Case study

Deployment Internet of Things by Telecom Operators in Developing Countries (Case Study Telecom Operators in Yemen)

ABSTRACT

Internet of Things (IoT) plays a vital role in life and enters all areas. The researchers see that the offer IoT services by telecom operators better than others, especially in developing countries. Where the concern of the community related to security issues the most prominent obstacles. This paper attempts to address a future vision of IoT services in developing countries by telecom operators. The primary object of this paper is to identify the possible opportunities and obstacles for telecom operators to offer these services. In addition, the paper presented a case study for telecom operators in Yemen, where this paper's field survey focused on MTN and Yemen Mobile operators in Yemen. We applied the samples of the study to 73 engineers, and using SPSS to analyze data. The results showed that (91.35%) from MTN's respondents and (81.14%) from Yemen Mobile's respondents agree that offer IoT services by the operator create new opportunities for profit. Results also presented services that can be provided by each operator, which are eleven services can be by MTN and seven services by Yemen Mobile.

Keywords: Internet of Things (IoT), Telecom IoT, Developing Countries, Opportunities, Obstacles, Telecom Operators.

1. INTRODUCTION (ARIAL, BOLD, 11 FONT, LEFT ALIGNED, CAPS)

The IoT is a substantial component of the future Internet [1,2]. The IoT enables physical objects to think, hear, see, and perform jobs by having them “talk” together, to share information and to coordinate decisions [3]. The IoT basic architecture divided into three basic layers [4,5,6,7] as shown in Figure 1, (I) Perception Layer: the main objectives of this layer are to connect things into IoT network, measure, collect and process the state information associated with these things via deployed smart devices (RFID, sensors, actuators, etc.). Then transmitting the processed data into the upper layer, (ii) Network Layer, also known as the transmission Layer. This layer uses to receive processed information provided by perception layer. Then determines the routes to transfer the data to the IoT hub, devices, and applications via integrated networks. Also, uses various communication technologies such as Bluetooth,

WiFi, cellular, etc. and (iii) Application Layer, (the top layer in IoT architecture) [3]. Receives the data transmitted from the network layer. Then uses the data to offer the required services or operations. Many applications exist in this layer, each having different requirements.
Cellular communications play a vital role in IoT because it works as a network layer in IoT [8]. In this context, many efforts have been made to enable IoT solutions by telecom operators. From these efforts Release 13 by 3rd Generation Partnership Project (3GPP). Release 13 includes IoT solutions within the licensed spectrum (Extended Coverage GSM for IoT (EC-GSM-IoT), Long Term Evolution Machine Type Communications (LTE-M) and Narrowband IoT (NB-IoT) [9,10].

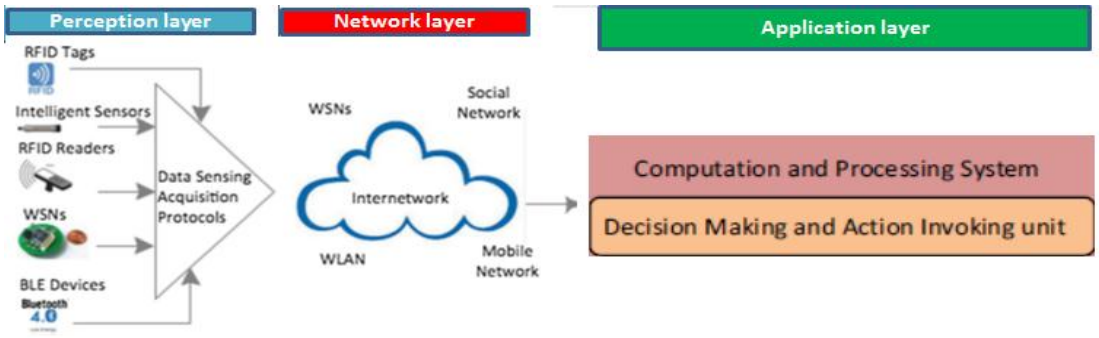

Figure 1 General Three Basic Layer

In Yemen, there are four operators, namely, MTN, SabaFon, Y and Yemen Mobile. The first of these companies was established in 2000 and the latest in 2007 [11,12,13]. Their coverage extends across Yemen and has a subscriber base estimated at millions.
This paper will look for operators' success to offer IoT services in developing countries. The rest of the paper organized as follows. Section 2, the theoretical background for IoT services delivery by the operators. Section 3, defines opportunities for the success of telecom IoT in developing countries. Section 4, describes obstacles of telecom IoT in developing countries. Section 5 and Section 6, details the methodology, analysis and results respectively to study a case for telecom operators in Yemen. Finally, the paper summarizes the conclusion.

