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Potential Benefits and Obstacles of the Use of Internet of Things in Saudi Universities: Empirical Study

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Abstract

Internet of Things (IoT) among of all the technology revolutions has been considered the next evolution of the internet. IoT has become a far more popular area in the computing world. IoT combined a huge number of things (devices) that can be connected through the internet. The purpose: this paper aims to explore the concept of the Internet of Things (IoT) generally and outline the main definitions of IoT. The paper also aims to examine and discuss the obstacles and potential benefits of IoT in Saudi universities. Methodology: the researchers reviewed the previous literature and focused on several databases to use the recent studies and research related to the IoT. Then, the researchers also used quantitative methodology to examine the factors affecting the obstacles and potential benefits of IoT. The data were collected by using a questionnaire distributed online among academic staff and a total of 150 participants completed the survey. Finding: the result of this study reveals there are twelve factors that affect the potential benefits of using IoT such as reducing human errors, increasing business income and worker's productivity. It also shows the eighteen factors which affect obstacles the IoT use, for example sensors' cost, data privacy, and data security. These factors have the most influence on using IoT in Saudi universities.

Keywords

Internet of Things (IoT), M2M, Factors, Obstacles, Potential Benefits, Universities

1. Introduction

The attempts of linking many things situated on different or same sites using the

internet to get an integrated system to develop the performance of transmitting information is called the Internet of Things (IoT) [1]. Many of the things that we are surrounded by will be connected to the network in one way or another. RFID (Radio Frequency Identification) and sensor network technologies will grow to face this new challenge, wherein information and communication systems are embedded invisibly in the environment surrounding us, which resulted in the creation of huge amounts of data. This data requires storage, processing, and presentation in a perfectly consistent and coherent way, with efficiency, and in an easily understandable method. This model will contain services that are commodities and produced in a way that is similar to traditional commodities [2] [3]. IoT is known as one of the very essential areas for future technology and is gaining enormous popularity in several global industries. The true value of the IoT for enterprises is understood when the communication between connected devices is possible, and the ability to integrate with inventory systems managed by vendors, customer support systems, business intelligence applications, and business analytics [4] [5].

The concept of IoT has grown, it is taking more visibility and the development of usable IoT products for our daily life is increasing. Hence, IoT is introduced in every field to provide suitable solutions for many applications such as medicine tracking, smart health, smart house, smart cities, waste management, traffic control, security, industrial control, logistics and retail services and emergency services. The future of the IoT is beyond what we can imagine today. We live in a rapidly changing era; the number of connected devices is growing precipitously. It is projected that societies will be completely connected to the grid which will be effective and efficient, alongside some interesting applications that have yet to be invented [6] [7].

With regard to the use of IoT in Saudi universities, it has been noticed the lack of use IoT in this environment, also the lack of users' knowledge about IoT concept [8]. Besides that, most of the previous papers have focused on using IoT in the health sector in Saudi [9] [10], while there have been a few studies in Saudi outlining the use of Internet of Things among academic staff in the universities [11]. In order to fill this gap, it is necessary to investigate this aspect of knowledge.

The purpose of this paper is to provide insight regard the current level of awareness of IoT concept and to identify and examine the associated obstacles and benefits among academic staff in Saudi universities as it has grown significantly in Saudi during the last few years.

2. Literature Review

In this section, the first several definitions of Internet of Things will be provided. Followed by some previous papers regarding the difficulties that affect IoT use will be explored. Then, further foregoing papers related to the potential benefits of IoT will be discussed.

2.1. Definition of IoT

The Internet of Things is the type of network to connect many devices to the internet. In order to exchange information and reduce human errors. IoT is a network of physical objects [12] [13]. This network is not limited to a computer network but covers devices, vehicles, smartphones, home appliances, toys, cameras, medical instruments and industrial systems, animals, people, and buildings, all connected, all communicating & sharing information based on stipulated protocols in order to achieve smart reorganizations, positioning, tracing, safe & control & even personal real-time online monitoring. Moreover, the Internet of Things can be defined into three categories [12] [13]. Those categories are people to people, people to machine and machine to machine. The Internet of Things is a concept and a paradigm that considers the pervasive presence in the environment of a variety of things/objects that through wireless and wired connections and unique addressing schemes are able to interact with each other and cooperate with other things/objects to create new applications/services and reach common goals. IoT is the new revolution in the world of technology. The main goal of using the Internet of Things is to allow things to connect to each other anywhere and anytime [12] [13]. According to [14] Internet of Things is a connection between people and things at any time and any place using a network. There are different definitions for IoT based on previous studies. Those definitions are IoT is Objects that have virtual personalities and identities, where they are embedded with smart interfaces that allow them to communicate and connect with user contexts and social environments, IoT is Interconnected things that have active roles in what could be called the internet of the future, Internet of Things is expression consists of two words [15]: Internet which is defined as the worldwide network of an enormous number of networks depending on communication protocols standards, whereas the word Things refers to all objects that are connected to that network based on the same standard and IoT is anything that can be accessed from anywhere at any time by anybody for any service through any network [16]. The Internet of Things is also called the internet of everything. That everything includes human beings as well so that becomes an Internet of everything. IoT is one of the greatest phenomena of this century [17].

