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Internet of Things

A survey about thoughts and knowledge

Eric Nilsson and David Andersson

Faculty of Computing
Blekinge Institute of Technology
SE-371 79 Karlskrona Sweden

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Contact Information:
Author(s):
David Andersson
E-mail: daae15@student.bth.se

Eric Nilsson
E-mail: erna13@student.bth.se

University advisor:
Huseyin Kusetogullari
Department of Computer Science and Engineering

Faculty of Computing
Blekinge Institute of Technology
SE-371 79 Karlskrona, Sweden

Internet : www.bth.se
Phone : +46 455 38 50 00
Fax : +46 455 38 50 57

ABSTRACT

In this paper we introduce our readers to Internet of Things, what it is, how it works and providing statistics on society knowledge and thoughts about this subject. Data gathered for our statistics will be collected through a survey. From the literature review of this thesis we provide information about how IoT works and how a general architecture behind an IoT product looks like. since IoT comes in all different shapes we want to find out the high-level architecture behind it. With our survey we will first focus on getting the raw knowledge of the society on IoT and these answers will be compared between IT-persons and non-IT persons, then we will get everyone's answers regarding their thoughts on IoT after we have provided information on IoT to get everyone on the same page. By finding out the thoughts of the society, we get to know if the society is willing to use IoT in their daily lives and if they think IoT will help us or not. Most of our respondents for our survey comes from the southern part of Sweden, as this survey was shared through social media and through our institution Blekinge Institute of Technology. Our goal is to catch the reader's interest for Internet of Things and provide statistics from our survey showing societies knowledge and view on Internet of Things.

Keywords: Survey research, Internet of Things, data analyzing and understanding

CONTENTS

1 INTRODUCTION

Internet of things may be the next big thing and it might change the way all businesses, governments and consumers will interact with the physical world. One of the first internet-connected appliance was made in the 1980s and it was a modified coke machine that could report its inventory and determine if newly added soft drinks were cold or not. The concept of Internet of Things (IoT) wasn't an official concept until it was named in 1999. IoT is now a nineteen year old term for objects that is connected to a network and with the years it has grown and become more and more interesting in the market of software development and development in general. A prediction made by Statista (a website for statistics) says, in 2025 there will be over 75 billion IoT devices worldwide in [34]. [32, 33, 36, 37]

An IoT object can be integrated with people for different purposes such as heart monitor implant or it can be used in different applications like farm animals with a biochip transponder, a car with built-in sensors that will provide an early warning when the air pressure in the tires are too low. In general, we can say that IoT is an object that got an IP address that gathers or provides data that can be sent over a communication network [32, 33, 34, 36, 37]

With the collected data gathered from an IoT object, advanced analytics can be used to analyze the data to make different processes of an IoT object more efficient. With advanced analytics, it's possible to automate certain tasks that is for example repetitive, time-consuming or dangerous. Imagine going to work every day, being woken by your alarm at 7am and getting a train at 7.30am. One day if the train is cancelled and you have to drive to work instead. If your alarm is an IoT object, the alarm would adjust based on these factors to ensure you get to work on time. This is just a small example of what one or more IoT objects can achieve based on data gathered from your daily routines. [32, 33, 34, 36]

The purpose of this thesis is to get to know what kind of knowledge and thoughts the society got about IoT. If they know what's about to come and how IoT could possibly help society in their daily life. Are society ready for these IoT devices? Are the society willing to use IoT objects to help them in their life or are they already using it? In that case what are their experience with such intelligent objects so far? The answers from this thesis will help companies and developers to know what the society is interested in and what kind of pros and cons the society think IoT devices have. As we think IoT will play a big part in a near future, we also think it's important to spread the word about IoT to share how it works and how IoT can help us.

2 RESEARCH QUESTIONS

2.0 What is IoT and how does it work?

IoT is not a new technology but as of lately it has become a big topic that we want to dig deeper into. The term IoT and IoT object is not something new to us, but we want to know more about how it really works, how the general architecture behind an IoT product looks like and see how it could possibly help the society in the future.

2.1 How can IoT objects help society in their daily life?

We would like to know how IoT object can possibly help the society in their daily life. How could a daily routine with IoT object involved help a person's daily life?

2.2 How great is the knowledge about IoT within the IT branch compare to people outside of the IT branch?

IoT object keeps increasing in number and it's getting more popular for each day. People within the IT branch might know more about IoT and how it works. But does people outside the IT branch know as much as the IT people? We find this interesting to see if there are a big gap between the knowledge.

2.3 What are the thoughts on IoT from the society?

Since we will answer the question "What are the knowledge on IoT within the IT branch compare to people outside of the IT branch?", we also want to know their thoughts. Is there a positive attitude towards IoT? What are the pros and cons according to our respondents? Is there any concerns about IoT that prevents them from using IoT?

2.4 Will society use IoT objects to help them in their daily life?

Since these IoT objects are fairly new to the society we want to know if people are ready to use this kind of technology in their daily lives? Is society willing to let IoT objects be a part of their life? Or is it to foreign?

3 RESEARCH METHOD

3.0 Theoretical method

To answer our first and seconds questions, we will perform a literature study that covers how IoT works, its general architecture and how IoT objects can help us in our daily lives. We started this study by collecting articles through Google Scholar, DIVA Portal and from Google search related to the subject “Internet of Things”. We read through them and discussed if they were relevant and trustworthy, we stamped them as trustworthy by comparing it with different sources, looking at date and author. By doing this we had enough to start writing this paper, as the time passed we searched and added additional articles.

3.1 Search Criteria

At the start of this paper our search term was more nonspecific, so we could get a more broad view of our subject as possible. The longer we worked in this subject we made more specific search terms for more specific results.

The following search terms were:

- Internet of things
- Security IoT
- IoT devices
- Network IoT
- Data storage IoT
- Home automation
- IoT architecture

3.2 Empirical method

Our empirical study will answer our third, fourth and fifth research questions. To execute the empirical part of this study, we decided to make a survey. The survey is meant for the society with the intention to get everyone’s opinion and not only restrict the survey for people who work within IT. Our questions will be focused on people's knowledge and thoughts on IoT. From the data gathered we can use the statistics to see and compare what people know about IoT. Some questions are meant for comparing IT with non- IT personal and some are not.

Our survey contains mostly single question, rating scales, a few optional questions and one multi-choice question. We designed our survey to start gathering background information about the respondent, whether they work within IT or not. This makes it possible to compare the IT and non- IT workers later. To find out if the respondents have any knowledge about IoT, we start asking if they know IoT or not. For those who answered no we asked a follow up question about the concept of IoT. From these questions we know how much the society knows about IoT.

To get everyone on the same page about what IoT is (whether they know about it or not), we provided a short information about it and gave an example. By doing this we can get more accurate results later in the survey, since we know that they actually know what IoT is by now.

To get the societies opinion about the future of IoT and if they use IoT in their daily lives, we asked them about the future of IoT and an optional question where they can motivate their answer. For the respondents that answered that they use IoT in their daily life, we asked a follow up question for them to write what kind of IoT object they use. Here we will get statistics about what kind of IoT object they use and if they are interested in IoT in the future.

To find out if the society is willing to use IoT objects in their daily life, we asked a question about it and an optional question for them to motivate their answers. From this we can see how willing the society is to use IoT objects in the future.

In order to find out more about the societies opinion on IoT. We asked them about the future of IoT, what kind of IoT object they would like to upgrade and about the pros and cons IoT have according to them. Here we have a rating scale from zero to five where zero is strongly disagree and five is strongly agree, a multi-choice with different non-IoT object and an optional question for pros and cons, where they can write their answer freely.

For a better view into how the society would like to use IoT objects in the future, we provided a few scenarios. In these scenarios, we described different IoT objects and their features that can help us in our daily lives. Each scenario has a rating scale between one and five where one means strongly disagree and five means strongly agree. From the answers we can see where the general interest lies and which scenario is the most and least popular.

Our survey was done online from March 2018 to April 2018. The survey was administered online via Google Forms as we found it to be the best option for making online surveys and for presenting the results in a good way. To reach out to the society of Sweden, we posted our survey on Facebook and LinkedIn, since we both have different connections and it's a good way to reach out the society. Additionally, we sent the survey to everyone at Blekinge Institute of Technology, where most of the students and workers are IT people, but not all of them.