2. BACKGROUND

IoT transforms objects from traditional things to smart things by exploiting its underlying technologies such as ubiquitous and pervasive computing, embedded devices, communication technologies, sensor networks, Internet protocols and applications [3]. The several phases of development of IoT [14], shows in Figure 2. The IoT initiated by use RFID (Radio-Frequency Identification) technology, which is used in logistics increasingly, pharmaceutical production, retail, and diverse industries [15,16].
Also, a number of technologies involved in IoT, such as NFC (Near Field Communication), ZigBee, WSN (Wireless sensor network), DSL (Digital Subscriber Line), WLAN (wireless local area network), WiMax (Worldwide Interoperability for Microwave Access), GSM (Global System for Mobile communication), GPRS (General Packet Radio Service), UMTS (Universal Mobile Telecommunications System), LTE (Long-Term Evolution),and so on [17,18,19,20,21,22].
The evaluations of these technologies bring new technologies to IoT [23,24]. Figure 3 describes the relationship between IoT and other existing networks [25]. This paper focuses on a mobile communication network, the 2G and 3G systems have been the backbone to

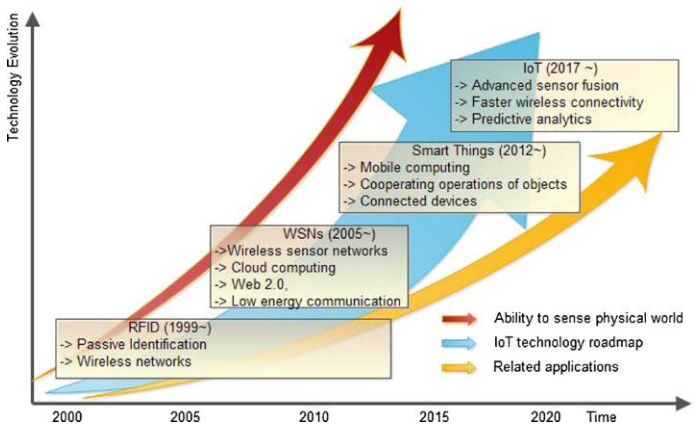

Figure 2 Evolution of the IoT

enable IoT features [26]. LTE is a standard wireless communication for high-speed data transfer between mobile phones based on GSM/UMTS network technologies [27]. This cellular 2G/3G/4G solution can provide wide-area coverage, and this tends to be at the cost of short battery life to the devices [26].

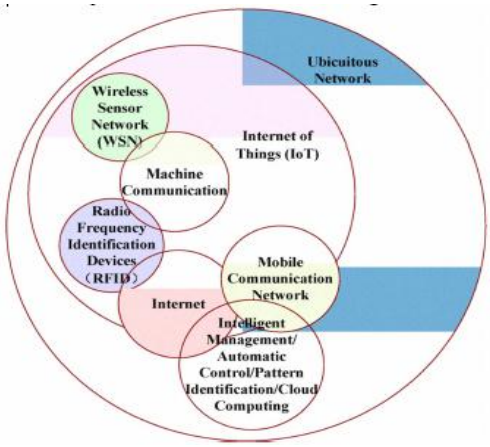

Figure 3 The Relationship Between IoT and existing networks

There are many advantages to offer IoT solutions by telecom. They already provide comprehensive coverage around the world in mature markets, so far covers 90 percent of the total population [9]. These networks have a robust identity mechanism and a vast mature ecosystem that can be successfully reused to offer IoT services to both organizations and individuals. Also, the scalability feature provides greater flexibility to handle a large amount of data traffic. Also, because traffic in most IoT applications is relatively small, it can be easily absorbed from the start-up phase and grows at low ownership cost and limited additional effort [28]. Traditional mobile network environments designed as a secure and reliable ecosystem [29]. In addition the QoS [30] that achieving by this network. The IoT also benefits from the vast customer base and billing mechanisms.

IoT must be integrated with telecom in the right way to achieve new opportunities for profit. There are several strategies to offer IoT solutions by operators mentioned in [31,32,33,34]. In Figure 4 the researchers summed these strategies.

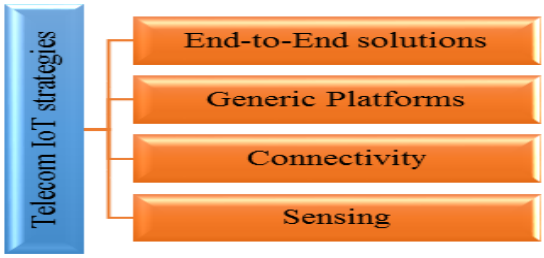

Figure 4 IoT strategies for Telecom

At the End to End strategy, the operator can provide all components of IoT solution including sensors, connectivity, middleware, analytics, applications, as well as support and billing, such as Healthcare application [35]. The researchers believe that the (Vertical-Specific Platform) strategy mentioned in the previous references can be considered as a particular case of End to End solutions, as it provides solutions for use cases designed for a specific vertical market. The Generic Platform strategy is provisioning a hosting environment for applications, which meet the requirements of the IoT of storing, processing, managing and sharing data in multiple sectors [31]. Connectivity is the foundation of all IoT solutions, where telecom operators provide high quality, economical and reliable communications package. The last strategy is Sensing, where data sold and purchased as an option to enable IoT solutions by operators [33,34].

To meet the requirements of IoT segment. 3GPP in Release13 introduced particular standards from LPWA technologies to allow IoT solutions in the licensed spectrum [36,37]. These standards are:

- EC-GSM-IoT improves GSM Evolution (EDGE) networks to offer IoT solutions by upgrading software without having to reserve dedicated IoT resources [38].
- LTE-M offers on LTE-type communications (MTC) improvements that allowing a longer battery life [39].
- NB has a great performance with GSM, GPRS, and LTE [40], improved internal and external coverage in legacy networks, and low power performance [41]. NB-IoT has three modes [26] Stand-alone, NB-IoT deploys in the idle GSM spectrum resources. In-band, current LTE carrier shares the time resource with NB-IoT. Guard-band, NB-IoT deploys inside the unused resource in LTE carrier's guard-band.

