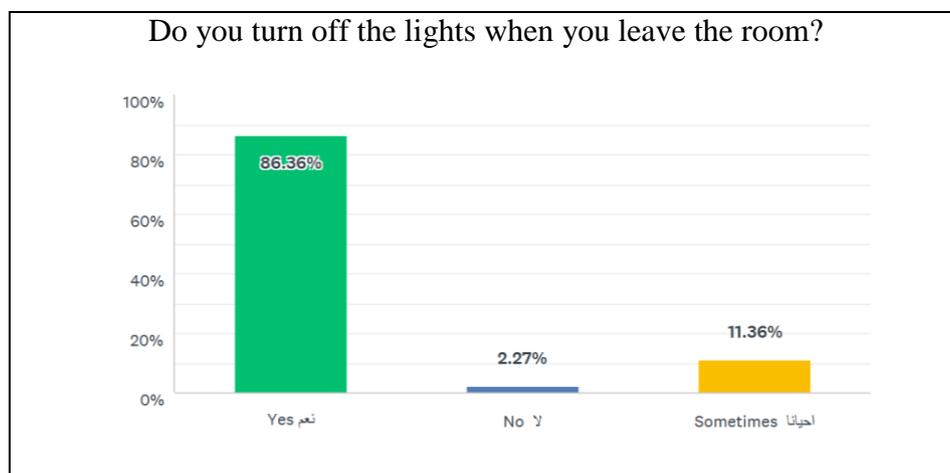


Figure 50:(Attidue toward lighting consumption by survey respondents)

Many participants with 68% wants to have control over the lighting of the home remotely using phone application, near 16% voted to maybe ,the rest 16% voted for “Never”, as shown in the figure 51.

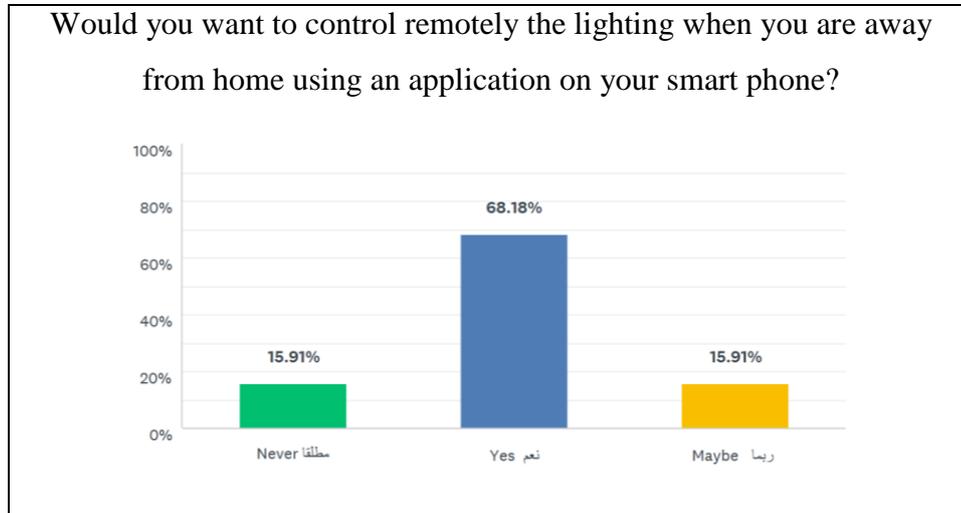


Figure 51: (Preference of automatically control the light by survey’s respondent)

Respondents who said yes filter by income and educational background, as shown below in figure 52. Most of them holds a master degree and can afford the automated system.



Figure 52(filtered answers by “Yes”)

Roughly, 68% of the survey's respondents voted most favorably to having a lighting system that is equipped with sensors to switch on and off or dim the lights. A smaller number almost to 14% replied to maybe and the rest 18% said no, as shown in the figure 53.

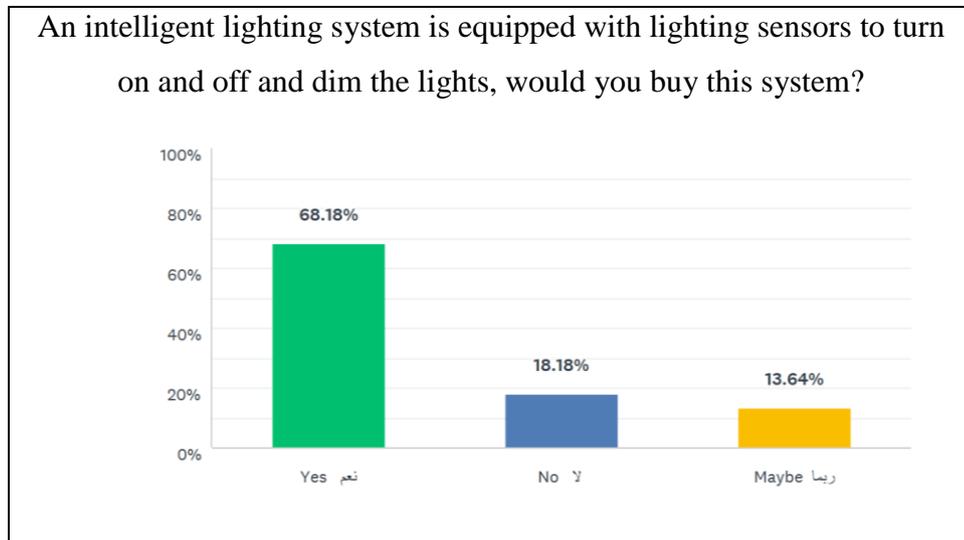


Figure 53:(survey's respondents willingness level to buy lighting control system)

In this stage of the survey, a question was raised after giving hints of purchasing internet-connected devices and state their benefits in the previous questions to have the ability to remotely control the AC, lighting and curtains. So in general exactly half of the respondents are interested to have an internet-connected appliances, 27% were not as interested and about 23% did not want to have internet-connected appliances, as shown in the figure 54.

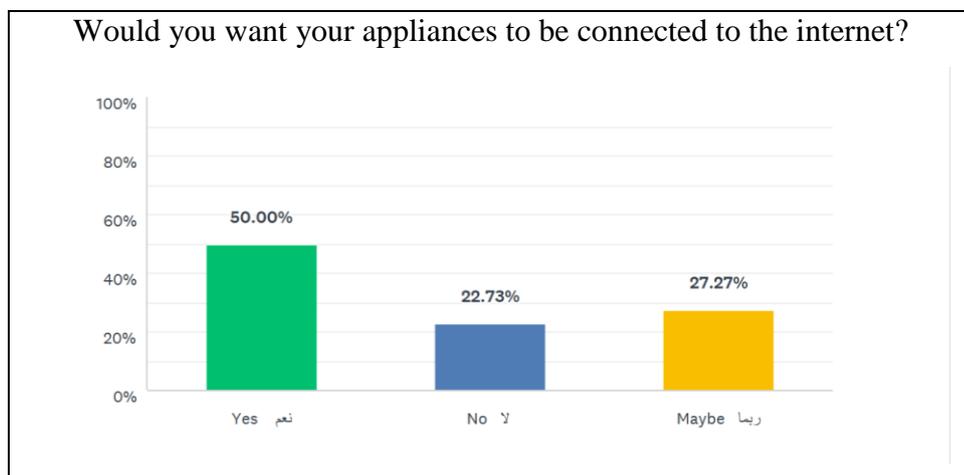


Figure 54: (survey's respondents willingness level to buy internet connected appliances)

As for the respondents who were less convinced about the concept of connecting their appliances to the internet .The highest rating were for two main reasons they either think it is not necessary 34% of participants voted for this, or they cannot trust the system other 34% voted for this obviously they are afraid it can be a threat to their privacy, also around 3% voted for “it is a waste of money”. As shown in the figure 55. There were 27% of the respondents who mentioned other factor one of replies quoted “They increase level of radiation in the house which causes health issues “, another reply “I believe we have to think about when and how to use it for the right place and right time and use it wisely”.

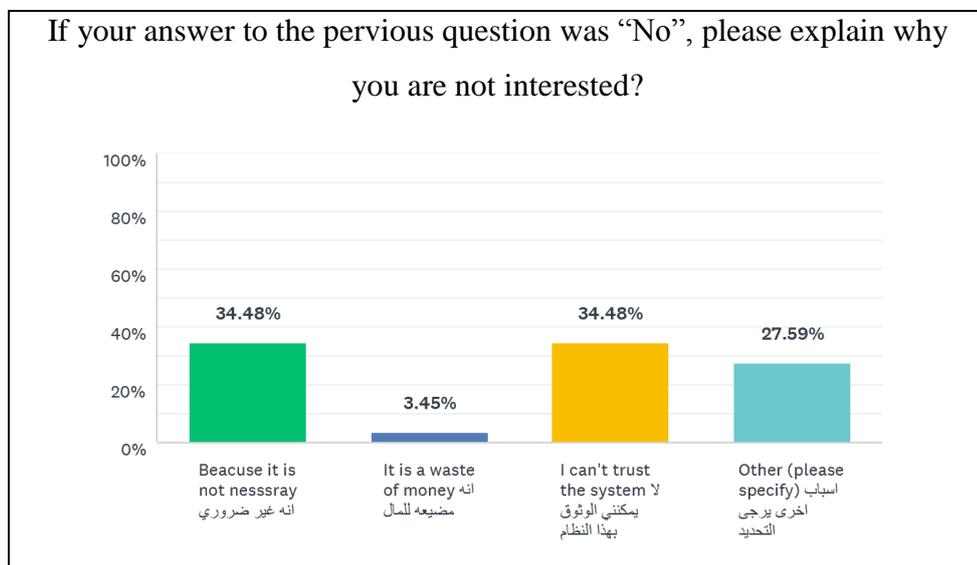


Figure 55:(survey’s respondents explains why they are not intrsted in intrenet connectd appliances)

A question was proposed to participants if they will be interested in internet-connected devices again to remotely control and analyze energy consumption. Positive 75% of the survey’s participants voted for wanting to use internet-connected appliances. Around 16% of replies are uncertain, and only 9% replied to not being interested, as shown in the figure 56.

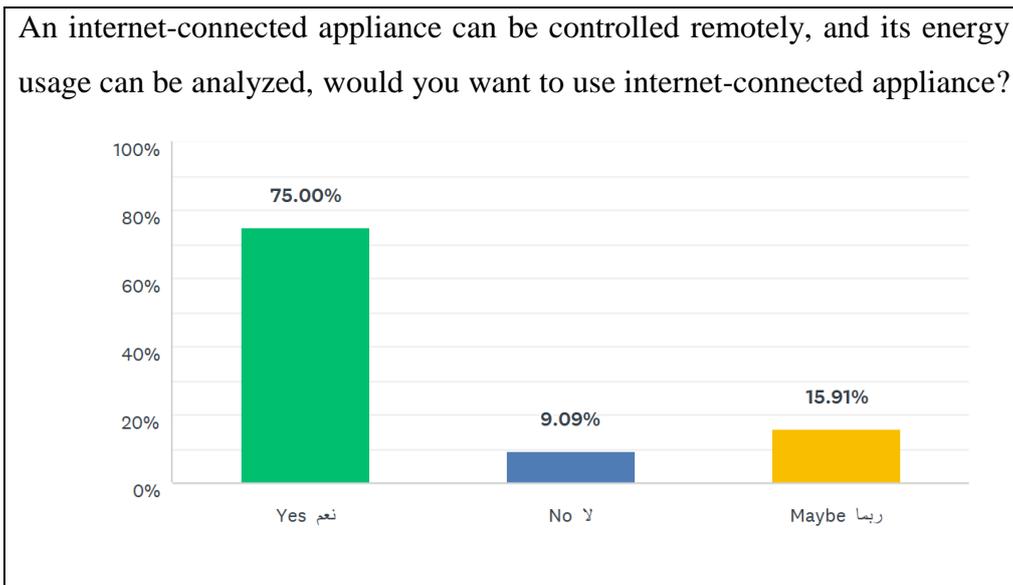


Figure 56: (Interest level of survey respondents about internet connectivity of appliances)

One of the previous questions was about how often do respondents irrigate their garden. Most of them irrigate it on a daily basis. When asked about if they would like to be encouraged to use an automation system to irrigate the garden, approximately 82% said yes, around 14% said no, and about 5% said maybe, as shown in Figure 57.

