Smart Community Challenges: Enabling IoT/M2M Technology Case Study

Norah Farooqi[1], Adnan Gutub[2], Mohamed Osama Khozium[3]

[1]Assist. Prof., College of Computer and Information Systems, Umm Al-Qura University, Makkah, Saudi Arabia.
nsfarooqi@uqu.edu.sa
[2]Prof., Computer Engineering Department; Umm Al-Qura University, Makkah, Saudi Arabia.
aagutub@uqu.edu.sa
[3]Prof., Department of Engineering & Applied Science; Umm Al-Qura University, Makkah, Saudi Arabia.
mokhozium@uqu.edu.sa

Abstract: With the great innovations and the fast improvements in technology, people tend to leave the countryside and started occupying the cities, and therefore, the population in cities dramatically increased to the extent that it's predicted by 2050, the urbans population will reach 70% of the world population for the first time in the history of mankind, knowing that cities use around 75% of the resources of the world and its energy. This leads to the fear from deficiency in the earth resources. The problem is of great concern, and researchers try to propose many ideas to overcome this dilemma. The idea of Smart cities has been one of the most efficient solutions because of what it has from advantages that could help in overcoming the hurdles of overpopulation and lack of resources. And for constructing a smart city, a great amount of data and information is needed which can be gathered from different resources such as: people, sensors, buildings, TV, transportations, Wi-Fi, etc. These resources have to be secured, available and accurate. And since the smart community is the intermediate gear between smart city and smart homes, where the features of the smart homes will be carried to the smart cities and vice versa, therefore in this paper we show smart community concept and proposed it's ideal components, how to harness the IoT and ICT for global development, showing the different challenges which arise that are related to ICT and IoT at the level of techniques and policy.

1.   Introduction

Smart city is believed to be city of the future, the upcoming utopia, since technology will be the link between institutions, citizens and governments.

The interventions of Smart city have arisen to try to deal with meta-issues like the change of climate, urbanization, efficiency of resources and citizen engagement etc. and this can be achieved by using sensors, available and obtained data and also by advanced computing. This intervention will help in speeding up the information flow, decreasing the amount of waste and in improving the accuracy and the quality of resource management.

Information and communication technology application is not a newly proposed intervention in urban design, planning and development. However, what is actually new is the impulse on ICT in the development of Smart city which puts more affirmation on the technologies of ICT and IoT.

Smart cities now are trying to concentrate on providing a smarter way for using resources, data collection and decision making.

In urban areas, people spend most of their times inside buildings, and this built environment produces a big amount of data. However, with the IoT development, ICT and digital technologies, city organizers are trying to find much better and efficient ways to get benefit from the available data in a more effective way, and to combine this data with other available information resources to create smarter solutions.

This paper consists of five sections; it begins with the introduction in the first section, followed by the second section which is the previously done related works, then the third section which is a background on IoT, ICT and machine to machine (M2M) communication, while the fourth section is about Smart Community use cases, component and

challenges, and finally the fifth section is the conclusion.

2.   Related Works

Smart city is a proposed concept, however, there hasn't been an exact definition for it among academia and practitioners.

A simple explanation can be given; a smart city is a community where services can be easier and more flexible in an efficient and a sustainable way for the benefit of the residents, this can be achieved by using obtained information, digital technologies and telecommunication. [1]

"Smart cities" term is somehow vague.

Different definitions have been proposed, for example, the narrow definition used by some people describes smart cities as cities that use communication technologies and available information to provide their citizens with services in an easy and efficient way.

A broader definition is also used by other people which declares that smart cities use ICT so as to be effective in the way of using resources which will lead to saving in cost and energy, improving the services provided, improving the quality of life, and reducing the environmental footprint. [2]

The communication between the infrastructure of urbans and the buildings is obstructed by the deficiency in the efficient data management and the data integration solutions oriented by the BIM (Building Information Modeling) despite the wealth of the BIM standards and the big amount of data generated by buildings. [3]

The best way in making a city smart is represented by IoT, where IoT can be applied in several scenarios like building status monitoring with passive Wireless Sensor Networks (WSNs) or even environmental monitoring which can be in observing water level for lakes, gas concentration, waste management, reducing CO2 footprint, soil humidity, smart parking or even autonomous driving. [4]