In this context, GSMA Low Power Use Case (LPUC) project group [38] offers 23 use cases that suitable for LPWA Applications. These use cases have several characteristics and are summarized by the researchers in Table 1, which presents the use cases in fixed or concentrated places, and Table 2, which is shown the use cases mobile in a wide area.

3. THE OPPORTUNITIES FOR DEVELOPING COUNTRIES TO OFFER IT SERVICES BY TELECOM OPERATORS

The success to offer IoT services by telecom operators because of the many advantages provided by telecom to the IoT in developing countries. This is what will be addressed in this section.

3.1. ACCEPTABILITY

The acceptance of society one of the most critical obstacles to offer any new services especially IoT services [42]. The acceptance problem increase in developing communities such as Yemen, where offer new services by a new provider more difficult than offer new

Table 1 the Stationary LPWA Applications

Application	Power	Coverage Propagation
Smoke Detector-Home/ Enterprise	Owns Batteries	Further from Network Infrastructure
Industrial- Tank Process/ Safety Monitoring	No Mains Power	Further from Network Infrastructure
City – Parking	No Mains Power	Further from Network Infrastructure
Building Automation- Alarms, Actuators	Owns Batteries	Further from Network Infrastructure
City - Waste Management	No Mains Power	Further from Network Infrastructure
Microgeneration	Mains Power	Needed for Some Devices
Industrial - Asset Tracking	No Mains Power	Needed for Some Devices
Home Automation, Ex Garage, Doors	Owns Batteries	Further from Network Infrastructure
Environmental Monitoring: Data Collection	No Mains Power	GSM Coverage is Sufficient
Consumer -White Goods, Ex Refrigerators, Washing Machines	Mains Power	Needed for Some Devices
Vending Machines - General	Mains Power	Needed for Some Devices
Vending Machine - Privacy/ Data Verification	Mains Power	Needed for Some Devices

Table 2 the Mobility LPWA Applications

Application	Power	Coverage Propagation
Consumer-VIP/PET Tracking	No Mains Power	GSM Coverage is Sufficient
Agriculture - Stationary Tracking/ Monitoring	No Mains Power	Further from Network Infrastructure
Consumer-Smart Bicycle	No Mains Power	GSM Coverage is Sufficient
Consumer – Wearables	Owns Power	GSM Coverage is Sufficient
Assisted Living/ Medical	Owns Batteries	Needed for Some Devices
Smart Grid	Mains Power	Further from Network Infrastructure
Agriculture- Live-Stock Tracking	No Mains Power	Further from Network Infrastructure
City – Lighting	Mains Power	GSM Coverage is Sufficient
Environmental- Near Real-Time Monitoring	No Mains Power	GSM Coverage is Sufficient
Water/Gas Metering	No Mains Power	Further from Network Infrastructure
Propane Tank Monitoring	No Mains Power	Further from Network Infrastructure

services by a well-known, reliable and experienced provider of an extended period.
Telecom networks designed by a set of user requirements that meet the quality of service (QoS) [9]. IoT services by telecom will be based on the same QoS requirements previously identified by the users. Also, the telecom systems designed as high levels of security according to the GSMA mobile security rules [29].

3.2. COMPREHENSIVE REACH

Telecom widespread in developing countries for long years, and covers a large part of these countries. Also has a consumers' base estimated at millions. Therefore, offer IoT services by the telecom will be more comfortable, and will reach the most number of people where rang of coverage. Also, the applications delivery mechanisms implemented by the operators, makes the telecom ecosystem is attractive to the specific IoT use cases [29].
Additionally, in telecom, IoT services do not need access to the Internet via IP addresses but will be possible access by telecom's core networks. Like in Yemen, Yemen Tracking Company with Yemen Mobile operator, where the Yemen Tracking using Yemen Mobile's core network and its SIM card to offer the tracing services.

3.3. ECOSYSTEM

Operators have invested millions of dollars in current infrastructures, including hardware, network equipment, device, application providers and others. Therefore, when IoT services offer by these infrastructures, operating expenses (OPEX) and the capital expenses (CAPEX) will be decreased over the network operators and thus over end users [9].
Also, the use of 3GPP standards to offer these services avoids the cost of new licenses, which estimated in millions. This reflected positively in the final price of subscribers. Also, scalability one of the essential features of telecom, that helps to speed and flexibility respond IoT service requirements, which are developing rapidly.

3.4. THE MATURITY

The operators' maturity one of the most significant opportunities to offer IoT services by telecom in developing countries [29]. The operators have accumulated many experiences over the years, in transmitting information in a safe and reliable method, building and operating networks, maintaining user privacy, sales and billing mechanisms, environment analysis that useful for deployment of sensors. In addition to experience in applications and integration between them.

4. THE OBSTACLES TO OFFER IT SERVICES BY TELECOM OPERATORS IN DEVELOPING COUNTRIES

This section highlights the main obstacles to offer IoT services by telecom operators in developing countries.

4.1. TECHNICAL OBSTACLE

Internet connection significant obstacle when we want to enable IoT. The IoT requires a fast connection and a reliable and scalable infrastructure, such as in Yemen where the internet provider still using IPv4 and uses NAT technology to overcome the lack of addresses [42]. Although telecom networks spread almost all over developing countries, and it easy to provide IoT services through these networks, but other types of problems related to internet speed. Also, in developing countries such as Yemen, operators are still using 2G and 3G networks with a low data rate.