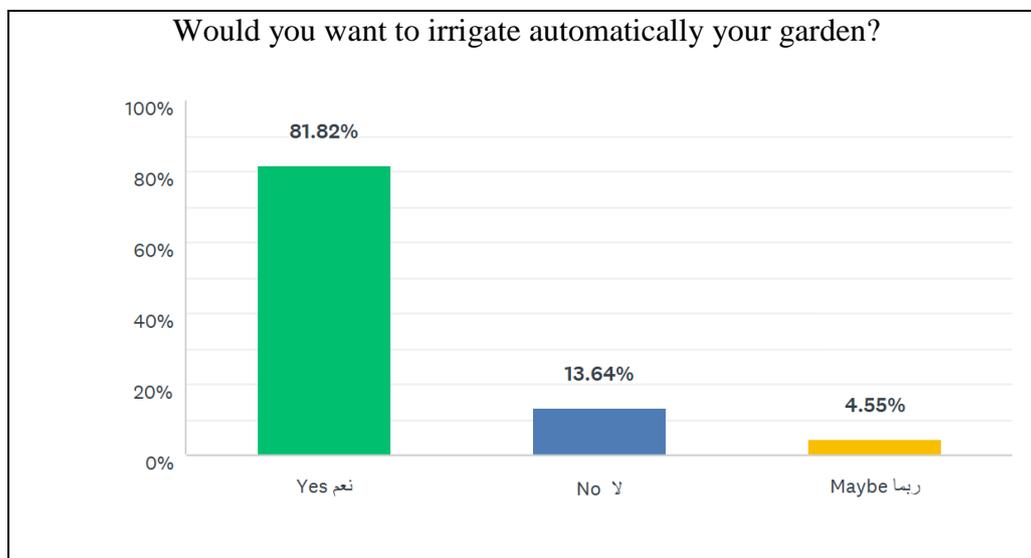


Figure 57: (Interest level of automated irrigation system of survey respondents)

Most of the respondents are into technological products. 84% voted to yes, 11% said it depends, and the minority 4% voted for no, as shown in Figure 58.

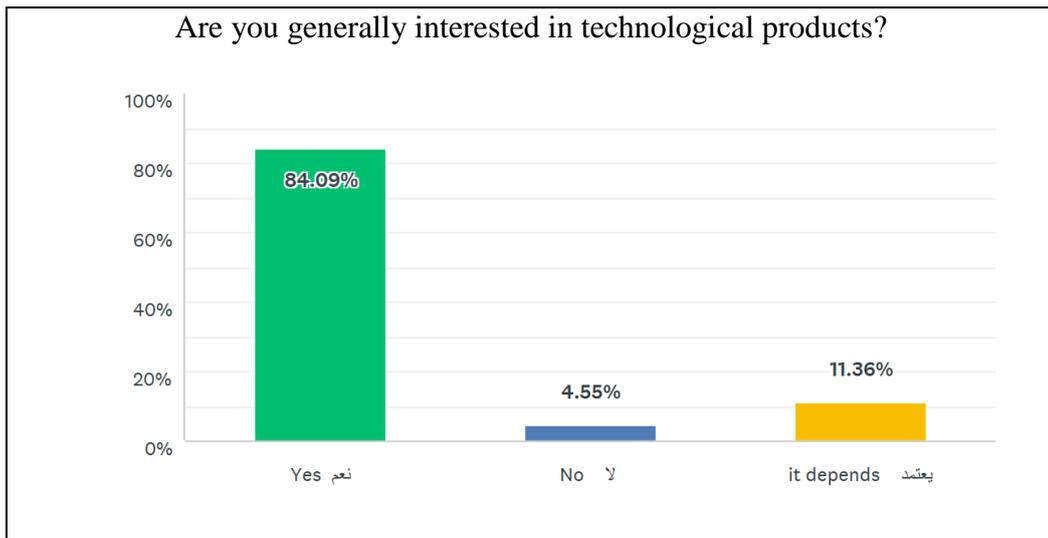


Figure 58 :(Technonogy interest level of survey's respondents)

Knowledge about Iot was clearer among the younger respondents with higher education level, the rest were not familiar with the term, as shown in figure 59.

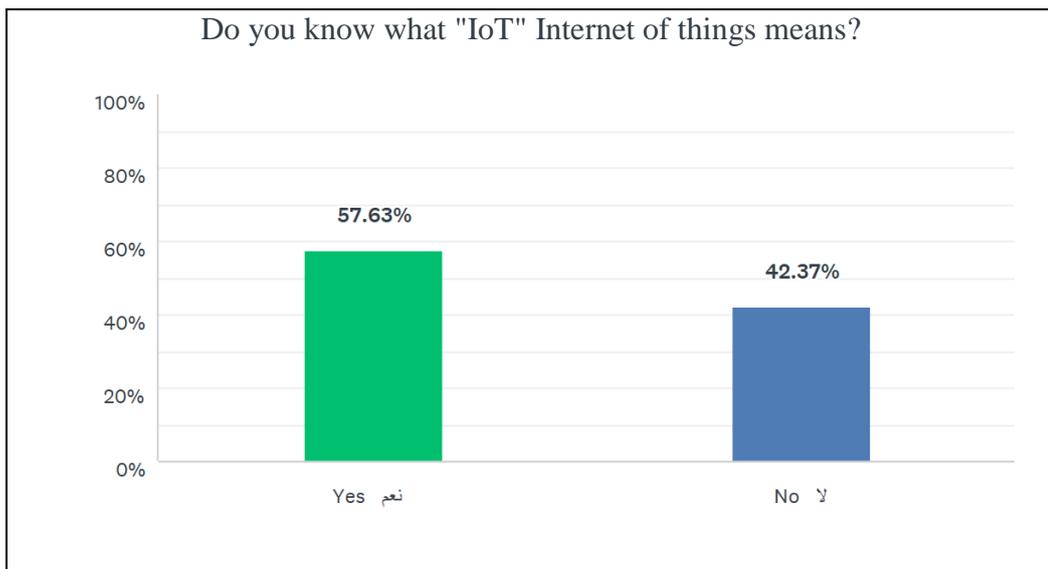


Figure 59:(Survey's respondents awarness level about "internet of things ")

Some of the responses expressed that Internet of things is a technology that will serve peoples need, and would like to apply it to their lifestyle, from another perspective they see it as a technology that saves effort, time and money. In addition, they had a concern about safety and confirmed that it should offer anti-hacking protection system, as shown in the figure 60.

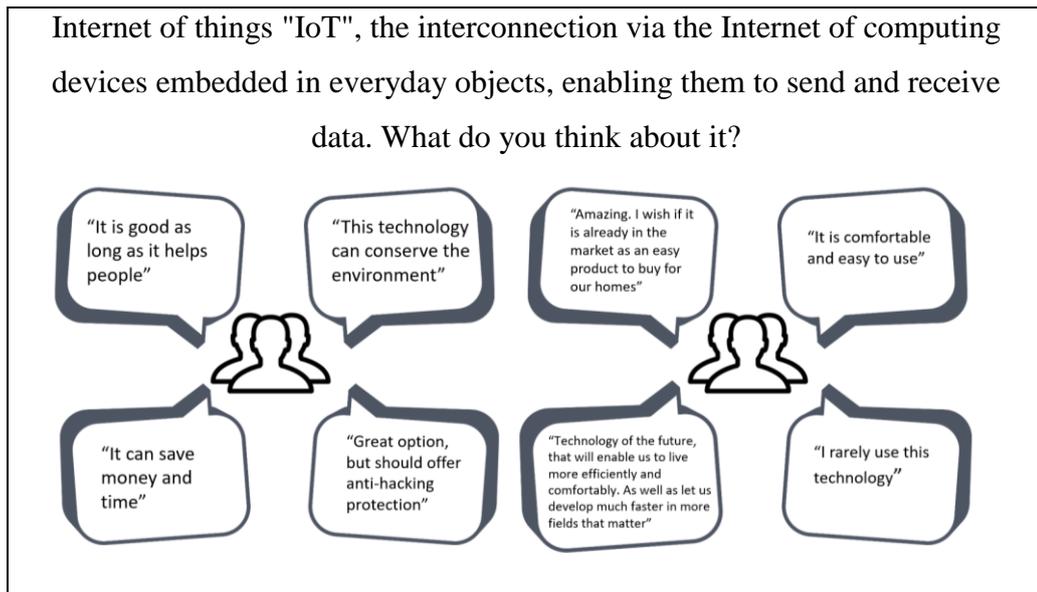


Figure 60 :(Survey’s respondents opinion about home automation)

When asked about if they are aware of home automation system the response rate was around 68% answered yes, and about 32% said no, as shown in the figure 61.

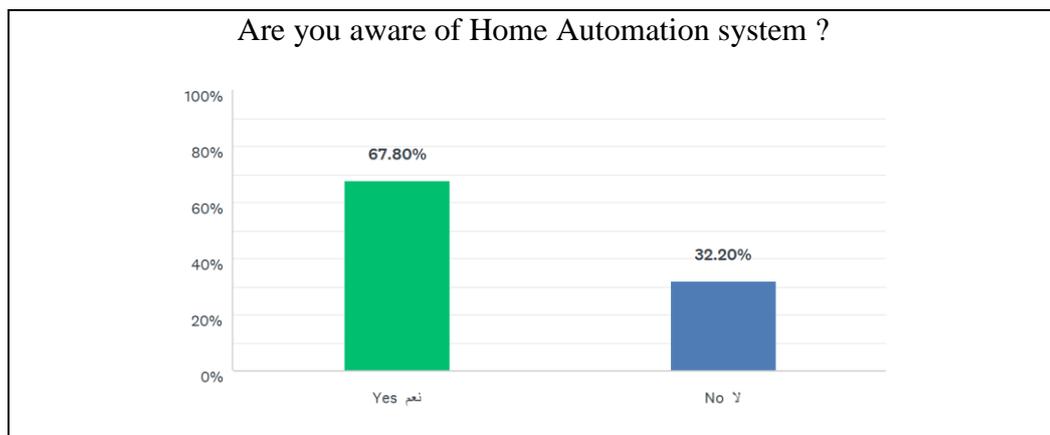


Figure 61 :(Survey’s respondents awariness level of Home Automation)

Respondents mostly agreed on shifting their homes into smart automated homes to have the ability to control lighting, heating, ventilation, appliances and other systems approximate to 51% are defiantly encouraged ,while 22% agreed and 24% were uncertain ,few responses 3% expressed that they were unwilling to adopt this technology, as shown in the figure 62.

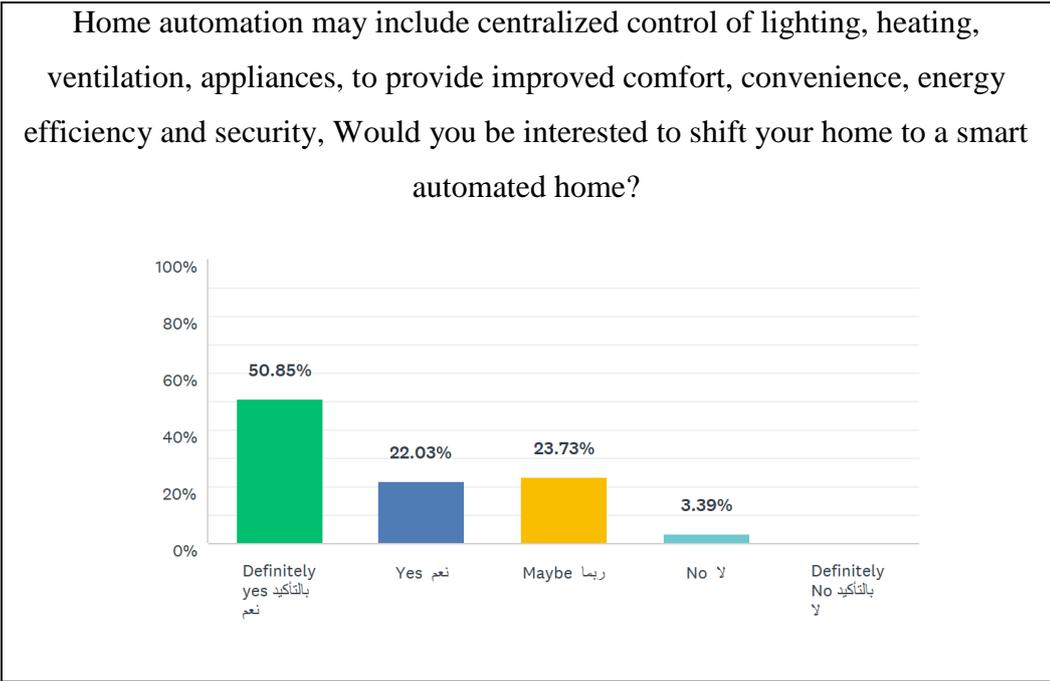


Figure 62: (Survey’s respondents interest level to transfer their home into smart automated home)

Part of home automation is to have control over home security, so currently 84% of participants do not have a smoke detector, however 16% have a smoke detector, and this indicates lacks of concern about the safety .An automated sensor will help saves occupants lives ,as shown in figure 63.

