Internet Of Things (IoT) awareness in Greece

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Abstract. Internet of Things (IoT) is a technology in which objects are embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the Internet. The main goal of the Internet of things is the real-time operation of devices; as a result, daily life improvement and data collection are without human intervention. In this paper, we investigate IoT awareness from Greek citizens. A worldwide literature review about IoT is presented, and the results are connected with the theoretical study. Furthermore, in 2018, 22 billion devices connected with IoT worldwide, and by 2030 it is expected that 50 billion devices to be enabled too. An online questionnaire was developed by the use of Google forms and distributed via e-mail and social media. The statistical analysis of the responses of 387 participants concluded that the level of security, privacy, and familiarity significantly affects the use of IoT. Some of our hypotheses and findings in the current survey are the extent of IoT technologies that are represented in Greece, the gender that is more familiar with IoT technologies, and the association of the monthly income with IoT knowledge.

1 Introduction

The definition of the Internet of Things refers to the network of physical objects accessible via the internet, as defined by analysts and visionaries of technology. IoT has sensors and actuators, part of smart systems such as smart homes, vehicles, and cities. Furthermore, in 2018, 22 billion devices connected with IoT worldwide, and by 2030 it is expected that 50 billion devices to be enabled too.

2 Internet Of Things

The definition of the Internet of Things refers to the network of physical objects accessible via the internet, as defined by analysts and visionaries of technology [1]. These objects contain built-in technology so that they can interact with internal situations or the external environment. Such objects can be household appliances, vehicles, utilities, sensors of a city, community, industrial appliances, roads, clothes, and any object of the artificial human environment [2]. It can be said that it is an umbrella for interconnected technologies, devices, objects, and services [3]. IoT enables remote control of objects through the existing internet infrastructure by integrating the physical world into computer systems, reducing costs, and improving accuracy [4]. IoT has sensors and actuators, which are part of smart systems such as smart homes, vehicles, and cities [5]. Moreover, it describes a future where objects will be connected to the Internet and identify themselves with other devices. It is a revolution of the Internet and, in the following years, will influence a lot of applications, like smart homes, healthcare systems, smart manufacturing, environment monitoring, and smart logistics[6]. IoT enables device connection by a combination of edge computing, pervasive networking, centralized cloud computing, fog computing, and database technologies [7]. Besides, IoT usage enables devices to manage and transfer data that are internetworking and offer advanced connectivity of devices, systems, and services . In 2018, 22 billion devices connected with IoT worldwide, and by 2030 it is expected that 50 billion devices to be enabled too [8].

2.1 IoT characteristics

The Internet of Things results from combining some components of technology and some other techniques and has some characteristics.
These characteristics are [9], [10]:

- Identification: Items are uniquely identifiable. Technologies such as RFID and NFC are used for object-finding technologies through the intercessor.
- Detection: Sensors are used for information collection about their environment.
- Communication and collaboration: Objects can be connected to the Internet or each other and updating their status.
- Addressing: On the Internet of Things, objects are placed to be adjusted remotely.
- Tracking: Smart objects know their natural position by using GPS and telephone networks to achieve this goal.

2.2 Application categories

The first category consists of ideas of different connected devices with IDs that communicate with the physical en-

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vironment. In this category, IoT's ultimate goal is the security and protection of data and information. Applications aim to find automation from machine to machine and generally the communications that can help the daily life of people. The second category concerns collecting data from final nodes to extract helpful information [3].

2.3 Smart Cities and Applications

A smart city is based on a communications infrastructure [5], [3]. In turn, a modern communications infrastructure is based on ICT, which must include technologies such as SHN that have so far interconnected the IoT [11]. The CoT (Cloud of Things) now, which connects smart homes and the various technologies used, is based on a "cloud", which manages all the data of the smart city. It includes a set of IoT smart homes, which contain appliances and services such as smart heating and entertainment system. These devices are interconnected by SHN, which in turn is connected to cloud internet services [12]. Smart applications and city services, which will use 5G more efficiently, will be described below. They will be implemented so that they can make people's lives easier. Many times, however, we look at how to make our lives easier but not the most efficient, these applications will also help in the effectiveness of important elements in our lives[13], [14].

2.4 Smart Homes

The requirements of the residents are many when it comes to a smart home, as they will require proper management when they are outside the home [5],[3]. The house will be monitored remotely and there will need to be secured to be able to monitor children and the elderly. It should have a central system, which will combine many technologies and communicate with the monitoring system [15], [14], [16].