4 LITERATURE REVIEW

In this section we will first go through how a high-level architecture of an IoT system could look like with different layers. Since IoT is still a fairly new phenomenon, the architecture is still debated. The high-level architecture that many researchers have agreed upon includes these following layers: [1, 2, 43]

- Perception layer
- Network layer
- Application layer

Within these layers we will follow a typical IoT products pattern from collecting data, in the cloud and being accessed by the user. Starting from the lowest layer, the perception layer is where all the data is collected through different types of sensors and converting it data to digital signals. In the network layer, the data received from the previous layer is processed and can be further preprocessed before being transmitted through different technologies including Bluetooth, ZigBee, Wifi, NFC, and so on. When the data reaches the application layer, it is stored, can be further processed by heavy computation and the end user can access and view the data collected from the IoT objects. [3, 4, 40, 43]

Secondly, we will go through the two characteristics of having a smart home, enabling automatization within the smart home and how a smart home can help humans with their daily lives.

4.0 Perception Layer

An IoT device also called IoT object must have at least an actuator or a sensor that enables the ability to collected data from the physical world. An important aspect of IoT is context awareness that gives us the knowledge of the device's state, surroundings, situation and location which is not possible without sensor technology. The sensors are often small when it comes to size, low cost and consume low energy and today's sensors are constrained by factors like battery capacity and the ease of deployment. It's a plethora of IoT devices all from water level detectors, air quality sensors, home voice controllers, and so on. [5, 6, 7]

Actuators are devices that can convert electrical energy into some form of useful energy, which can manipulate the physical environment by using force, motion, heat, flow, and so on. The physical environment can be speakers, lights, motors, displays, and so on. A scenario with the use of actuators can be inside a smart home that consists of sensors and actuators. The actuators roles can be to lock or unlock the doors and turn on or off the lights. [5, 7, 9]

Sensors are devices that can collect environment data from the physical world. The data collected can range from all types of environmental phenomena such as motion, pressure, heat, and so on. A scenario can be a smart vacuum cleaner also called robot vacuum cleaner that have sensors that can detect if there are any obstacles in front of the cleaner. [5, 10]

4.1 Network Layer

4.1.1 Preprocessing

By having an IoT device collecting analog data streams from their sensors will create large amount of data rapidly. Based on what kind of IoT object it is, an object can collect data from all possible measurable types. Because there are quite many measurable scenarios, data storage will be filled quite fast. A scenario could be an aircraft engine which is an advanced machine and there is no theoretical limit of how much data the engine will generate based on all the sensors in an engine. Since IoT objects are always on, data gathering won't stop. With this amount of data from only one IoT object, it is the best to preprocess it before passing it. [11]

The gathered data needs to be converted to digital form before it is passed on for further processing, analyzation and storage. The most common storage is in the cloud since the cloud can handle massive amount of data and have great scalability and flexibility. With constantly collection of data, the cloud is a good place to store data in. To send data to the cloud an connection is required and since most IoT objects are mobile based, cloud solution will not be sufficient following these four reasons according to Pallavi Sethi and Smruti R. Sarangi "Internet of Things: Architectures, Protocols, and Applications"

- Mobility: Most of the smart devices are mobile. Their changing location makes it difficult to communicate with the cloud data center because of changing network conditions across different locations.
- Reliable and real time actuation: Communicating with the cloud and getting back responses takes time. Latency sensitive applications, which need real time responses, may not be feasible with this model. Also, the communication may be lossy due to wireless links, which can lead to unreliable data.
- Scalability: More devices mean more requests to the cloud, thereby increasing the latency.
- Power constraints: Communication consumes a lot of power, and IoT devices are battery powered. They thus cannot afford to communicate all the time. [5]

To solve these four problems, further preprocessing and storage can be done at the edge of the network before sending the data to the cloud. We will go through two different types of preprocessing, edge computing and fog computing.

4.1.2 Edge computing

With edge computing, the preprocessing is done as close as possible to the IoT object. Since certain IoT objects require real-time updates, the data is preprocessed either at the IoT object or in an intermediate server that is not too far from the IoT object. After preprocessing, data that is more valuable and less sensitive can then be sent periodically to the cloud. A scenario can be the air pressure in the tires of a car, each sensor in each tire makes their own calculations and determines if something is wrong or not and then send summaries to the cloud instead of waiting for an analysis response from the cloud. The main advantage gained from this method is that the time between data collection and execution done by the IoT object based on the analysis is done in milliseconds. With this method there is a possibility to have many intermediate servers to do this preprocessing of data and with many servers there will be an increased threat of attacks on these. [13, 45]

4.1.3 Fog computing

Fog computing works a bit like edge computing but the difference is that it focuses on preprocessing the data at the end of the local network. Data is collected and stored within the network via a fog node or an IoT gateway. All IoT objects that are connected in this network send their collected data through this intermediate node or IoT gateway which does the preprocessing of the data and sends back the required data to the IoT object and summaries to the cloud. If you take the air pressure scenario from edge computing, the sensors in each tire send their data to a fog node or IoT gateway in the car, which does the preprocessing of all data gathered from each tire and then sends back necessary data to the correct tire. Fog computing has the advantage of having a strong and central device capable of receiving data from multiple IoT object and sending back necessary data. But with a central device doing the preprocessing comes the drawback of having to handle tons of data from different IoT objects. [14, 15, 42]

4.1.4 Connection

To get the data from the IoT object to the cloud or an intermediate server, there needs to be a way to communicate. Typically, IoT objects use the internet protocol to connect to the internet. By using the internet protocol, the IoT object needs to set aside a lot of power and memory. Since many IoT objects are not connected through an Ethernet cable, wireless communication is done and that requires more energy from the IoT object.

But IoT objects can also be connected to a non-IP network and this network later sends the data to the cloud. The non-IP network can be an IoT gateway as explained in the preprocess part above. Communication between the non-IP network and the IoT device can be done through different technologies, below we will cover a few communication technologies used by IoT objects. [35]

4.1.4.1 Bluetooth

Bluetooth is an important short-range technology for communications. Bluetooth is not new but when it comes to using Bluetooth in IoT objects the power consumption is too high. That's why the Bluetooth special interest group released BLE (Bluetooth low energy), to reduce the energy consumption of the device using Bluetooth. With BLE, an IoT object can run on their battery power for a longer time at a cheaper cost. This is because BLE remains in a sleep mode until a connection is initiated to the IoT object using BLE. But BLE is not designed for applications that need to transfer large files nor transferring data over approximate 100 meters. An example of BLE usage is in wireless speakers, Fitbit or headsets. [5, 16, 17]

4.1.4.2 Zigbee

ZigBee is like Bluetooth, designed to send small data chunks over short distances with the intent to not consume too much energy. ZigBee runs on a mesh topology network which means that data is sent through a web of nodes that acts like a data source and repeater till data reaches the destination. As said in the article “The ZigBee Vs Wifi Battle For M2M Communication” written by Brian Ray, “It uses a version of the IEEE (Institute of Electronics and Electronics Engineering) 802.15.4 standard, and as such, is widely used in local area sensor data networks.” [19]. The intention of ZigBee is to be simpler and less expensive compared to other wireless communications (e.g. Bluetooth or Wifi) and to be integrated into applications that requires low energy consumption and accepts low data transfers. An example of ZigBee uses in IoT objects are in home automation e.g. in lights, temperature control or security. [5, 18, 19]

4.1.4.3 Wifi

Wifi is not something new to the world, but recently the Wifi alliance have released Wifi halow which is based on the IEEE 802.11ah standard. Wifi halow consumes less energy and got a longer range. The 802.11ah standard uses 900 MHz which is relative low compared to regular Wifi and with lower frequency the range is increased and the ability to penetrate obstacles like trees and walls is higher. By using Wifi an IoT object have direct connection to the internet compared to IoT objects using ZigBee or Bluetooth. An example use in IoT objects can be in smart homes and cities where sending data through obstacles is necessary. [5, 17, 21]