2.2. Obstacles of IoT Use

Nowadays all of the internet applications are providing information and services for humans. It means humans have action in those applications. The Internet of Things (IoT) is a new technology that helps humans by allowing the machine-to-machine (M2M) to do actions [18] [19]. According to [20] [21] there are many challenges facing the application of IoT. M2M has four layers, those layers are Sensors collect data, communication units relay the information collected, computing units analyze the information, and service layers take action. There is a huge concern about sensors for the cost, availability, and service. In the future, will need to connect many sensors wirelessly through a system such as WIFI and

other. In addition, the results come from M2M still need to check by the users. It is mean the users will work for machines and still need the human to act. According to [18] [19] security is one of the biggest challenges of using the Internet of Things. Because IoT generates so much data from the users such as personal information, customer behaviors, or even access to surveillance cameras. The security technologies must be good enough to protect IoT devices and platforms from both information attacks and physical tampering [22].

According to [23] there are difficulties to use operating systems for the Internet of Things. Traditional operating systems such as windows and iOS are not suitable for use. Because those require high specification of hardware and consume a lot of power. Some criteria were used to evaluate the OS are: Power consumption, Processor requirements and Unique points [23]. According to [22] IoT requires a high experience programmer and the cost of providing the tools for IoT is very high. Healthcare become one of the most important sectors around the world. IoT can provide several benefits to improve the quality of life for citizens and prove lifestyle suggestions for welfare.

There are some obstacles facing healthcare to use the Internet of Things to manage and run the business. Healthcare sectors need to connect various medical devices to provide good services. Those devices are made by different companies and some of them cannot connect with other [24] [25]. Also, need to make the privacy of the health history of the patent available to allow the machine to make a decision. As well, the cost to apply the IoT in the health sector is very high. Moreover, the size of the patient's data is very huge, and it will affect the performance of the systems [26] [27]. Because of that the data need to be decentralized. The availability of electricity is the main issue facing the adoption of IoT in health sectors. Because some areas cannot guarantee the sustainability of the electricity. The data which comes from the IoT is noisy and it is very difficult to analyse the data [28]. The Internet of Things does not have any stander for security. And the cost of security is very high because of a different kind of devices used [26] [28].

According to [26] following points present the obstacles facing healthcare to use IoT. The data transmitted from the sensor to the control device and further transmitted to the monitoring center, which will affect the quality of the data due to noise. Better architecture helps to transmit the data without affecting its nature. Noise removal techniques can also help to enhance the data signal. Most of the existing method in ECG monitoring involves analyzing the signal in a supervised manner. This increases the cost, and it may produce a detection error. Machine learning can be applied to analyzing the signa, which helps to improve efficiency and reduce expenses. An increasing number of sensors and devices require higher energy to process, and it increases power leakage and energy consumption. An optimization algorithm can be used to reduce the usage of energy. Monitoring many numbers of users in the IoT requires more storage and mainframe, which can be overcome by storing the data in the Cloud. However, the IoT integrated with the cloud increases the complexity. Another important

problem in the IoT is privacy as the devices are more vulnerable to attack. These devices are low resource constraints and are difficult to apply encryption techniques on them [26].

2.3. Potential Benefits of IoT Use

Previous studies indicated that there are a lot of challenges faced to adopt the Internet of Things in different sectors. On the other hand, there are advantages to enhance the performance of people, businesses and others by using the Internet of Things in different sectors. According to [20] [29] designing a lower-power sensor unit is one of the opportunities of using IoT. As well, designing a new video processing and encoding algorithm is considered an opportunity of using the Internet of Things. The Internet of Things allows better communication between machine to machine. This will assist in the correlation between different components. Also, it helps to deliver the right message and the right time with needed documents [20] [29]. The analysis of the results coming from the organization is one of the difficulties facing the management to make the right decision. Using the Internet of Things leads to zero touch for management and analysis. In future, those advantages lead to the availability of the smart device for people.

According to [18] [30] technology makes life easy and instant. Internet to things is one of the newer trends in the technology field and has become more and more relevant. There are a lot of benefits organizations can achieve by using IoT. The Internet of Things can use for building, transportation, city, and industry. As well, using the Internet of Things help to reduce human errors, reduce operating cost, increase the productivity of workers and business and generate data. Those data can use to produce new reports to assist the progress of the organizations. According to [24] [31] IoT has multi benefits to enhance the quality of life for the citizen.

Recently, the Internet of Things has had wide use in the health sector. RFID Radio Frequency Identification is an automatic and contactless technology, that provides a communication interface with the tagged objects through wireless data transmission to retrieve relevant information. It allows automatic identification and data capture using radio waves, a tag, and a reader. IoT is a suitable technology to get the best advantages of using RFID in the health sector.

Machine to Machine communication is the definition of the Internet of Things. M2M can help the health sector to reduce errors in delivering data. Delivering data is a huge concern for the health sector. As well, the availability of the Internet of Things in the health sector allows to create health application. Health applications can take place of the lack of doctors in the hospital [24] [31]. IoT will help doctors to respond quickly in emergencies and allow them to cooperate with international hospitals to track the status of a patient. There are also other applications of IoT such as patient identification; this application aims to reduce adverse events for patients, and maintenance of comprehensive electronic medical records [24] [26]. According to [28] IoT will reduce the need for physical se-

curity in health sectors. Also, it can assist doctors with emergency cases and remote cases. IoT can speed up the patient's services in the hospital and can have high security for patients' information. It can make the patients' information available for patients in anywhere or anytime they need his health information.

According to [26] [32] the Internet of Things is used to monitor and control electrical devices. This will support the services provided to the citizen. Monitoring the patients in the hospital was a huge concern for the health sector. The availability of sensors and using IoT Will assist doctors to monitor patients. Moreover, using IoT can help to analyse the data provided by the sensor to make a decision [27].

3. Methodology

In this paper, the data is collected in two stages. In the first stage, several databases have been used to find papers related to the use of the Internet of Things. To investigate and discuss the most important factors of potential benefits of using IoT. In addition, to examine the main factors that influence the obstacles of IoT.