Another obstacle related to development and integration IoT applications with the operator's applications without creating any security gaps. Furthermore, in developing countries, investment in technology and software development still low. Also, the technical knowledge lack for staff (Engineers and technicians) in the operator. IoT is a modern term, and the integration of IoT with the usual operator services requires educated technical personnel. Furthermore, developing countries deficient a number of research centers, funding and investment for innovation are low [43].

4.2. ADMINISTRATIVE OBSTACLES

Administrative systems in developing countries often aren't integrated. This is an obstacle to the integration of any new services such as IoT.
The unawareness' the decision makers (in operators) of the importance of the transition to the IoT is also a significant obstacle. In addition the routine procedures and traditional administrative systems, which lack the flexible development plans, necessary to accommodate all new technologies and create different opportunities for profit.

4.3. FINANCIAL OBSTACLE

Although offering IoT services by the operator is cheaper than by offering these services a new provider, the purchasing ability of the consumer one of the financial obstacles. Especially that the prices of sensors and provide the internet at a reasonable price may contribute to raising the price of final service to the consumer.

4.4. SOCIAL OBSTACLE

The awareness in the developing countries society one of the most critical obstacles to offer new services. The level of technology usage in these countries is low. Therefore, the demand for IoT services matter of concern for the operators. Also, consumers' concern about security and privacy.

5. METHODOLOGY

This paper presents a case study for telecom operators in Yemen, especially Yemen Mobile and MTN operators. Data of this study collected through two steps. The first step, personal interviews with engineers (branch managers, network managers, and other engineers).The second step, a questionnaire distributed to the engineers of these operators. We deduce the range of factors affecting the choice of services. Thus identify the services that can offer by their infrastructure.

5.1. ANALYSIS INFRASTRUCTURES' YEMEN MOBILE AND MTN

In Yemen, there are four operators, MTN, SabaFon, Y and Yemen Mobile. The first of these companies established in 2000 and the latest in 2007 [11,12,13]. Their coverage extends across Yemen and has a subscriber base of millions. Yemen Mobile works using CDMA (Code Division Multiple Access) technologies, while the rest of the operators using GSM networks. This paper will focus both Yemen Mobile as a 3G operator and MTN as an example of 2G networks.
Yemen Mobile executes by 3G technology that has a better chance to offer IoT services. MTN works by 2.75 EDGE technology, especially in the main cities. Since few years Yemen Mobile and MTN want to upgrade to 4G, but there are various obstacles related to community awareness and pricing of licenses, and finally political and economic instability.
Therefore, these operators want to evolute into 4G rather than offer new services such as IoT services. Also, operators now suffer overloading the network and focused to develop

performance only, especially in light of the deteriorating security situation and difficult to supply and install the equipment. They focus to offer efficient regular services rather offer new services. Furthermore, Yemen Mobile and MTN agreed on the following points:

1 Don't mind investing in any level and according to any strategy if the gain is sure.
2 In the event to offer IoT services, Yemen Mobile initially preferred to use time-sharing techniques between IoT services and regular services. Then they move to the allocation of channels for IoT services.
3 They prefer to offer IoT services through a third party so that operators focus to offer main services (such as connectivity and platform) with high efficiency, and not concerned with other administrative matters such as new department, application developers, guards and other administrative issues.
4 Nowadays in Yemen Internet using the IPv4. The providers use NAT as a solution to IPv4 shortage. NAT mechanisms limit the direct accessibility to IoT devices as well as can break specific applications, or make these applications more challenging to run where IoT requires many new sensors with new unique IP-addresses, so the transition to the IPv6 is essential.

5.2. THE SURVEY METHODOLOGY

The descriptive analysis was used to analyse the data of this study. The data was gathered through a survey and was quantitatively analyzed using the Statistical Package for the Social Sciences (SPSS) software. The five-point Likert- type scales were used to measure the respondent's degree of agreement or disagreement with each statement (Strongly Disagree=1, Disagree=2, Neutral =3, Agree=4, and Strongly Agree=5). The survey was conducted in the Arabic language, but the analysis in English.

5.3.1. The questionnaire objectives

The objectives of this questionnaire are:

1 Define the main obstacles to offer IoT services by operators.
2 Determine the best strategy for delivering IoT services by each operator.
3 Define the main characteristics of IoT services, which are preferred by each operator.

5.3.2. Questionnaire Design

The questionnaire first included the demographics data for the study, used for determining the operator, age, the experience, and specialization. The questionnaire paragraphs divided into three axes, each one use to achieve one of the questionnaire's objectives of the mentioned in paragraph 5.3.1 (obstacles, strategies, services).

5.3.3. The Community and the Sample

The target Sample was engineers from Yemen Mobile and MTN operators. The number of questionnaires was 73, distributed 36 questionnaires in Yemen Mobile operator, as well as 37 questionnaires in MTN operator.

5.3.4. Reliability

The reliability test means there are no errors in the measurements [44]. We use Cronbach's alpha measurement to measure reliability. The resulting values must meet accepted standards that starting at 0.70 [45]. Table 3 shows reliability statistics that provides the actual value of Alpha Cronbach for each sample (Yemen Mobile and MTN).

It is clear from the results shown in Table 3, the value of the Alpha Cronbach coefficient was (0.813 and 0.790) for MTN and Yemen Mobile respectively, so the researchers have verified the validity and consistency of the questionnaire.

Table 3 Reliability Statistics

Operator	Cronbach's Alpha	N of Items
MTN	0.813	25
Yemen Mobile	0.790	25

6. DATA ANALYSIS AND RESULTS

In this section, the survey data will be analyzed using SPSS software.