A number of ethical issues clearly arose

from the spreading of smart city technologies and attendant urban science and informatics, which caused the consequence of some criticism concerning the underlying concepts and practice of smart urbanism. [5]

A Smart City Control Authority (SCCA) model has been suggested by researchers for the management of all of the facilities of smart cities and controlling its related services according to certain privileges given to the authority unit, this authority unit has the ability to hold the SCCA and has specific and standardized principles and guidelines which are well-defined under the law with the preservation of security and privacy. [6]

Smart resident buildings were described by the authors in [7] by quoting the organization theory ideas, and mostly, the idea of a learning organization.

In [8], [9] and [10] articles show some examples of smart cities. The case studies done in these articles were divided into geographical categories which means cities related to the Middle East, cities related to the Mediterranean, cities related to Asia and cities related to North Europe.

On a large scale, this refers to three different types of cities, and thus, various levels of heterodoxy in technology and kind of human capital that are considered to be the main principles in smart development achievements.

3.   IoT, ICT and M2M Communication Background

Innovative solutions are essential and necessary for improving the productivity and increasing the operational efficiencies since cities expand and grow by time, and homes nowadays are being gradually equipped with IoT devices such as TV, Internet, smart alarms, thermostats, smart locks for the doors and other appliances.

IoT was explained as an international infrastructure for the society of information which allows sophisticated services by the physical and visual interconnection between things. This connection is based on the presence of mutual communication and information technologies [16].

Since IoT and Smart cities are strongly inter-related, IoT has a heterogonous network with IP devices and non IP ones. These devices have a connection by using IP Gateways, and thus, these Gateways are going to have the connection with IoT. Sensors will generate a big amount of data, and the analytics of Big data is used to originate intelligence, that can be even used for different activities of operation and planning that will help in the development and improvement of smart cities [17].

The advantages of ICT including the urban designing and planning, and also the processes of management such as maps, available and regularly updated data or even the assembled model, these advantages are progressively becoming a widespread tradition, which is clearly obvious in the combination between the GIS applications with the web, the sensors and the technologies based on wiki.

This combination is a very effective way in providing and improving the opportunities of interaction and constructive communication between policy makers, citizens and the available skills which are together needed for the processes of urban planning.

ICT tools can be used for different and variable data collection, and for the constant collection of this

data. These tools can also be used for data analysis and simulation which can all be of great benefit to urban designing and planning practices, and with the remarkable technologies of smart cities, the uses, the power and the extent of these tools can be greatly augmented and reinforced. [11]

On the other hand, M2M communication is an advanced technology that permits the connection between wired or wireless systems as long as they are of the same ability [18]. Figure 1.
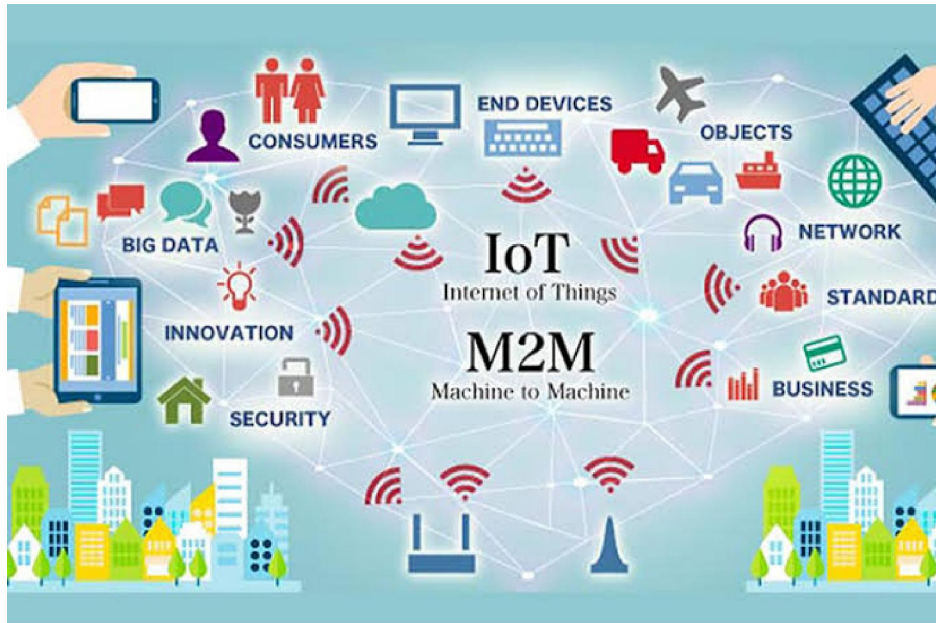

