



# **Opportunities and Obstacles to Deploy Internet of Things Services by Telecom Operators in Developing Countries (Case Study Telecom Operators in Yemen)**

**Mansoor N. Ali<sup>1\*</sup>, Manal A. Alareqi<sup>2</sup> and Ammar T. Zahary<sup>2</sup>**

<sup>1</sup>*Faculty of Education, Arts and Sciences-Marib, Sana'a University, Sana'a, Yemen.*

<sup>2</sup>*Faculty of Computing and IT, Sana'a University, Sana'a, Yemen.*

## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

Internet of Things (IoT) plays a vital role in the modern life. The authors see that offering IoT services by telecom operators better than others, especially in developing countries, where the concern of the community related to security issues is the most prominent obstacles. This paper addressed a future vision of IoT services in developing countries by telecom operators. This paper identified the possible opportunities, and obstacles for telecom operators to offer these services. This paper also presented a case study for telecom operators in Yemen. The case study has been taken from MTN and Yemen Mobile operators. The study's samples includes 73 engineers and SPSS has been used to analyse data. The results showed that (91.35%) from MTN's respondents and (81.14%) from Yemen Mobile's respondents agree that offering IoT services by the operator create new opportunities for profit. Also, results concerning to present services that can be provided are eleven services by MTN and seven services by Yemen Mobile operator.

\*Corresponding author: E-mail: [almarhoob@gmail.com](mailto:almarhoob@gmail.com);

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## 1. INTRODUCTION

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 make decisions [3]. The IoT basic architecture divided into three basic layers [4,5,6,7] as shown in Fig.1, (I) Perception Layer: this layer connects things into IoT network, measure, collect and process the state information associated with these things via deployed smart devices (RFID, sensors, and actuators). Then transmitting the processed data into the upper layer, (ii) Network 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, it uses various communication technologies such as Bluetooth, WiFi, and cellular. (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.

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

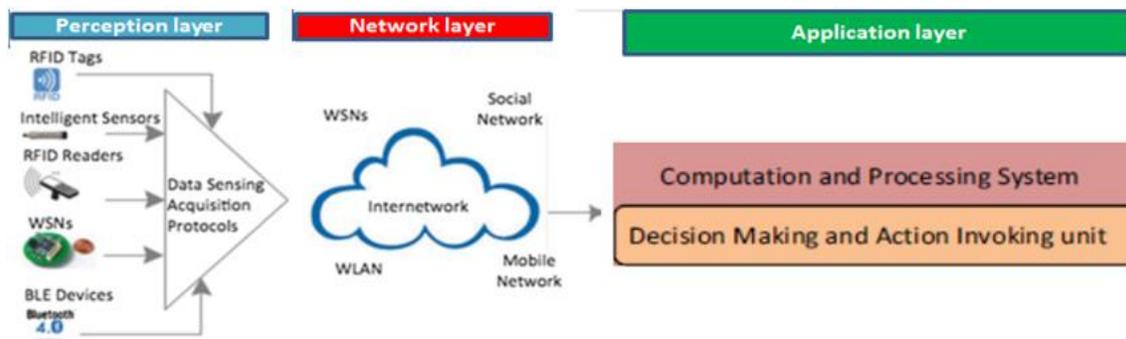
Communications (LTE-M) and Narrowband IoT (NB-IoT) [9,10].

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 summarises 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 Fig. 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].



