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DIGITAL SOCIETY RESEARCH REPORT VOL 07

MALAYSIAN COMMUNICATIONS AND MULTIMEDIA COMMISSION, 2024

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About the Digital Society Research Grant (DSRG)

The Digital Society Research Grant (DSRG) was conceived to contribute towards the enhancement of information resources that are necessary and in line with changing community expectations as we navigate the transition towards a sustainable digital civil society.

This grant aims to grow the evidence base necessary for the nation to optimise the advancements made in communications infrastructure and service deployment. This base will assist the development of policy, programmes, and interventions to promote the inclusion and participation of all segments of the population as the nation transitions towards being a fully digitally connected and informed society.

About MCMC

The Malaysian Communications and Multimedia Commission (MCMC) is a statutory body established under the Malaysian Communications and Multimedia Commission Act (MCMCA) 1998 which implements the government's national policy objectives for the communications and multimedia sector.

MCMC regulates and develops the communications and multimedia industry, which includes telecommunications, broadcasting, online activities, postal services, and digital certification. The Communication and Multimedia Act (CMA) 1998 assigns the policy implementation role to MCMC, while policy decision-making is vested with the Minister. MCMC is also responsible for postal services and digital certification under the Postal Services Act (PSA) 2012 and the Digital Signature Act (DSA) 1997.



**YBhg. Tan Sri
Mohamad Salim bin Fateh Din**

**Executive Chairman
Malaysian Communications and
Multimedia Commission**

In 2024, we have made significant strides in advancing Malaysia's communications and multimedia landscape, driven by a steadfast commitment to ensuring that Malaysia remains at the forefront of emerging technology. Our pursuit to serve the industry and the public with integrity, foresight, and responsibility has guided every decision and initiative we've undertaken.

At the Malaysian Communications and Multimedia Commission (MCMC), our approach to regulation is deeply rooted in evidence and research. Every decision and policy implementation is grounded in robust data analysis. Therefore, we fund research projects that directly support our work, ensuring we address the current needs of the industry while anticipating future challenges. The Digital Society Research Grant (DSRG) continues to provide valuable insights, having awarded 66 grants as of Q2 2024.

These research projects cover a wide range of key areas, from improving digital infrastructure to enhancing consumer experience. The insights gained from these researches not only support our internal decision-making but also benefit a broader range of stakeholders across the industry. The relevance of this research underscores our dedication to making informed, impactful decisions.

As we plan for 2025 and beyond, we are focused on positioning ourselves as a progressive and adaptive regulator. Our main goals include continuously improving our policies and regulatory frameworks to better serve the Rakyat and the industry.

One of our top priorities is expanding and continuously improving connectivity, ensuring that all Malaysians have access to high-quality digital services. We are also committed to enhancing the overall service quality, making sure that consumers can rely on a robust and reliable digital infrastructure. As the industry evolves, so too must the skills of its workforce. We are dedicated to enabling a skills-first workforce that is adaptable to the rapidly changing technological landscape.

Looking ahead, we are also exploring new research areas that will be crucial to our ongoing efforts. These include the future of work within the communications and multimedia sector, focusing on essential skills and competencies. Additionally, we are paying close attention to sustainability and environmental practices within our industry, recognising their growing importance on a global scale.

I would like to take this opportunity to express my sincere appreciation to the university and research communities for

their hard work and dedication in contributing to the success of DSRG. Your research has been invaluable in shaping the policies and regulations that guide our industry.

I would also like to acknowledge our research sponsors for their continued support and contributions, which have been instrumental in creating a wide range of research topics and maintaining our position as a proactive regulator.

As we move forward, I am confident that together, we can continue to build a communications and multimedia industry that is innovative, inclusive, and resilient. Let us continue to work together towards creating a better digital future for all Malaysians.

**YBhg. Tan Sri
Mohamad Salim bin Fateh Din
Executive Chairman
Malaysian Communications and
Multimedia Commission**

Executive Summary

The seventh edition of MCMC's "Media Matters" features comprehensive research findings that provide critical insights into various aspects of Malaysia's communications and multimedia landscape. This edition encompasses 18 studies funded under the Digital Society Research Grant (DSRG) 2022 Cycle 2 and 2023 Cycle 1, with research projects focusing on public awareness, technological integration, policy impacts, and emerging trends in the industry.