Figure 1. Shows the interactions among M2M communication and IoT

M2M is used to record a certain situation or a specific event using a recording device such as sensors, these records are transferred through a certain network which could be wired, wireless or hybrid to a software, this software then processes the recorded situation and translates it into significant information.
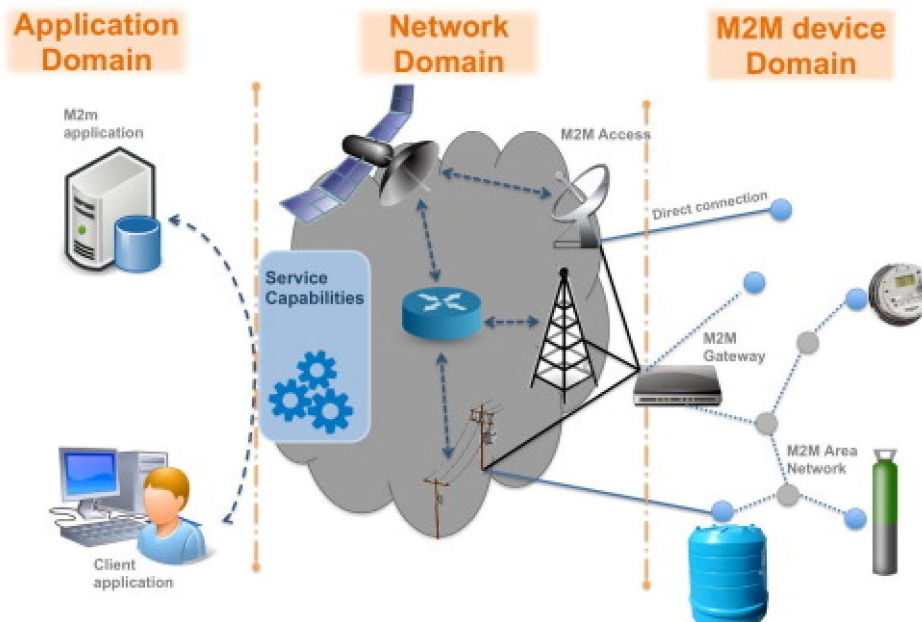
The concept of M2M can be illustrated figure 2.

Figure 2. Shows the concept of M2M communication through three domains

There is an inter-connection between IoT and M2M with different and multiple sectors like remote health management industries, agriculture, surveillance systems and safety. And for the refinement of the quality and the efficiency of life, these sectors can be converted to be smart by passing through IoT and M2M technologies [19].

4.   Smart Community use cases, component and challenges [12,14,15]
The origin of smart community is mainly based on the interconnection between: communication, Infrastructure and analytics, it is shown in further details in figure 3.
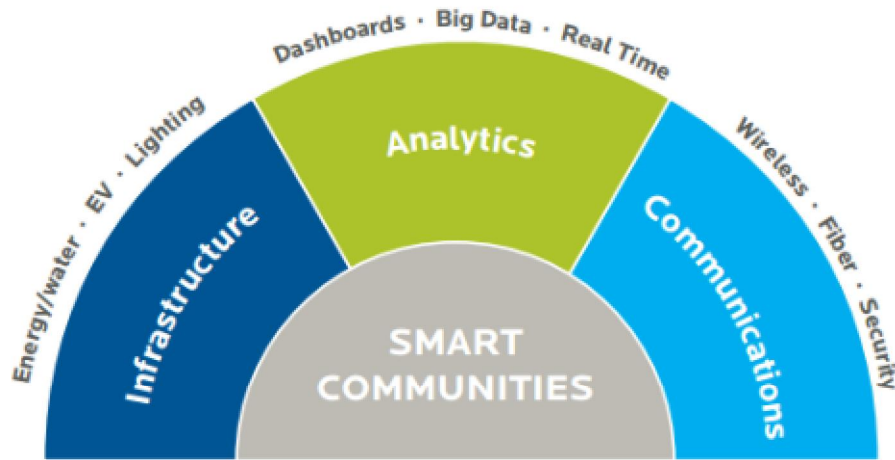