**Fig. 1. General three basic layer**

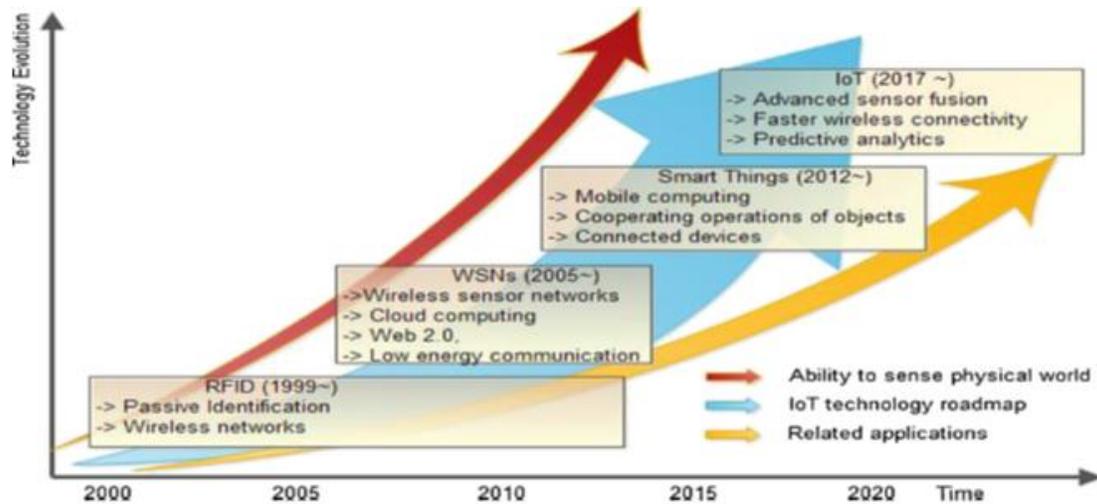


Fig. 2. Evolution of the IoT

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, and so on [17,18,19,20,21,22].

The evaluations of these technologies bring new technologies to IoT [23,24]. Fig. 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 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].

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, and 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]. Also the QoS [30] that achieved 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]. 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 authors 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 provides 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. 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 resources for dedicated IoT [38].
- LTE-M improvements LTE-type communications (MTC) with 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, the GSMA Low Power Use Case (LPUC) project group [38] offers 23 use cases suitable for LPWA Applications. These use cases have several characteristics and summarised by the authors in Table 1, which presents the use of cases in fixed or concentrated places, and Table 2 shows the use cases mobile in a wide area.

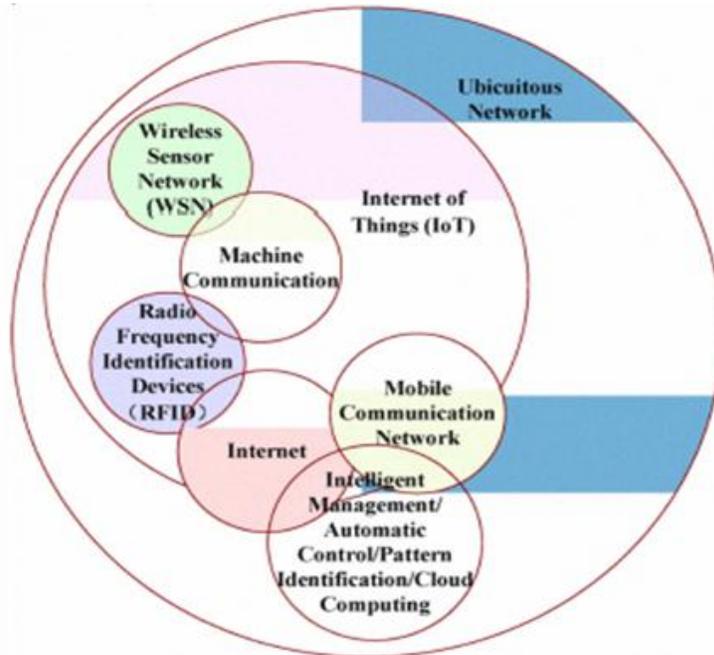


Fig. 3. The Relationship between IoT and existing networks

Table 1. The stationary LPWA applications

Application	Power	Coverage Propagation
Smoke Detector-Home/Enterprise	Owens 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	Owens 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	Owens Batteries	Further from Network Infrastructure
Environmental Monitoring: Data Collection	No Mains Power	GSM Coverage is Sufficient
Consumer -White Goods,	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**

<b>Application</b>	<b>Power</b>	<b>Coverage propagation</b>
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	Owens Power	GSM Coverage is Sufficient
Assisted Living/ Medical	Owens 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

**3. THE OPPORTUNITIES TO OFFER IOT SERVICES BY TELECOM OPERATORS IN DEVELOPING COUNTRIES**

This section addresses the advantages provided by telecom to offer IoT services in developing countries.

**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 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 for long years, and covers a large area of 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. Also, the applications delivery mechanisms implemented by the operators make the telecom ecosystem 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, such as Yemen

Tracking Company with Yemen Mobile operator, where the Yemen Tracking using Yemen Mobile's SIM to offer tracing services.