This paper focused on studies was published from 2017 until 2023. Various academic databases were used such as Google Scholar, Springer, Science Direct, and IEEE. Then, using the collected papers, the researchers identified various factors. All factors of using IoT were collected inside an Excel file. Next, it was organised according to its articles, and it was classified based on advantages and obstacles of IoT. Then, it was filtered and categorized into two new sheets, the researchers found that twelve factors affect benefits of the IoT, while eighteen factors affect the IoT obstacles.

After that, the researchers moved to the second stage to examine the factors that have been highlighted from the first stage. A quantitative methodology has been used to determine the most factors affecting the IoT use. Therefore, a structured questionnaire method has been used to collect the data from the users. This questionnaire distributed using a google form. The survey consists of three main sections, the demographic information section which consists of seven main questions: participants' age, gender, nationality, university, faculty, major and years of experience. To answer the questions in the next two sections, the participants were required to share their perspectives by rating their responses on a five level of agreement Likert scale. The next section includes 12 questions about the obstacles of using IoT from the users' perception. The third section has 18 questions about the benefits of IoT from their opinion.

The sampling frame was academic staff who are assistant professor, associated professor, and full professor in computer science faculty. The invitation with the URL of online questionnaire was send via several social platforms including WhatsApp and email. The survey took place over a period of a month in May 2023 and involved five Saudi universities from different regions: Taibah Univer-

sity, Jeddah University, Jizan University, King Saud University, and Tabuk University. The estimated whole population was 250 as it shown in Table 1. According to Morgan's sample table [33], the researcher determined the sample size of this study to be 150 responses.

Validation stage is significant to check the questionnaire data accuracy. Therefore, the collected data went through rigorous data cleaning procedure so that it's uniform and prepared for analysis. Several tools were used; the mean tool was Excel. The data cleaning was applied based on a few criteria including redundancy, all the duplicated data was deleted. The other used criteria are inconsistency and incompleteness, the incomplete and irrelevant data was also removed. The result of this process was the total responses reduced from 150 to 117 responses.

4. Results and Discussion

This section continue three parts, first the demographic profile which has participants' personal information. Following by obstacles of IoT, this section will analyse the participants' perspective regarding twelve factors of IoT obstacles. The third section evaluates potential benefits of IoT which evaluate their opinion of eighteen factors of IoT benefits.

4.1. Respondents' Demographic Profile

As stated previously, the paper collected 117 usable responses. The respondent characteristics demographics demonstrates that the majority of respondents were between 20 and 40 years old (n = 99, 84.6%), followed by those between 40 and 60 (n = 18, 15.4%) however, none of the response was above 60 years old, see Table 2. In addition, the sample included more women (n = 68, 58.1%) than men (n = 49, 41.9%) as shown in Table 3. The majority of them were Saudi (n = 108, 92.3%) while a very few numbers of participants were non-Saudi (n = 9, 7.7%), as shown in Table 4.

With respect to participant's occupation, as it seen from Table 5, the participants work at Taibah, Jeddah, Jizan, King Saud, Tabuk Universities. The majority of them from different Computer science, Cyber security, Information system, Information technology, and Data science.

Table 1. Five universities in different regions.

University	Number of lecturers	Region
Taibah University	54	western region
Jeddah University	46	western region
Jizan University	37	southern region
King Saud University	70	middle region
Tabuk University	38	northern region
Total	250	

Table 2. Age distribution.

Age	20 - 40	40 - 60	Over 60 yrs
SubTotal	99	18	0
Percentage	84.6%	15.4%	0

Table 3. Gender distribution.

Gender	N = 117	Percentage
Women	68	58.1%
Men	49	41.94%
Total	117	100%

Table 4. Nationality distribution.

Nationality	N = 117	%
Saudi	**108**	**92.3%**
None-Saudi	**9**	**7.7%**

Table 5. Occupation distribution.

University	n	Faculty and Major	n
Taibah University	38	computer science	60
Jeddah University	20	Information system	21
Jizan University	19	Information technology	15
King Saud University	15	Data science	12
Tabuk University	12	Cyber security	23

4.2. Factors of IoT Obstacles

4.2.1. Sensor's Factors

Participants in the study were asked to provide their opinion about whether the sensor is an obstacle of IoT use. Figure 1 demonstrates the largest population (over than 50) agreed that all factors of sensor, namely—availability, cost, communication units, computing units, services—influence the IoT difficulties. On the other hand, none of the users strongly disagreed with the role of sensor's factors in terms of IoT difficulty.

1) Availability Factor—Of the participants, about half of the participants 58 (49.6%) agreed that sensors' availability is considered one of the main IoT difficulty factors. 23 (19.7%) of participants strongly agreed regarding the effect of sensors' availability. 24 (20.5%) of them has neutral opinions and a very small number 11 (9.4%) of users do not agree that sensor's availability might increase the IoT difficulty as shown in Figure 1.