6.1. DESCRIPTION OF SAMPLES

Aims to provide the characteristics and descriptive statistics of the personal data for respondents to the questionnaire. As shown in Table 4, clear that the majority of respondents age range (31- 40) with the percentage of (75.7%) for MTN engineers, and (65.7%) for Yemen Mobile engineers.

Table 4 Demographical Data Analysis

Study Variables	Classification	MTN		Yemen Mobile	
		Freq	%	Freq	%
Age Group	20-30	6	16.2%	6	17.1%
	31-40	28	75.7%	23	65.7%
	41-50	3	8.1%	6	17.1%
Level of Learning	Bachelor	29	78.4%	30	85.7%
	Masters	8	21.6%	5	14.3%
Years of Experience	< 5	4	10.8%	10	28.6%
	5-10	14	37.8%	10	28.6%
	> 10	19	51.4%	15	42.9%
Specialization	Communications	34	91.9%	26	70.3%
	CS	2	5.4%	5	13.5%
	IS	0	0%	1	2.7%
	IT	1	2.7%	5	13.5%

Regarding the Level of Learning, (78.4%) of MTN engineers have a Bachelor degree, (21.6%) have a Masters. As well as for (85.7%) of Yemen Mobile engineers have a Bachelor degree, (14.3%) have a Masters.

Regarding the experience's years, the majority of respondents (42.9%) of Yemen Mobile engineers, and (51.4%) of MTN engineers had experience above 10. Also, the (91.9%) of the respondents from MTN and (70.3%) of the respondents from Yemen Mobile are communications engineers.

6.2. DESCRIPTIVE STATISTICAL ANALYSIS

6.2.1. Results of the First Axis

Table 5 and Table 6 show the main obstacles to offer IoT services by operators. Obstacles (O1, O3 and O4) respectively achieved the highest approval rate was achieved in both operators. The operators agreed that provision IoT services offer new opportunities for profit (O1), reflecting the engineers' awareness of the benefits to offering IoT services, with a percentage of (57.095%) in MTN and (50.714%) Yemen Mobile.

Table 5 Results of MTN Questionnaire on the First Axis

Rank	Q. No	Statement Text	Mean	Std. Dev	Mean%	Recog
1	O1	Provision IoT services by the operator offer new opportunities for profit	4.568	.5022	91.351%	Strongly Agree
2	O3	Community awareness of IoT benefits is an obstacle to the deployment of its services by the operator.	4.054	1.0527	81.081%	Agree
3	O4	The operator's internet package is an obstacle to offer IoT service.	3.919	1.2333	78.378%	Agree
4	O6	Integrating normal operator services with IoT services is one of the obstacles to providing IoT services by the operator	3.405	1.0661	68.108%	Agree
5	O7	one obstacle to the implementation of IoT services by an operator is the cost of deploying sensors	3.243	1.0112	64.865%	Neutral
6	O8	One of the obstacles to implementing (IoT) services by the operator is to deploy sensors	3.216	.9757	64.324%	Neutral
7	O5	The difficulty of providing IoT Applications is one of the obstacles to providing its services.	2.973	1.2357	59.459%	Neutral
8	O2	The operator has the plan to offer (IoT) services in the coming period	2.892	1.0745	57.838%	Neutral

Table 6 Results of Yemen Mobile Questionnaire on the First Axis

Rank	Q. No	Statement Text	Mean	Std. Dev	Mean%	Recog
1	O1	Provision IoT services by the operator offer new opportunities for profit	4.057	.6835	81.143%	Agree
2	O3	Community awareness of IoT benefits is an obstacle to the deployment of its services by the operator.	3.714	1.1000	74.286%	Agree
3	O4	The operator's internet package is an obstacle to offer IoT service.	3.543	.8168	70.857%	Agree
4	O7	one obstacle to the implementation of IoT services by an operator is the cost of deploying sensors	3.457	.9805	69.143%	Agree
5	O8	One of the obstacles to implementing (IoT) services by the operator is to deploy sensors	3.114	.9322	62.286%	Neutral
6	O6	Integrating normal operator services with IoT services is one of the obstacles to providing IoT services by the operator	3.114	.9000	62.286%	Neutral
7	O2	The operator has the plan to offer (IoT) services in the coming period	2.829	.8907	56.571%	Neutral
8	O5	The difficulty of providing IoT Applications is one of the obstacles to providing its services.	2.800	1.0233	56%	Neutral

They also agreed that community awareness of IoT benefits an obstacle to offer its services by (50.676%) in MTN and (46.429%) in Yemen Mobile. Both operators considered the Internet package an obstacle to offer IoT service by (48.986%) in MTN and (44.286%) by Yemen Mobile.
MTN engineers said the integration of regular operator services with IoT services one of the obstacles to offer IoT services by percentage (42.568%). As for Yemen Mobile engineers, the cost of deploying sensors one of the obstacles to offer IoT services by percentage (43.214%). As for the rest of the phrases, the operators' engineers agreed don't know that they were obstacles or not (neutral). The obstacles to offer IoT services by operators were ordered according to as illustrated in Figure 6 and Figure 7.