Public Awareness and Perception

The study on public awareness of the MCMC label for communication devices underscores the significant impact of consumer knowledge on the effectiveness of the Check Your Label (CYL) campaign and self-regulation behaviours. Key recommendations include promoting QR code verification, engaging university students in campaigns, setting up educational booths, and using targeted advertising strategies for different age groups. Furthermore, the research on public perception of 5G electromagnetic field (EMF) emissions reveals significant health concerns among the public. With 56.6 per cent of respondents expressing worry about potential health risks such as cancer, headaches, and fertility issues, the study recommends clear communication of safety standards, funding independent research to provide scientific evidence on 5G health effects and launching targeted awareness campaigns. Regular safety audits of 5G infrastructure and continuous monitoring of EMF emissions are also suggested to ensure compliance with safety limits and build public trust.

Regulatory and Policy Impact

Policy impact is a crucial aspect of MCMC's work, reflected in studies on the implementation of Pelan Jalinan Digital Negara (JENDELA) and regulatory developments within the postal industry. The JENDELA study highlights a significant lack of awareness about the plan among various groups, including

educators, private individuals, and rural communities. Recommendations include enhanced promotional efforts to raise awareness, digital literacy programmes to address resistance to technology adoption, and robust infrastructure investment to ensure reliable coverage, especially in underserved regions. Similarly, the postal industry study reveals substantial negative gaps in service quality dimensions, with top issues including timely notifications, prompt responses to customer requests, and handling lost or damaged parcels. Both studies underscore the importance of improving accessibility and service delivery, whether through better infrastructure or more responsive customer support systems, to address the needs of diverse communities. Additionally, the research on Environmental, Social and Governance (ESG) adoption in the communications and multimedia industry addresses challenges such as energy consumption, e-waste management, and supply chain complexity. Opportunities identified include adopting energy-efficient technologies, renewable energy, and innovation in green technologies and sustainable practices.

Technology Adoption and Implementation

MCMC's role in promoting technological integration within the local economy requires assessing the relevance of innovations to local industries. The report includes studies on the impact of 5G digitalisation, internal data sharing, and ESG adoption on business productivity and growth across various industries. The findings from the study on internal data sharing indicate that such practices positively influence employee performance and decision-making quality by making work more efficient and effective. Recommendations emphasise promoting frequent data-sharing, implementing best practices for data management, and encouraging data-driven innovation through competitions like the Challenge on Innovation and Problem Solving through Technology Advancement (CHiPTA) conducted by the Malaysian Administrative Modernisation and Management Planning Unit (MAMPU). The research on 5G digitalisation benchmarking for smart industries outlines the adoption of 5G in agriculture, cities, and government. Key recommendations include developing regulatory frameworks and standards for 5G deployment, investing in scalable

5G infrastructure, and fostering collaboration between government agencies and research institutions to create tailored solutions for smart verticals.

Digital Signature and National Digital Identity

The adoption of digital signatures for e-government initiatives is another focal point of the report. The study identifies moderate awareness of digital signatures, with significant gaps in knowledge about the differences between digital and electronic signatures and the costs associated with adoption. Key factors influencing adoption include simplicity, security concerns, and management support. Recommendations include increasing awareness through campaigns and training programmes, simplifying the implementation process by providing guidance on integration with existing systems, and addressing security concerns by emphasising the robustness of digital signatures. Additionally, the study examines the National Digital Identity (NDI) initiatives indicating that the public has limited knowledge about NDI, with significant variations in awareness and acceptance. Younger individuals exhibited higher levels of familiarity with NDI compared to older individuals. Recommendations include developing comprehensive public awareness campaigns, integrating digital literacy programmes into educational curricula, and ensuring NDI platforms are user-friendly with intuitive designs and multilingual support.

Media Consumption and Preference

The research on Free-to-Air channels explores viewing patterns and motivations in the East Coast region of Peninsular Malaysia and Sarawak. The study finds that key motives for watching Free-to-Air TV include economic benefits, flexibility of use, and the accessibility of content. Popular genres include religious, comedy, health, and entertainment, reflecting local practices and cultures. Recommendations for improving viewer satisfaction include tailored programme scheduling that considers regional viewing patterns and preferences, targeted advertising that aligns with audience cultural values, and the use of engaging advertising formats such as cross-promotion with online marketing. Additionally, the study highlights the importance of addressing

barriers to the adoption of digital TV technology, such as technical difficulties and lack of access in remote areas, by implementing educational campaigns and improving technology literacy.