4.1.4.4 NFC

Near field communication also known as NFC is a communication technology that is wireless and is limited to only a couple of centimeters. When having two IoT objects with NFC enabled, all types of data can be transferred within seconds. Transferring data with NFC is done by the magnetic field between two NFC objects, one that generates the magnetic field and the other object for transferring the data. The benefit of the low range between objects is that it is useful for secure transactions for payments. [17, 22, 39]

4.2 Application layer

4.2.1 Data Storage

In the article “What is an iot platform”, Calum McClelland writes “IoT platforms are a critical component of the IoT ecosystem” [23] and that is because IoT objects collects huge amount of data and it needs to be stored somewhere and that's where the IoT platform comes in. Within an IoT platform, a cloud computing solution will play a big part of the system, as said by the National Institute of Standard and Technologies(NIST) [24] “Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction”. Which is necessary for an IoT ecosystem to work. Within many IoT solutions, a cloud computing solution acts as the head of the IoT system, where data gathering and actions are performed by IoT objects, but analysis and processing are done in the cloud. [11, 25]

4.2.2 Storage

By definition IoT objects produces large amount of non- or semi structured data which also have three characteristics that are big data volumes, different data types and data generation frequency. Within a cloud solution there is virtually unlimited and on-demand storage capacity which generates opportunities for data aggregation, integration and sharing data with others. [26, 41]

4.2.3 Computation

With IoT objects having limited processing power and energy resources, they cannot perform advanced data processing. As mentioned above, gathered data is transmitted to a IoT gateway or an intermediate server for further processing but without a proper infrastructure, achieving scalability becomes a challenge. By doing data processing in a cloud environment you have access to virtually unlimited processing capabilities and on-demand usage. Which makes it possible to do different types of processing and analytics. [26, 41]

4.2.4 Graphical User Interface

After data is made useful for its end-user, depending on the purpose of the IoT object, it could notify the end-user using email, text, notification, and so on. For example, a thermostat can send a text alert when the temperature is too high in the cold storage. The user might also have an interface for the their IoT objects that allows them to check the latest data in the system. [6, 26]

However, the GUI of the application layer isn't always one-way street, depending on the application the user may also be able to configure setting and perform actions that will affect the system. Some action can even be performed automatically, rather than the user changes some settings the system could do it by itself via rules that have been predefined into the system. For example, a security system that can alert it´s user when there are intruders, the system can notify the authorities automatically instead of just notifying the end-user of the system. [6, 26]

4.3 Smart Homes

With IoT objects comes the ability to have a smart home that gives you access to control devices in a home from a device anywhere in the world or through a virtual assistant. A smart home may involve thermostats, sprinkler, lights, alarm system, locks or heating and cooling system. By having smart homes, humans will be able to use one of the characteristics with a smart home and that is automation. This includes the ability to schedule or program events for different IoT objects in a home. These commands can be time-related, for example the sprinklers start in the morning. [38, 44]

The second characteristic of a smart home is remote control. Remote control gives the owners the ability to connect to their home when they are not home. This is also where the data that is collected can be displayed and reviewed through an app. Depending on what's installed in a smart home, the owner can check for example if the doors are locked, if the lights are on or off or the security status. If cameras are installed, owners have the possibility to check live-feed and see what's going on. [38, 44]

4.3.1 Home automation

The IoT objects that are being developed for smart homes, provides intelligent and automated services for the homeowner. They help the home owners with different daily tasks and maintaining their daily routines. IoT objects collect data from the home environment which can include light, temperature, humidity, gas, and fire events. [5]

With the use of advanced analytics comes the opportunity to make processes a lot more efficient. IoT objects and systems can automate certain task, in fact most of the IoT device that's being created are essentially using some kind of automation. Automation will often come with great cost but will also come with greater benefits. [29]

A use of home automation could be that the IoT objects controls the schedule for the lights, radio and TV to avert burglary when the home is unoccupied. Through an interface, homeowners can control this functionality to set the schedule or the smart home can act autonomously based on knowledge after learning the usually behavior of the owner. [30]

By using IoT objects with motion and pressure sensors, smart homes can help elderly and their close ones. In case an elderly person falls and becomes unconscious, motion sensors will record these events and with the use of an AI and machine learning algorithms, the smart home can find out what's happening. The smart home will analyze the motion pattern and compare with old data to detect abnormalities. If abnormal activity is detected, the smart home can with automation alert family or local authorities for help. Many different use cases within a home can be done with the help of automation. Other examples can be, automatically turning on the AC when humidity rises, sensors sense a gas leak and all the lights are shut off or when the home is unoccupied all of the light are turned off. [5, 31]

5 METHOD AND ANALYSIS

5.0 Knowledge about IoT

To identify how well the society knows about IoT and to see if workers within the IT branch knows about IoT more than those who don't, we first asked "Do you work within IT development" and "Do you know what internet of things (IoT) is". Most of the respondents 60% which equals to 141 answers said "No" and 40% equals 94 answers said "Yes" (see figure 1).

For those who don't work within the IT-branch (see figure 2), 84 (59.6%) answered that they know what the IoT is, compared to those who work within the IT-branch, 85 answers (90.4%). This shows that the people who don't work with IT have less knowledge about IoT and how it works.

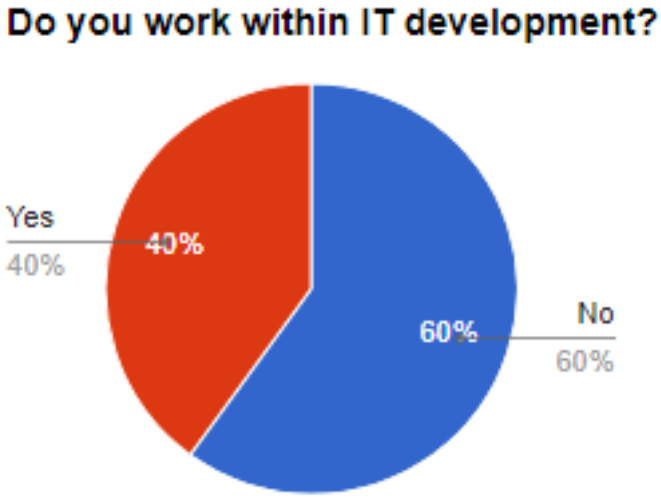

Figure 1: Results of the First Survey Question.

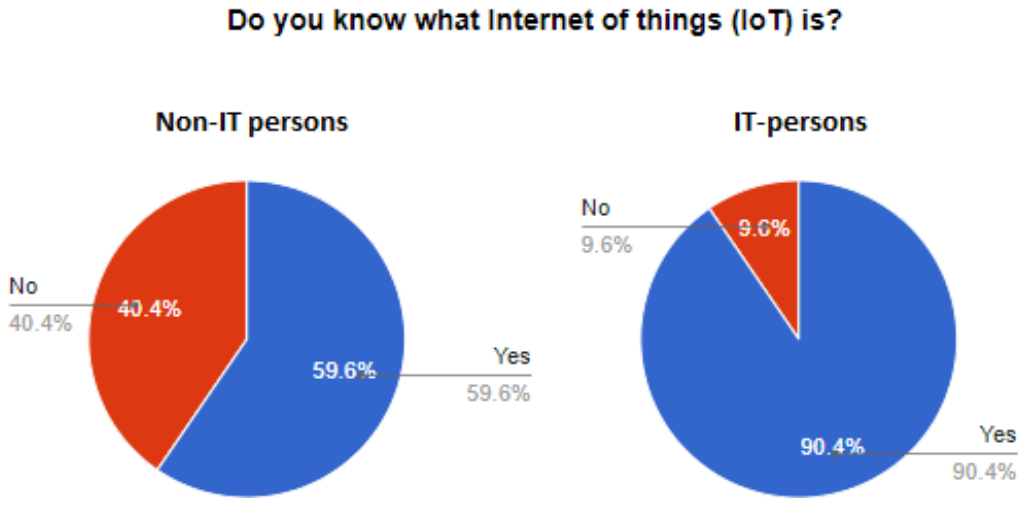

Figure 2: Results of the Second Survey Question.