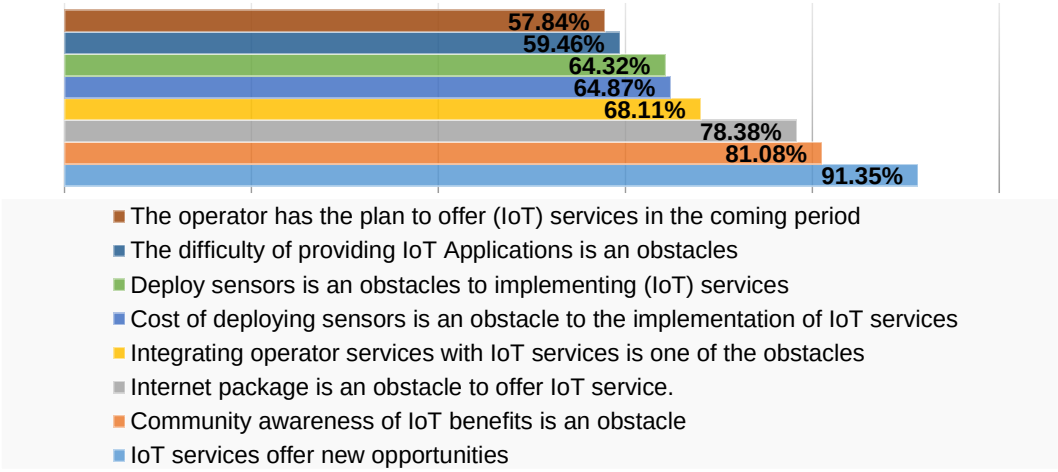

Figure 6 Ordering Obstacles Either Offer IoT Services by MTN

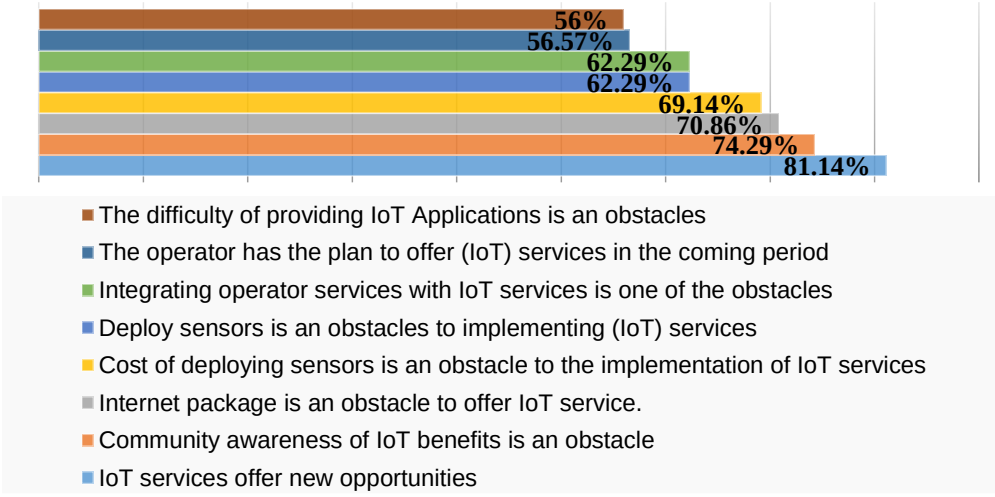

Figure 7 Ordering Obstacles Either Offer IoT Services by Yemen Mobile

6.2.2. Results of the Second Axis

Table 7 and Table 8 show the strategy for delivering IoT services by each operator.

Table 7 Results of MTN Questionnaire on the Second Axis

Rank	Q. No	Statement Text	Mean	Std. Dev	Mean%	Recog
1	T1	The operator prefers to provide (Connectivity) strategy	3.865	.7514	77.297%	Agree
	T3	The operator can only provide (Connectivity) strategy in major cities	3.432	1.0149	68.648%	Agree
	T2	The operator can provide (Connectivity) strategy in the entire geographical area.	3.054	1.1291	61.081%	Neutral
		Average	3.451	0.9651	69.009%	Agree
2	T6	The operator prefers to provide (Platform) strategy	3.514	.9894	70.270%	Agree
	T7	The absence of willing parties (Third party) is an obstruct to offer (Platform) strategy	3.324	1.1317	66.486%	Neutral
	T8	lack of parties with software capabilities is an obstruct to offer (Platform) strategy	3.243	1.1403	64.864%	Neutral
		Average	3.361	1.0871	67.207%	Neutral
3	T9	The operator prefers to provide (Sensing) strategy	3.459	.8691	69.189%	Agree
	T10	Dissemination of sensors from obstacles to offer the (Sensing) strategy	3.324	1.0815	66.486%	Neutral
		Average	3.391	0.9752	67.837%	Neutral
4	T5	Limited Data Rate is an obstacle to offer End- to- End IoT services	4.135	1.0584	82.702%	Agree
	T4	The operator prefers to provide End- to-End IoT service	3.027	1.3014	60.540%	Neutral
		Average	3.391	0.9752	71.621%	Neutral

We found T1 (MTN operator prefers to provide Connectivity strategy) achieved the highest percentage with (77.297%). Also, the (68.648%) of the respondents agree that the major cities an appropriate coverage area for the Connectivity strategy. The platform strategy ranked second with (70.27%), while they were neutral in term of obstacles of this strategy. Also, (69.189%) of the respondents said the operator could provide the Sensing strategy. The end-to-end solutions strategy has the lowest percentage (60.540%).