**3.3 Ecosystem**

Operators have invested millions of dollars in current infrastructures, including hardware, network equipment, device, application providers and others. Therefore, 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 helps to speed and flexibility respond to IoT service requirements that 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 IOT 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

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

Another obstacle related to 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 centres, funding and investment for innovation are low [43].

#### 4.2 Administrative Obstacles

Administrative systems in developing countries often are not 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. Also 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 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

Lack of awareness in the societies of developing countries one of the most critical obstacles to offer new services. The level of technology usage in these countries low. Therefore, the

demand for IoT services matter of concern for the operators. Also, consumers' concern about security and privacy.

### 5. METHODOLOGY

This section presents a case study for telecom operators (Yemen Mobile and MTN operators) in Yemen. Data of this study collected in two ways. The first, personal interviews with engineers (branch managers, network managers, and other engineers).The second, is a questionnaire distributed to the engineers of these operators.

#### 5.1 Analysis Infrastructures' Yemen Mobile and MTN

The study will focus both Yemen Mobile as a 3G operator and MTN as an example of 2G networks. Yemen Mobile executed by 3G technology while MTN executed by 2.75 EDGE technology, especially in the main cities. Since few years, Yemen Mobile and MTN want to upgrade to 4G; however, their plans face several difficulties including community awareness, pricing of licenses, and political and economic instability. Therefore, these operators focus nowadays on the upgrading process into 4G rather than offer new services such as IoT services. Also, operators now suffer overloading the network and focused on developing performance only, especially in light of the deteriorating security situation and difficult to supply and install the equipment. Furthermore, Yemen Mobile and MTN agreed on the following points:

- 1 They accept a new technology and investment that could increase the profit.
- 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 on offering main services (such as connectivity and platform) with high efficiency, they do not concern 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 network address translation (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 analyze the data of this study. The data was gathered through a survey. The data was analyzed using the 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.

### 5.2.1 The questionnaire objectives

- 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.

### 5.2.2 Questionnaire design

The questionnaire first included the demographics data for the study, used for determining the operator, age, and the experience. Then paragraphs divided into three axes, each one use to achieve one of the questionnaire's objectives of the mentioned in paragraph 5.2.1.

### 5.2.3 The community and the sample

The target Sample was engineers. The number of questionnaires was 73, distributed 36

questionnaires in Yemen Mobile operator, as well as 37 questionnaires in MTN operator.

### 5.2.4 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. Table 3 shows the value of the Alpha Cronbach coefficient was (0.813 and 0.790) for MTN and Yemen Mobile respectively, so the authors 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

This section aims to provide the characteristics of the personal data for respondents to the questionnaire. As shown in Table 4, the majority of respondents age range (31- 40) with the percentage of (75.7%) for MTN engineers, and (65.7%) for Yemen Mobile engineers. Regarding the Level of qualification, (78.4%) of MTN engineers have a Bachelor degree, (21.6%) have a Masters, and (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.

**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 Qualification	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%

## 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, 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 (57.1%) in MTN and (50.7%) Yemen Mobile.

They also agreed that community awareness of IoT benefits an obstacle to offer its services by (50.7%) in MTN and (46.4%) in Yemen Mobile. Both operators considered the Internet package an obstacle to offer IoT service by (48.9%) in MTN and (44.3%) by Yemen Mobile.

MTN engineers said integrate operator's services with IoT services an obstacle to offer IoT services by percentage (42.6%). As for Yemen Mobile engineers, the cost to deploy sensors an obstacle to offer IoT services by percentage (43.2%). As for the rest of the phrases, the operators' engineers were neutral.