For those who answered that they didn't know about IoT, we asked a follow-up question "Have you heard the concept of IoT before (see figure 3)". For those 9 who work within IT, 5 answered that they have heard about the IoT concept before and 4 answered that they have not. Compared to non-IT persons, 47 out of 57 answers have never heard about the IoT concept before and only 10 have heard about it. This shows that the concept of IoT has not reached non-IT persons as well as IT-persons. Also, this shows that workers within IT have a better insight of what IoT is and those who are not within IT don't have any idea what IoT is. This may be bad for the IoT market if the knowledge is low, it may be good if the society knows about IoT since it can and probably will affect us in how we live our daily lives.

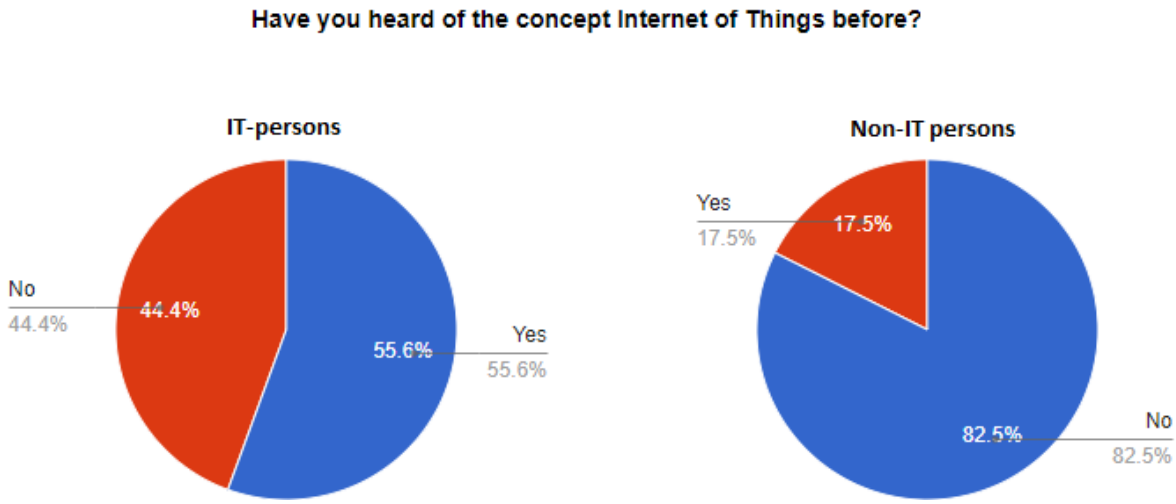

Figure 3: Results of the Third Survey Question.

5.1 Statistics on devices being adopted to IoT in the future

To find out if our respondents think IoT will play a big part in the future, we made the assumption "Most devices will be adopted to IoT in the future". From a scale of zero to five points, how accurate is the assumption according to them. Five indicates "Strongly agree" and zero indicates "Strongly disagree" (see figure 4).

Both groups strongly believe that most devices will be adopted to an IoT device as seen in the figure, where both groups have over 69% agreed votes (four to five). There are some slightly more positive votes from non-IT persons than IT-persons, but it only differs a small percentage for each alternative when comparing both figures.

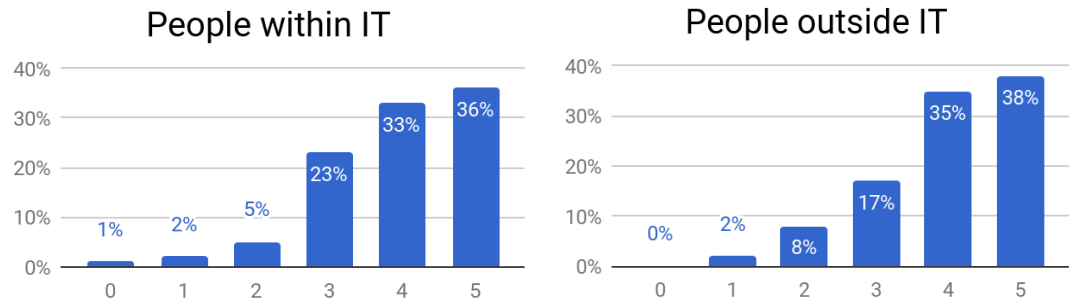

Figure 4: Results of the Fourth Survey Question

5.2 Future thoughts on IoT devices

IoT is on the uprising and we asked the society if they think IoT will play a big part in the near future (see figure 5). From the figure we can see that the answers are quite equal when comparing non-IT persons and IT-persons in terms of percentage. Most respondents for both figures states that IoT will be a part of the near future. More respondents (19.1%) and (23.4%) states that they don't really know. Least of the respondents (2.1%) and (1.1%) stated that they don't think IoT will be part of the near future. Our finding shows that most of the people asked think that in some way IoT will be playing a big part in a near future.

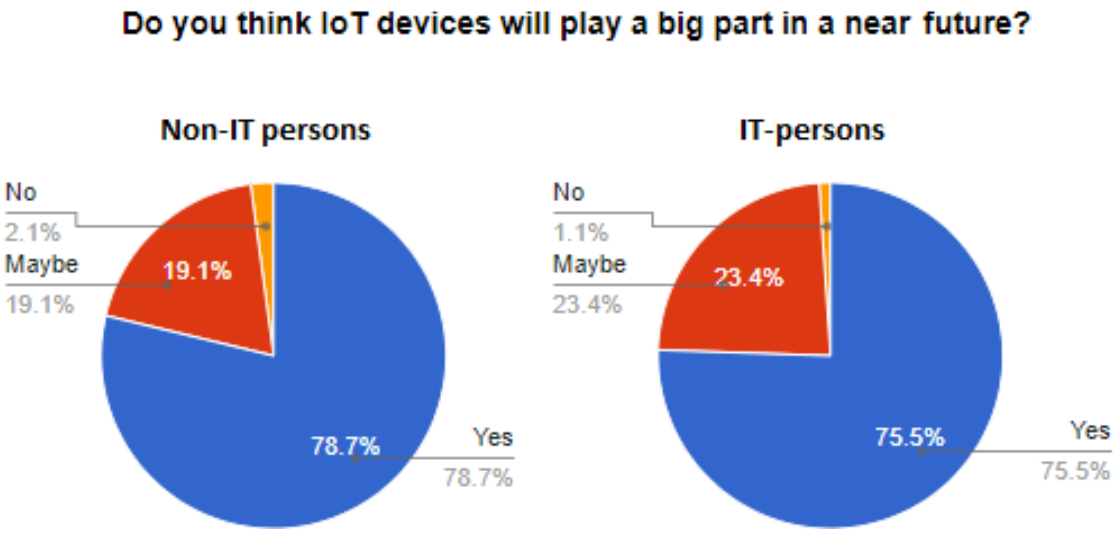

Figure 5: Results of the Fifth Survey Question.

As an optional follow-up question, we asked them to write a text on why or why not they think IoT will play a big part in a near future, to identify what kind of thoughts they have on IoT. We divided the answers both from non-IT persons and IT-persons into three categories (see figure 6). Out of 131 answers, 49 answers stated that IoT devices will simplify our daily life. 41 answers stated that having IoT devices is a part of the digital trend, that most of our digital gadgets will be connected to the internet all the time. All though most of the answers tend to be positive about IoT, 41 stated that IoT will be forced upon us by companies that will be developing new products with IoT in it.

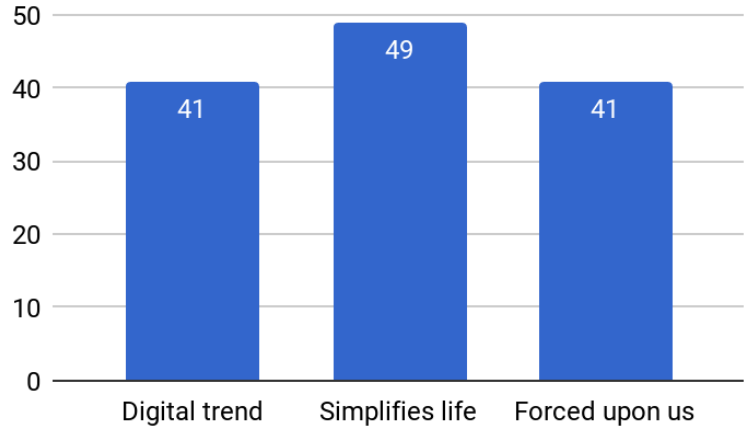

Figure 6: Results of the Sixth Survey Question.