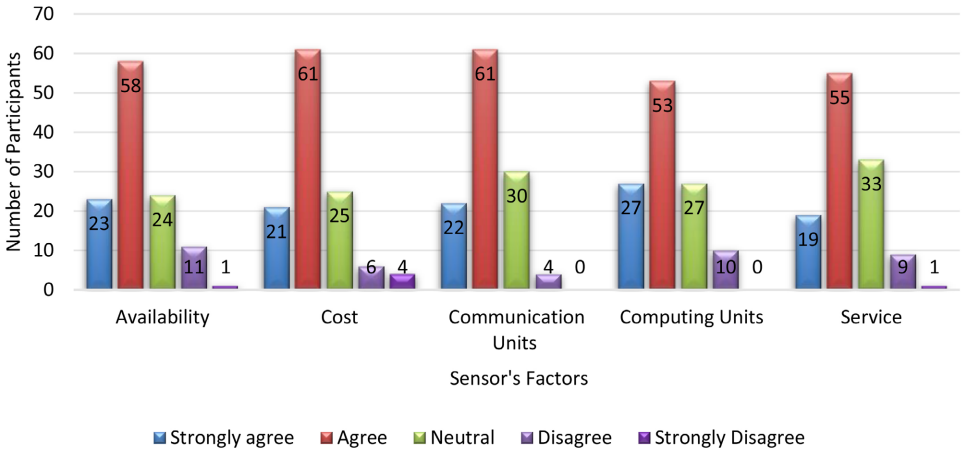


Figure 1. Sensor's factors.

2) Cost Factor—approximately 61 (52.1%) users agreed that both sensor's cost and communication units factors are considered the IoT difficulties as shown in Figure 1. A notable number of users 21 (17.9%) strongly believed sensor's cost is a difficulty of IoT use. However, around 6 (5.1%) of people do not agree and only 4 (3.4%) of population strongly don't think that sensor's cost factor might affect the IoT use.

3) Communication units Factor—Figure 1 demonstrates that 22 (18.8%) of participants strongly thought that this factor difficulty the IoT use while only 4 (3.4%) of participants don't believe that. Unexpectedly a quarter of participants 30 (25.6%) chose neutral perspective regarding the role of this factor in IoT difficulties.

4) Computing units Factor—around 53 (45.3%) of people had supportive perspective regarding that computing unit is a factor of IoT difficulties. Along with that, 27 (23.1%) of users strongly agreed that this factor is considered an IoT difficulty. Among participants, only 10 (8.5%) users believed that both computing units and service are not factors of IoT difficulties.

5) Service Factor—55 (47%) users thought that the service was a IoT difficulty. Also, 19 (16.2%) of participants strongly believed this factor as a difficulty. However, 33 (28.2%) of participants voted neutrally regarding this factor as an IoT difficulty, see Figure 1.

4.2.2. Security and Privacy Factors

The participants were also asked to provide their perspectives regarding the information privacy and the security level during access information, are considered issues of IoT use. See Table 6.

1) Data Privacy Factor—The result in Table 6, shows that about 29.1% reported they strongly agreed that the privacy factor might significantly influence the difficulty of IoT use. A large number 43.6% of them reported a similar positive attitude to this factor. 9.4% users disagreed that privacy is an IoT difficulty and with only 1.7% who strongly reported their negative attitude about both privacy and security factors.

Table 6. Data privacy and data security factors.

Factors	% of SA	% of AG	% of N	% of DG	% of SD
Data Privacy	29.1	43.6	16.2	9.4	1.7
Data Security	45.3	37.6	10.3	5.1	1.7

SA strongly agree, AG agree, N natural, DA disagree, SD strongly disagree.

2) Data Security Factor—Table 6 also illustrates that approximately 45.3% of people strongly confirmed that this factor affect the IoT use and is an IoT difficulty. Also, a reasonable number of participants (37.6%) agreed with the negative effect of this factor on IoT use. However, a very small number of them (5.1%) strongly don't believe security is an IoT difficulty. 16.2% and 10.3% respectively, had a neutral opinion regarding privacy and security factors of IoT difficulty.

4.2.3. Operating System Factor

The participants were required to say their opinions about the difficulties of using operating systems for the Internet of Things, see Figure 2.

Based on Figure 2, the majority of participants 51 confirmed that operating system is a factor causing issue regard IoT use. Furthermore, 19 of them strongly believed that this factor has a major role to increase the difficulty of IoT use. However, 13 users disagreed with the role of operating system as a difficulty of IoT use and only 3 of them strongly don't believe in this factor. It seems from Figure 2, that 31 participants don't agree nor disagree with the operating system factor as a difficulty of IoT use.

4.2.4. Programmer's Experience Factor

Figure 3 represents the different perspective of participants about the programmer's experience as an issue of IoT use. It's well known that IoT needs a very high experience programmer.

Figure 3 demonstrates a large number of participants 47.9% provided a positive attitude to the idea of programmer's experience forms a difficulty in IoT field, also around 20.5% of them reported their strongly believes of the same idea. While the other participants (17.1%, 11.1% and 3.40% respectively) have neutral, disagree, and strongly disagree opinions that programmer's experience is difficulty of IoT use because there is a high demand for high programmer experience.

4.2.5. Availability of Electricity Factor

Figure 4 shows the respondents' perspective in terms of whether the availability of electricity is an issue in the adoption of IoT in some sectors.

The results, as shown in Figure 4, indicates that the topmost percentage of participants 47 (40.2%) agreed the availability of electricity is a difficulty of IoT. Approximately 21 (17.9%) users strongly believed about the same opinion. Whilst around 22 (18.8%) said they don't believe, 3 (2.6%) strongly disagreed that this factor is considered a difficulty.

