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Internet of Things-based Services Implementation and Challenges in Malaysia: An Inquiry

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Abstract:
The fields of electronics and computer science have merged to form one of the most significant technological advances; the Internet of Things (IoT). IoT has become a key trend all over the world. Although still in its early stage of development, the impact of IoT in Malaysia has been significant. However, there exist particular challenges in achieving successful implementation of IoT-based services. This paper aims to review and understand the implementation status of IoT-based services in Malaysia. The challenges, as well as suggestions for future research trends, are discussed.

***Keywords:** Internet of Things, Implementation, Challenges, Future Research, A Review*

I. INTRODUCTION

A growing literature has synthesised the evolution of Internet of Things (IoT) technology in many industries around the world [1], [2]. With the ability to collect, share, process, and produce valuable data, IoT-based services (IoTbS) become the best solution of better efficiency, performance, cost, and time savings for future applications or services in organisations [3]–[6]. For example, IoTbS will be able to provide a system monitoring solution that drives optimised energy consumption and proactive maintenance programmes. It seems easy in theory, but IoT implementation is challenging.

Malaysia is one of the Asian countries at the initial stage of IoT implementation. It becomes more challenging to implement IoTbS due to the dynamic and unpredictable characteristics of IoT technology [7]. In addition, there are many emerging research challenges on IoTbS that need in-depth investigations. Thus, this paper aims to provide developers, researchers, and practitioners from both industry and academia with literature on recent implementation of IoTbS. This paper also discusses the key challenges that may influence the success of IoT implementation in Malaysia. Finally, this paper analyses the future direction of IoT research.

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II. About IoT

A. IoT Definition

The phrase 'Internet of Things' was first formulated by Kevin Ashton in the mid-1990s. Various definitions of IoT are found in previous studies as shown in Table 1. However, there is no standard definition pertaining to general context of IoT-based services.

TABLE I
Definition Of An IoT

Authors	Definition	Industry
[8]	The IoT is the greatevolution of the Internet, in which devices have the abilityto collect, analyse and distribute data that can give rise toinformation that can help people's daily lives.	Environmental
[9]	The Internet of Things is a new technological paradigm that aims to connect anything and anyone at any time and any place, giving rise to innovative new applications and services.	Business
[10]	IoT allows billions of devices, peoples, and services to connect with others and exchange information.	Security
[11]	IoT is a combination of diverse, smart objects which have sensing capabilities and identified by Radio Frequency Identifier (RFID) technology.	Healthcare
[4]	IoT is refer to a set of physicalobjects embedded with sensors or actuators and connected to a network - offers numerous opportunities for the federal government to cut costs and improve citizen services.	Government
[12]	IoT is a concept that considers pervasive presence in the environment of a variety of things/objects that through wireless and wired connections and unique addressing schemes are able to interact with each other and cooperate with other things/objects to create new applications/services and reach common goals.	Information and Communication

Despite the diverse definitions of IoT, its standard definition still remains fuzzy. However, the basic idea remains the same; collect and analyse data, then generate insight to re-engineer the processes and finally realise the benefits.

B. IoT Architecture

IoT architecture is vital to be an open interface, application-based requirement, with current technologies. Figure 1 shows the Four Layer of Service-Oriented Architecture (SOA) of the IoT system architecture proposed by Yang et al. [13] in healthcare. This layer of IoT system architecture is similar to the one proposed by Talavera et al. [14] in the agro-industrial and environmental fields. Therefore, the system architecture proposed may also be suitable for other industries. Table II lists the details of the four layers in IoT architecture.