5.3 Personal use of IoT devices in daily life

To identify if the society are using any IoT device in their daily life, we first wrote a description of what IoT is and provided an example of using an IoT device. By describing IoT for everyone answering the survey, we will know that they have some kind of knowledge of what IoT is. Then we asked if the society uses any IoT device in their daily life (see figure 7). Most respondents 63% do not use any IoT device in their daily life. Respondents that use IoT devices, we asked a follow-up question to see what kind of IoT device they use (see figure 8) and from 87 answers, we can see that many use some kind of smart gadget (Fitbit, kitchen tools, raspberry pie etc.) but the use of smart keys for unlocking doors are not that popular.

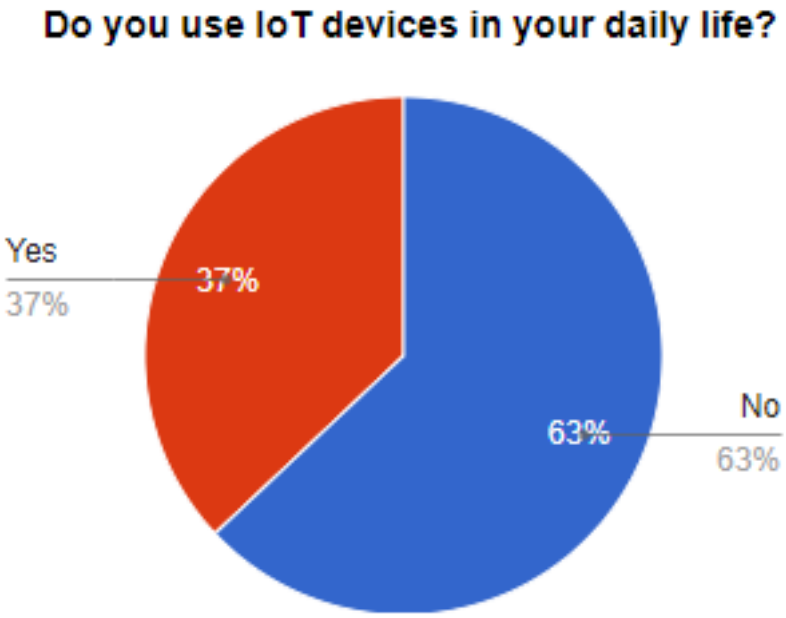

Figure 7: Results of the Seventh Survey Question.

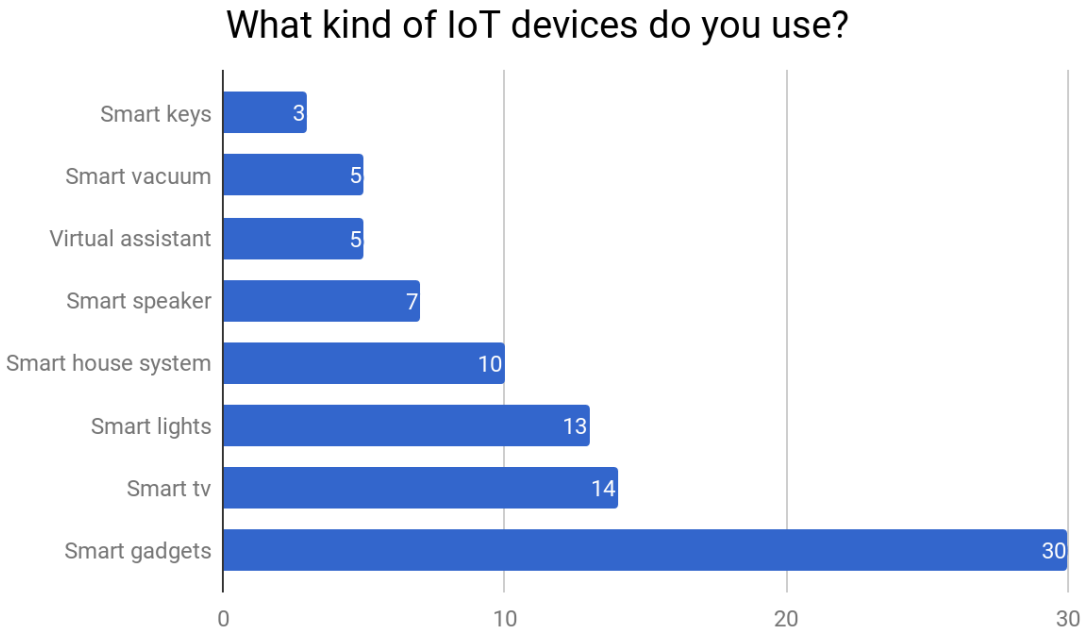

Figure 8: Results of the Eight Survey Question.

5.4 Future usage of IoT devices of non IoT users

For those who don't use or own any IoT device, we wanted to find out how willing they are to get some kind of IoT device in the future. We asked would you like to use IoT objects in the future (see figure 9) and 71.6% of the answers agreed on using any IoT device in the future.

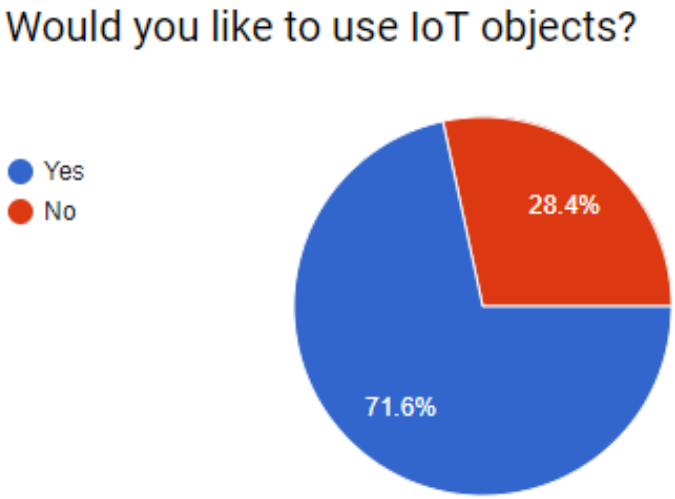

Figure 9: Results of the Ninth Survey Question.

As an optional follow-up question for those who answered, we asked them to write a text on why or why not based on their answer to use IoT devices. We took the answers and divided them into four categories (see figure 10). From the categories we can see that 48 answers were positive about using IoT objects but 39 answered that they were not interested in using IoT objects. From the answers that were not interested, 26 of those were concerned about the security and privacy. Since it's quite many who think this is a problem with IoT, it could be bad for the market when trying to sell IoT products to the society.

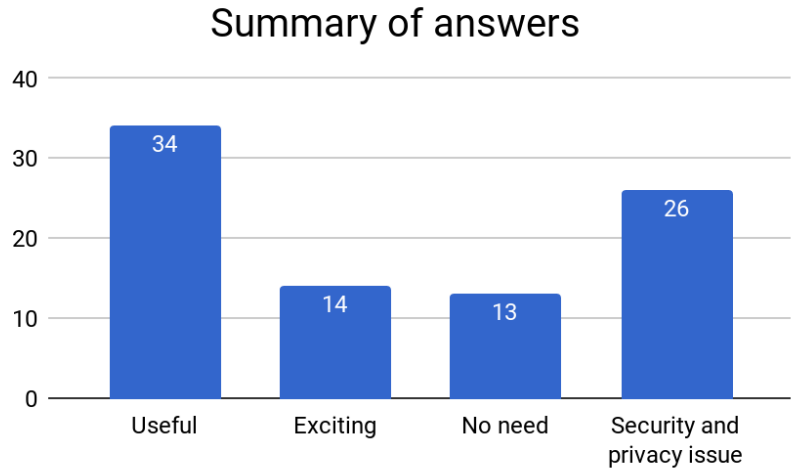

Figure 10: Results of the Tenth Survey Question.