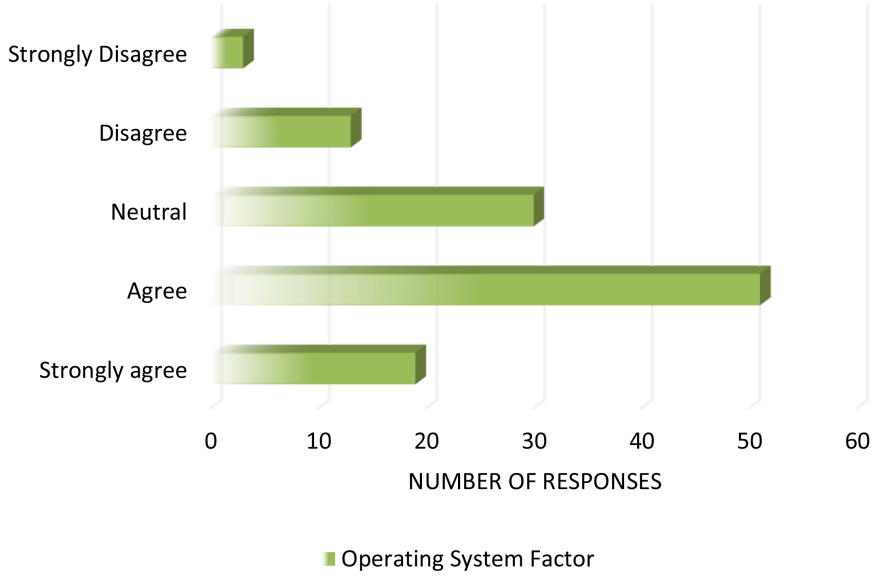


Figure 2. Operating system factor.

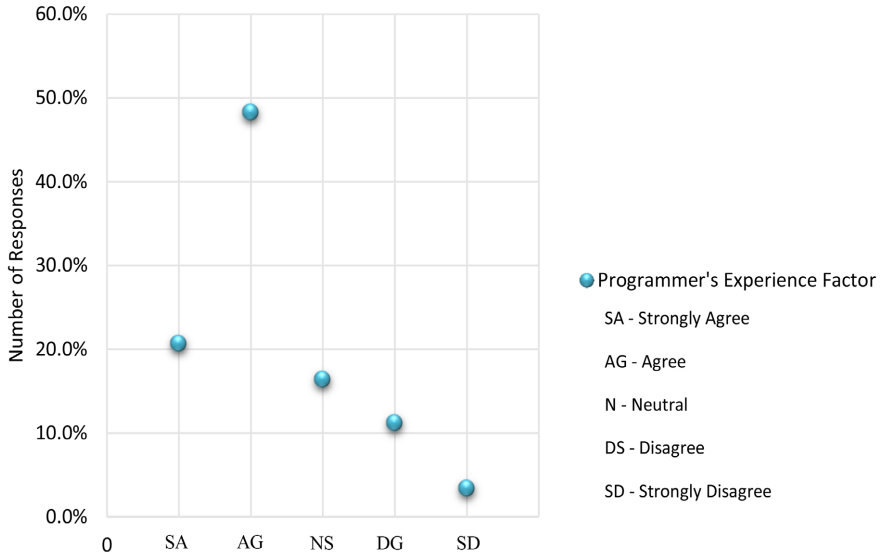


Figure 3. Programmer experience factor.

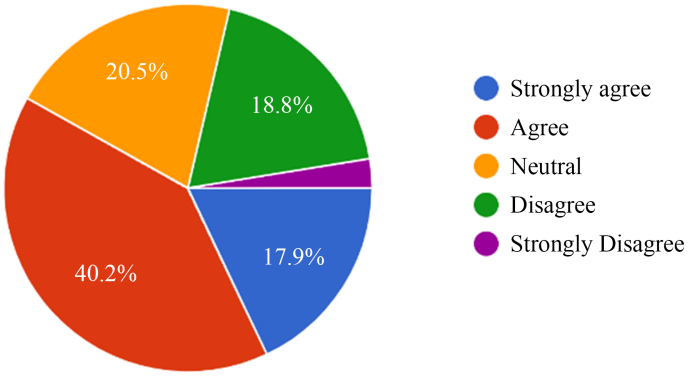


Figure 4. Availability of the electricity.

4.2.6. Transmit Data Factor

As it mentioned before that transmitting the data affect its quality and because of the noise. In this paper, the respondents were asked to report their opinion whither this factor is an issue of IoT, see Figure 5.

Figure 5 illustrates that a remarkable number of responses 46.2% believed on the transmit data factor affecting IoT use negatively which means it's causing the difficulty of IoT. 17.1% of them strongly emphasized their agreement on the role of this factor as an issue of IoT. However, around 12% of participants reported a contrary opinion to the previous one. Almost none of participants 0.9% reported their opinion as strongly disagreed about it.

4.2.7. Monitoring Factor

The participants were also required to report their perspective regarding the monitoring factor as difficulty of IoT, Figure 6 shows the result of this factor.

From Figure 6, a large number of responses (47.9%) confirmed their agreement on this factor. Besides that, a noticeable percentage (21.4%) strongly agreed while a very small number (12.8%) disagreed about the role of this factor. However, 17.9% of them have neutral opinion about monitoring factor is an IoT challenge, and none of all responses strongly disagreed about it.

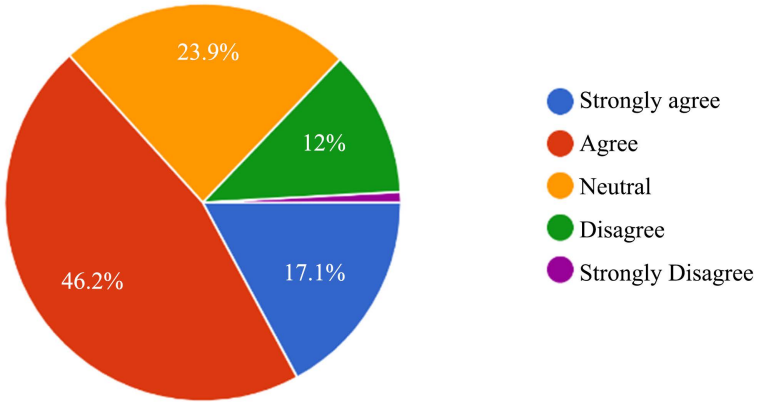


Figure 5. The transmit data factor.