Figure 3. Smart community illustration

4.1   Smart Community Use cases
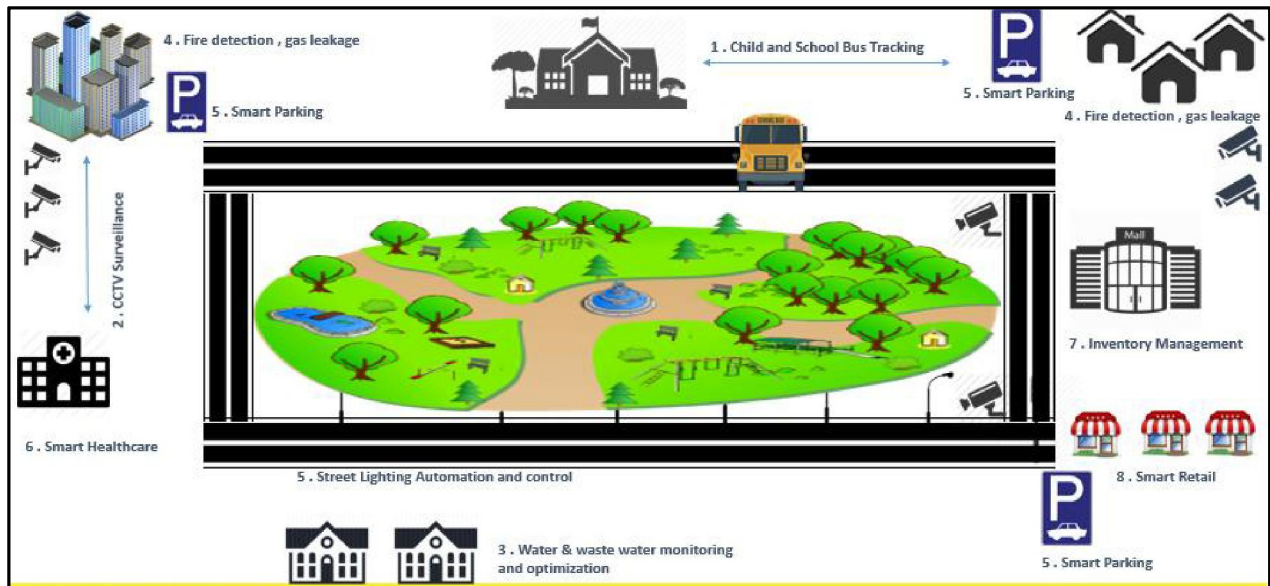A related representation is in Figure 4.

Figure 4. Smart community use case

4.2   Components of Smart Community
Smart Energy:
Digital technology is used which can be achieved by Advanced Meter Infrastructure (AMI), distribution grid management, transmission system of high voltages.

Smart Buildings:
These buildings are considered to be green buildings, intelligent, and of effective energy. Many

14

features such as temperature, light, energy consuming or security can be managed and controlled separately or with the least human intervention, and this is due to the presence of sophisticated automated infrastructure.

Smart Mobility:

Allows efficient and smart mobility. This can be achieved due to the innovation and integration in solutions and technologies like multimodal transport systems and low emission cars.

Smart Technology:

The innovation that connects the house, the mobile phone, the car and the office on one common wireless IT platform.

Smart Healthcare:

It depends on using smart and connected medical devices which could be like e-health system and m-health system. It also depends on applying some methods that could encourage the well-being an health of citizens including health monitoring and diagnosis.

Smart Infrastructure:

It is the presence of a sophisticated and automated system that can manage, communicate and merge with various kinds of intelligent infrastructures like telecommunication or waste and water managements.

Smart Governance:

It mainly depends on rolling out of digital services and policies from the government. This will aid in providing smart and green solutions especially when being supported by some kind of promotions as rewards.