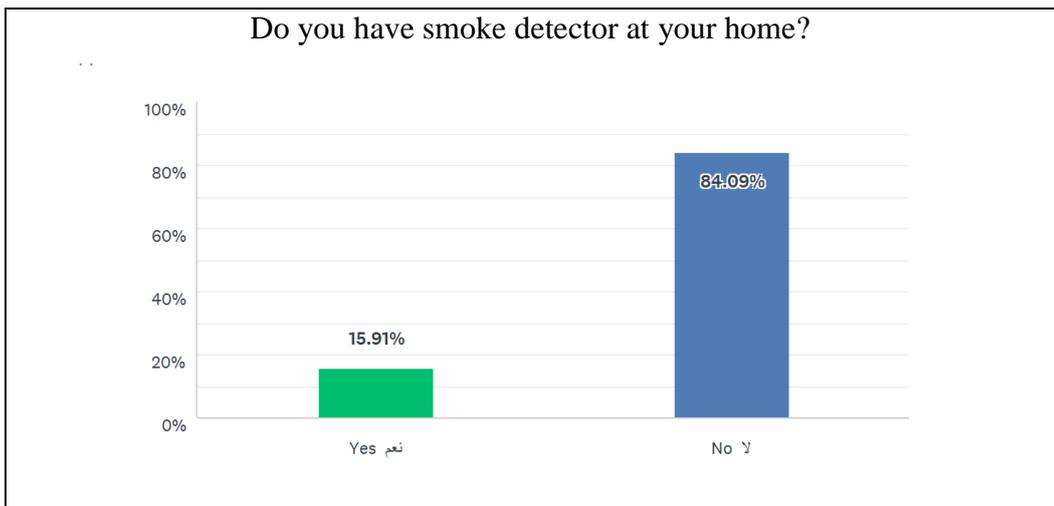


Figure 63: (Owning a smoke detector)

Household are positive to the concept of saving electricity and water through Home Automation system and they are willing to invest in it, the majority 44% is willing to pay

around 5000 AED. About 20% are willing to invest in less than that from a 1000-2000 AED. Others will invest more with the range of 5,000-10,000 AED .Finally a good percentage around 14% will pay up to 15,000 AED, as shown in the figure below 64.

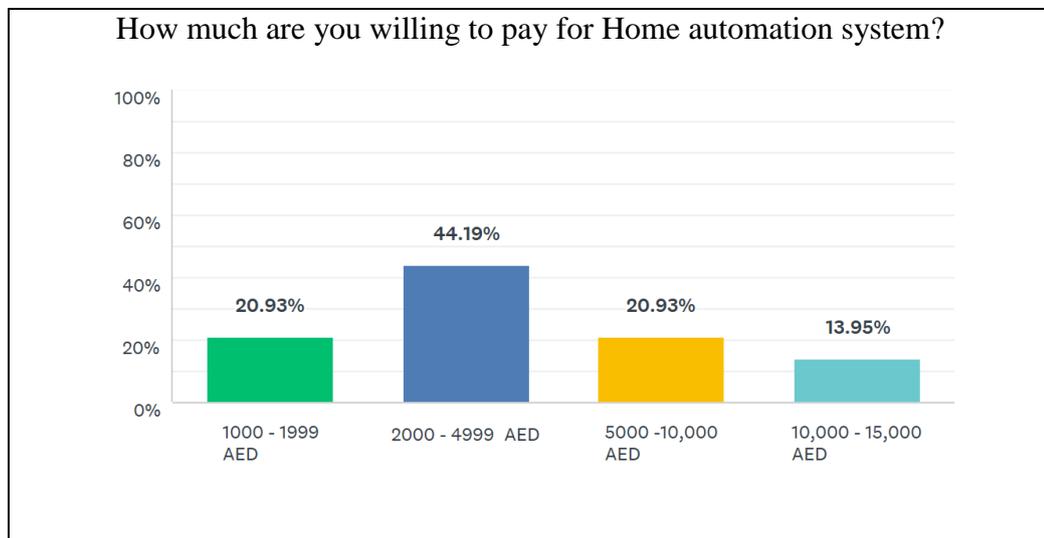


Figure 64: (Home Automation pudget of survey's respondents)

4.4 Opinion toward Energy conservation and Home Automation:

Purchasing smart home automation appliances alone is not sufficient to save energy consumption but also the behavior of the occupants should alter to double the benefit of the system. In addition, it is important to know the mindset, opinion and general knowledge about energy consumption and the willingness level to transfer their home into automated home.

From the previous part, and after knowing about the consumer attitude and behavior toward energy, it is as important to know their opinion about few points. More than half of the participants 55% strongly agree to the importance of saving household electricity, followed by 41 who agrees, only 3 % neither agree nor disagree .No votes for disagreements at this point as shown in the figure 65.

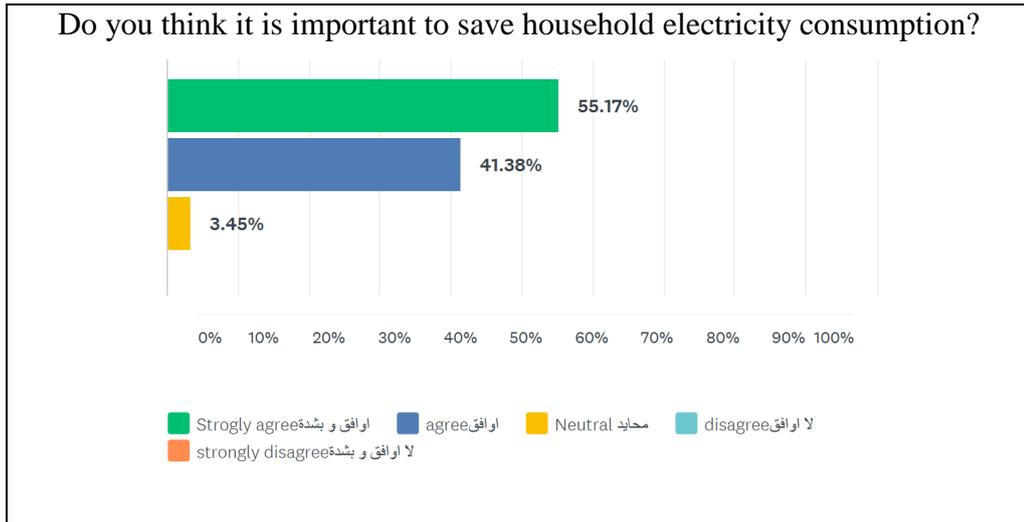


Figure 65: (Survey’s respondents opinion about the importance of saving household electricity)

Respondents strongly believe that they have a responsibility toward saving the environment 61%, 30 % somehow agree, almost 7% are uncertain about their role. Finally approximate to 2% do not feel that they can contribute into saving the environment, as shown in the figure 66.

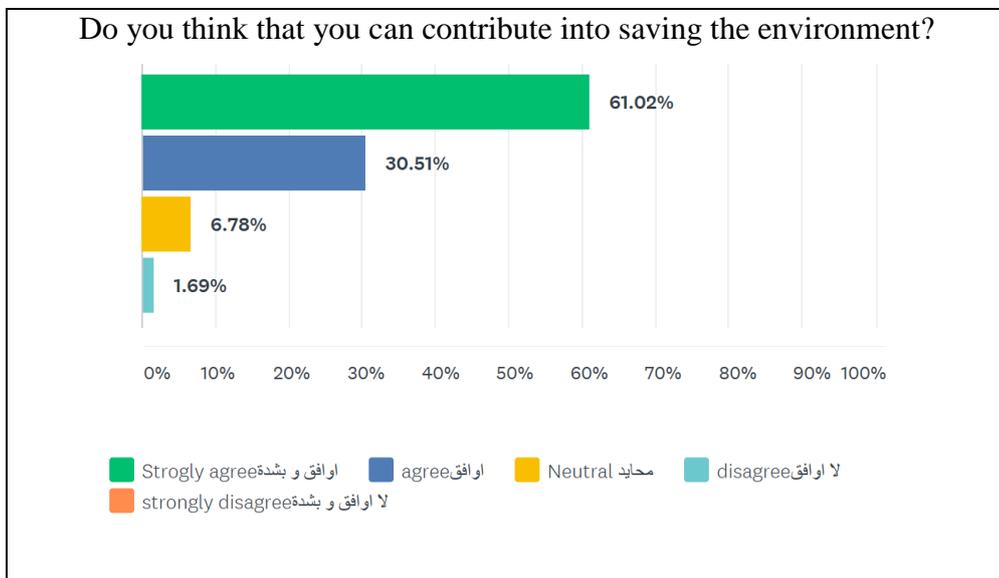


Figure 66: (Survey’s respondents opinion about their role to save the environment)

On a bigger scale, many governments and authorities are making an effort toward saving the environment by conserving energy. In addition to, raises the awareness level of their people to contribute in conserving energy and water .It was found out from the survey that 30 % of the

participants strongly agree with that it is the government responsibly to save energy. A quarter agrees. Around 17% neither agree nor disagree; noticeably 8% disagree, as shown in the figure 67.

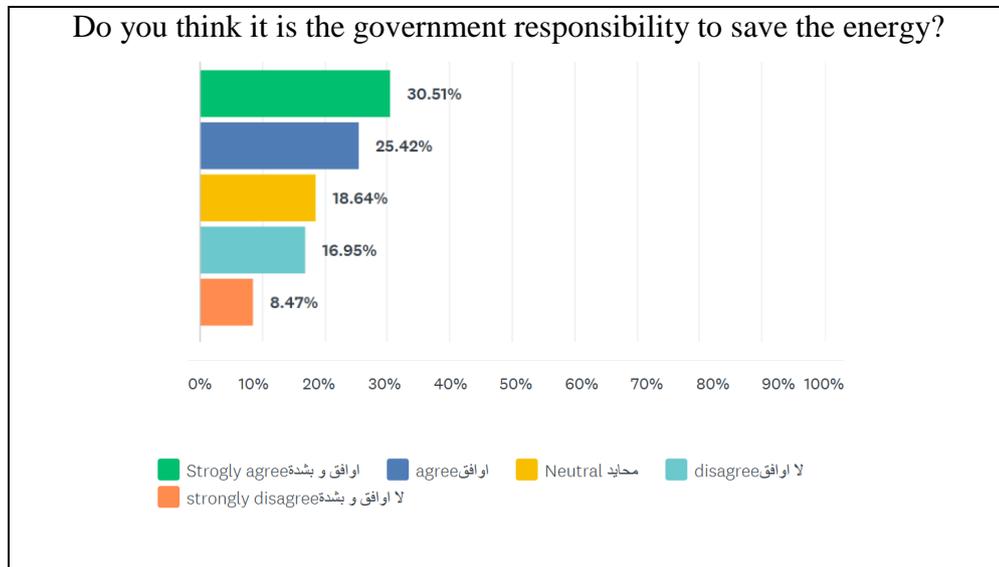


Figure 67:(survey’s respondents opinion about the government responsibility to save the enviroment)

Fifty two percent of respondents strongly agreed that they have a responsibility to use electricity more efficiently, 37% of them still agree, 10% are mutual. However, no one voted for disagreement, as shown in the figure 68.