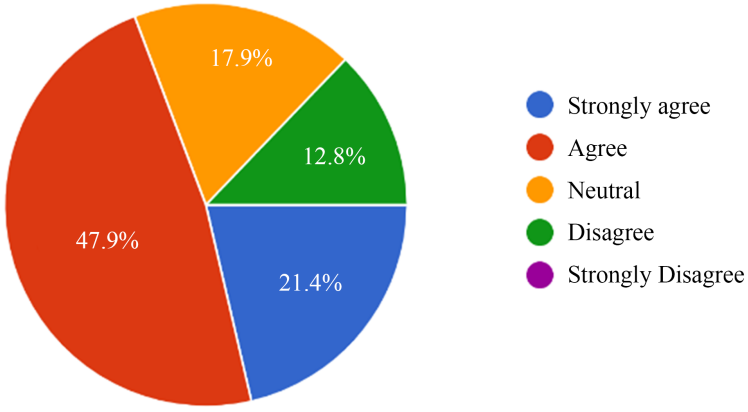


Figure 6. Monitoring factor.

4.3. Factors of IoT Benefits

This section includes the results of survey the participants' perspective about the factors are considered IoT benefits. The participants were asked to report their opinion about whether the given 18 factors increase positively the IoT use. Table 7 shows five factors with the corresponding percentages of participants' opinion.

4.3.1. Design Lower-Power Sensor Unit Factor DLSF

It seems from Table 7 that around (29.1%) of users agreed and (6.8%) strongly agreed this factor as a benefit of IoT comparing with a number of users (10.3) who disagreed and (12.8%) strongly disagreed with this factor.

4.3.2. Designing New Video Processing Factor DVPF

Approximately 30.8% users confirmed their agreement, 4.3% strongly believed that DVPF increase the possibility of IoT use while 13.7% reported their disagreement with it.

4.3.3. Encoding Algorithm Factor ECF

Out of 117 participants, 46 (39.3%) agreed that it is enhancing the IoT, 12.8% confirmed they strongly agreed about it whilst only 10.3% of them disagreed about it. 12% of participants reported they strongly don't believe these three factors DLSF, DVPF, and ECF are beneficial in IoT use, see Table 7.

4.3.4. Zero Touch Analysis Factor LZAF

As represented in Table 7, 33.3% of users believed LZAF is considered an advantage of IoT use and just under 20% of them said they strongly agreed about the role of this factor. Whereas a very small number (7.7% and 0.9%) of participants reported disagree and strongly disagree respectively about this factor.

4.3.5. Availability of Technology Factor ATF

More than one-third of them 42.7% thought this factor is an advantage of IoT, and around 35.9% users strongly believed that. While 5.1% disagree and 2.6% strongly disagree, which consider a very small number, see Table 7. However, 41%, 39.3%, 25.6%, and 38.5% of people have a neutral opinion that DLSF, DVPF, ECF, and LZAF respectively are advantages of IoT. It indicates that they are not widely understood the IoT factors.

Table 7. Five factors of IoT benefits.

Factors	% of Responses				
	SA	AG	N	DA	SD
Design lower-power senor unit Factor—DLSF	6.8	29.1	41	10.3	12.8
Designing a new video processing factor—DVPF	4.3	30.8	39.3	13.7	12
The encoding algorithm factor—ECF	12.8	39.3	25.6	10.3	12
Lead to zero touch analysis for management factor—LZAF	19.7	33.3	38.5	7.7	0.9
Availability of smart device factor—ATF	35.9	42.7	13.7	5.1	2.6

SA strongly agree, AG agree, N natural, DA disagree, SD strongly disagree.

The evaluation of the three factors shown in Figure 7, demonstrates that generally majority of participants reported their positive attitude towards these factors as advantages of IoT, which are generate data report, business income, and worker's productivity whereas non noticeable number of them had a negative attitude regarding these factors.

4.3.6. Generate Data Report Factor

It is shown in Figure 7 that almost half of participants 46.2% strongly confirmed generating data report is considered an advantage of IoT use, also, approximately 18.8% of them agreed the same point. However, out of all participants, only 3.4% strongly didn't believe the advantage of this factor in IoT field.

4.3.7. Business Income Factor

Large percentage of users 45.3% and around 20.5% strongly agreed and agreed respectively, that using IoT improves the business income while only 2.6% of them strongly disagreed with that, see Figure 7.

4.3.8. Worker's Productivity Factor

40.2% of participants strongly believed that IoT increases the productivity of worker which consider an advantage of IoT, almost a quarter of them agreed as well while only 1.7% strongly disagreed and 6.8% disagreed this factor is opportunity of IoT, see Figure 7.

There have been some neutral perspective with regard to three factors as advantages in IoT field. Approximately a quarter of participants had this opinion. As mentioned before, this indicates the participants are not widely aware of IoT factors.

Generally speaking, the majority of participants have a supportive perspective towards the four factors as advantages of IoT, namely, reducing human error, operating cost, errors of delivering, and need for physical security as it shown in Figure 8.

