The Role of IoT Technologies in Malaysia During the Covid-19 Pandemic: A Mini-Review

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ABSTRACT

The Covid-19 global infection has significantly influenced people's health, resulting in sudden changes in lifestyle through social exclusion and isolation. To break the transmission and terrifying health threat of Covid-19, the Malaysian Government imposed a Movement Control Order (MCO) starting March 18, 2020, by restricting movement and contact. The Covid-19 pandemic emphasized the importance of the digital inclusion agenda, and the application of Internet of Things (IoT) services has given tremendous benefits in various disciplines, as it helps maintain physical distance during the pandemic. Modern lifestyles are being transformed by the IoT revolution by embracing technological, economic, and social prospects. In fact, many sectors in Malaysia would be transformed through the application of IoT, particularly in productivity, and services. Thus, this review paper discusses IoT's most recent breakthroughs and applications that are used in Malaysia during the Covid-19 crisis. Furthermore, it investigates current IoT implementation and discusses the potential impact of the pandemic on the application of IoT in terms of technology trends and economic impact. IoT is worth mentioning as one of the technologies demonstrating its importance and capabilities in mitigating the severity of the pandemic within the country. This article delves into the applications, social and economic impact, and barriers to the widespread adoption of IoT in the Covid-19 pandemic. This review paper will be useful to academic researchers, business professionals, organizations in various sectors, and anyone interested in determining IoT services' impact on pandemics.

Keywords: IoT; Covid-19; Malaysia; Technology Trend; Economy Impact

INTRODUCTION

The outbreak of coronavirus disease 2019 (Covid-19) caused a global health crisis that has profoundly impacted our perception of things and our daily lives. The World Health Organization's (WHO) initial media announcement in 2019 alluded to viral pneumonia; however, by March 2020 after it spread to 120 countries, it had been declared a pandemic. Governments implemented restrictions such as quarantine, self-isolation, and stay-at-home orders to control the disease's spread (Moosavi et al. 2021). By April 2020, more than four billion people around the globe were ordered to stay indoors.

The stay-at-home restrictions resulted in significant changes to how individuals work and live. The work-from-home concept is no longer uncommon, as people have adapted to the change by utilizing innovative technologies (Hamadani et al. 2020). Recent data from WHO discovered that Covid-19 spreads mostly through droplet transmission, which can infect anyone within 1 meter. As a result, social, and technological initiatives have been implemented globally to prevent the transmission of the virus and minimize the resurgence of epidemics (Oksanen et al. 2021).

This pandemic is an accelerator for digital transformation because Covid-19 has established or expanded applications for digital technology (Mohammed et al. 2020; Umair et al. 2021). Despite the Covid-19 pandemic, Malaysia's technology sector-maintained production during the Movement Control Order (MCO) era with a minimal workforce. Numerous organizations adopted and implemented highly advanced technologies in response to Industry 4.0 advancements and capabilities prior to the pandemic (Kumar et al. 2020). Emerging technologies such as Machine learning (ML), Big Data analytics, the Internet of Things, and blockchain technology were the most used technologies (Akpan et al. 2021).

The IoT, is the most cutting-edge example of modern technology. The IoT is growing rapidly in a wide variety of industries. Its inception was motivated by the need to connect machines, devices, and applications across a network (Zakaria et al. 2019). IoT is a system that enables machines and devices to generate data and transmit it to control systems for analysis, processing, and control action via the Internet. Consumers can collect personal data using IoT devices, such as monitoring health and automating household operations. IoT can benefit industries

by streamlining processes and generating cost savings. The public sector and communities can utilize IoT devices to address environmental challenges (Sivakumar et al. 2017).