5.5 Statistics on devices society would like to use

To get an insight of what kind of IoT device our respondents would like to have, we provided eight example IoT devices and an input field where they can write their own device they want to have as an IoT (see figure 11). The most wanted upgrade was “Home security” with 157 votes (67.1%) and least wanted upgrade where on “Shower” with 66 votes (28.2%). Some other devices that were wanted but were not in the predefined alternative was car, bikes, coffee maker, e-health devices, light and window blinds.

Although some respondents took “None” the overall interest in upgrading or using IoT devices is extremely high and the concept seems very appealing for our respondents.

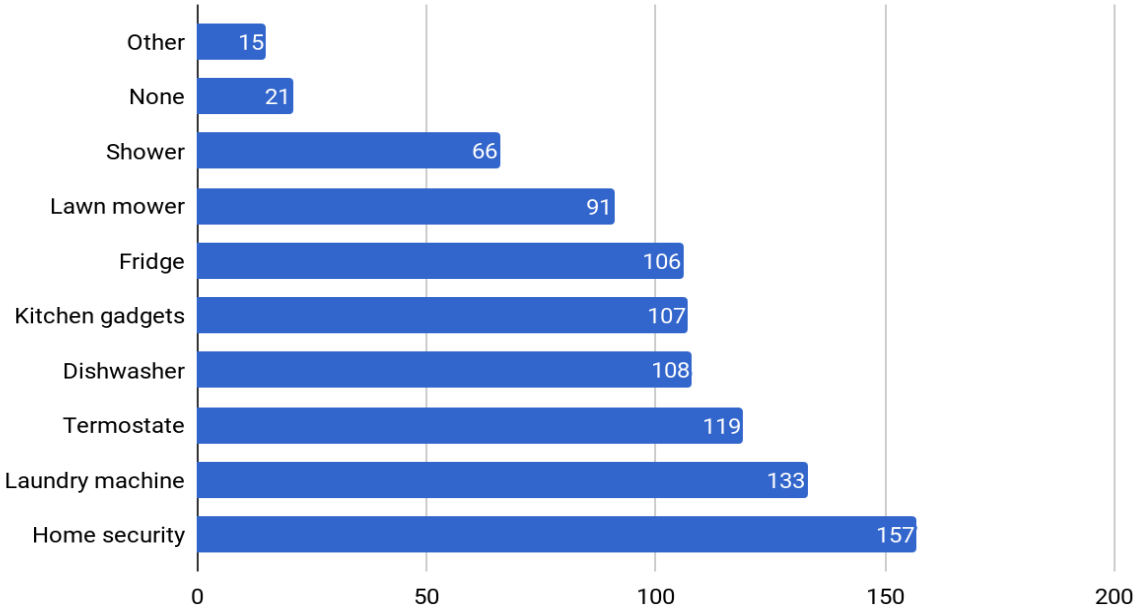

Figure 11: Results of the Eleventh Survey Question.

5.6 Statistics on scenarios

For the last part of the survey we wanted to get an insight into how they feel about using IoT in different areas. We provided a few scenarios where IoT devices can be used by a regular person. From the result we get general understanding of what the society thinks of IoT and if they are willing to use it to help them in their daily life. For the scenarios, we asked on a scale of one to five where one is the lowest (not interested) and five is the highest (very interested). The scenarios that we chose for this part where chosen because it could be used in a daily life by a average joe right now or in a near future. For each scenario we have calculated an average score by multiplying all responses for each x-value and then divide by the number of responses.

5.6.1 Smart Fridge

As seen in figure (12), out of 234 answers, 147 respondents are willing to use a smart fridge some of the answers are clearly below which are considered “not interested” in such object. We can clearly see that the majority is having a positive attitude towards a smart fridge.

The average score landed on 3.71.

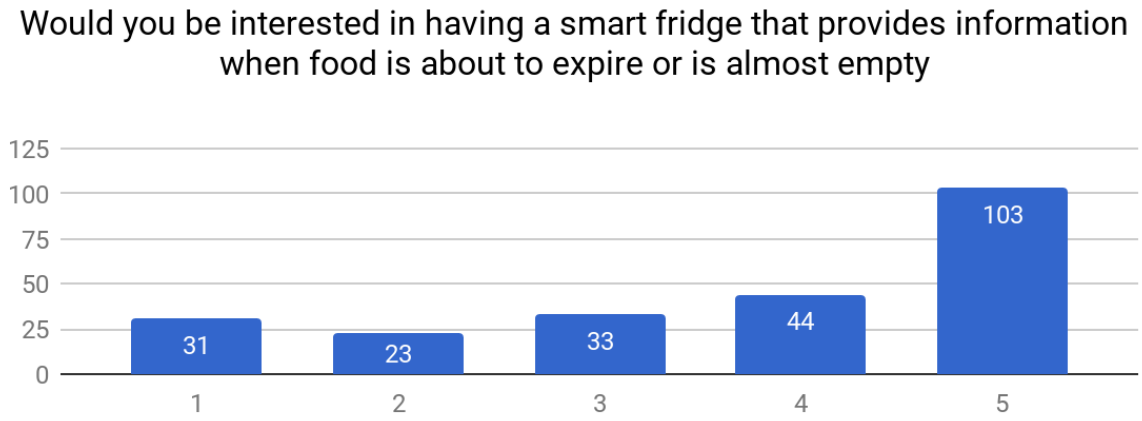

Figure 12: Scenario One

5.6.2 Virtual assistant

In figure (13) are the statistics on “Virtual assistant”, as we describe in the question the “Virtual assistant” helps the user to control the other IoT devices in their home etc. From the figure, we can see that most respondents are very interested, but compared to the smart fridge in the previous question there are not as much interest when it comes to having a virtual assistant. But the positive opinions are still the majority in this case.

The average score landed on 3.46.

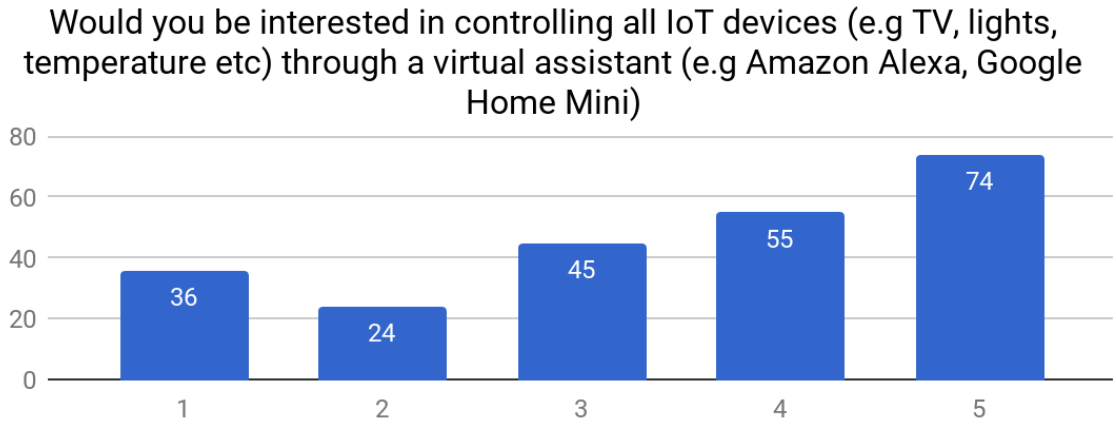

Figure 13: Scenario Two

5.6.3 Home security

The home security scenario got second most five pointers in this study with whole 48% (see figure 14). To be able to control the home security remotely seems very

appealing for our respondents. The result indicates that security and safety are very important for our respondents, particularly home security. We can also see from these results that people see IoT as a key technology for security and safety systems in the future.

The average score landed on 3.86.