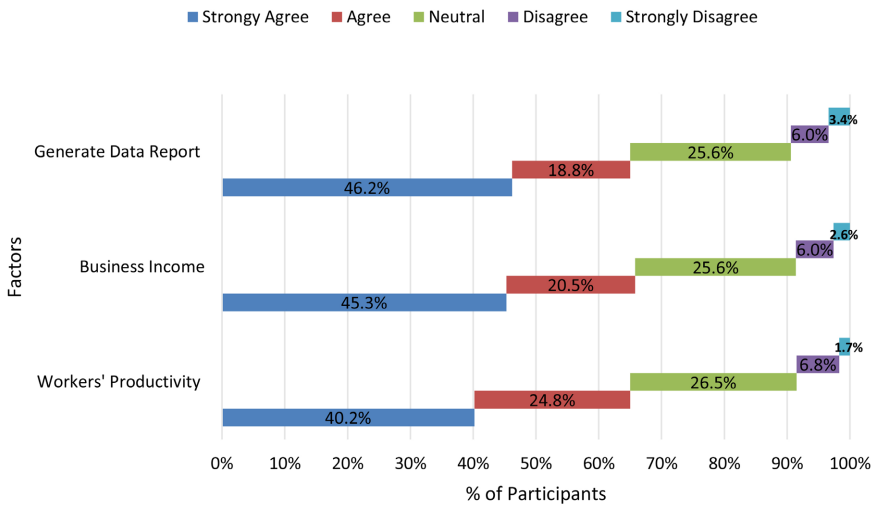
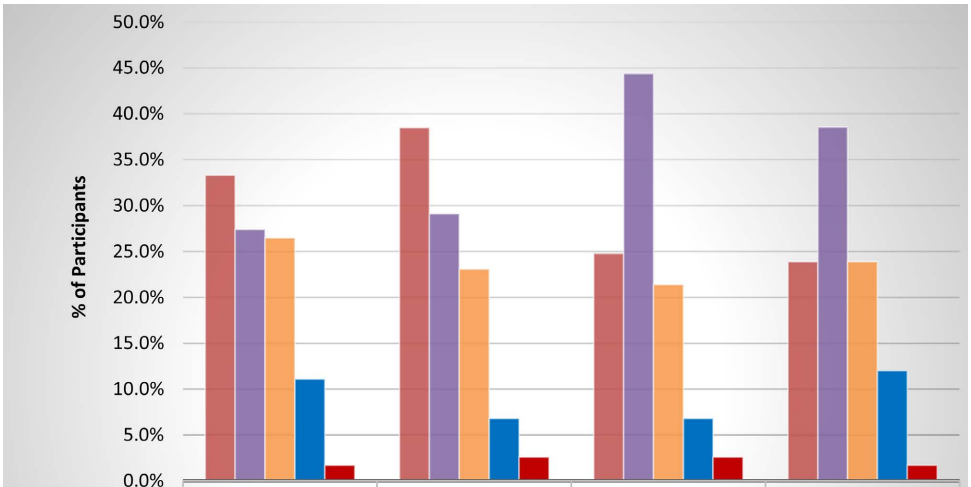


Figure 7. Three factors of IoT benefits.



	Human Errors	Operating Cost	Errors of Delivering	Need for Physical Security
Strongy Agree	33.3%	38.5%	24.8%	23.9%
Agree	27.4%	29.1%	44.4%	38.5%
Neutral	26.5%	23.1%	21.4%	23.9%
Disagree	11.1%	6.8%	6.8%	12.0%
Strongly Disagree	1.7%	2.6%	2.6%	1.7%

Figure 8. Factors of IoT opportunities.

4.3.9. Human Errors Factor

27.4% of participants thought that reducing huma error is an advantage of using IoT, 33.3% of them strongly agreed with the same opinion. On other hand, a very small number 11.1% voted negatively regarding this factor and 1.7% strongly disagreed about it, see **Figure 8**.

4.3.10. Operating Cost Factor

A reasonable number of users 38.5 strongly agreed that using IoT reduce the operating cost which means it is considered an advantage. In addition, nearly a third of them 29.1% confirmed their agreement perspective to this factor.

4.3.11. Errors of Delivering Factor

Just under a quarter of people 24.8% reported that reducing delivery errors is an advantage of using IoT. There is a remarkable number of participants 44.4%, who reported their strong agreement of this factor as shown in **Figure 8**.

6.8% of people disagreed that both reducing operating cost and reducing errors of delivering are not advantages of IoT use. Furthermore, only 2.6% of them strongly disagreed about it. See **Figure 8**.

4.3.12. Need for Physical Security

38.5% of participants reported that they strongly agreed that reducing the need for physical security is an advantage of IoT. Also, 23.9% of them agreed about it while 12% and only 1.7% respectively disagreed and strongly disagreed with it. Approximately, a quarter of users reported their neutral opinion regarding whether these four factors are advantages of IoT.

As generally represented from Table 8, there was a significant positive perspective with regard to the following three factors, which are enhance the quality of life, monitor, and control the electricity devices. On other hand, a small minority of them indicated an opposite opinion and didn't believe these four factors are advantages of IoT.

4.3.13. Enhance the Quality-of-Life Factor

38.5% of subjects replied on this survey that enhancing life's quality is considered an advantage of the IoT. Besides that, 36.8% of them replied they strongly agreed with the same opinion whilst very few participants 4.3% reported their disagreement about this factor. Nearly, 19% of users reported a neutral opinion about this factor. See Table 8.

4.3.14. Monitor the Electricity Devices Factor

Just over 40% of participants indicated their supportive perspective regarding monitoring the electricity devices is an advantage of using IoT whereas 21.4% of them strongly emphasized this opinion. However, 7.7% users replied with a negative perspective about considering this factor an advantage of IoT. A very small number 1.7% strongly don't believe both enhance the quality-of-life and monitor the electricity devices Factors are advantages of IoT.