IoT applications are beneficial for online learning and smart classrooms. The inclusion of IoT in education became another impetus for modern education in Malaysia during the pandemic (Abd Samad et al. 2021). The unexpected situation compelled educators to reorganize their teaching materials into an interactive multimedia format and develop a methodology for reliable remote examination and evaluation. IoT can help classroom instruction by improving learning environments, methods, and techniques, expanding learning resources, increasing management efficiency, and lowering management costs. The learning resources available on devices like e-books are more engaging and interactive (Ilieva & Yankova 2020; Mircea et al. 2021; Routray & Mohanty 2022).

The development of a smart and IoT-based healthcare sector could also be extremely beneficial in serious worldwide pandemics, such as the Covid-19 crisis, which poses a severe threat to the global population. IoT systems have been used in the medical field, such as smart sensors, medical equipment, big data, cloud computing, telemedicine, clinical information system, and many other applications. IoT technologies in the healthcare sector can be used in different ways to combat Covid-19. For example, remote patient monitoring, remote tracking of the contact network, and hand wash monitoring sensor-based devices can all be used to fight Covid-19 (Allam & Jones 2020; Mutlag et al. 2019).

As a result of the current pandemic situation, numerous studies and reviews have been conducted on the impact of the Covid-19 pandemic on various fields, particularly in the healthcare system and education (Ennafiri & Mazri 2020; Paudel, 2021). However, no review paper has been published to date that discusses the impact of IoT technologies, particularly in the technology trend in numerous areas and how it affects the Malaysia economy during the Covid-19 pandemic.

This paper aims to discuss a thorough review of technology trends of IoT and its impact on the economy in Malaysia during and after the Covid-19 pandemic. This paper is structured into three main parts: an overview of IoT, technology trends of IoT and the economic impact of IoT during pandemic.

OVERVIEW OF IoT

Industrial Revolution 4.0 and the IoT have sparked a lot of attention in recent years, and they are predicted to gain popularity locally and internationally if they become part of various governments' primary initiatives. The government realized the need of incorporating the IR 4.0 program into the national agenda as a means of keeping up with the current developments. In its latest budget presentation, the Malaysian government stated that some funds will be allocated to encourage enterprises to transition to IR4.0. With the advancement of technology, the number of devices continues to grow. This includes intelligent tools that are directly connected to the internet IoT ecosystem (Shu et al. 2011).

Radio Frequency Identification (RFID), remote wireless communication, real-time localization, and sensor networks are all examples of IoT technology. Smartphones, tablets, and laptops are examples of smart gadgets and technologies that are embedded with IoT (Jara et al. 2013). It can involve as many connected devices as possible with IoT technologies to assist the report to record the identification and position via wired or wireless communications (Kamilaris & Pitsillides 2016). To conduct business, entrepreneurs use a variety of technologies, including any path and network to get to any destination as quickly as possible. They also utilize devices implanted with an intelligent system at any place and use it anytime. All of them can be integrated to create an IoT that reaches out and communicates with people.

IoT is growing rapidly and is being recognized as an innovative future technology that is attracting interest from a variety of areas across the globe (Al-Fuqaha et al. 2015). Malaysia is not exempted from being one of the Southeast Asian countries with the necessary infrastructure for IoT adoption. By 2015, the Malaysian government will have implemented IoT across the country. Malaysia has a strategic and structural backdrop that is relevant to the development of IoT and can be a factor point to support and drive IoT in the home market, according to National Internet of 2641 Things Strategic Roadmap, 2014. (Badarudin et al. 2018). Malaysia also has been named the leading digital economy among developing countries, ranking fourth in the UN E-Government Commission's 2015 Online Services Index.

Due to the growing number of mobile users in Malaysia, mobile device penetration has surpassed 150 percent and is expected to reach 280 percent by 2025. While 137 percent of Malaysians use the internet, this number is expected to rise exponentially to 190 percent by 2025. This is largely due to active online behavior, with more than 59 percent of Malaysian internet users downloading mobile apps compared to the Southeast Asian average of 67 percent (Weber & Studer 2016). As a result of online evolution, the Internet has gone through several different phases. As opposed to the earlier phase, which was more focused on private comfort, current usages have a more profound impact on society and industry. Although the internet and World Wide Web are different, they are interconnected. Additionally, there are chances to implement the IoT thanks to the rising use of RFID.