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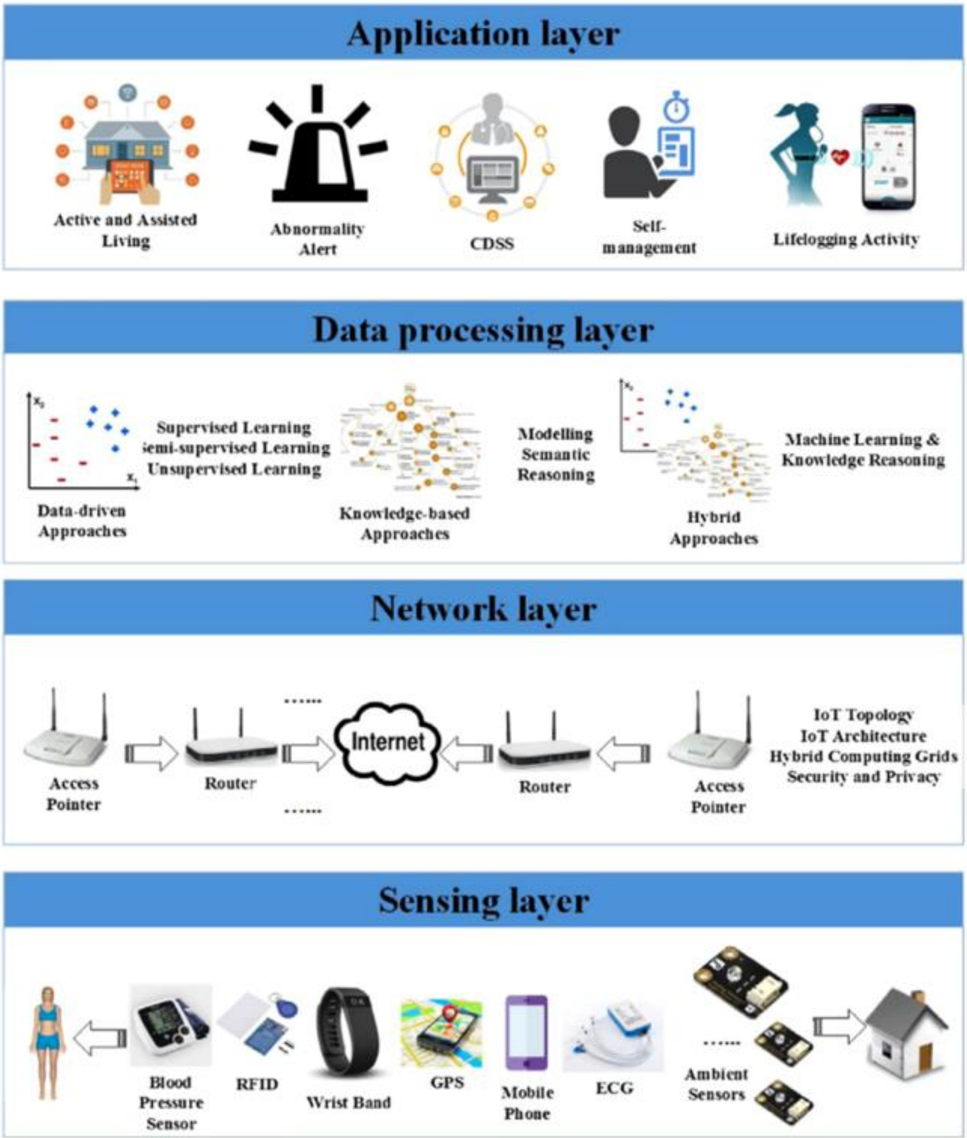

Fig. 1. IoT System Architecture Layer (adopted from the[13])

TABLE II
FOUR LAYERS OF IOT ARCHITECTURE

Layer	**Details**
Sensing layer	connects the controllers, RFID readers, sensing devicesto a network and service layer
Network layer	includes the resources administration and backbone of networks
Data processing layer	specializes in designing useful data processing methods for heterogeneous data set
Application layer	provides an open application programming interface (API) and the standard function to develop the specific IoT applications

III. THE IOT IMPLEMENTATION IN MALAYSIA

The emergence of IoT as a suite of wirelessly connected embedded sensors and devices seems to offer opportunities for organisations to improve efficiency, production, communication, resource planning, sustainability, operational performance, and quality of life [39, 63, 67]. In Malaysia, the Ministry of Science, Technology, and Innovation (MOSTI) is authorised by the Government to drive and develop IoT as the new source of Digital Economic growth, which aligns well with the era of Industry 4.0. In July 2016, the National IoT Strategic Roadmap was launched. It is forecasted that the market of IoT technology will contribute RM9.5 billion in 2020 and RM42.5 billion by 2025 to the country's Gross National Income (GNI)[18]. Due to its importance, IoT becomes one of the strategic thrusts under the data-driven Government in Malaysian Public Sector Information and Communication Technology (ICT) Strategic Plan 2016–2020. IoT also becomes the main thrust under effective communication in Local Authorities Transformation Plan by the Ministry of Urban Wellbeing, Housing, and Local Government in Malaysia.