Smart Citizens:

Citizens are interested in applying green and smart solutions daily, they choose the smart products and concepts, and as a result, they make smarter lifestyle choices.

4.3   Challenges

Industries work in isolated and proprietary standards, and thus, it is necessary to have a clear definition to open standards at network, device, and application levels. This will provide a joint action and interoperability for proper and sustained growth. Different uprising challenges related to IoT at the policy and technical levels are represented in Figure 5.
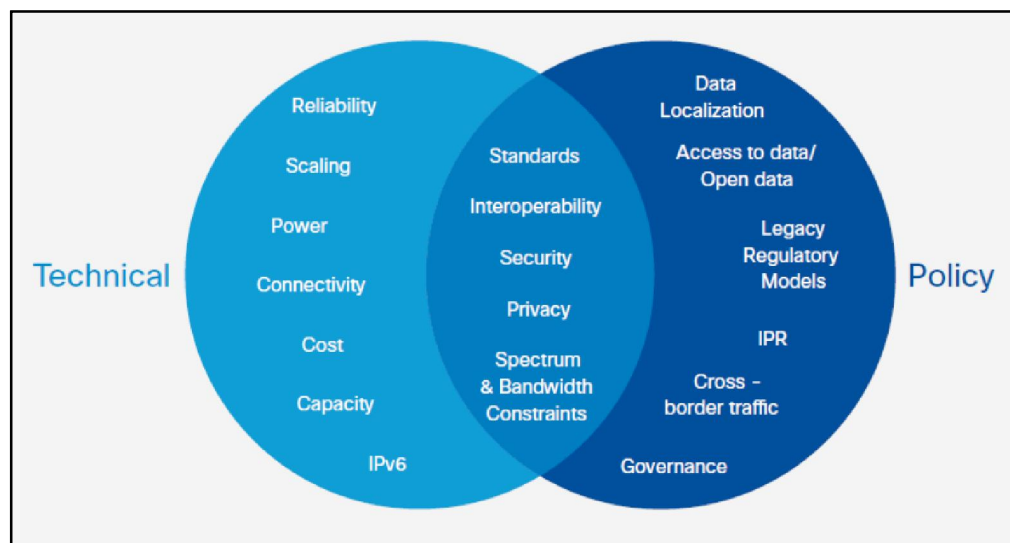

Figure 5. Harnessing the IoT for Global development [13]

The key challenges:

4.3.1.   Standards   and   interoperable technologies deficiency: Industries work proprietarily and in silos solutions to provide fine and comfortable evolution to sectors. Open standards based devices have to be used to obtain economical scale. And in all levels, interoperability is greatly needed.

4.3.2. To reach minimal usage and consumption of power, then technologies are of big importance and play an important role to guarantee that batteries have longer lives, and this needs to be mainly guaranteed in wearable devices where they must have a regular wireless connection so that communication is available at any time with the nearest gateway available.

4.3.3. The non-speedy spread of IPv6: It is expected that the placed devices of high volume are in the domain of M2M/IoT. The direct connection to PSTN or PLMN requires IPv6 or even IPv6 and IPv4 mix since IPv4 on its own will get fatigued.

4.3.4. Affordable and low cost devices: Smart devices are of high price, however, their adoption and invasion isn't as high, and this can somehow be related to the presence of several suppliers and salesmen, although standardization is the key to

decreasing the price of these devices and guaranteeing their interoperability.

4.3.5. Privacy and Security of Data: Connection of devices at home became typically normal which increases the importance of security and privacy. Consumers need to have confidence and feel safe that they are properly secured against malpractice of any kind and thus, this points to the importance of security which can be as end to end type of security.

4.3.6. Health care regulations are greatly needed, where the wearable health devices are used for regularly checking patient's vital signs remotely at home. This will be of great help by decreasing the load on the hospitals.

4.3.7. High speed and credible internet services: Smart homes developments greatly require fast internet and mobile connections. However, as much as fast internet is deeply important, being available and reliable can't be of less importance.

4.3.8. Gateways of Smart homes, and having several protocols for HAN is needed as the device can have various ways of communication protocols.

4.3.9. Fragmented Market - Market development is slowed down by fragmentation as the salesmen control which product or technology related devices to back from market. This increases the prices as well since some problems need to be solved by the combination between several devices, and this will lead to even more disappointment of the customers when the problem doesn't get solved.