RFID is a system that transmits the tags (in the form of a unique serial number) of an object without cables by using radio waves. This system is an automatic identification technology that has three main components which are Antenna or coil, RFID Reader or Interrogator and RFID Tag RFID Tag (Mandeep Singh et al. 2011). It is also pushed by market forces, as the business is becoming more and more aware of the financial advantages of applications that may

be implemented with the technology of the IoT (Sicari et al. 2015). As a result of the need to communicate anytime and anywhere, cell phone usage has evolved significantly, which has had a substantial impact on the development of the Internet of Things (Tsai et al. 2014).

The power of the IoT has disrupted several industries during the pandemic Covid-19 with established business models, particularly in the healthcare sector. Healthcare has been changing from a case-based paid service to a value-based care service as linked sensors and gadgets have become more prevalent, wireless technology has advanced, cloud computing has been more accessible, and data analytics has become more advanced. IoT-enabled healthcare apps (Yuan & Cheah, 2020) are what are known as these value-based care services. The goal of IoT-enabled healthcare is to offer patients and consumers high-quality medical services that are low-cost, technologically cutting-edge, and easily accessible. This system has been valuable during the endemic season and helps a lot in reducing the man force of healthcare workers especially.

In addition, the research on IoT entrance in the ICT industry has been divided into five areas, which include smart wearables that are frequently used to track human health, such as calories, heartbeats, and walking steps. The second type is the "smart home," which allows for remote monitoring and management of the residence via a website or a mobile device. Smart cities come in the third position with the use of sensor devices, intelligent cameras, and other tools. Lastly, there is a smart enterprise (Perera et al. 2015), followed by a smart environment where individuals may monitor the environment online.

In Malaysia, IoT can truly help numerous industries, including supply chains. With the use of IoT, businesses can reduce risk and increase profit. The ability of the supply chain to trace products is well established. With the developing industrial of IoT, the sector is now attempting to wager the rivals. The courier will obtain the client's signature on the delivery sheet after giving the customer the package during the delivery procedure to the final customer (Khairuddin et al. 2019). Following the delivery of the packages, the courier will visit the delivery location to manually update the shipment status by inputting the necessary data into the system. The system will then update the shipment's status to "delivered," and the customer may check the status by entering the tracking number on the courier's website. The last mile delivery is the term used to describe this procedure. For the direct-to-consumer market, the last mile of the supply chain is seen as its final component.

Today, Malaysia has developed a new teaching strategy called a Massive Open Online Course that advocates the use of open learning (MOOC). With this learning approach, everyone in the community has access to open educational resources at any-time, anywhere and they can also learn from one another. Malaysia's goal in the academic sphere is to promote lifelong learning and a favourable learning environment (Badarudin et al. 2018). To maintain its competitiveness, Malaysia's IoT industry has developed new methods of testing, reference data and materials, infrastructure, and technological services distributed in the academic sector.

IoT technologies are needed in agriculture to manage animal farms and agriculture. IoT is also utilized to frequently monitor and track their movement. Real-time animal tracking is an example of an IoT application, particularly when there are diseases that can impact animals. As a result, animal diseases can be regulated and prevented. This is all feasible because of the system identification that has been introduced over the world (Nukala et al. 2016). Besides, Malaysia's goal in the agriculture sector is to emphasize food capacity by enhancing Malaysia's reputation for high-quality food and as a centre for halal trade. Field monitoring for irrigation, plantation and crop field analysis can also be done by using an IoT system. This will reduce the need for the workforce as well as the cost.

As shown in Figure 1, the various application of IoT was stated regarding the enhancement over the world. According to respective figure, IoT can be classified into several factors such as healthcare to focus on monitor human health, education in developing the new teaching and learning method, smart home to monitor and control the house from smartphone or website, agriculture in managing agricultural and animals farming, transportation and logistics as well as in industry 4.0 to provide better two-way communication, control, and data distribution in whole system of transport and industries elements.