As the Fourth Industrial Revolution or Industry 4.0 sweeps over the global front, Malaysia has conclusively taken on the challenge to bring the nation one step forward into the digital economy era. Understanding that this new industrial revolution may lead to a more enormous and complex challenge, Malaysian Communications and Multimedia Commission (MCMC) has positioned itself as the critical driver to prepare Malaysia with an IoT platform of borderless information. The IoT offers opportunities to citizens to use open data in daily lives and in return, contribute to a better quality of life, higher productivity, and greater efficiency of public services. This is in line with the ICT strategy outlined in the Eleventh Malaysia Plan (RMK 11).

The Malaysian Government has outlined a strategic plan towards the creation of new IoTbS by the industry through pilot projects. The pilot projects act as catalysts for industry players to employ forward-thinking approaches on how IoTbS are developed and utilised. At the same time, it is important to increase the industry’s involvement in economic activities by utilising IoT-enabled technologies. Table III shows several pilot projects that are currently being implemented in Malaysia.

TABLE III
IOT PILOT PROJECTS IN MALAYSIA

Industry	**Project Name**	**Project Objective**	**Ref.**
Healthcare	IoT Continuous Health Monitoring System	To producecontinuous diagnostics and precision treatment by medical experts utilising IoT technologies ranging from diet habits and vital signs to further merge, wearable devices that track daily activities, crunch data and dissectfor measurable indicators or biomarkers.	[18]

Tourism & Culture	Home & Community Living: IoT Smart Village in Lachang, Pahang.	To offer a services-oriented, holistic approach to revitalise cities for inclusive and sustainable growth through: 1) Climate change mitigation and resource efficiency; 2) Job creation and economic development; 3) Rork and leisure, liveable places for life; 4) Community support; and 5) Effective city management.	[18]
Energy, Green Technology & Water	Home & Community Living: IoT Intelligent Landfill Management	To improve and prevent the environmental accidents by enabling sensing strategies featuring real-time data perception, reduce waste, resource concentration and sharing, system integration as well as effective decision making and supervision.	[18]
Telecommunications and Network	IoT Cloud Services	Delivering better medical support services and security enhancements to Internet- ready homes	[18]
Electric Power & Energy	IoT-based Smart Meter	To measures energy usage accurately	[19]
e-Commerce	IoT-based Toll Gate System	To automatically pay for tolls without waiting in line for a teller and public transport.	[20]
Smart Cities Industry	Smart City Solution Initiative: IoT Trusted Mobile Digital Wallet System.	A virtual wallet beyond payment purposes including non-payment applications such as authentication and loyalty. This project supports the direction towards a cashless society and attempts to spur e-commerce and m-commerce and aligns with the National Digital Economy Initiative, for the convenience of society and towards a digital lifestyle.	[18]
Smart Cities Industry	Smart Facilities Management Services	To increase citizen's trust, enhance the communication transparency between citizen and LA, reduce the maintenance and operation costs, increase the productivity of LA, also improve the quality of services in order to improve citizens' quality of life.	[21], [22]

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IV. IoT Implementation Challenges in Malaysia

The IoT's dynamic ecosystem promotes the creation of practical and useful new applications across various industries in Malaysia. The contribution from IoTbS development will reach RM34 billion in 2025 as compared to RM7.5 billion in 2020 [18]. This statistical analysis highlights the importance of IoT in creating new economic values. Despite the advantages of this new technology, many organisations are facing challenges, primarily in the context of developing countries that can impact the usage of IoT. Table IV lists the specific challenges of IoT implementation in particular domain.

As IoT involves interactions through the Internet between 'people to things', 'people to people', and 'things to things', these challenges can be categorised into issues related to humans and things. Thus, addressing user readiness and technological challenges such as Information Quality, System Quality, and Service Quality might potentially increase more users of IoT-enabled devices thereby leading to the success of IoTbS implementation.