2.5 Smart Education

In recent years there has been a great deal of research regarding "smart" education (smart education). Smart learning environments have been developed that contain digital content and are efficient and enjoyable for both learners and educators. Students will be able to choose the platform they will enter and from whom they will get the information they want [13], [15]. Also, the training will become more fun so that it can have absolute attention. This can be achieved through various methods such as the game will meet the needs of learners . Apart from Education applications [17] , IoT has also been applied in other such as sign language learning [18] , gaming [19] and medical applications [20].

2.6 Smart Health

The intensions of the feature health care are the control and prevention. Today, patients can be tracked and monitored by specialists even if the patient and specialist are not in the same place. Tracking patients' health history by using IoT will be very useful [3]. Health is also one of the most important in terms of smart cities and 5G. 5G features that will support the use of healthcare will include:

- Bandwidth and device connections for processing large volumes of data and services. There will be many devices that will be connected to wireless networks such as motion sensors and various Ultra-Low Latency imaging tools: The applications that will be used for remote surgery.
- High reliability for remote surgery, care and full monitoring of patients when they are in remote areas and do not have the ability to go directly to a specific environment.

2.7 Smart Transport Systems

Intelligent transport systems can greatly improve road safety. Road accidents will be significantly reduced with the development of local warning systems through vehicle communication [5]. Departure vehicles can be informed of the traffic on the roads they are interested in and will be able to get information on an alternative route. Vehicles at intersections can also send information to nearby vehicles for movement and a precise point of attention. Finally, with sensors there will be automatic braking when the car detects an obstacle, this will reduce a significant number of collisions [21], [22], [15]. There will also be smart systems in vehicle operations with 5G enabled capabilities. These functions will include:

- Passenger entertainment that requires both high capacity and high mobility.
- Cars that will have built-in driver support systems based on 3D imaging, built-in sensors and will give the appropriate information to the driver.
- Vehicles capable of detecting critical safety situations, such as accidents and other hazardous road conditions [23], [15].

It will make the supply chain transparent, visible and controllable, and enable intelligent communication [3].

2.8 Security of IoT systems

IoT is used in homes and hospitals, used outside to control and report the changes in the environment, prevent fires, and much more helpful information. All these advantages have vast risks of privacy loss and security issues [4]. The Internet of Things is a universal Internet-based network and has characteristics that involve risks, such as inherent openness, heterogeneity, and terminal vulnerability [24]. The Internet of Things has a large number of protocols that vary depending on the connected devices, thus increasing the complexity of a consistent security solution. The issues of IoT protection and security management can be divided into three levels: device, network, and cloud. The most important issue in IoTs' security is the protection of the data that are transmitted, exchanged, and stored because the protocols about data protection are limited. For

example, smartwatches and other mobile devices collect personal data. In addition, there are commercial companies that have software for information collection. From the above examples, it is understood that the information encryption applications on these devices are designed to protect personal data from other users and avoid access to these [25].

3 Statistics and data

The data and forecasts on the evolution of the IoT globally are particularly encouraging, highlighting the market potential. According to estimates by Mordor Intelligence, the fastest growing continent in IoT is Asia and has the largest market. The Compound Annual Growth Rate for this market is 10.53, which indicates significant potential [26]. IBM, Huawei, Google, Cisco, and Microsoft are the players with the largest market share in IoT.
The global IoT market at the end of 2019 increased to 212 dollars billion. In 2017, this market reached 110 billion dollars and forecasts show that this number will increase in 2025 to 1.6 trillion dollars. The data and forecasts on end-user costs in IoT are particularly encouraging with the relevant estimates presented in the chart below showing the significant increase over time. However, apart from the

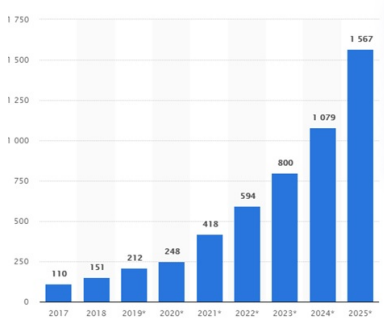

Figure 1. Forecast end-user spending on IoT solutions worldwide from 2017 to 2025 (in billion U.S. dollars) Source: (Vailshery, 2021)

forecasts regarding the expenses of the end-users in IoT, which are upward, the data in terms of annual income are also important, as well as the relevant forecasts. In particular, the total IoT market is estimated to have reached $389 billion in 2020 and is projected to grow to more than $1 trillion by 2030, more than doubling its revenue over a decade. At the same time, the number of devices connected to IoT worldwide is expected to increase significantly and specifically to triple by 2030 [27]. An important element for this market is the fact that during the pandemic, several organizations collaborated with the healthcare industry to offer integrated technology solutions to overcome the crisis effectively and safely. For example, the Shanghai Public Health Clinical Center used a continuous temperature monitor to monitor patients with COVID-19, thus reducing the risk of their caregivers being exposed to the virus [26].