IoT is aggressively developing over the world including in Malaysia. Malaysia had started IoT deployment facing issues and challenges to maintain the operability of IoT. During Covid-19, Malaysia was actively cultivating IoT-based industries like e-commerce, big data analytics, artificial intelligence (AI), blockchain and automation. Malaysia has announced action plans focuses on expanding and improving the country's digital connectivity through widespread deployment of mobile, fiber and fixed wireless access for every sector. For example, in agriculture sector, smart farming is rapidly becoming the future of agriculture such as IoT or traceability systems in supply food chain that improve food safety and production transparency. This pandemic also has changed the conventional way of learning, and the government has introduced initiatives to soften the impact, including improving the digital platform infrastructure for online learning.

This section will focus on the technology trends with IoT applications in varieties sector including education, healthcare, housing, agriculture, transportation, industry, and tourism. Furthermore, the economic impact of the pandemic also will be discussed.

FIGURE 1. Various applications of IoT technology

TECHNOLOGY TREND OF IoT DURING PANDEMIC

The IoT is advancing into an important technology for long-term sustainability. Intelligent connected devices' ability to enable and advance applications such as environmental monitoring, territorial management, and energy optimization is well-known within the IoT community (Belli et al. 2020). IoT technology has the potential to enable green marketing solutions, for cities, and communities, especially as the focus on building a green economy and mitigating climate change grows (Almalki et al. 2021). These applications, which include lowering energy costs, enabling remote deployments, monitoring failure points, and many others, will quickly be transitioned from niche applications to IoT growth drivers. One of the IoT community's main goals should emphasize the integration of IoT into any viable model of a long-term global economy (Nicolescu et al. 2018).

Moreover, with IoT being used to help manage the Covid-19 crisis and improve healthcare, the number of innovative and sometimes unexpected use cases we see each year is staggering, and never more so than now. As a result of the pandemic situation, we provide a summary of how IoT networks have been used so far for major existing and emerging applications as depicted in Figure 1.

In addition, Table 1 summarizes the most common Covid-19-related applications that have already emerged or are expected to emerge. This table lists the sector, trend applications in each sector, and IoT applications that are being used to collect data on various physical parameters that could aid in pandemic monitoring and management at both the personal and organizational levels.

Figure 2 and Figure 3 shows infographics of the IoT transformation for certain sectors before and after the pandemic respectively. The infographic showing how the implementation of IoT before and after the pandemic.

TABLE 1. The most common COVID-19-related applications have already emerged or are expected to emerge

Sector	Trend	IoT Applications
Education	Learning management systems (LMSs) were implemented and diversified enjoying the reliance on various methodologies and efficient algorithmic developments	• Remote Schooling (Zaguia, Ameyed, Haddar, Cheikhrouhou, & Hamam, 2021) • Teaching process through timely DDoS detection (Cvitić, Peraković, Periša, & Jurcut, 2021)
Health care	Collecting healthcare data helps in analyzing, personal health and provides strategies to combat illness.	• Monitoring U.V radiation (Odusami, Misra, Abayomi-Alli, Olamilekan, & Moses, 2022) • Athletes care (Balcombe & De Leo, 2020) • Smart Management of Healthcare Services (Akbarzadeh, Baradaran, & Khosravi, 2021; Kaiser, Al Mamun, Mahmud, & Tania, 2021) • IoT based bracelet that measures body temperature and blood oxygen level (Ennafiri & Mazri, 2020)
House	Smart houses consumer needs IoT technology to increase convenience, reduce costs and converse energy.	• Monitoring the environment of internal building (Aziz & Nasir, 2021) • Monitoring water (Mahaboob, T, R, V, & V. B, 2022)