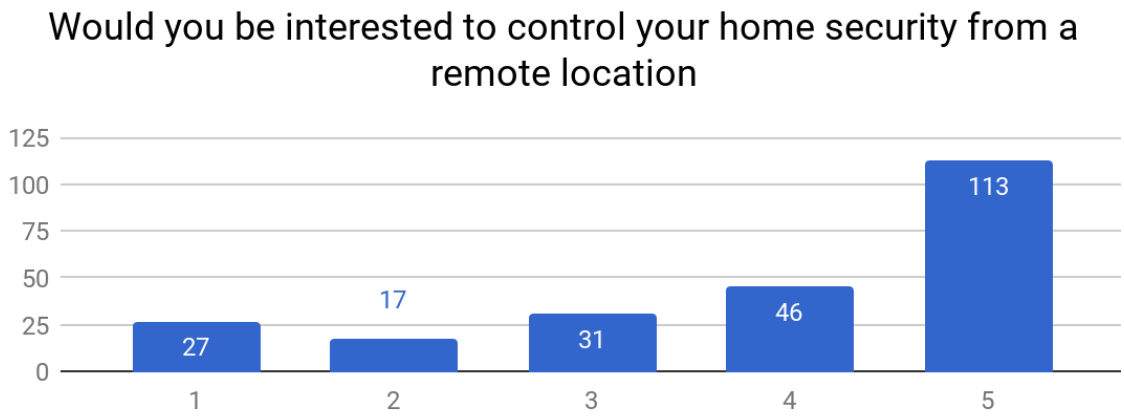

Figure 14: Scenario Three

5.6.4 Health assistant within a home

The health assistant has more positive points like all the other scenarios with 127 interested and 62 not interested. To have a health assistant are not as popular as past scenarios, could be that it's quite a futuristic scenario or that people are not that interested into having a health assistant.

The average score landed on 3.50.

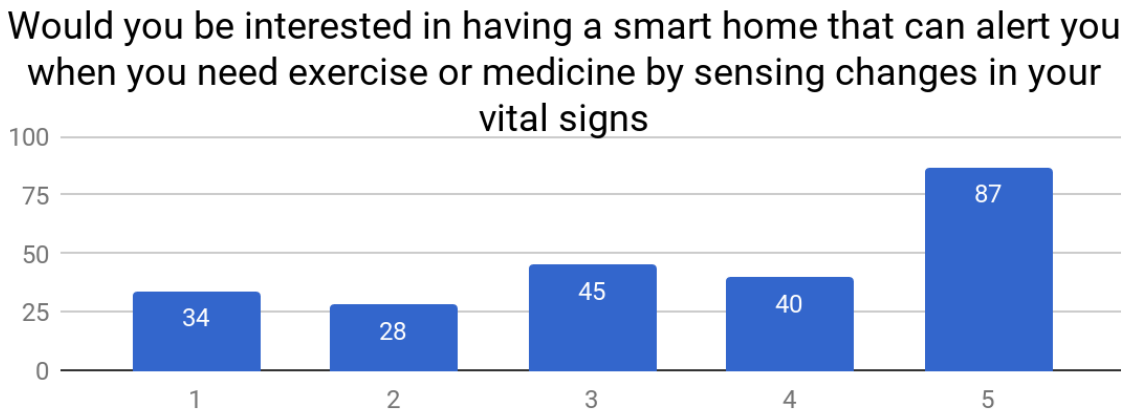

Figure 15: Scenario Four

5.6.5 Energy control and monitoring

The energy control and monitoring system is the only one to have above 50% on very interested, for every point from five to one the number of votes decreases nearly by 50%. It's also the only scenario where the average score is above four, energy consumption and to be able to control your energy consuming devices from remote seems to be something very appealing for the society.

The average score landed on 4.22.

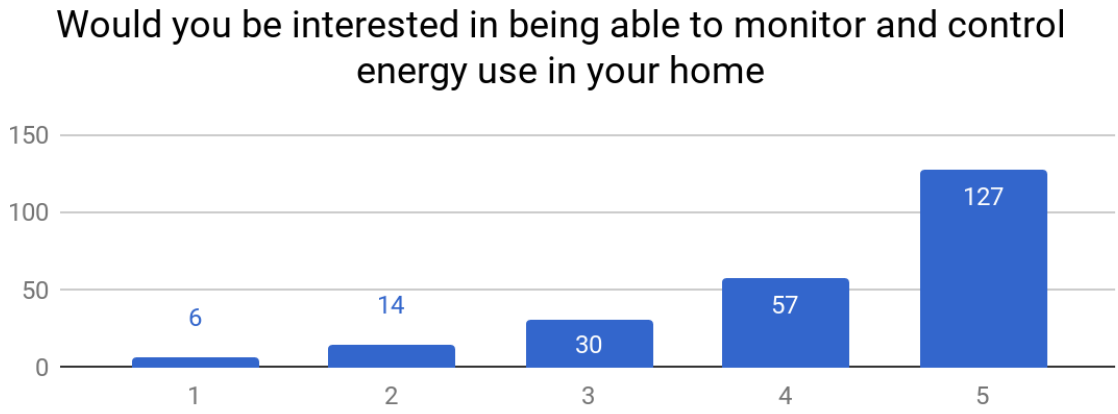

Figure 16: Scenario Five

5.6.6 Smart toilet

One of the most "unwanted" scenario was the smart toilet that analyzes the user's feces to inform if she or he may have any sort of disease. With most score being very interested, it also has the second most not interested after the smart keys scenario.

The average score landed on 3.44

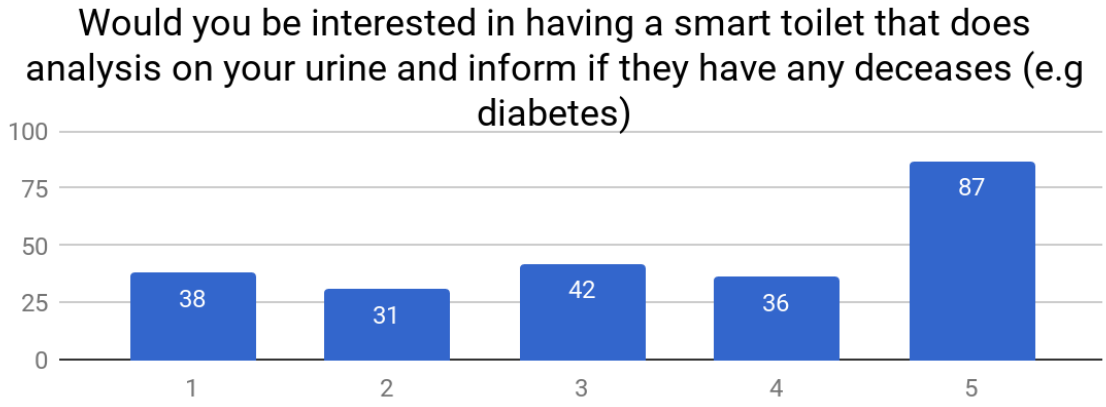

Figure 17: Scenario Six

5.6.7 Smart keys

With 3.11 average score, this scenario is the lowest rated scenario in this study, with both most one's and two's. But even if this is the lowest rated object there is still more five pointers than one's and more positive points (4-5) than negative points (1-2). So, the society are not totally agreed that using smart keys are something they would like to use on a normal basis.

The average score landed on 3.11.

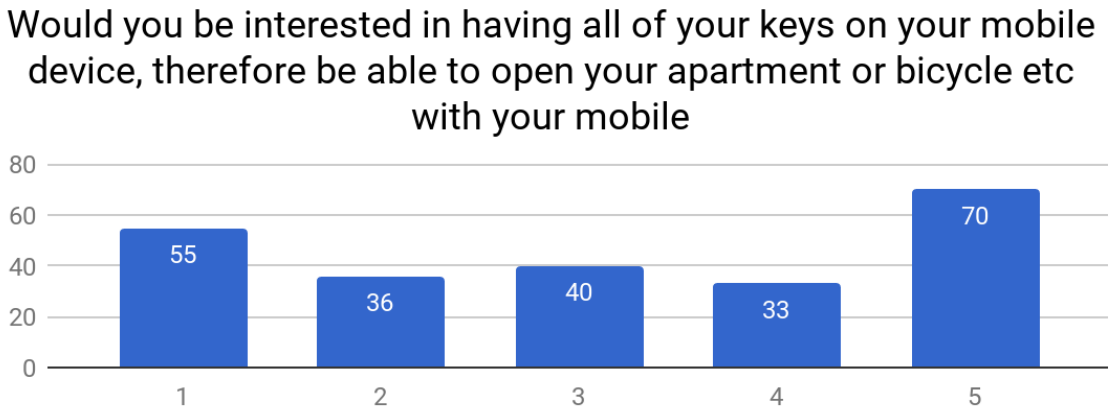

Figure 18: Scenario Seven

5.6.8 Summary from scenarios

As seen in all scenarios above "very interested" is always the most chosen alternative and there are also more positive points than negative in all scenarios. Throughout a business perspective there are a lot of interests in IoT and people seem to be very willing to use IoT objects in their lives, which means there is a stable market for IoT. The most wanted object in this study was "Energy control and monitoring" and least wanted was "Smart keys".