In a sub-market analysis, the retail industry has grown significantly in the last two years especially with the massive expansion of the e-commerce industry worldwide. Retailers use IoT solutions not only to improve their operational efficiency but also to enhance the customer experience, to enhance their competitive advantage. Reduced cost of IoT devices and connectivity, customer demand for a better shopping experience, and the adoption of smart payment solutions are some of the key drivers of IoT growth in retail.
In addition, the use of IoT in commerce plays an important role in the automation of processes and enhances the operational efficiency of stores, optimizes energy, surveillance, security, and workforce management. Finally, in terms of retail trade, the use of IoT devices in millions of units amounted to 1.53 in 2016 while the forecast for 2015 amounts to 3.09, as shown in the following chart.

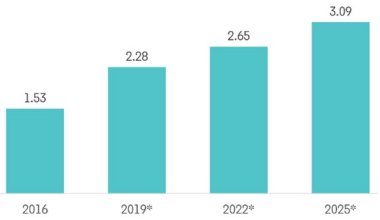

Figure 2. Internet of Things Active Collections in Retail (in million euros) in European Union Source: (European Telecommunications Network Operators' Association, 2019)

Apart from Europe, the use of IoT devices is growing significantly in North America and even plays an active role in market development, since it provides a strong base for IoT suppliers. Some of the most important groups based in North America are also key players in the industry such as BM Corporation, Microsoft Corporation, Intel Corporation, Cisco Systems, and Google Inc. In February 2020, Cisco even announced that it was going to increase IoT in its portfolio to achieve optimal management of the mobile and 5G environment. Finally, Avast, in collaboration with Stanford University, found that homes in North America have the highest density of IoT devices of any region in the world. Remarkably, 66 percent of homes in the area have at least one IoT device. The average household in the area will have an average of 9 devices by 2022 and almost half (48 percent) of the total devices and connections, i.e., will belong to the category of IoT [26]. Another key market for the use of IoT is home automation systems. They are products that consumers want to have in their homes such as the most in-demand cameras, video bells, connected light bulbs, smart locks, and smart speakers.

4 Survey Methodology

This section presents the design of the survey, the process of designing the questionnaire, its structure, the sampling method, the sample as well as the data analysis techniques used. Non-probable sampling method was applied. The data was collected via an electronic questionnaire which

was developed based on an extended literature review. Specifically, it was developed by the use of Google forms and distributed via e-mail and social media. Regarding the respondents, anyone could complete it anonymously with our aim to ensure confidentiality. In the present survey, the primary data collection method, which is known as a quantitative method and based on a sample survey using a standardized questionnaire, was also selected. This questionnaire included closed-ended questions. Closed type questions are the questions that are accompanied by a series of suggested answers to the respondent from which to select one. In the present questionnaire, there are "yes-no" questions, multiple-choice questions, and Likert scale questions. In the Likert scale questions the Likert scale with 5 grades was used, where option 1 does not indicate any option and option 5 means very high.

4.1 Research questions

Every research project may answer some questions called research questions, and their development is essential in every survey. Research questions are not common questions and must be answerable. Questions construction is one of the most critical aspects of each research too. In our survey, the main research questions are:

- To what extent is IoT technologies represented in Greece?
- Which gender is more familiar with IoT technologies?
- Is monthly income associated with IoT knowledge?

Data gathering period was from September up to November 2020. 458 responses were collected and were valid. Afterwards, data were encoded and analysed using the SPSS Statistical program.

4.2 Main Results

4.2.1 Gender Results

The sample consisted of 458 valid questionnaires. Of 458 participants, 283 participants (61.8%) were women and 175 (38.2%) were men.