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| Agriculture	Enabling farmers in smart agriculture to contend with the challenges they face.	• Microclimate monitoring (Muladi et al. 2021) • Smart irrigation (Bei & Fayeez, 2022) • Animal tracking (Niranjana et al. 2022)
Transportation / aviation	Smart cities applications include traffic management, water distribution, waste management, environmental urban security, and monitoring	• Managing traffic (Krishnan et al. 2021) • Managing smart street (Elbany & Soliman, 2021) • Managing car in parking area (Delot & Ilarri, 2020)
Industry	Smart industries IoT (IIoT) is empowering industrial with smart devices, big data analytics, and software to design brilliant	• Reducing waste (Rahman et al. 2021) • Reducing energy intensity (Guha Roy, 2022; Sharifi, Ahmadi, & Ala, 2021) • Reducing carbon emission (Vaka, Walvekar, Rasheed, & Khalid, 2020)
Tourism	Provide travelers with a luxurious experience they expect while safeguarding their health in these trying times	• Touchless service (Gaur, Afaq, Singh, & Dwivedi, 2021) • Redefine structure (Bank, 2020),
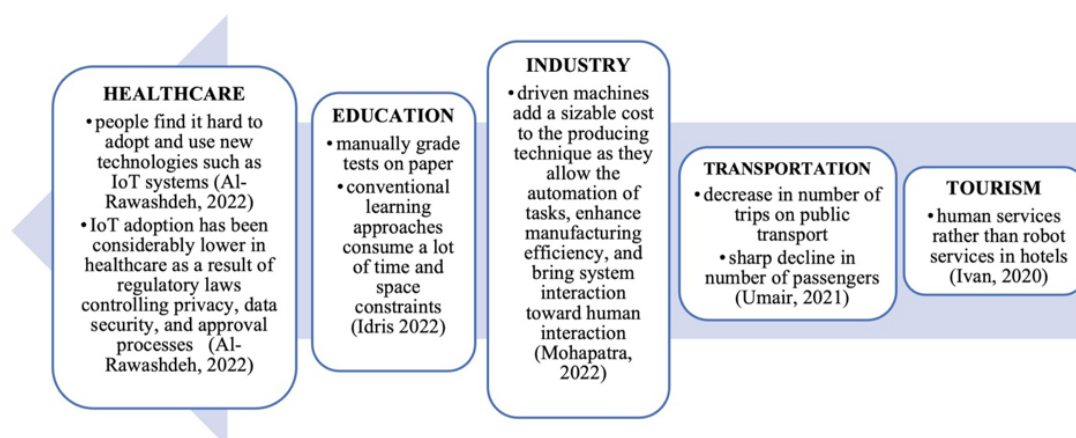
FIGURE 2. Infographic of the IoT transformation for certain sectors before the pandemic.
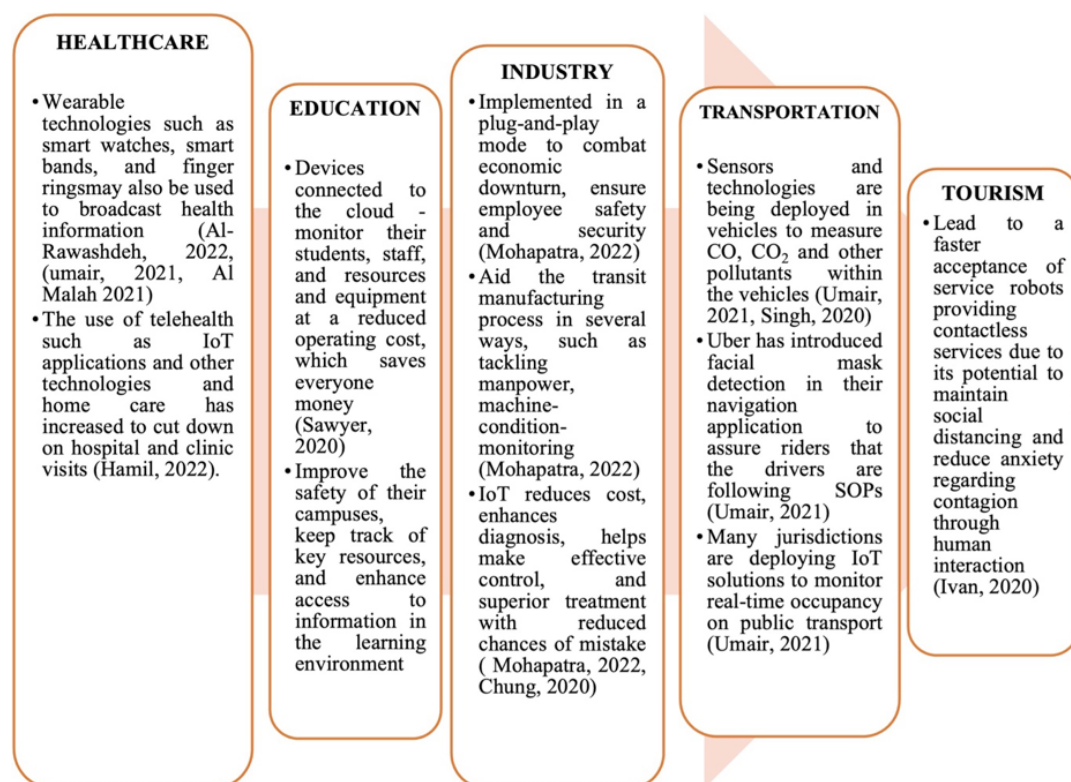
FIGURE 3. Infographic of the IoT transformation for certain sectors after the pandemic.