As shown in Table 8, like MTN respondents, the respondents of Yemen Mobile prefer to provide Connectivity strategy with the rate (76.571%). Furthermore (69.142%) respondents think the operator coverage area allows the provision of connectivity in the entire geographical area of the operator. The Sensing strategy and Platform strategy ranked after that with close percentages (69.142%) and (68%) respectively. While the respondents were neutral regarding these strategies' obstacles. As well as like MTN the end-to-end solutions strategy has the lowest percentage (57.142%).

About the obstacles to these strategies, operators agreed the limited data rate is the most critical obstacle. The strategies for delivering IoT services by these operators were ordered according to as illustrated in Figure 8.

Table 8 Results of Yemen Mobile Questionnaire on the Second Axis

Rank	Q. No	Statement Text	Mean	Std. Dev	Mean%	Recog
1	T1	The operator prefers to provide (Connectivity) strategy	3.829	.7470	76.571%	Agree
	T2	The operator can provide (Connectivity) strategy in the entire geographical area.	3.457	.7005	69.142%	Agree
	T3	The operator can only provide (Connectivity) strategy in major cities	3.257	1.0387	65.142%	Neutral
		Average	3.5143	0.82876	70.285%	Agree
2	T9	The operator prefers to provide (Sensing) strategy	3.457	.8168	69.142%	Agree
	T10	Dissemination of sensors from obstacles to offer the (Sensing) strategy	3.371	.7702	67.428%	Neutral
		Average	3.4143	0.79354	68.285%	Agree
3	T6	The operator prefers to provide (Platform) strategy	3.400	.7746	68%	Agree
	T7	The absence of willing parties (Third party) is an obstruct to offer (Platform) strategy	3.086	.9813	61.714%	Neutral
	T8	lack of parties with software capabilities is an obstruct to offer (Platform) strategy	2.857	1.0042	57.142%	Neutral
		Average	3.1143	0.92004	62.285%	Neutral
4	T5	Limited Data Rate is an obstacle to offer End- to- End IoT services	3.686	.9632	73.714%	Agree
	T4	The operator offers End- to- End IoT service	2.857	1.0612	57.142%	Neutral
		Average	3.2714	1.01217	65.428%	Neutral

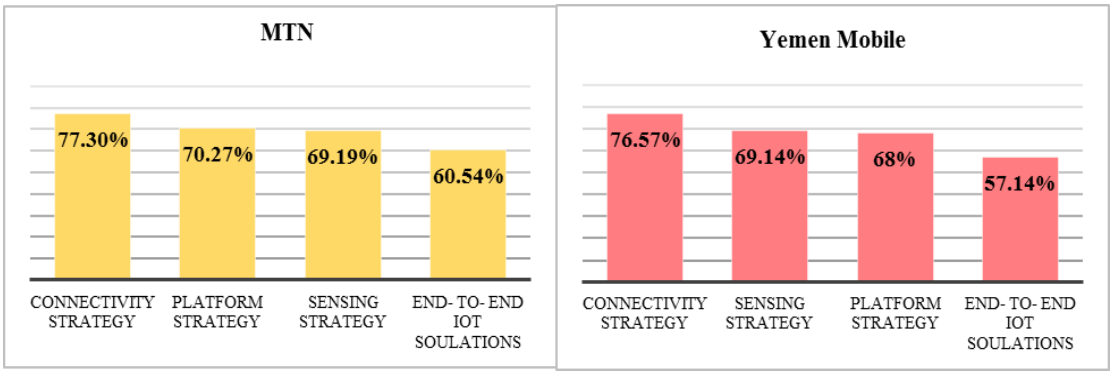

Figure 8 Ordering Strategies for Delivering IoT Services by MTN and Yemen Mobile

6.2.2. Results of the Third Axis

Table 9, and Table 10 show the main characteristics of IoT services which are preferred by each operator. As shown in Table 9, in terms of power source, the respondents in MTN said that first, they prefer to deploy devices that have a battery for a long time with the percentage (82.4%). After that the appliances that need a recharge with the rate (75.2%). Finally, the devices that require a continuous power source with the percentage (74.5%).

Table 9 Results of MTN Questionnaire on the Third Axis

Rank	Q No	statement Text	Mean	Std. Dev	Mean %	Recog
1	SR1	The operator prefers devices with a battery for a long time.	4.121	0.7398	82.40%	Agree
2	SR4	The operator prefers to deploy devices in stable locations	3.97	0.7282	79.40%	Agree
3	SR2	The operator prefers the devices that need its battery to recharge.	3.758	0.9364	75.20%	Agree
4	SR3	The operator prefers devices with a continuous power source	3.727	1.1256	74.50%	Agree
5	SR10	The operator prefers equipment that needs support devices for deployment (outdoor floors	3.727	0.7191	74.50%	Agree
6	SR9	The operator prefers devices that are deployed in current coverage locations	3.333	1.0206	66.70%	Neutral
7	SR5	The operator prefers to deploy devices in mobile places	3	0.9354	60%	Neutral

Table 10 Results of Yemen Mobile Questionnaire on the Third Axis

Rank	Q No	Statement Text	Mean	Std. Dev	Mean %	Recog
1	SR1	The operator prefers devices with a battery for a long time.	4.161	0.7788	83.20%	Agree
2	SR10	The operator prefers equipment that needs support devices for deployment (outdoor floors	3.806	0.7033	76.10%	Agree
3	SR4	The operator prefers to deploy devices in stable locations	3.7	0.7497	74%	Agree
4	SR2	The operator prefers the devices that need its battery to recharge.	3.667	0.8442	73.30%	Agree
5	SR3	The operator prefers devices with a continuous power source	3.387	1.0223	67.70%	Neutral
6	SR9	The operator prefers devices that are deployed in current coverage locations	3.194	1.0462	63.90%	Neutral
7	SR5	The operator prefers to deploy devices in mobile places	2.968	0.875	59.40%	Neutral