**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	.502	91.4%	Strong Agree
2	O3	Community awareness of IoT benefits is an obstacle to deploying services by the operator.	4.054	1.052	81.1%	Agree
3	O4	The internet package is an obstacle to offer IoT service.	3.919	1.233	78.4%	Agree
4	O6	Integrating operator services with IoT services is an obstacle to providing IoT services	3.405	1.066	68.1%	Agree
5	O7	Cost of deploying sensors is an obstacle to offer IoT services by an operator.	3.243	1.011	64.9%	Neutral
6	O8	Deploy sensors is an obstacle to offer IoT services by the operator.	3.216	.975	64.3%	Neutral
7	O5	The difficulty in providing IoT Applications is an obstacle to offer its services.	2.973	1.235	59.5%	Neutral
8	O2	The operator has the plan to offer IoT services in the coming period.	2.892	1.074	57.8%	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	.683	81.1%	Agree
2	O3	Community awareness of IoT benefits is an obstacle to deploying services by the operator.	3.714	1.100	74.3%	Agree
3	O4	The internet package is an obstacle to offer IoT service.	3.543	.816	70.9%	Agree
4	O7	Cost of deploying sensors is an obstacle to offer IoT services by an operator.	3.457	.980	69.1%	Agree
5	O8	One of the obstacles to implementing Deploy sensors is an obstacle to offer IoT services by the operator.	3.114	.932	62.3%	Neutral
6	O6	Integrating operator services with IoT services is an obstacle to providing IoT services.	3.114	.900	62.3%	Neutral
7	O2	The operator has the plan to offer (IoT) services in the coming period	2.829	.890	56.6%	Neutral
8	O5	The difficulty in providing IoT Applications is an obstacle to offer its services.	2.800	1.023	56%	Neutral

### 6.2.2 Results of the second axis

Tables 7 and Table 8 show the strategy to offer IoT services by each operator. We found T1 (MTN operator prefers to provide Connectivity strategy) achieved the highest percentage with (77.3%). Also, the (68.6%) of the respondents agree that the major cities an appropriate coverage area for the Connectivity strategy. The platform strategy ranked second with (70.3%), while they were neutral in term of obstacles of this strategy. Also, (69.2%) of the respondents said the operator could provide the Sensing strategy. The end-to-end solutions strategy has the lowest percentage (60.5%).

As shown in Table 8, like MTN respondents, the respondents of Yemen Mobile prefer to offer Connectivity strategy with the rate (76.6%). Furthermore (69.1%) respondents think the operator coverage area allows to provide connectivity in the entire geographical area of the operator. The Sensing strategy and Platform strategy ranked after that with close percentages (69.1%) 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 (57.1%). About the obstacles to

these strategies, operators agreed that the limited data rate is the most critical obstacle.

### 6.2.3 Results of the third axis

Tables 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 with a battery for a long time with the percentage (82.4%). After that the appliances that need a recharge with (75.2%). Finally, the devices require a continuous power source with (74.5%). Regarding things position, respondents agreed to deploy devices in stable places (79.4%) and were neutral (60%) about devices with mobility.

In term of propagation, they chose services to require coverage support devices with (74.5%) and were neutral (66.7%) about devices that are limited to current coverage.

As shown in Table 10, like MTN the respondents in Yemen Mobile prefer to deploy devices with a battery for a long time with (83.2%). After that, the appliances that need a recharge with (73.3%) and were neutral about the devices need a continuous power source (67.7%).

**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 offer Connectivity strategy.	3.865	.751	77.3%	Agree
	T3	The operator can offer Connectivity strategy in major cities.	3.432	1.014	68.6%	Agree
	T2	The operator can offer Connectivity strategy in the entire geographical area.	3.054	1.129	61.1%	Neutral
<b>Average</b>			<b>3.451</b>	<b>0.965</b>	<b>69 %</b>	<b>Agree</b>
2	T6	The operator prefers to offer Platform strategy	3.514	.989	70.3%	Agree
	T7	The absence of willing parties (Third party) an obstruct to offer Platform strategy	3.324	1.131	66.5%	Neutral
	T8	lack of parties with software capabilities an obstruct to offer Platform strategy	3.243	1.140	64.9%	Neutral
<b>Average</b>			<b>3.361</b>	<b>1.087</b>	<b>67.2%</b>	<b>Neutral</b>
3	T9	The operator prefers to offer Sensing strategy	3.459	.869	69.2%	Agree
	T10	Dissemination of sensors an obstacle to offer Sensing strategy.	3.324	1.081	66.5%	Neutral
<b>Average</b>			<b>3.391</b>	<b>0.975</b>	<b>67.8%</b>	<b>Neutral</b>
4	T5	Limited Data Rate is an obstacle to offer End- to- End strategy.	4.135	1.058	82.7%	Agree
	T4	The operator prefers to offer End- to- End IoT strategy.	3.027	1.301	60.5%	Neutral
<b>Average</b>			<b>3.391</b>	<b>0.975</b>	<b>71.6%</b>	<b>Neutral</b>

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 limited to current coverage (63.9%) like MTN respondents. Regarding things position, like MTN they chose devices in fixed and stable places (74%) and were neutral (59.4%) about the devices with mobility.