ECONOMY IMPACT OF IoT DURING COVID 19

The IoT has been called the main component of the 4th industrial revolution (4IR). IoT uses sensors and internet-connected devices to track and control objects. These IoT sensors can help factories in their manufacturing process, which enables them to send and receive data. Companies that embed IoT technologies will get a great gain as it improves the overall efficiency of the company's operation. The analysis processes such as quality control, demand forecast, machine utilization, preventative maintenance, and detecting fraud can be done with the help of IoT technologies.

Globally, according to Lionel Sujay Vailshery who is a research expert in the consumer electronics industry, the IoT global annual revenue was worth around $389 billion U.S. dollars in 2020 and is forecast to rise to more than $1000 billion in 2030 (Vailshery 2022). While McKinsey reports that IoT applications will have a total economic impact of $3.9 trillion to $11.1 trillion per year in 2025 (James & Chui 2015). The IoT will give benefit on operation costs of companies that implemented IoT technology by 4-6% on average (Merzlova 2022).

In the IoT era, businesses are powered and grow by using various smart devices and smart data. With this technology, enterprises are choosing to optimize and increase asset productivity and reduce operational costs. The effect of business with IoT is shown in Figure 4.

The IoT influenced business by enabling the development of new smarter and better products and services, resulting in an increase in the number of Android-based devices. For operational management, IoT aids in asset tracking via barcodes and sensors via RFID tags. Furthermore, remote control devices might help to streamline the automation process in supply chain stages or even in retail stores. The IoT, real-time data business experience machine downtime and energy consumption will enhance efficiency and firm profitability. The use of cloud technologies for real-time operations and data processing will help speed up the company's development of cloud technology. If no changes are made to the business processes, the old business model will vanish. Finally, the IoT will increase demand for qualified labour as businesses expand.

FIGURE 4. How has IoT affected the business?

Meanwhile, in Malaysia, with the recent issues of the Covid-19 pandemic had highlighted a newfound sense of urgency to the digital inclusion agenda. While the crisis has enabled many millions to figure out, learn and connect digitally, it's easy to determine how it's also exacerbated the situation for far too many people in vulnerable situations around the world. Digital Transformation Roadmap has been launched with action plans focusing on expanding and improving the country's digital connectivity (Bernama 2021).