4.3.10. Implementation cost– For an average customer it is very expensive to afford this kind of business which is related to the increasing number of presented and introduced devices to be connected with their homes. And not only is the cost high, but also the achievements and applications are still limited, and some even don't provide any real value.

5. Conclusion

Due to the fast increase in population and the decrease in Earth resources, Smart Communities and Cities became a life saving solution and the need for this solution is increasing day by day.

Therefore, in this paper we discussed the importance of Smart Communities, and how the merge between IoT, ICT and M2M provides smart and efficient solutions, and that they are the cornerstone of creating a smart community which is necessary since Smart Community is considered the intermediate gear between Smart Homes and Smart Cities.

Creating a Smart Community is occupied by several challenges, and some of these challenges were overcame by the help of IoT, ICT and M2M, it also requires some necessary components, where the availability of these components guarantees that the solutions outcome will be efficient, sustainable and smart solutions.

However, it must be put in consideration that the constriction of a proper sustainable Smart Community is a part that everyone shares in, the Government and the residents.

References
1. Saraju P. Mohanty, "Everything you Wanted to Know about Smart Cities ", IEEE Distinguished Lecture CE Society Webinar, 5th Oct 2017.
2. Somayya Madakam, R. Ramaswamy, "The State of Art: Smart Cities in India: A Literature Review Report", International Journal Of Innovative Research & Development issn: Vol 2 Issue 12, December, 2013.
3. Amin Anjomshoaa, "Blending building information with smart city data", S4SC'14 Proceedings of the Fifth International Conference on Semantics for Smarter Cities - Volume 1280, 2014, pages 1-2.
4. Badis Hammi et al, "Internet of Things (IoT) Technologies for Smart Cities", IET Research Journals, pp. 1–14, The Institution of Engineering and Technology 2015.
5. Rob Kitchin, "The ethics of smart cities and urban science" Philos Trans A Math Phys Eng Sci. 2016 Dec 28.
6. Ali Alshaery, Reem Alshalawi, Mohmed Osama Khozium "Smart Cities: Integration of GPS and IoT Approach", Knowledge Electronic Comprehensive Journal For Education And Science Publications (MECSJ) K -MULTI: Issue (18), Apr (2019).
7. Markus Schatten, "Smart Residential Buildings as Learning Agent Organizations in the Internet of Things", Business Systems Research: Vol. 5 No. 1 / March 2014.
8. E. Riva Sanseverino et al, "Smart Cities: Case Studies", Springer Tracts in Civil Engineering: AG 2017.
9. Sang keon lee et al, "International Case Studies of Smart Cities", Inter-American Development Bank: 2016.
10. The Internet of Things-Enabled Smart City Framework, or IES-City Framework (pronounced "YES-City"), Version:2017-03-25.
11. Margaret Rouse, "Wiki", July 2016, https://whatis.techtarget.com/definition/wiki
12. Pepper, R. & Garrity, J. (2014) The Internet of Everything: How the Network Unleashes the Benefits of Big Data. Global IT Report 2014. WEF.
13. http://www3.weforum.org/docs/GITR/2014/GITR_Chapter1.2_2014.pdf

14. ITU-CISCO, "Harnessing the Internet of Things for Global Development," ITU, Geneva, 2016.
15. Technical Report, "M2M/IoT Enablement in Smart Homes," TEC-TR-IoT-M2M-007-01, Release 1.0, 2017.
16. Technical Report, "IoT/ICT Enablement in Smart Cities," TEC-TR-IoT-M2M-006-02, Release 2.0, 2017.
17. Joel Bacquet, "IERC European Research Cluster on the Internet of Things" http://www.internet-of-things-research.eu/about_ierc.htm, last visit may, 2019.
18. Satish Phakade Pawar, " Smart City with Internet of Things (Sensor networks) and Big Data", Phakadepawar, 2013.
19. Jiafu Wan, "Machine-to-Machine Communications: Architectures, Standards and Applications" KSII Transactions on Internet and Information Systems 6(2) · January 2012.
20. Sushil Kumar, "M2M/IoT Enabling Smart Infrastructure", Communication today, February 2019.

6/19/2019