## 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 authors' attribute the reason is that the operators' desire to upgrade into 4G and therefore not to want them in providing new services with an infrastructure they would change. They also concerned that the end-user is not 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 that 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 devices with a battery for a long time, and the devices 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, Smoke Detector-Home/ Enterprise, Industrial - Asset Tracking/ Tank Process/ Safety Monitoring, City – Parking/ Waste Management, Building/ Home Automation, Microgeneration, Consumer -White Goods and Vending Machines –General/ Privacy/ Data Verification.

**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 offer Connectivity strategy.	3.829	.747	76.6%	Agree
	T2	The operator can offer Connectivity strategy in the entire geographical area.	3.457	.700	69.1%	Agree
	T3	The operator can offer Connectivity strategy in major cities.	3.257	1.038	65.1%	Neutral
<b>Average</b>			<b>3.5143</b>	<b>0.8287</b>	<b>70.3%</b>	<b>Agree</b>
2	T9	The operator prefers to provide Sensing strategy	3.457	.816	69.1%	Agree
	T10	Dissemination of sensors an obstacle to offer Sensing strategy	3.371	.770	67.4%	Neutral
<b>Average</b>			<b>3.4143</b>	<b>0.7935</b>	<b>68.3%</b>	<b>Agree</b>
3	T6	The operator prefers to provide (Platform) strategy	3.400	.774	68%	Agree
	T7	The absence of willing parties (Third party) an obstruct to offer Platform strategy	3.086	.981	61.7%	Neutral
	T8	lack of parties with software capabilities an obstruct to offer Platform strategy	2.857	1.004	57.1%	Neutral
<b>Average</b>			<b>3.1143</b>	<b>0.9200</b>	<b>62.3%</b>	<b>Neutral</b>
4	T5	Limited Data Rate is an obstacle to offer End- to- End strategy	3.686	.963	73.7%	Agree
	T4	The operator prefers to offer End- to- End IoT strategy.	2.857	1.061	57.1%	Neutral
<b>Average</b>			<b>3.2714</b>	<b>1.012</b>	<b>65.4%</b>	<b>Neutral</b>

**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	0.739	82.4%	Agree
2	SR4	The operator prefers devices in stable locations	3.97	0.728	79.4%	Agree
3	SR2	The operator prefers the devices that need its battery to recharge.	3.758	0.936	75.2%	Agree
4	SR3	The operator prefers devices with a continuous power source	3.727	1.125	74.5%	Agree
5	SR10	The operator prefers equipment that needs support devices for deployment	3.727	0.719	74.5%	Agree
6	SR9	The operator prefers devices deployed in current coverage locations	3.333	1.020	66.7%	Neutral
7	SR5	The operator prefers devices in mobile places	3	0.935	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	0.778	83.2%	Agree
2	SR10	The operator prefers equipment that needs support devices for deployment	3.806	0.703	76.1%	Agree
3	SR4	The operator prefers devices in stable locations	3.7	0.749	74%	Agree
4	SR2	The operator prefers the devices that need its battery to recharge.	3.667	0.844	73.3%	Agree
5	SR3	The operator prefers devices with a continuous power source	3.387	1.022	67.7%	Neutral
6	SR9	The operator prefers devices deployed in current coverage locations	3.194	1.046	63.9%	Neutral
7	SR5	The operator prefers devices in mobile places	2.968	0.875	59.4%	Neutral

As shown in Table 10, in Yemen Mobile operator, the respondents prefer devices with a battery for a long time, and the devices 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 authors concluded that operators preferred to offer IoT services by a third party. However, the limited data rate an obstacle to offer these services through their infrastructure. There are other important factors, such as administrative

reasons, routine procedures, level of awareness, users demand, and matters related to the economic situation.

The authors believe that if operators did not 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 The operators suffer the network pressure and inability to expand due to equipment detention. Therefore they focus on improving the main services only.
- 2 The economic level of the citizen, where operators are unprepared to offer any new

- services may do not get any gain by providing.
- 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 authors 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.

As a future work further efforts to define factors affecting on deploy of services in developing countries.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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