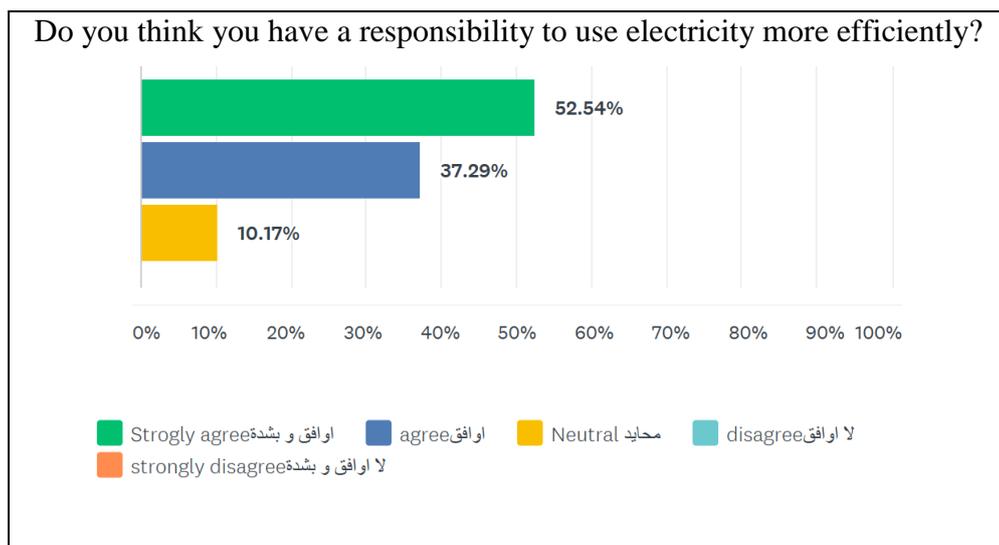


Figure 68 (Survey’s respondents opinion about using electricity more effciently)

When home occupants saves energy to save the environment it is a good deed, but part of the sustainability billers, which are economic, social, environment .It is equally essential to save costs on energy consumption.

So it was asked if participants “Only” conserve energy to reduce electricity bills 22% voted to strongly agree, 22 % voted to agree, approximate to 17% neither agree or disagree.

On the other hand, 30% disagree and 8% strongly disagree this indicates that they have more reasons to use energy more efficiently to reduce cost it is analyzed that saving the environment is an addition motivation to do so, as shown in the figure 69 .

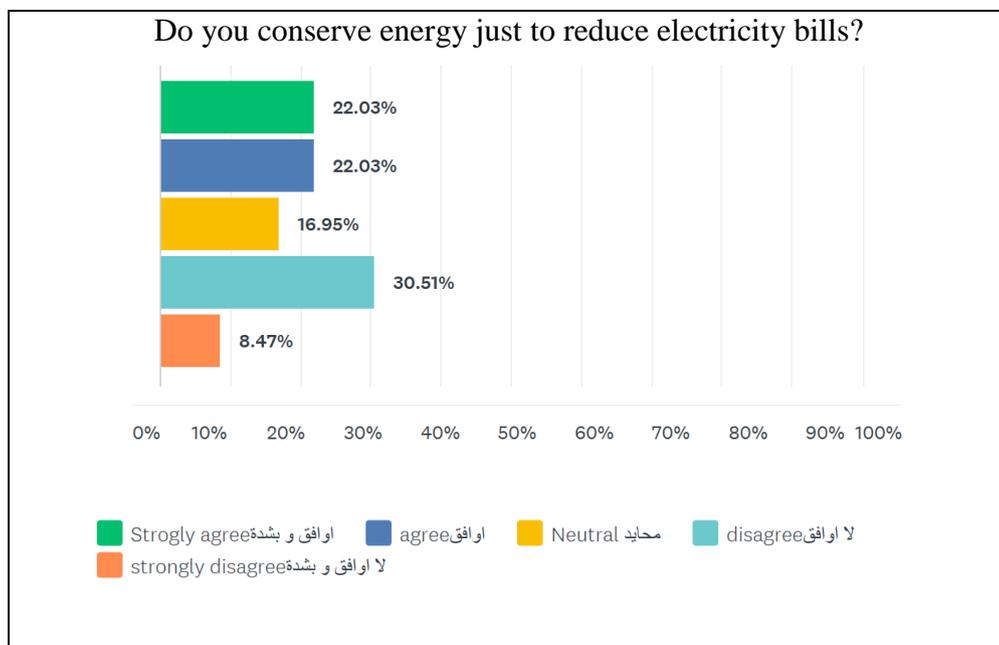


Figure 69:(Survey’s respondents opinion about reducing electricity bills through conserving energy)

In order to be committed to save energy it takes extra steps, so a question was asked to test their opinion if “saving electricity is not convenient to my own life style “, almost 7% voted to strongly agree, while almost 7% agree to that sentence, approximate to 19% were indecisive.

In contrary the majority 48% voted to disagree and around 19% strongly disagree, this imply good awareness level and seriousness of participants to saving electricity as it is not contradicting with their lifestyle ,as shown in the figure 70.

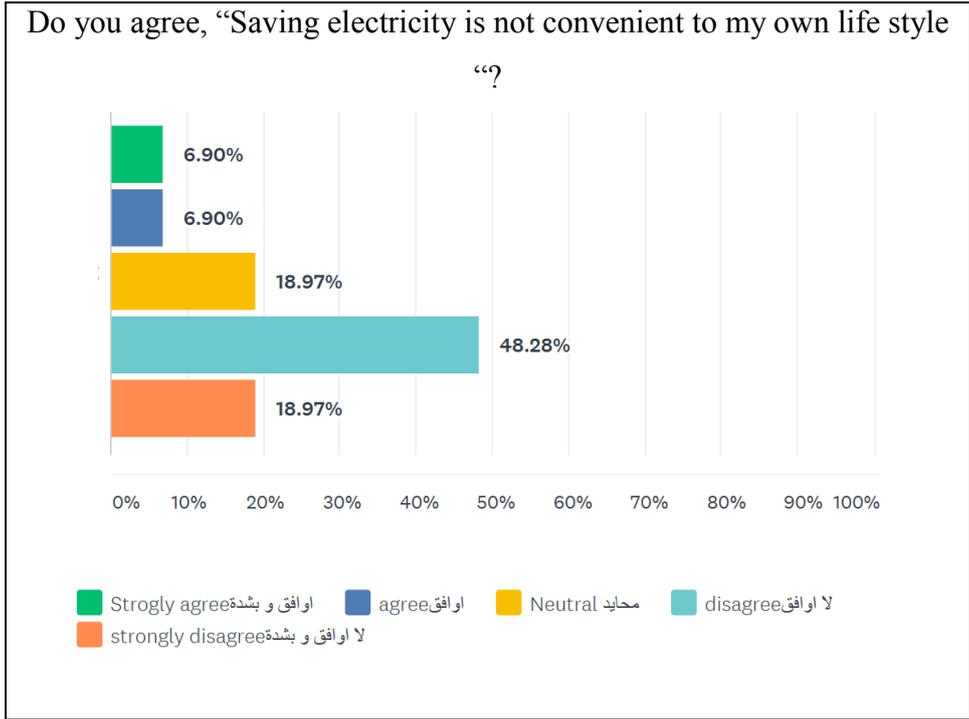


Figure 70(survey's respondents opinion about convenience and saving electricity)

The majority are aware and willing to avoid using appliances in "Peak Hours" to save energy, as shown in figure 71.

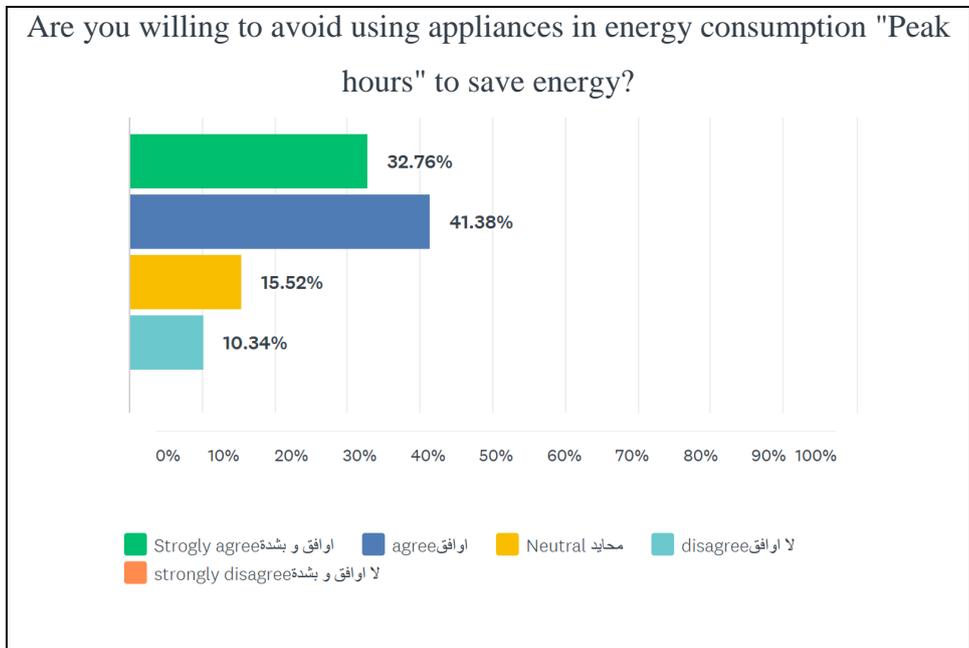


Figure 71 : (Survey's respondents opinion about avoiding "Peak hours " to save energy)

Here comes the part of how people can take action toward saving energy, 48% of the participants are strongly willing to replace their home appliances to more energy efficient types, 34% also agree. Approximate to 14% neither are willing or unwilling to make that change .Finally few strongly disagree with 2% and 2% strongly are unwilling to replace their appliances to conserve energy through efficient replacement type, as shown in the figure 72.

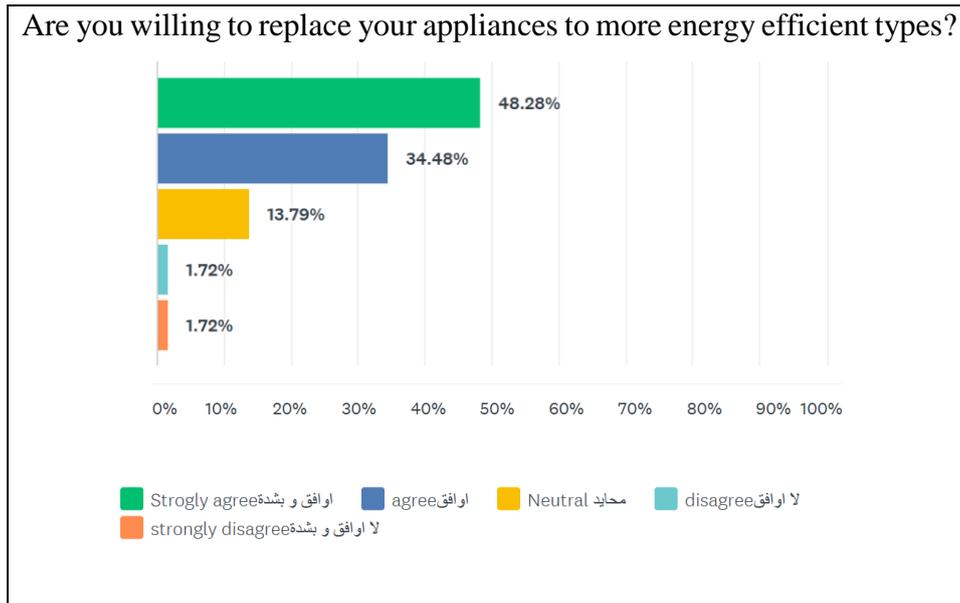


Figure 72 :(Survey’s respondents opinion about replacing their appliances to more effecinet types)

Human thermal comfort inside buildings could greatly affect the satisfaction, productivity and well-being of occupants. As a result, 22% of respondents were strongly willing, take risk and turn up AC temperature even if it is not comfortable for the sake of saving electricity. Near to 26% agreed to do so. An estimated 21% were neutral. Another part of the respondents 26% disagree ,and 5% prioritized their thermal comfort over saving energy by rising indoor air temperature and reduces cooling loads, as shown in the figure 73.