Besides, the government has established Malaysia Digital Hub which was built for facilitating entrepreneurs or SMEs in getting support such as intellectual property protection, market access, and fintech technologies (Bernama, 2022). It is very important for the digital economy because it brings a better opportunity to connect local business companies with ASEAN through the global digital ecosystem.

Aside from Malaysia Digital Hub, MDEC (Malaysia Digital Economy Cooperation) was also instrumental in hastening Malaysia's economic digitization. SMEs have been identified as one of the change agents that would propel national development. To deal with the abrupt change in business, the Malaysian government introduced several programs under the Short-Term Economic Recovery Plan (PENJANA 2020) and Budget 2021 and 2022. This aims to ensure that Malaysian SMEs can experience several stages of digital adoption, and as such, various digitization grants have been granted, including the SME Digitalization Grant, the Smart Automation Grant, the 4IR Catalyst Grant, and the Global Technology Grant.

The Ministry of Science, Technology and Innovation reported that the digital economy is expected to contribute 22.6% of Malaysia's gross domestic product (GDP) and create over 500,000 jobs by 2025 which is in line with the 12th Malaysia Plan (Ahmad, 2022). Furthermore, to support

the digital economy plan, MRANTI which is Mosti's on-campus 5G Experience Centre will become the first artificial intelligence (AI) park in Malaysia, which will serve as the platform for the development of AI solutions and a drone technology center of for flying, testing, research, and development activities. Since the pandemic in 2020, 81% of all internet users in Malaysia are now consumers of digital services reported by Google, Temasek, and Bain & Company on the e-Economy in Southeast Asia (Bernama 2021).

The Malaysian Digital Economy Blueprint (MDEB) is depicted in FIGURE 5. MDEB will be delivered through six strategic thrusts, twenty-two strategies, 48 national initiatives, and twenty-eight sectoral initiatives. These initiatives are divided into six categories: economy, digital talent, digital infrastructure and data, society, emerging technology, and government. It will be implemented in three phases, with Phase 1 (2021-2022) aimed at accelerating adoption and strengthening the digital foundation required for the rapid and smooth rollout of Phases 2 and 3. Phase 2 (2023-2025) focuses on driving digital transformation and inclusion across the digital economy, emphasizing inclusivity among citizens and businesses at all levels. Phase 3 (2026-2030) will pave the way for Malaysia to achieve strong, long-term growth in the coming decades (Economic Planning Unit (Prime Minister's Department), 2021).

MyDIGITAL Cooperation presented a 2021 progress report to the public to report on the progress of the Malaysian Digital Economy Blueprint (Economic Planning Unit (Prime Minister's Department), 2022). MyDIGITAL Progress Report 2021 presents a glimpse of the digital space's progress. It creates the groundwork for Malaysia's digital goals and ambitions to be achieved gradually in the years ahead as we approach 2030 when Malaysia will assume its hard-earned position as a leading regional digital economy.