4.3.15. Control the Electricity Devices Factor

Large number of subjects 46% and 20.5% agreed and strongly agreed respectively that this factor is advantage of IoT. Comparing that with the minority of subjects who reported a negative opinion 2.6% and none of them voted strongly disagree about it as shown in Table 8.

Interestingly, 28.2% and 30.8% voted a neutral opinion in regards with both factors which are Monitor the electricity devices Factor and Control the electricity devices Factor.

Its seen from Figure 9, the overall response to three factors (namely, build smart cities, enhance transportation, improve industry) was quite positive. The majority of responses positively reported with regards to the role of these factors as advantages of IoT use whereas a tiny number of responses had a negative opinion about these factors.

4.3.16. Build Smart Cities Factor

Over half percent of subjects strongly confirmed that building smart cities is a

Table 8. Quality life, monitor and control electricity devices factors.

Factors	% of Participants				
	SA	AG	N	DA	SD
Enhance the quality of life	36.8%	38.5%	18.8%	4.3%	1.7%
Monitor the electricity devices	21.4%	41%	28.2%	7.7%	1.7%
Control the electricity devices	20.5%	46.2%	30.8%	2.6%	0

SA: Strongly Agree, AG: Agree, N: Natural, DA: Disagree, SD: Strongly Disagree.

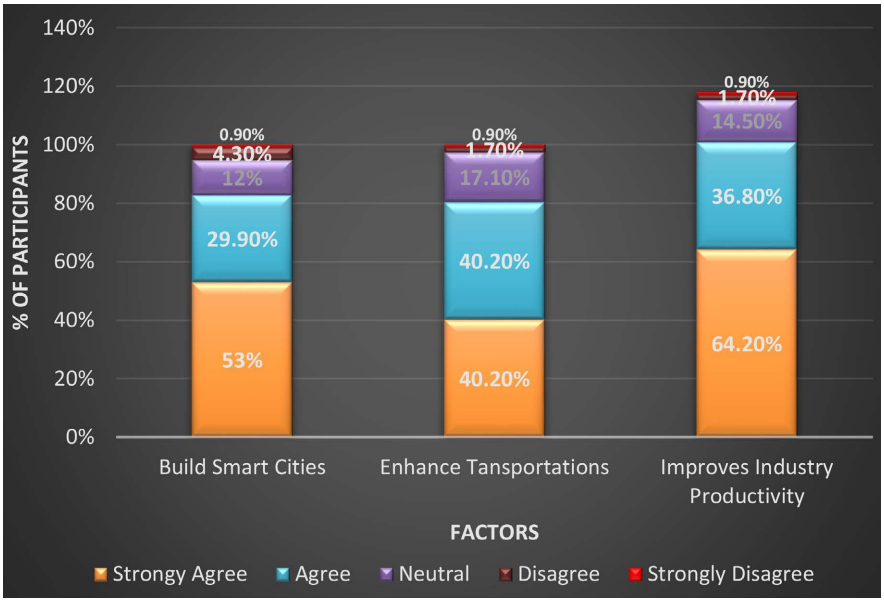


Figure 9. Smart cities, transportation, and industry productivity factors.

benefit of IoT. 29.9% of participants agreed with the same opinion whilst a very few percents 4.3% disagreed with it as it seen in **Figure 9**.

4.3.17. Enhance Transportations Factor

40.20% of participants believed this factor is an advantage of IoT, a similar percentage reported they strongly agreed about. However, just over 17% users provided a neutral vote regarding this factor.

4.3.18. Improve Industry Productivity Factor

Approximately two-thirds of participants 64.2% indicated they strongly believed that IoT usually increase industry productivity. 36.8% of them also agreed about it while a very small number of them 1.7% reported their disagreement about it. 14.5% and 12% of them had neutral opinion regarding industry productivity and smart cities are opportunities of IoT. A tiny number of them 0.9% strongly disagreed that these factors are considered benefits of IoT use, see **Figure 9**.

The results of this investigation demonstrated the various participants'' perspectives and the difference level of their knowledge regards the obstacles and potential benefits related to applying IoT in various sectors. Even though the majority of responses reported their agreement the highlighted obstacles affecting negatively the IoT use which support other studied [18] [20] [22], third of responses had a natural opinion about three factors of IoT obstacles, namely sensor's communication units, sensor's services, and operation system. This result indicates the lack of IoT knowledge and factors affecting it between lecturers. This is a big indicator to high demand for conducting more studies in this field.

As for the examined potential benefits of IoT, it seems from the result that remarkable number of responses agreed regards most of factors as potential benefits in the IoT field which will enhance people's awareness. This result is con-

sistent with the result of other previous studies [20] [24] [28] [32].

However, Of the 117 subjects who took part in the survey, 30% to 40% of them were unsure about the four advantages of IoT which are Design lower-power senor unit, designing a new video processing, zero touch analysis for management and control the electricity devices. As mentioned before, its indicate the absence of IoT knowledge among users which means there is a huge need to improve the people awareness of IoT.

5. Conclusion

It's obviously seen that the number of devices connected to the internet has grown. This has increased the way that M2M change people's lives. IoT has become a reality and a good number of studies have been exploring this concept. That is because the Internet of Things is considered a great area for invention. Although it's known that IoT has potential benefits which are reflected obviously in academic staff's lives, there are still a few obstacles that need to be addressed. This paper explored and discussed the concept of IoT and highlighted eighteen factors that affect IoT advantages such as the productivity of employees and number of the obstacles of using IoT in Saudi such as cost of sensors' deployment.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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