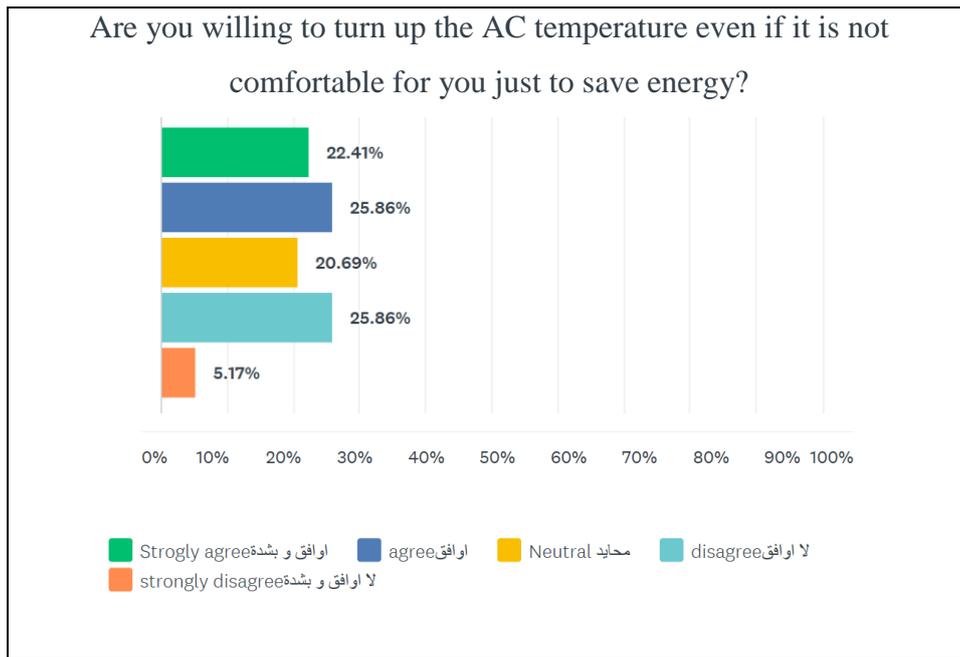


Figure 73: (survey's respondents opinion turning up the AC temperature to save energy)

Nowadays, there is a technological revolution everyday there is a change wither by producing advanced machines or manufacturing appliances that are smart. Smart home devices are beneficial in assisting home occupants with their daily life style, by controlling and monitoring the system, which leads to saving time and effort as well as energy costs. The 40% respondents voted to strongly agree to thinking that using latest smart home devices could help in saving energy and time, another 40% agreed to that .Part of the respondents 15% were not sure ,and only 5% disagree and didn't think that smart devices helps with saving energy moreover, time ,as shown in the figure 74.

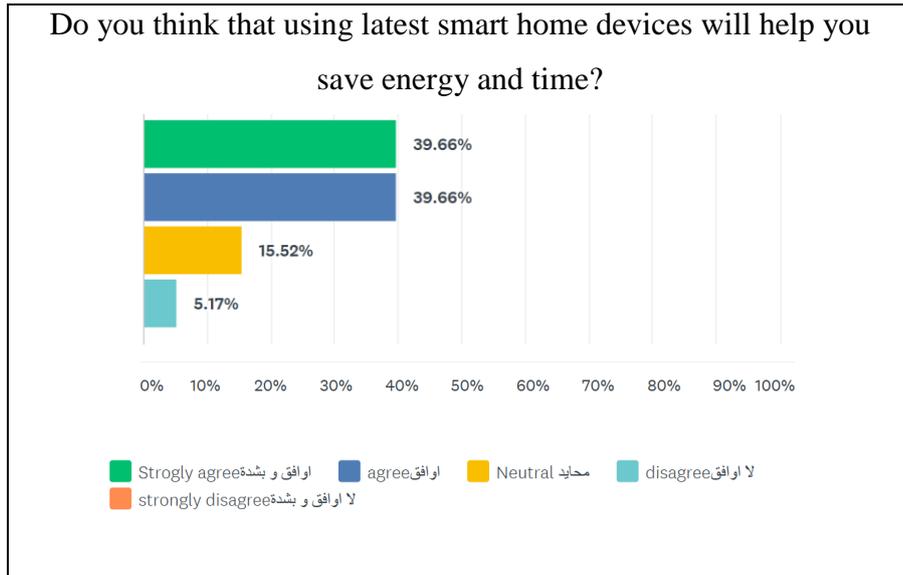


Figure 74 : (survey’s respondents opinion about using latest smart home devices)

Off course with the revolution of technology there will be a risk, privacy is a major concern with internet connected devices chances are that hacking could be made to invade personal and home privacy are valid .So about 24% of the survey’s respondents are certain that home automation system could invade their privacy . However, 35% are uncertain, last 35% did not seems to see the risk of home automation and privacy, as shown in the figure 75.

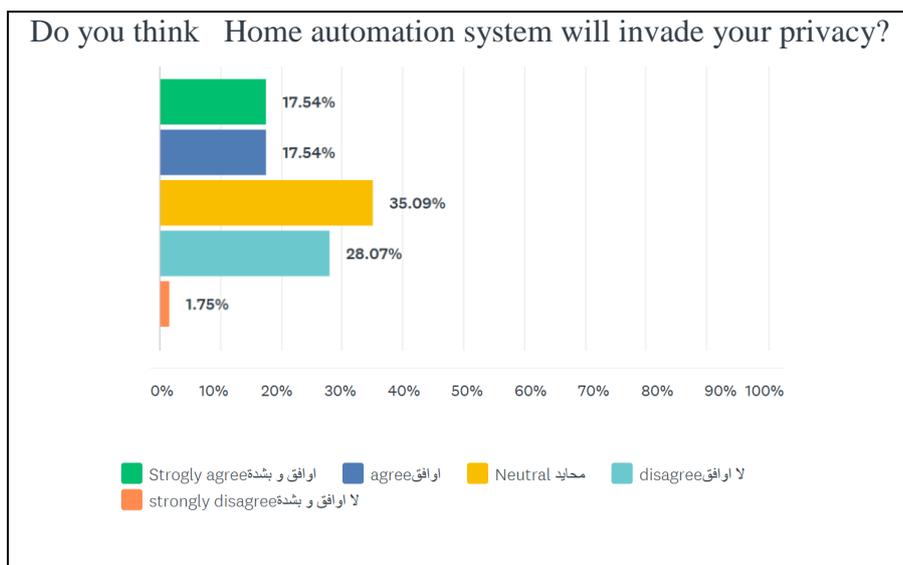


Figure 75: (Survey’s respondents opinion about home automation and privacy)

Approximate to 84% of the survey's respondents are interested in downloading an application to their smart phone or tablet to track home energy consumption .Around 9% of the participants are indeterminate , while estimated 5 % are not interested at all in downloading such an application , as shown in the figure 76.

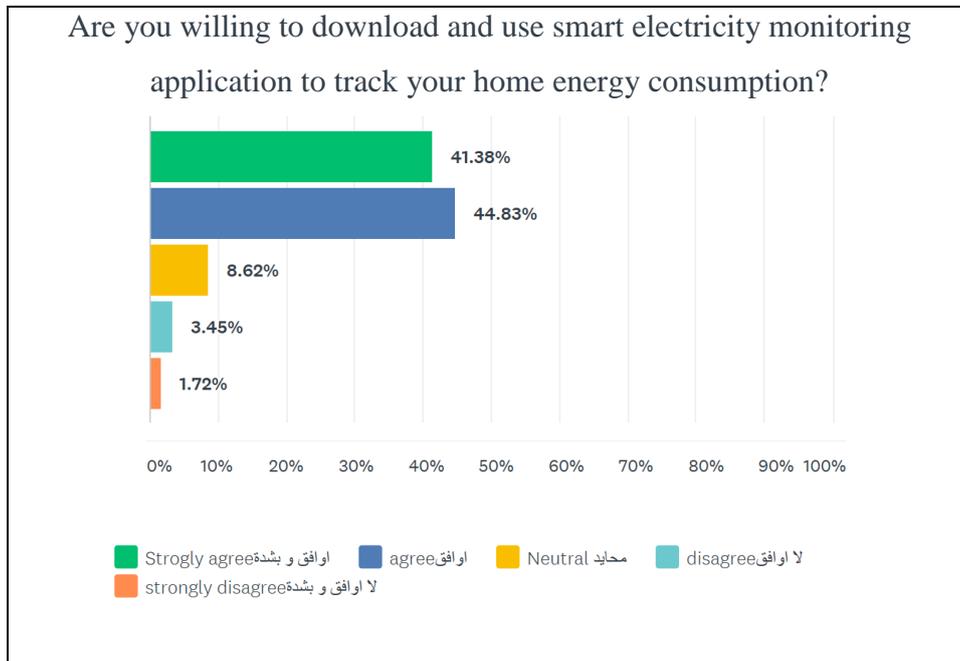


Figure 76: (Survey's respondents opinion about using phone application to track energy consumption)

Out of total replies 84% showed a positive interest in purchasing a monitoring system to control the Air-condition system remotely .Nevertheless around 9% are neutral, on the other hand 7% showed no interest , as shown in the figure 77.

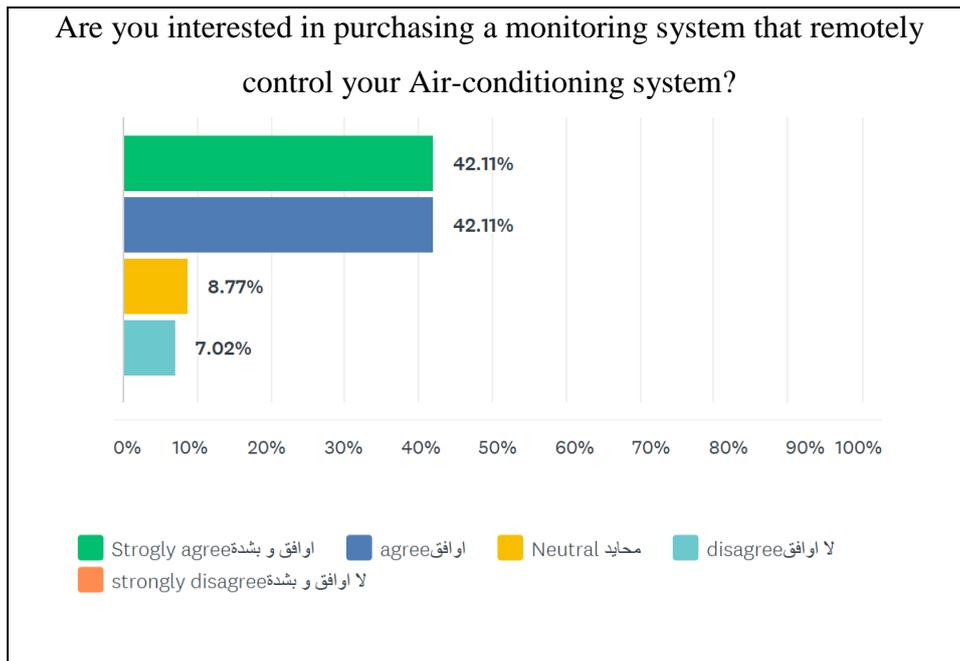


Figure 77: (Survey’s respondents opinion about controlling AC remotely)

Noticeably participants were more enthusiastic about purchasing security system to monitor their homes 50% were strongly interested in the system. Moreover, 34% are somehow interested, 12% are not as excited, and only few 3% are not interested to purchase and install security system at their home, as shown in the figure 78.

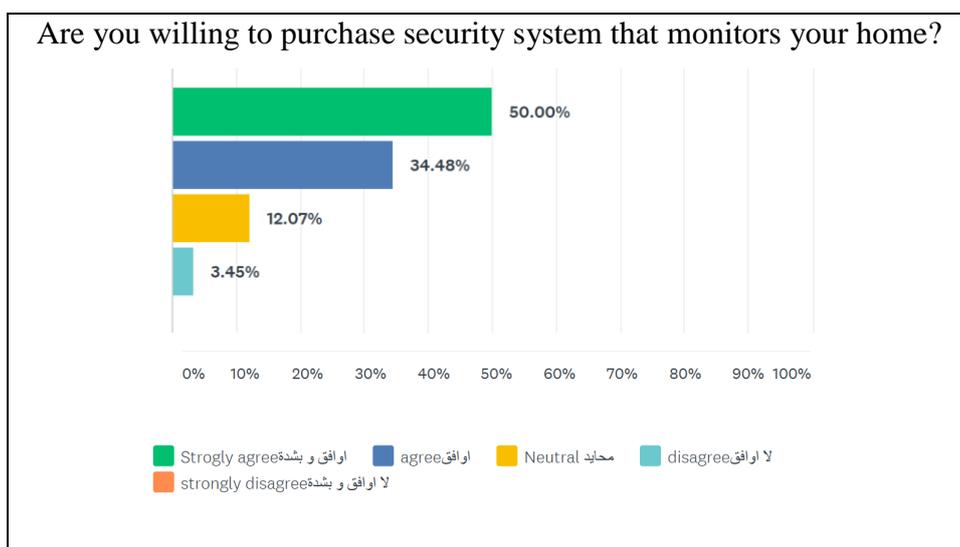


Figure 78 :(Survey’s respondents opinion about purchsaing security system)

Out of the total responses 53% strongly desired to have a system that pre-set up participants home before they arrive to increase comfort , also around 28% are motivated , while 15% were uncertain and only 3 % didn't want to have this advantage, as shown in the figure 79.