Regarding things position, respondents agreed to deploy devices in stable places (79.4%) and were neutral (60%) about the deployment of devices with mobility.
In term of propagation, they chose to deploy services that require coverage support devices with a percentage (74.5%) and were neutral (66.7%) about deploying the devices that are limited to current coverage.
As shown in Table 10, like MTN the respondents in Yemen Mobile prefer to deploy devices that have a battery for a long time with a percentage (83.2%). After that, the appliances that need a recharge with the rate (73.3%) and were neutral about the devices that need a continuous power source with the percentage (67.7%).
In term of propagation, they chose to deploy devices require coverage support devices, e.g. outdoor floors (76.1%), and were neutral about deploying the devices that are limited to current coverage (63.9%) like MTN respondents.
Regarding things position, like MTN they chose to deploy devices in fixed and stable places (74%) and were neutral (59.4%) about deploying the devices with mobility.

6.3 T SAMPLE TEST

T-Test uses to see if there were differences in the sample answers on the questionnaire axes has been caused by the duo pair variables that is the MTN operator, Yemen Mobile operator. Table 11 describes the comparisons' results of the average responses of the samples. Can be observed that the significance level (Sig) is larger than .05 (alpha value). Therefore, we accept the null hypothesis, which says there are no differences with statistical significance in all the axes of the questionnaire due to the operator.

Table 11 the Variation Independent T-Test on the Effect of the Operator on Respondents' Responses

Axis	MTN		Yemen Mobile		T-test	Sig.
	Mean	Std. Deviation	Mean	Std. Deviation		
O (Obstacles to Providing IoT Services by the Operator)	3.533	1.0189	3.328	0.9158	1.0255	0.2933
T (Strategies for Delivering IoT Services by the Operator)	3.437	1.0467	3.325	0.8857	0.4401	0.3824
SR (Characteristics of IoT Services which are Preferred by the operator)	3.675	0.9621	3.555	0.8372	0.5960	0.5766

7. RESULTS AND DISCUSSION

As explained above, although respondents agree on the IoT services provisioning benefits by operators, there are no plans for operators to integrate these services. The researchers attribute the reason is that the operators' desire to upgrade into 4G and therefore not wanting them in providing new services with an infrastructure they would change. They also concerned about the end-user isn't interested in these services due to lack of awareness of IoT benefits. This is why the operators are hesitant to integrate these services, especially during the current war. As Table 7 and Table 8 show, both MTN and Yemen Mobile engineers agreed the limited data rate is the most critical obstacle in IoT deployment. All the interviewees confirmed it is possible to offer IoT services at any level unless a high data rate.

Regarding strategy, engineers agreed a connectivity strategy is the best strategy. Yemen Mobile engineers confirmed their ability to offer IoT services in the entire geographical area covered by the operator, while MTN engineers confirmed their ability to offer IoT services in major cities. The operators' engineers also agreed possible to offer Sensing and Platform strategies.

As shown in Table 9, in MTN operator, the respondents prefer to deploy devices with a battery for a long time and the devices that need a recharge as well as need a power source. Also, they prefer to deploy devices in stable places and devices that require coverage support devices. By comparing these results with Table 1 and Table 2, the potential applications that MTN may be provided are:

1 Smoke Detector-Home/ Enterprise
2 Industrial - Asset Tracking
3 Industrial- Tank Process/ Safety Monitoring
4 City - Parking
5 Building Automation- Alarms, Actuators
6 Home Automation, Ex Garage, Doors
7 City - Waste Management
8 Microgeneration
9 Consumer -White Goods, Ex Refrigerators, Washing Machines
10 Vending Machines -General
11 Vending Machine -Privacy/ Data Verification

As shown in Table 10, in Yemen Mobile operator, the respondents prefer to deploy devices with a battery for a long time and the devices that need a recharge. Also, they prefer to deploy devices in stable places and devices that require coverage support devices. By comparing these results with Table 1 and Table 2, the potential applications that Yemen Mobile operators can offer are the same first seven services that MTN operator can offer.

8. CONCLUSION

This paper presented the opportunities to offer IoT in developing countries by telecom operators. The researchers concluded operators preferred to offer IoT services by a third party. However, the limited data rate an obstacle to offer these services through their infrastructure.

The researchers believe that if operators didn't follow up on the new technology such as IoT will find them self-outside the competition. Also, they lose many profit opportunities.

In Yemen, where this paper presented a case study there are also other obstacles related to the current situation in Yemen and can be summarized as follows:

1 Reservation the equipment of companies such as Yemen Mobile operators, which suffers the network pressure and inability to expand due to equipment reservation, and therefore focus on improving the main services only.
2 The economic level of the citizen, where operators are unprepared to offer any new services may don't get any gain by provide.
3 Other obstacles related to security and community awareness.

However, it possible to offer a variety of services by telecom operators in Yemen, but the researchers believe that better to start providing the following services (Smoke Detector-Home/ Enterprise, Building/ Home Automation, and Vending Machines -General/ Privacy), because they closer to a large number of people and can easily deploy and don't need high data rate.

COMPETING INTERESTS

"Authors have declared that no competing interests exist.".

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