Below we show a table with the calculated interest score from all scenarios.

1. Energy control and monitoring	**4.22**
2. Home security	3.86
3. Smart Fridge	3.71
4. Health assistant within a home	3.50
5. Virtual assistant	3.46
6. Smart toilet	3.44
7. Smart keys	3.11

Table 1. Ranking of IoT devices from the most wanted to the less wanted.

5.6.9 Statistics on pros and cons with IoT

We wanted to know what kind of pros and cons IoT have according to the society, we asked our respondents an optional question "If you think there are any pros/cons with IoT, please describe them". We summarized their answers and divided them into five different categories (see Figure 18). From the answers we received, there were mostly disadvantages. Out of 142 answers, there were only 38 who thought that IoT would make our lives easier. But the remaining 106 answers think that IoT brings more disadvantages than the advantages to our life. Below we list these four categories that are cons according to our respondents.

1. 59 out of those wrote about the security and privacy issue around IoT, how our personal data can be hacked or sold which is a big concern.
2. 29 thought that we humans will be too dependent on IoT objects in our daily life, that we could not do things by our self without the help our IoT objects.
3. 13 thought that we would be vulnerable if something would happen to our IoT devices, in case you have your keys in your phone and the battery dies, what happens then?
4. 3 answers were concerned about the increased energy use with increase IoT objects, our energy consumption will increase which leads to increase energy production. This will also affect to the environment in the nature.

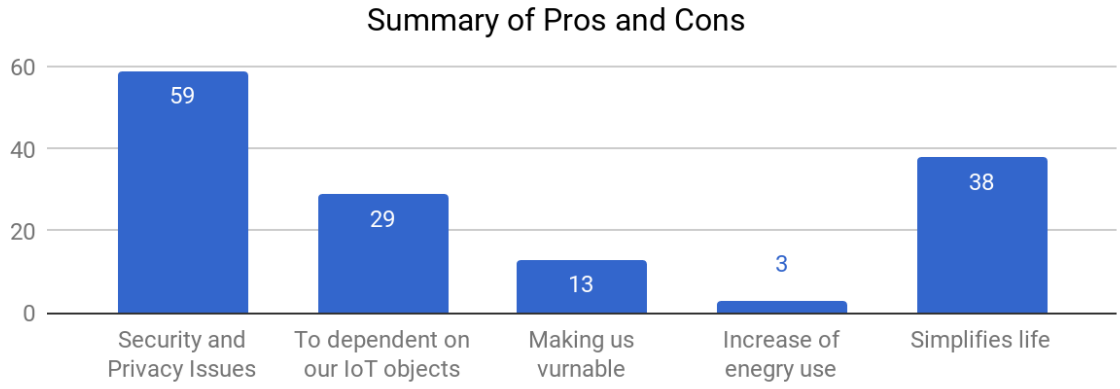

Figure 18: Results of the Twelfth Survey Question.

6 RESULT AND DISCUSSION

6.0 What is IoT and how does it work?

IoT is a device that are provided with the ability gather and transfer collected data from the physical world over a network without the need of human interaction. The design of a IoT architecture can differ from product to product but a general architecture consists of three layers, perception, network and application layer. Perception layer is where all the data is collected from the physical world. Network layer is where preprocessing takes place and the transportation of the data over the network. Application layer consists of storing the data, additional preprocessing and a way of displaying the processed data for the user.

6.1 How can IoT objects help society with their daily life?

There are a variety of advanced IoT object that are being developed to make society lives easier and smoother. By converting a regular home to a smart home with IoT objects has a great potential to help the society with their daily lives. From installing security systems with sensors and cameras that can determine if a police, ambulance or fire truck is required to having a refrigerator that can notify when the food is about to expire. With the help of the collected data from IoT objects and advanced analytics, IoT objects can adapt and perform various automated tasks, making the lives of society easier, smoother and safer.

6.2 How great is the knowledge about IoT within the IT branch compare to people outside of the IT branch?

The knowledge about IoT is greater for people within the IT branch (90.4%) but the knowledge is still great for those who doesn't work within the IT branch (59.6%). When it comes to might know the concept of IoT (for those who doesn't know what IoT is), IT people (44.4%) have heard about the concept more than does who doesn't work with IT (17.5%). From the survey we can see that people within the IT branch have better knowledge about IoT than people outside the IT branch. The knowledge and concept of IoT have not reach people outside the IT branch as much as it has reached those within IT branch.

6.3 What are the thoughts on IoT from the society?

The responses from the survey shows that people thinks IoT will play a big part in a near future since it will become a digital trend, it will make our lives easier but it will also be forced upon us by companies. We can also see that non-IT workers have a more positive view, where 78.7% thought that IoT will play a big part in a near future and IT-workers have only 75.5%. As IT-workers have more knowledge about IoT and are also less positive about the future of IoT, they also have a slightly more disbelief on the subject which is an interesting point. The pros and cons of IoT that we got from our responses show that people found more cons than pros (Figure 18), where most said cons were the security and privacy issues with 59 votes. But the second most voted feature was simplifying the lives (which also was the only mentioned pro with 38 votes). Most thoughts on IoT are positive but some seems skeptical about how the security and privacy of the data is mitigated and whether the private data will be kept stored within the company and not sold to third parties.

6.4 Will society use IoT objects to help them in their daily life?

From the responses of the survey, only 37% uses IoT objects today and the most used IoT objects that our respondents use are smart gadgets e.g. Fitbit, kitchen tools, raspberry pie. As for those who doesn't use IoT objects today, 71.6% were willing to use IoT objects and are excited and finds IoT objects useful. The main reason that some respondents picked no, were because they are concerned about being exploited when it comes to the security and their privacy. Overall most respondent would like to use IoT objects but depending on what kind of object it is, the appealing shifts.

7 CONCLUSION

The digital trend continues to evolve and the new trend may be that most electronic devices will be connected to the internet. Reading about how IoT works and seeing the society view around IoT, it is possible that IoT is the new digital trend. With this report, we provided quick and easy information on how IoT works and finding out the thoughts and knowledge from the society and the possible future of IoT. The targeted audience with this thesis is developers, companies working with IoT and people with interest of IoT.

Developers can create new IoT objects with the intention to help people in their daily lives. The underlying IoT architecture of an IoT product may look different, but there are general concept for this matter that involves a device that sends collected data to the cloud for storage and analyzation. By having a smart home with various advanced IoT objects can make a daily life of a person easier, smoother and safer. But the knowledge about IoT is fairly low when it comes to people outside the IT-branch compared to those working with IT. However, this does not stop people for getting involved with IoT objects in their lives as our survey shows that the interest in IoT and the belief that IoT will play a major role in the future is high. But some are still sceptic about the big questions about security and privacy issues IoT might bring. People are not completely convinced that their personal data collected by IoT objects are safely stored and are not sold to third parties. If IoT companies can guarantee the security of personal data and not selling it to third parties, the interest in IoT can grow stronger and society will be more willing to use IoT objects in their daily lives.

8 FUTURE WORK

As we made this paper about how IoT works and the societies thought and knowledge around IoT. We have learned a lot in this area of subject and as this knowledge was learned we have raised our eyes for this technology and learn more about the subject, not only more detailed how it works but also more how it will and can affect us.

If we get the opportunity again we would like to dive deeper in some more specific components like security and storage. After this investigation about IoT we learned from our respondents that security is a main factor for them and thereby we would like to investigate that topic a bit more and see how fragile it is and how it can be better. As said we would also like to investigate storage a bit more, like how can you can handle big data better and how it be more optimized.

Something that we found interesting was the survey, we got to know other people's knowledge and view of IoT which was both interesting and educational. To keep working on the survey to make it more complex and reach out to more people is something that could be a strong alternative for a next paper.

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