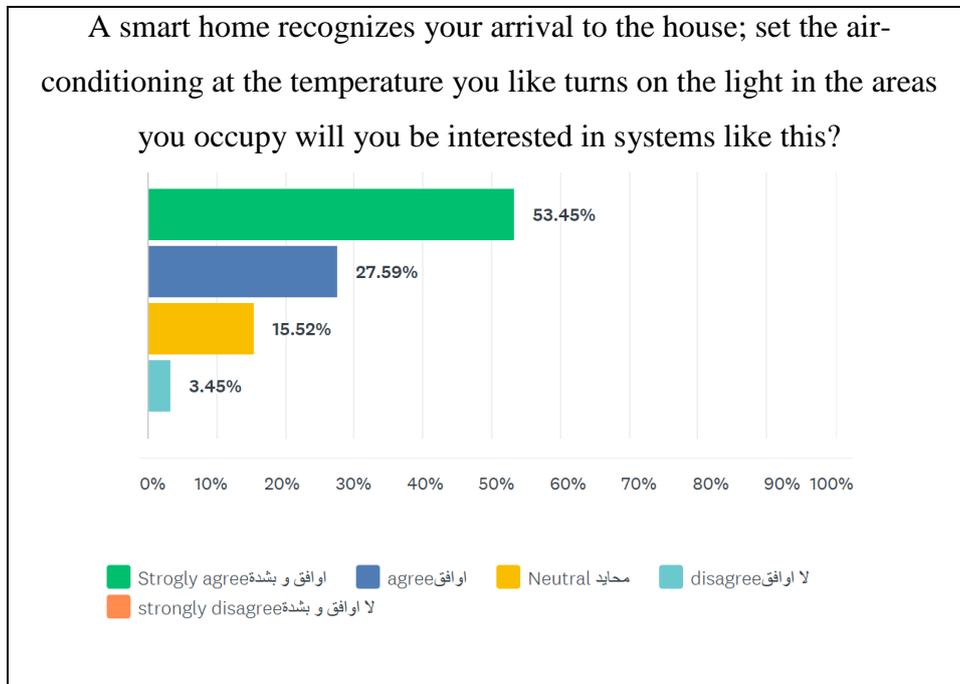


Figure 79 : (Survey's respondents opinion about home automation)

4.5 Survey's summary and important findings:

As a result, the analysis of the survey's findings revealed couple of points and observations .The respondent are highly educated ,also the majority are young bachelor and master degree holders living in two vibrant metropolitan lifestyle in Dubai and Sharjah .

Those participants showed good knowledge about the importance of conserving energy although some people thought it was the government role to take charge into saving the energy. From the feedback, it is clear that people are aware of the importance of saving energy, use it efficiently to save the environment, also associated it with saving money from monthly bills.

In addition, finding shows that there were three stages of the awareness level, at first they did not give a priority to purchase appliances with internet connectivity they focused on the quality and no one voted for internet-connectivity feature.

Midway through the survey they were asked if they would want their appliances to be connected to the internet and half of the respondents agreed. Finally, after explaining the benefits of connecting appliance to the internet 75% were motivated to use this feature, as shown in the figure below 80.

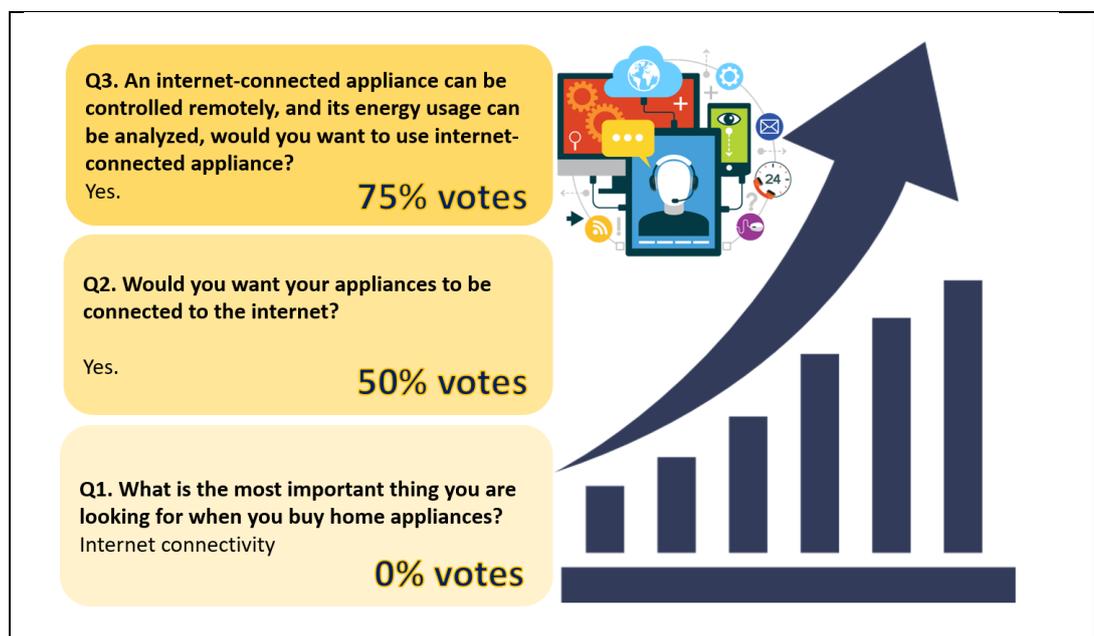


Figure 80 :(Survey’s respondent’s awareness level toward internet-connected devices)

Consumers can alter their behavior toward consumption, however consumers must be educated and updated on how to use home automation appliances to better deal with technology and respond to notifications of the system.

Artificial intelligence will assist people to deal with Home Automation , especially with people who have different behavioral living style pattern either by voice command and face recognition , the system will not only assist them but built a cyber-relationship between the user and the machine. Moreover, Artificial intelligence will help notify the users if there is an

over consumption of energy or what is the ideal time to use those appliances in non-peak hours.

AI supported with voice commands can be user friendly and easy to use by kids and elderly people.

Convenience is also an important factor to transferring home into smart ones. They showed interest in knowing the consumption by smart phones or tablets and control energy consumption, security remotely. In addition, respondents were willing to download an application in their phone to track consumption rates and control their home remotely.

5 Chapter 5: Framework design for Home Automation

5.1 Chapter overview:

Based on the survey's findings most of the participants spend 12 hours or less at home and were interested to have a Home Automation system and were willing also to download an application in their smartphones to track and monitor home's energy consumption rates and overall home security even when they are away. Therefore, a user manual will help them understand the system better. Before that, knowledge about the difference between automated home and smart home should be clear because not all automated homes are smart.

In addition to develop an overall understanding of the whole automation system requirements and components to be able to turn any typical home into smart automated home that understands the user's need over time and react to it, therefore home automation system is a combination of different components from user interface, to connectivity, to appliances.

As it was explained before there are so many advantages of using Home Automation on of which is to do more with less remotely, increase the sense of security, which requires authentication of home occupants identity, and make home more of a private sanctuary and shelter. As an advantage, also it helps with increasing comfort and convince level, as well as reduces cost by saving water and electricity of home, see figure number 81.



Figure 81 :(Home Automation remote control)

To turn any traditional home into smart intelligent functioning home with less of human direct intervention there are several requirements that should be fulfilled so that the system works faultlessly. Therefore, any appliances that is plugged to electricity can also be connected to each other and to the internet, which should be constantly working with functional uncorrupted internet speed. The required components consists of Central Management Unit (CMU) which is a combination of an operating system along with database center supported by Artificial Intelligence technology and a well-designed User interface (UI) or a display medium like screen dashboard on computes or tablets or smart phone .

There is mainly two approaches to transfer the home into a smart one, either by whole-home transformation from appliances, water management, lighting, entertainment system, security system to heating and cooling in order to calculate the total energy consumption of the whole household consumption as a full operating system or on the other hand to partly equip certain appliances with sensors or smart power outlet depending on the user's needs it is also offers more flexibility and customization of the requirement and saving priorities.

To assure remote control and real-time follow up to the household consumption rates of water and electricity through relative applications downloaded on mobile phones, the system should be constantly connected to the internet from mobile phones to smart appliances.

To maintain privacy the system is programed with personal identification of the family users (mostly parents) to avoid any intruding action or hacking from strangers by either voice or face recognition technology or a passcode known by the user.

As for the appliances or home devices, wire or wireless internet connectivity property and a common protocol must be an embedded feature. Plus, it should have a sensor and switch control which all shall be compatible with the smart meter to save and operate the data and send it to the cloud so that the occupant can rely on the interactive user-friendly graphical representation

to ease the readings from the system even if they are not experts .The system language and notification messages can be programmed and tailored according to the nationality background of end-user.

Charged or long life battery energy efficient, the problem with short life battery is that the users change the battery regularly and this is not efficient or sustainable, the same concept goes with exchanging the no longer working device it should not affect the overall framework of home automation system specially when there is inseparable mesh connectivity

Nowadays with high internet speed along with internet connected cameras installed in homes it can permits a live stream access to watch over the house regardless of your physical location, this specialty increases safely and precautions level .The motion detection sensor system also can notify the users if any suspicious event occurs .

Other than that, the devices should be reliable, fast which receive and performs commands in few seconds only, and easy to use satisfying the user by performing tasks with high percentage of accuracy, moreover efficient in reducing energy consumption.

According to the International Energy Agency, changing lighting type to LED more efficient lights could save the energy by 10% of the world total electricity consumption, automated lighting also save about 10% as well, when home appliances are in standby mode having an automated system to switch off unnecessary standby appliances can contribute into 20% saving to the household energy consumption.

So the layers of IoT and Home Automation start with user layer with an application, then a network gateway to where the data transfer from private to public network with Cloud managed by government servers , see figure 82.

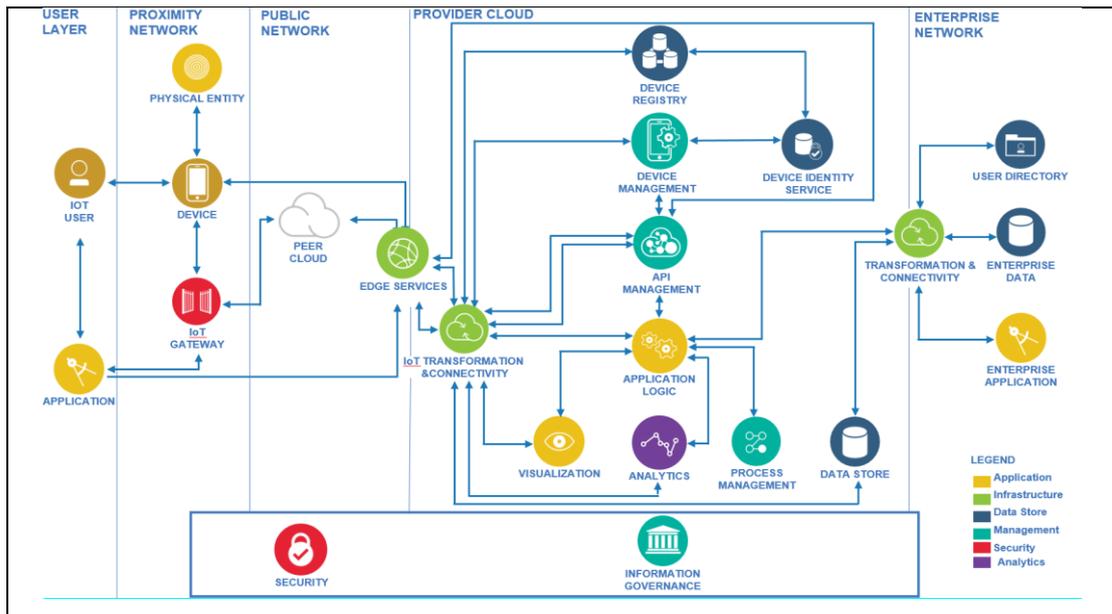


Figure 82:(IoT Layers, Source :IBM Corporation , 2016)

5.2 Automated home Vs. Smart home:

The difference between home automation and smart home is that both are emerging and trending technologies, the future of these technologies is now. People will eventually replace their regular appliances to more advanced one and ride the wave of technological revolution so they might as well start to learn the basics. Automated home enable users to make appliances work automatically by pre-programming and setting time schedule for appliances to work also gives the power of remote control to the users even if they are away from home because it is connected to the internet. On the other hand ,Smart home is an advanced level of home automation it is supported by artificial intelligence a technology that can learn from the given data or environment, it also recognizes users and their behavioral pattern. It has the power of connecting machines to machines to users whether they are at home or not, over time AI can assist in making decisions according to users preferences and routine.