A. *Individual Readiness*

In implementing IoTbS, organisations are being pressured to face a range of challenges in dealing with resistant employees to adapt and change their work routine. The consequences of this situation can result in IoT being underutilised. The success of IoT implementation heavily depends on the employees' willingness to use the IoTbS and the individual readiness for change. There have been concerns expressed regarding failure of new technology initiatives due to the unwillingness of employees to adopt and use the technology [76–79].

TABLE IV
IoT Implementation Challenges

Author	Domain	Challenges
[54]*	Environmental – River Monitoring	An irrelevant architecture, complex streaming data, and high energy demand.
[55]*	Agriculture – Water Quality Monitoring	Service disruption, server disconnection, and power supplyproblem.
[27]*	Manufacturing	People readiness issues
[56]*	Construction	Security functions such as authentication and encryption, integration difficulties, network address restriction, complex user requirement, low usage of IoT application.
[57]*	Road transport industry	Inability to monitor the incredibly vast road networks in a timely manner and comprehensive.
[14], [18], [52], [53]	Organization	Standardization, cost, regulation or policies

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[3], [48], [52–59]	Services	Tangible, responsiveness, assurance, empathy
[32], [42–51]	System or Application	Usability, system reliability, convenience of access, turnaround time, flexibility, functionality, response time, system integration
[10], [15], [28]–[37]	Data or Information	Privacy, security, accuracy, currency, format of data, understandability, relevance, completeness, timeliness
[2], [19–26]	Human	Competence workers, knowledgeable, innovativeness, User satisfaction

* Note: Research in Malaysia

In examining user adoption of new technology, the Technology Readiness Index (TRI) model, proposed by Parasuraman [62] has gained attention among researchers to measure people's propensity to embrace and use cutting-edge technology. A number of studies have investigated the effects of TRI influencing individual's behavioural intentions and general beliefs towards new technology in Malaysia [71–77]. Understanding individual readiness is fundamental for new digital technologies such as IoT. Thus, the role of TRI in the IoT adoption and utilisation is needed to better understand the contributing factors that affect successful IoT implementation. Meanwhile, in addressing Information Quality, System Quality, and Service Quality of the IoT, DeLone and McLean IS Success Model [70] can be a guide for measuring overall IoT quality.

B. *System Quality, Information Qualityand Service Quality*

Several studies have established that the reason of the new technology's under utilisation is attributed to the quality of IoTbS (such as Information Quality, System Quality, and Service Quality) that does not meet the needs of users [69, 80]. System Quality is defined as the desirable attributes of an information system (i.e., system flexibility, system usability, system reliability, system functionality, as well as system features of sophistication, intuitiveness, and response time) [70]. In IoT-embedded applications, real-time operating systems are becoming quite familiar. The operational accuracy is crucial to ensure System Quality. Likewise, System Quality plays a critical role in user satisfaction and IoT operations[48]. As an intelligent cyber-physical application, System Quality has a significant influence on IoT success.

Information Quality is defined as the system outputs [70]. Information is a set of data which is processed in a meaningful way according to specific requirements. IoT offers new possibilities to the organisations by providing smart services and making intelligent decisions with the power of data collection from global smart things [72]. Information that suffer from quality problems will fail to represent the reality. Decision makers often rely on quality information to support their decision-making process. Information Quality plays a critical role in today's organisations because poor quality can lead to poor decisions that result in poor organisational productivity.

Service Quality is defined as the quality of the support that system users obtained from IT support personnel or IS organisation. Developing a high quality customer service or technical support for the IoTbS is a significant challenge because the IoT landscape still lacks standardisation[37]. The

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IoTbS need to guarantee the required levels of latency and reliability in order to provide advanced applications and high-quality services to end users. Tanganelli et al. [73]claimed that service quality in IoTbS will demand explicit support at every level. For example, specific technical communication standards at the network level will be beneficial to ensure responsiveness and reliable data delivery. Subsequently, technical support at the application level is often subdivided into a three-tier level in order to provide better customer service. On the other hand, explicit support from application protocols and design of novel resource allocation algorithms will be mandatory to implement proper management of resources and cope with concurrent access.