4.2.2 Age results

About the age of the participants we had:

- 6 (1.6%) participants were under the age of 18
- 345 (75.3%) participants were between 19-25
- 16 (3.5%) participants were between 26-30

4.2.3 Place of origin

About the place of origins of our respondents, we have:

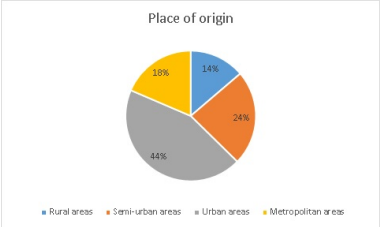

Figure 3. Internet of Things Active Collections in Retail (in million euros) in European Union Source: (European Telecommunications Network Operators' Association, 2019)

4.2.4 IoT technology usage

According to the table below, 47.6% of our respondents have used IoT technologies as 52.4% have not used.

	Frequency	Percent
Yes	218	47.6
No	240	52.4
Total	458	100

4.2.5 Gender and IoT technologies usage

To examine which gender is more familiar with IoT technologies, we used cross-tabulation in SPSS. The results are that 118 men (67.4%) are familiar with IoT technologies, and 138 of the women (48.8%) are familiar with IoT technologies. As a result, we can say that Men are more familiar with IoT technologies than women.

4.2.6 Place of origin and familiar with IoT technologies

In order to examine which place of origin is more familiar with IoT technologies, we used cross-tabulation in SPSS. The results are:

	Frequency	Percent
Is done more efficiently	7	3.2
Less efficiently	9	4.1
Efficiently	40	18.3
More efficiently	82	37.6
Much more efficiently	80	36.7
Total	218	100

Figure 4. Internet of Things Active Collections in Retail (in million euros) in European Union Source: (European Telecommunications Network Operators' Association, 2019)

- 36 (57.1%) of our respondents are familiar technologies and come from rural areas
- 53 (49.1%)of our respondents are familiar technologies and come from semi-urban areas
- 119 (58.9%) of our respondents of our respondents are familiar technologies and come from urban areas
- 48 (56.5%) of our respondents are familiar technologies and come from metropolitan areas

4.2.7 *Monthly income and familiar with IoT technologies*

In order to examine which monthly income is more familiar with IoT technologies, we used cross-tabulation in SPSS. The results are:

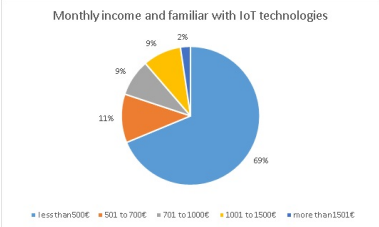

Figure 5. Monthly income and familiar with IoT technologies

In general, respondents with a salary of 501 to 1500 € who know IoT technologies are almost twice as many as those who do not know IoT technologies.

4.2.8 *Employee and familiar with IoT technologies*

To examine if employees or unemployed are more familiar with IoT technologies, we used cross-tabulation in SPSS. The results are:

- 79 (63.2%) or our respondents (N=125) are employee and familiar with IoT technologies
- 177 (53.2%) or our respondents (N=333) are unemployed and familiar with IoT technologies

Moreover:

- 46 (36.8%) or our respondents (N=125) are employee and not familiar with IoT technologies
- 156 (46.8%) or our respondents (N=333) are unemployed and not familiar with IoT technologies

In general, we can say that two out of three employees know IoT technology, and one in two unemployed do not know IoT technologies.

4.2.9 *Familiar with IoT technology and Use IoT technology*

SPSS cross-tabulation was used to examine if our respondents were familiar with IoT technologies and if they used them.
Our survey showed that 205 (94%) of respondents who know about IoT technologies have used them, while 6.0% have not used them.

5 Conclusions

At the end we can summarize: According to the research questions we have: For the first research question, we can say that IoT is a new technology for Greek citizens and has become known to them lately. For the second research question, we can say that men are more familiar with IoT technologies than women. Finally, for the third research question, we can say that respondents with a salary of 501 to 1500 € who know IoT technologies are almost twice as many as those who do not know IoT technologies. In general, we can conclude the following statements: Internet of Things refers to the networks of connected objects that can collect and exchange data in real-time by using embedded sensors. By 2025 22 billion devices expecting to be connected to IoT. Numerous applications are using IoT technologies such as Smart homes, Medical and healthcare, Transportation, and others. As mentioned before, businesses in the Asia Pacific and Europe, Middle-East and Africa, expressed the highest interest in IoT, even more so than those in Western Europe and the USA. This can be explained as citizens in these countries are more interested and aware of IoT technology. Greek society is not fully informed about IoT technology. We can say that Greek citizens are now starting to learn about this technology and will take advantage of it soon.

5.1 Proposals for future research

Researchers can include more questions to examine the IoT extension in Greece and other countries. Moreover, the same questionnaire could be distributed to different nations via e-mail and social media for generalizing and comparing the results.

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