So as a result, whether this technology is about automated home or smart home it is made to make people's life easier and simpler without complication or spam of notifications and gift people the award of time to spend in doing more of outdoor activities for example.

5.3 State of IoT equipped appliances in market:

Many companies already launched in the market their intelligent devices that can be embedded in Home Automation category. For example: Nest got a Thermostat that can be programmed and automated either by tracing user's preference or behavioral pattern to adjust HVAC system to comfortable temperature that is convenient with the season changes and different climate condition. The connection protocol is weave ("Nest Thermostats" 2018). Another special product is Nest cam for live streaming it looks for motion and captures any strange move to report it to the home user when they are away or nearby ,as well as, face recognition for family members or visitors .

Whirlpool smart washing machine tracks the water and electricity consumption and sends notifications to the user. WeMo company got several products with smart integrated technology connected to home Wi-Fi light sensor with Eco-smart saving that's turns on the light only when the room is occupied with people or users ,another smart appliances like a smart cooker allowing cooking rice from far away as well as smart coffee maker .

When it comes to home illumination, Philip Hue lighting LED lighting fixtures are connected and can be controlled with a phone application to select the color of lighting as well as the luminance level or even to dim the lights when day light is sufficient.

By its nature as LED lighting it consumes 2.8W as a constant comparing to traditional lighting bulbs which consumes 60W but as long as it is connected to the internet (Zigbee connection) it uses energy so the sensor are turning the lights on only when needed .

Off course Samsung Company needs no introduction, it is known for investing in research field to keep up with the latest state of the art technology. The company released smart appliances next to the famous Samsung phones. SmartThings from Samsung is a group of kit devices, sensors and outlets connected to the internet as controller for other home compatible appliances and allows also to monitor and secure home remotely .SmartThing got a motion sensor and

cameras to identify arrival and departure of users inside the home and by that it can automatically open the lights or HVAC system, another sensor is designed to notify the user if there is an unwanted water leakage. Users can also take advantage of the security smart door locks it can give them more control options to enter a pass code and they can get rid of keys.

On the other hand LG Company got a similar products called Smart ThinQ with HomeChat hub technology connected to a smart meter through Wi-Fi connection protocol. It helps with assisting user with everyday tasks from turning on the washing machine to sending commands to refrigerators; they claim that the more you use the system the more it gets smarter to anticipate the user's requested.

When it comes to controlling the HAVC system that got a remote controller at homes, Sensibo comes in handy as it is a small device that can be attached to air-conditioning units connected to the Wi-Fi to turn them into smart devices it permits users to control the energy consumption moreover the user can set the timing to precool or preheat the room in advance and before home arrival to it saves time and it creates a thermal comfort.

5.4 Home automation requirements and components:

Home automation technology should be available and accessible everywhere as previously mentioned in the Home Automation and market statues, nowadays the technology is somehow available and the market is constantly developing more smart product but not widely applied yet in the aimed scale ,also it should be affordable and cost effective and worth the investment. Moreover, products and appliances must be durable with less experienced maintenance. This technology should offer flexibility and allow being compatible with updated technology and networking systems.

Therefore, to design a framework of home automation integration and achieve its desired goals there are several main component and requirements to the system, which are:

- a) Software requirements
- b) Hardware requirements
- c) Connectivity requirements

Altogether, will work to give the user the experience of achieving more tasks and home chores with less time, pre-set living spaces to ultimate convenience standards of the user's experience and gives them the ease of mind when they have more sense of control and secure their home more and lower their energy consumption rates.

5.5 Software requirements:

Home automation software acts as a medium between the end user and the machine to collect data by sending and receiving any notification, which allows for remote control from one screen or application. Some of the software necessities to take into consideration when it comes to Home Automation in terms of user interaction is to have a simple straight forward design , as well as an interactive application that is easy to understand and control, in addition to having the ability to sends push notification by voice, text commands or simply by clicking tabs.

The software requirements of Home Automation system design must be customized according to the user's wishes and priorities as a user-friendly application, also to be visually attractive. The design of the dashboards and application should offer flexibility with timer and controlling tabs and icons to have a real-time monitor of energy performance and safety control. Another important feature of the software is that it should be built to be compatible with other appliances and embedded web servers like MQTT, Raspberry Pi and HTTP.

Normally the coding of the program could be by computer programming language like Python, JavaScript, shell or C++. Reinforced with WebSocket, which is a computer communication protocol between a browser, and webserver it contributes in real-time information flow. As a software component it should offer a Logging Getaway (embedded web server), with Personal

identification and encryption for authorized identified users to assess and convey messages between the users services with privacy, moreover providers a strong cloud infrastructure.

Some examples of open source software that are available for home automation are: Wink, HomeKit, Domoticz, LinuxMCE, HomeOs , FHEM and openHAB. All of these software makes it simple for home occupants to control the whole living space in one window or downloaded application from App Store or Google play at ease with their fingertips.

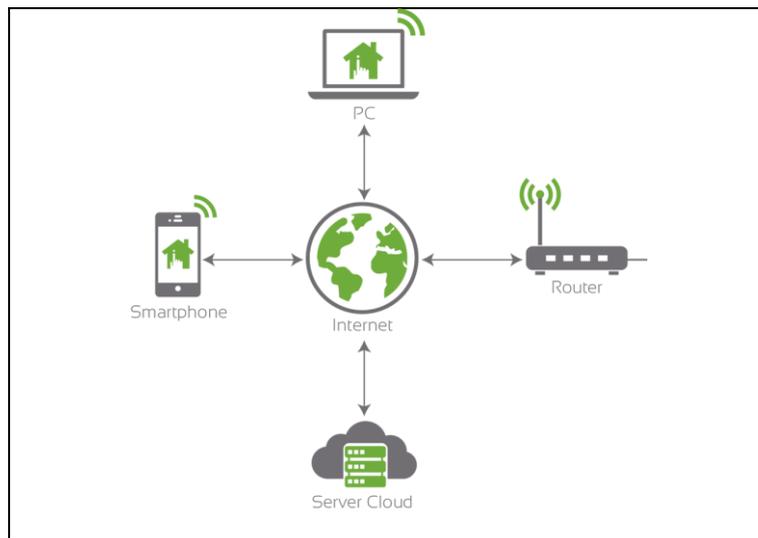


Figure 83:(software components of Home Automation)

5.6 Hardware requirements:

Selecting the right smart-automated appliances and hardware from wide range of products can greatly affect the quality and workability of the home automation system.

As mentioned in the previous chapters IoT is the technology of connecting things to the internet in other words to link the user with the machine in an interactive way. While AI assists in replicating human behavior by teaching the machines how to think and take action. After knowing some of the software requirements, when it comes to hardware requirements of automated homes it consists of a set of devices like: IoT sensors, smart connected appliances, IoT Sockets, Remote controllers, Timer, Device tracker, voltage regulator, electricity transformer and receiver .

In addition, the hardware consist of a Smart power meter for energy performance management, which helps with sending and receiving data to the users.

There are different types of Sensors that could be used in domestic level such as indoor & outdoor motion detector, light sensor to switch on and off or dim the lights, thermal, security, locks, smoke or gas detector, sensors are either solar-based, runs on battery or charged by electricity.

There are many IoT supported sensors and they are categorized based on their sensing capabilities like:

- IoT Thermal sensors: which measures air temperature in the room, the user can control the temperature remotely, from the collected survey; respondents have different thermal comfort level in summer and winter. Also, change the temperature in the thermostat more than once, so this technology can provide a solution to occupants to set up their living space before they reach home to increase their comfort level, the problem with these sensors type is potential inaccuracy with thermometers readings.
- IoT Humidity sensors: Just like thermal sensors humidity sensors could affect occupant's health and wellness, by notifying the users if the home is dry or wet and possibly switch on the humidifiers if it is dry and if the room is humid switches on dehumidifier automatically.
- Water Pressure and level sensors :the kind of sensors which helps with saving water like eTape to increase water pressure and use less water ,also water level sensor which could help to alert the user of any leakage or over consumption of water .
- IoT surveillance webcam supported with Infrared for night or dark vision sensors or motion detection sensors: It gives the advantage of live streaming or video documenting of home and especially useful to alert occupants of any suspicious event happens which

increases security measures. However the downside of using cameras are “Blind zones “the vision angle is limited so several cameras and supporting kits should be placed in more than one place. In addition, cameras with limited memory spaces is not practical. If internet connectivity signal is weak, there will be a delay or low quality when it should be in HD (High definition) mood.

- Smoke detector and gas leakage sensors: Home owners can selected sensors based on their priorities .But when it comes to safety smoke and gas sensors are equally important compared to other sensors, from the survey most of the respondent’s don’t have a smoke or fire detection sensors at their homes so installing one will increase the safety level at their homes, as a protection from worst case scenarios.
- IoT luminance sensors: Which measures the room luminosity enable and enable user to switch on and off the lights to save energy .Also, it can change lighting colors and set different moods to dim the lights and create a more relaxing vibes.
- IoT Sound sensors: which can respond to voice commands of users can take action like switching on or off appliances .Probably one of the most famous application of sound sensors is amazon home assistance Alexa which answers users question and requests, inform them about the weather condition and much more.
- Vibration and velocity sensors :can be integrated to appliances to maintain their connectivity and if the appliances works probably for example it can check if washing machine works or if it is damage sends a notification to repair it.

All of the mentioned sensors incorporated with IoT and AI, can assists with home energy management and security to control the following:

1. HVAC or indoor temperature adjustment and humidity control with smart thermostat.
2. Switching on and off lights and change luminosity intensity, avoid glare and changing the ambient colors to user’s perception.

3. Automatically opens and closes curtains or blinds to reduce glazing heat gain to save cooling energy if the temperature is hot outside.
4. Control Appliances remotely like (washing machine, dish washer , refrigerator ,coffee machine , electrical cooker ,robotic vacuum cleaner.
5. Spot and notify the homeowner if there is any water leakage to save water.
6. Automatically irrigate the garden when needed or by pre-programming the system to a fixed schedule and duration, a smart system will recognizes the weather in advance ,so when it is raining outdoors soil moisture sensor will stop the irrigation to save water.
7. Smart entertainment (TV, Speakers, video games) multi-media.
8. Security & surveillance.
9. Automatic doors locks and face recognition sensor to watch and identify homeowners from guests opens garage door for home car.
10. For windows users can install glass break sensor to alert occupants if these is any breaking into the house by thieves or attackers
11. Other applications such as pet smart feeder.
12. Driveway sensors to switch on appliance before arrival.

5.7 Connectivity requirements:

As explained previously connectivity between the user and appliances is very essential, in other words without internet connectivity, it is not possible to have an effective Home Automation system, which is the heart of the whole system, and the vital link between the software, hardware and the user. Part of the connectivity is to enable data flow from the transmitter to the receiver and the other way around from known getaway.

The connectivity allows the data to be transferred from a Server to a centralized or decentralized cloud; some of the common connectivity protocol are Zigbee, Z-wave or Bluetooth. Bluetooth wireless router is preferable because there is less cabling and wiring, so wireless

network is ideal and aesthetically more pleasing. For homes, internet connectivity is a router based with Wi-Fi Network, and in smartphones a Mobile internet data with 2G|3G|4G network as for both cases the internet must be with at a high speed Broadband otherwise it will cause jams and failure of communicate between devices and user. Also bad or weak networking can result in slow data transfer rate losing data, errors, and congestion. From chapter 2 in telecommunication the internet speed was high and affordable so chances to adopt Home Automation is better.

Some important consideration of connectivity, it is preferable to use wireless charging method because the downside of using typical battery is that it needs a regular replacement, which is very unconventional and possibly harms the environment in negative aspect.

Just as anything connected to the internet there is always a risk of security attack, privacy invasion that questions the reliability of the system.

5.8 User interface and communication protocol:

In order to have a user-friendly application that is easy and not complicated to use, the design of the user interface dashboard on smartphone or tablets must be simple to understand by non-expert users. The control of the application is either by tapping on icons or give voice commands by AI technology .The advanced level is when the system starts to learn then recognizes the user voice or behavior by storing accumulated data about the user.

Another interaction method is by using the camera on the smart phone and downloading an application with a virtual reality feature. Which shows a representation of the data of energy ,and water consumption in a house for example with three dimensional perspective of the house or over the top plans featuring all plugged appliances and lighting fixture, as well as, HVAC, and control board location.