Covid-19 in 2020 causes Malaysia's economy suffered a 5.6% fall in real GDP. However, Malaysia's economy managed to recover in 2021 with 3.1% growth and even stronger in the first quarter of 2022 with a growth of 5.5%. Malaysia's economy, like that of many other countries, will likely be impacted by recent global economic disruptions and rising prices. Currently, the Malaysian economy's prognosis remains bright, with GDP expected to increase between 5.5 and 6.5 percent in 2022, in line with the World Bank's prediction of 5.8 percent with a with headline inflation expected to range between 2.2% and 3.2% (Vailshery 2022). It is being driven by strong domestic demand and significant export expansion. It demonstrates that, despite the Covid-19 global health crisis, Malaysia maintains robust economic growth with the integration of the digital economy.
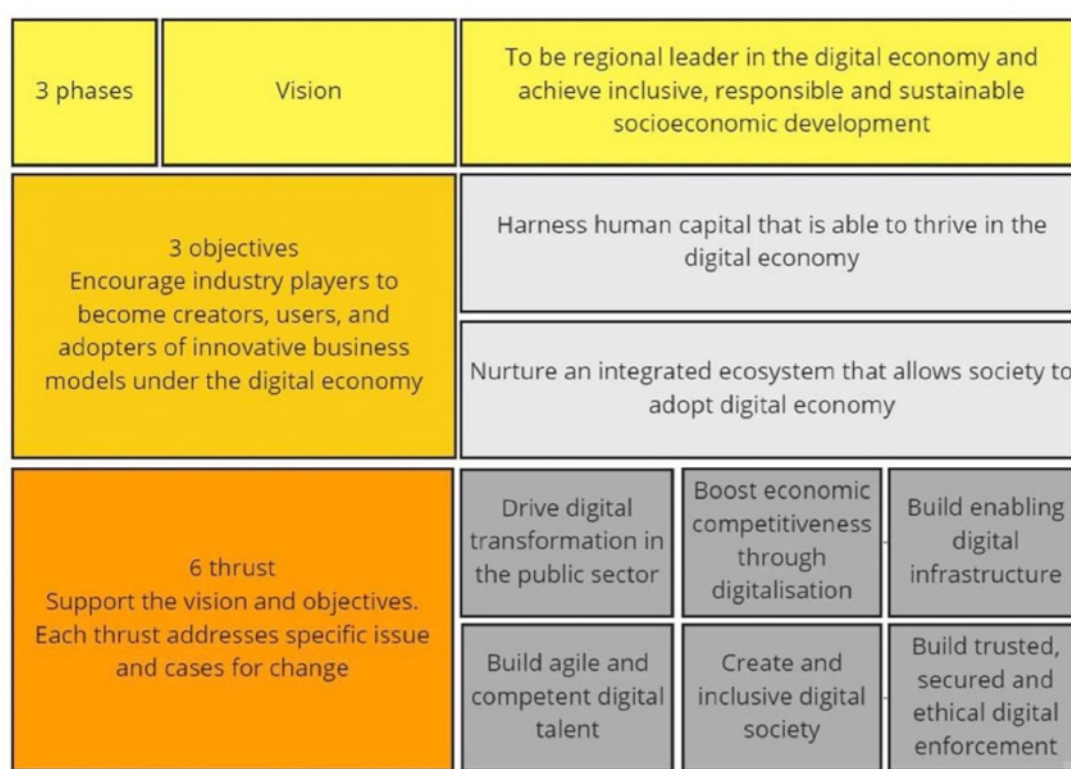

FIGURE 5. The Malaysian Digital Economy Blueprint (MDEB) (Economic Planning Unit (Prime Minister's Department), 2021)

CONCLUSION

During this pandemic situation, activities that do not require human interaction are being increasingly driven by the IoT. The IoT is used worldwide, including in Malaysia, because it gives valuable information that can be used in many ways. In this paper, we presented and reviewed the impact of IoT applications from several sectors (i.e., healthcare, education, logistics, and industry) by highlighting how it benefits Malaysia's economic growth. The implementation of IoT provides a tremendous opportunity to improve our lives, potentially impacting society, particularly during the Covid-19 pandemic.

The most significant contribution of IoT during and after Covid-19 is the availability of long-term healthcare services. Integrating IoT technology into the healthcare system can help with digitally storing the health information of Covid-19 patients. The ability of IoT services such as MySejahtera Application has helped in collecting remote data and monitoring quarantined patients thus has made it a critical component in containing the virus pandemic.

The Covid-19 pandemic in Malaysia has had a significant impact on economic growth, with GDP declining significantly and the unemployment rate rising significantly. However, in terms of business benefits, the COVID-19 crisis accelerated the growth IoT implementation with the e-commerce shopping transition of the business model from physical to digital stores. During MCO, people begin to realize that they can purchase a wide range of products and services online.

Micro-businesses, on the other hand, are one of the industries most affected by MCO restrictions. Over the medium-term, a fiscal consolidation strategy is needed to contain the economic impact of these situations.

ACKNOWLEDGEMENT

DECLARATION OF COMPETING INTEREST

None

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