Overall, IoT quality is crucial to gain user acceptance and engagement[28]. Poor IoT quality has far-reaching effects and consequences. For instance, in the area of IoT in healthcare, data incompleteness might trigger medical errors during treatment and hinder further analysis for research and monitoring purposes [74]. When incomplete data is found at the point of care, this could impact the patient's condition through inaccurate diagnosis. Data incompleteness is also one of the significant barriers for secondary use to recognise real-world status of patients. According to Kim [75], IoT implementation will be highly dependent on the overall quality of the IoTbS and the execution of Government regulations to tackle technical barriers. Hence, it may be necessary to review the existing regulatory constraints.

C. *Government Regulatory and Policies*

The guideline is necessary to ensure smooth technical alignment and device interoperability since there are different IoT standards and technologies implemented in many verticals. The regulatory challenges and implications have been identified to facilitate smooth roll-out and offer strategies in meeting future demands. However, MCMC[6]claimed that the Malaysian industry is required to have new comprehensive IoT Regulatory Framework to complement the National IoT Strategic Roadmap. Five (5) regulatory aspects have been highlighted by the MCMC [52] which are; 1) Resources: Network Numbering, Spectrum Requirement, and Addressing; 2) Technical: Mobility Requirement, Roaming, or Standardisation; 3) Security and Data Privacy; and 4) Talent Development and Proof of Concept.

A new model of IoT governance is needed to allow and promote the benefits of IoT, while at the same time protecting the consumers. Therefore, examining the challenges in IoTbS implementation would be a fruitful direction for future research [22].

V. Future Research Direction

Future research may help Malaysia become a Premier Regional IoT Development Hub; at par with other countries. One interesting avenue for further research could be on critical success factors of IoTbS implementation in Public Sector. Since IoT is identified as one of the most powerful initiatives to drive the establishment of digital government transformation [5],the Government needs to have an established model that can effectively manage the use of IoTbS and successfully implement the IoT technology initiatives. Through this framework, the Government can improve the country’s competitiveness within the global economy and create a world-class quality services for their citizens. Other than that, Table V lists the directions for future research as suggested by MIMOS [18].

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TABLE V
FUTURE RESEARCH IN IOT

Key Area	**Scope of Future Research**
Spectrum Requirement	Study on the development of new communication standards for the IoT. Identify modulation technologies, Duty Cycle and EIRP limits which can mitigate congestion in Class Assignment frequencies.
Market Study	Study on the size and shape of Malaysia's market to determine the future demand for spectrum for IoT applications.
Additional Spectrum Band	Study on the feasibility of making new bands available for IoT applications.
Public Network	Study the existing numbering plans to accommodate IoT deployment either by opening up a dedicated numbering range or increasing the capacity.
Device Safety	Study on the relevancy of the current exercises that cover electrical safety, Electromagnetic Compatibility and Radio Frequency safety for IoT devices.
Interoperability	Study on the facilitate interoperability challenges between legacy and new networks through adoption of International standards.
Proficiency	Study on the needs to expand the scope of current proficiency exercise from cabling work to installation work of IoT devices.
Human Health	Study onthe implications of EMF emitted from IoT devices and the requirement for proper disposal of end-of-life IoT devices.
IoT Roaming Requirement	Study on IoT roaming requirement and capabilities; and IoT roaming development in neighbouring countries.
Security	Study on the feasibility to incorporate security test in the device security programme;Coordination effort with other agencies i.e., Cybersecurity Malaysia, Polis Di Raja Malaysia;on penetrability and vulnerabilityof IoT systems and devices.
Data Collection	Study on the coordination effort with the Department of Personal Data Protection.

VI. CONCLUSION

This paper serves to shed some light on the IoT platform features and implementation challenges in Malaysia. There are numerous contributions from this paper. First contribution is through the extensive review of current trends of IoT definitions and architecture. The next contribution is through the review of the current status of IoTbS implementation in Malaysia and the identification of key challenges that emerge from the implementation. Lastly, future directions of IoT research have also been highlighted. Malaysia needs to implement successful IoT initiatives in order to reap the benefits. Instead of randomly creating new projects, Malaysia would need to identify high priority domains with specific features that will gain IoT domain experts and expand IoT-enabled competitive advantage over time. The success of Malaysia's IoT initiative implementation relies on excellent execution through a combination of infrastructure, people readiness, and overall quality. Thus, the results of this study are useful for future developers, researchers, and practitioners from both industry and academia. With that, Malaysia can stand on par with the other top IoT countries.

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