The difficulty with this representation is that it requires advanced and recent devices with a large data storage space and processing capacity in order to handle the data exchange and the graphical quality of the application.

The aim of home automation is to create comfort for the users and energy management and security solution to control things and keep an eye at their homes even if they are present. In order for the user to get the maximum benefit of Home Automation technologies, it is logical that the integrated system should be easy to use as well as being accessible at their fingertip.

For the user, it is important to connect to Home Automation system through a Smartphone or tablets also to have a touch screen home dashboard which is portable. To maintain an active user interaction with machine Artificial intelligence can assist in sending audio and text notification if important events that occur at home or if there is any over consumption of domestic water and electricity. Users should know how to deal with technology having smart or automated system alone is not enough so education about the basics of how the system works can help with changing the behavior of users to a more moderate aware approach.

5.9 Partial Home Automation:

To have a partial home automation for existing, new homes, temporary, residential or retrofit. The partial automation method is decided by how smart or automated the users want their home to be, so first they should make a list of automation priority for example if they want to control the HVAC and lighting fixture, or only the most energy consuming one. Second, users can have a meeting with energy consultant specialized in this field to customize a prototype to better fit the client's need, budgets and lifestyle, they could select the automation system to be combined with existing appliances or install new additional features. In addition, the partial integration of home automation can be specific to certain zones at home.

5.10 Full Home automation:

Full home automation enable for a full home interior and exterior control also fully transferring homes into smart automated home from scratch ,construct a reliable infrastructure with active mesh of connected devices and appliance . It is ideal to build and design home automation system in newly constructed homes or buildings. User can consult with Architects, sustainability engineers and specialist in home automation to design the optimal smart advanced hub.

As for the system Installation, it is preferred to have a central home monitoring unit that is located in a strategic place at home for the whole system. Also covers all interior and exterior places, most probably living room or hallway also for the optimal wireless range to penetrate all rooms without interference or building material absorption of the connectivity range. If the wireless range is not sufficient, a repeater can help with increasing the network range.

5.11 Smart Automated home appliances specifications:

Smart TVs are on of smart home entertainment additions, but as for home appliances, one product alone is not enough to achieve smart, automated and sustainable home goals, it is an interconnected mesh of appliances. To double the benefit of home automation the selected appliances must have the ability to connect to the internet and before that it should be at least energy efficient .Energy star for example is an American volunteering a rating program that rates appliances, lighting, electronics and equipment in terms of energy efficiency and produces less greenhouse gas emissions. In United Arab Emirates, Emirates Authority for Standardization & Metrology issues a star rating sticker from a star to five rating as the best, placed on the green appliances that are energy efficient so that customers can easily select the appropriate type from any electrical gadget shops.

Also when purchasing a new home device customer should put in their mind to buy a product that will be compatible and not heterogeneous with existing IoT home automated appliances and use the same connection protocol of those appliances to be connect with the same smart grid.

5.12 Examples of smart automated appliances:

Some of the smart home appliances can change the occupant's lifestyle and choices in addition to saving times and effort. For example smart kitchen appliances like a smart refrigerator can notify the user about the ingredients which is about to expire or gives cooking recipes or even smarter do some online grocery shopping. Energy wise every time someone opens the fridge door some cooling energy is lost so a smart fridge can reflect an image at the screen of the interior or alert the user to close the fridge door. At the morning, a smart coffee machine can prepare coffee and at lunch or dinnertime, home occupants can pre-heat the oven or cook rice in smart rice cooker remotely.

Another example a user can pre-program dishwasher, clothes washer and dryer to operate in non-peak hours to save energy or notify the user if there is any water leakage happening so that the user switches off the machine and call for maintenance. A smart lighting system can identify if someone is in the room to switch on and when the leave it switches off automatically without the need of switching it manually.

Smart appliances not only could saves time and effort but also makes elderly occupants daily tasks easier they can irrigate their garden without physically using hose and randomly spray plants under the harsh local climate, they could simply use automated water sprinklers to control it even if they are indoor and use their time for other activity. A smart robotic floor vacuum cleaner can be controlled by remote controller or phone application to clean dust and it have motion sensor so when it runs to the wall it can change the motion direction so people

with backache can relax from doing this home task ("Home Automation Using IoT - DZone IoT" 2018).

6 Chapter 6: Summary and Conclusion

6.1 Chapter Overview:

The final chapter summarizes and highlight the important findings of the research; it will discuss some results and will focuses on Home Automation technology, based on that will recommend solutions for the current and future work.

6.2 Summary:

UAE pursue to establish a pioneering hub in the field of AI and Home Automation by taking advantage of the latest technological innovation, qualify local prepared skilled people, and invest in relative investigation and studies. From the survey positive responses about adopting Home Automation indicates that even if they are not fully aware of the system they accept to give it a chance if they were more knowledgeable about it therefore the framework will enhances the important features of the system, see figure below.

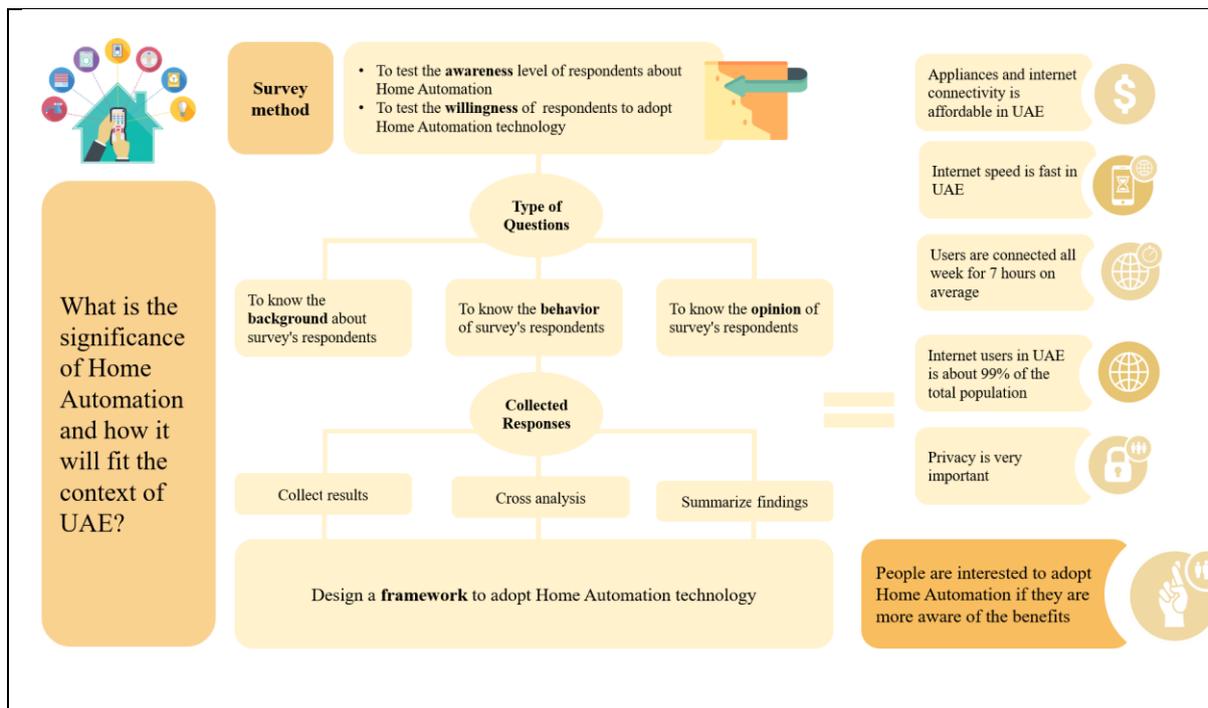


Figure 84:(Research summary, source: Author: 2018)

6.3 Recommendations for future work:

Before we rush into integrating Home Automation to our life, we should understand that it is a network of effort from government to sectors to individuals so some of the recommendation to effectively use Home Automation are:

1. Involve the local government to work on set of initiatives and particularly secure local data as the privacy is and always is a priority.
2. Build a local centralized cloud data storage which is monitored by locals to raise the trust level of residents of UAE toward data management.
3. Create a special hub the world's first research lab in Home Automation field to work with the targeted sectors like housing programs, invest more in research and finding talented people.
4. Attract and train national talent for jobs based on AI, IoT and Home Automation in the future.

Improving the skills of graduates in the fields of science, technology, engineering and mathematics is the quickest solution that can be applied in the short term to increase the number of experts in the field of digital world and its applications.

5. Encouraging and supporting government and private sector to adopt and invest in new technologies to be used not only to housing projects but also to offices and so on to support growth.
6. Encouraging individuals and users to using smart technology more to improve the lives of individuals and government works.
7. Establishing; Information campaign to promote to demonstrate and explore the possibilities of smart technologies and home automation in the state in an innovative and attractive manner.
Specialized control centres
8. Organise conferences and exhibitions like Gitex to promote for home automation and in the same time rising the awareness through seminars.

6.4 Conclusion:

In conclusion, technology is ever evolving in most fields of life, it transformed people's life generally in a positive way, to save time and effort, unless it was used in the wrong way by individuals. When it comes to homes we were slowly introduced with smart gadgets like smartphone and smart TV, people were purchasing these devices as entertainment or a source of luxury then people started to use connected smart surveillance cameras for security reasons. The next stage is smart automated appliances whether people will buy them unconsciously or deliberately it will allow them to have more control over their homes.

From the conducted survey it was found out that there is a gap between what people want to find in their appliances and truly switching their preference to connected devices. Home Automation is a useful tool, but can't stand on its own, a lot of stakeholders, government and individuals should calculate the benefits of these technologies in the short term or long term, how will this technology affect our culture, values and what are the risks that we should collaboratively avoid.

Home Automation technologies have a positive result in cost reduction as well as saving time and possibly lives. An example of cost reduction notifying the users of energy consumption by the collected data from the home different sensors. The sensors can send and receive information about the real time data and the current status of appliances. In case of appliances damage the system sends a message to the controller to take action or forward it to the specialist.

Home Automation can raise the quality of living. To be realistic, there is always a threat or risk of invading the privacy of home occupants cybercrimes is a common connectivity issue from stock market to bitcoin currency stealing and so on, so a blockchain technology can provide extra protection walls of security to minimize the risk of hacking home system.

Governments should play a key role in setting new laws, it should be compatible with the new technologies, by tracking the IP address cybercriminals can be caught and punished to encourage safety of Home Automation usage. Local municipalities should also play a major role in introducing Home Automation to home owners and apply the technology in stages and organize awareness campaigns.

Creating UAE Artificial Intelligence council is greatly helping with understanding and promoting these technologies more, also to enhance local authorities such as transportation sector, medical sector, education sector, innovation sector, manufacturing and building sector etc.

The future city is a smart city consists of smart infrastructure, transportation and smart homes. The ideal situation is to perform many tasks with maximum control, efficiency, and security with a minimum errors, risk, efforts, time and cost.

This is what sustainability is all about it should link local community to local governments to list and face challenges as well as predicting the future to be ready for it and to come up with creative solutions to the benefit of the current and next generation and achieve the goals of happiness of UAE's residents and be the smartest city in the world.

This study shows that there is a lack of awareness of home automation in UAE and to raise the awareness level people should be familiar with the system taking small steps to adopt this technology. Huge Companies are already aware of the benefits of the Home Automation system but they should not mislead consumers to what they want to sell but rather advise them to select the right appliances for the desired tasks. As for the government they should import the right effective products to conserve consumer's rights.

As an implementation strategy, the government should focus on:

1. Establishing a local authority for smart technology.

2. Encouraging the local and federal government and societies to use modern AI technology.
3. List all the related challenges and suggest a tangible solutions.
4. Prepare human resources specialized in this field.
5. Gain experiences for world’s best AI companies.
6. Encourage locals under housing program data list to purchase smart appliances and collaborate with gadgets companies to make discounts for them.
7. Local Telecommunication sector like Etisalat or Du should promote and encourage the adoption of Home Automation technology for example by giving occupants more phone data to use for remote controlling purposes.
8. Local authorities of electricity and water should collaborate in developing a smartphone application for example FEWA to let users follow their home consumption rate so they develop a habit of using the energy more efficiently.

UAE is a very ambitious country it will invest in great ideas for the benefit and happiness of its residents , so selecting the “right “kind of Home Automation technology that respects the culture and privacy of people is not to be compromised toward smarter homes and smarter UAE, see figure 84.



Figure 85: (Vision of Future UAE homes, source: UAE national vision 2018)

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