Educational and Professional Development

The readiness of higher educational institutions (HEIs) for micro-credentials is critical for fostering skills development and capacity building within the industry. Key challenges identified include infrastructure readiness, management support, quality assurance, and learner centricity. Technological factors such as data privacy, credential fraud, and platform reliability are also critical. Recommendations emphasise enhancing infrastructure readiness, fostering management support and strategic alignment within HEIs, ensuring quality assurance and standardisation of micro-credentials, and promoting learner-centric approaches by providing adequate training for educators. Moreover, the study on the role of micro-credentials in capacity building finds that they enhance employee engagement and support ongoing professional development. Malaysian universities offer diverse micro-credential programmes including programming, security, data analytics, Artificial Intelligence (AI), and multimedia. Recommendations include developing future micro-credential courses focusing on network and communications, Internet of Things (IoT), cloud computing, applied multimedia, and security to meet industry needs. Additionally, the study highlights challenges such as securing expertise, gaining recognition, and developing suitable assessment methods. Addressing these challenges is crucial for the successful implementation and sustainability of micro-credential programmes.

Specialised Industry Insights

The present issue of Media Matters offers targeted insights for identified industry vertical segments. The study on digital healthcare adoption by senior citizens identifies barriers such as lack of trust, financial constraints, limited internet access, and concerns about privacy and data security. The recommendations to tackle the issues have focused on improving digital infrastructure, enhancing

digital literacy through tailored training programmes, boosting health literacy with high-quality information, and increasing awareness of digital healthcare services through targeted campaigns. In comparison, the research on digitalisation in the oil palm plantation sector reveals a moderate level of digital adoption, driven by performance expectancy and social influence. Both studies emphasise the need for targeted education, infrastructure improvements, and support to address sector-specific challenges and promote broader adoption of digital technologies, whether in healthcare or agriculture.

Conclusion

The DSRG-funded research projects provide actionable insights that enable MCMC to develop well-informed strategies and policies. By leveraging these findings, MCMC is committed to enhance regulatory frameworks, promote technological advancements, and ensure a digitally inclusive society. Additionally, these research underscores the importance of collaboration between MCMC, the research community, and industry stakeholders to drive innovation and progress in Malaysia's communications and multimedia landscape.

TOPIC 01

Public Perception on Electromagnetic Field Emissions from 5G Radio Communication Infrastructure and Consumer Premise Equipment in Malaysia

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Abstract

The massive deployment of advanced wireless networks is essential to support broadband connectivity, low-latency communication, and Internet of Things applications. Nevertheless, in the time of coronavirus disease (COVID-19), there is a massive amount of misinformation and uncertainty about the impact of the fifth-generation (5G) cellular network on human health. Fake news and misconceptions about 5G in Malaysia may spread fear and undermine public trust, potentially causing delays in 5G deployment. Understanding Malaysian public perceptions of 5G EMF health effects is crucial for network infrastructure and devices. We conducted a research study on Public Perception on Electromagnetic Field (EMF) Emissions from 5G Radio Communication Infrastructure and Consumer Premise Equipment (CPE) in Malaysia with the project acronym EMFERCICE. The project aims to investigate the level of Malaysian public perception of 5G radiation emissions in Malaysia. The study looked into public understanding factors, including information source characteristics (media exposure) and health-risk characteristics, taking into

account their perceptions of EMF emission from network infrastructure and consumer premise equipment. The study found that over half of the respondents (56.6 per cent) out of 410 total respondents were concerned about 5G, with the biggest concern being the potential health effects of 5G radiation (69.4 per cent). The majority of the respondents perceived low to moderate levels of 5G radiation exposure, which may be due to their trust in policies protecting them from 5G EMF radiation. Most respondents (77.1 per cent) believed that public policies provide protection from EMF exposure. However, respondents who perceived high 5G radiation exposure were likely to have health concerns about 5G. The study suggests several recommendations to strengthen public trust in 5G emissions which include clear communication of safety standards, independent research and studies, independent safety audits, continuous monitoring of emissions, and independent safety audit, aiming to build a positive narrative around 5G technology and maximise the benefits.

Introduction

The recent development of the fifth-generation (5G) network has led to widespread expectations that it will revolutionise mobile communications. With applications such as industrial automation, extended reality, and autonomous vehicles, 5G is expected to lead to substantial benefits globally, including an estimated contribution of up to USD 588 billion in global tax revenue from 2020 to 2034 (GSMA, 2018).

Among the pioneer countries of 5G, Korean mobile carriers began distributing the service in April 2019 (France Presse, 2019), and in less than three (3) months, more than a million users have joined the network (Chamberlain, 2019). Since then, other countries have also witnessed steady increases in the number of subscribers, leading experts to project that the 5G network would cover 55 to 65 per cent of the world's population by 2025 (Reichert, 2019).

As such, demand for the 5G network has been high; Malaysia has also begun to strategise for 5G deployment via the National Digital Network (JENDELA) plan. JENDELA has targeted reaching 100 Mbps speed through 5G service by 2025, which means Malaysia will be charted as part of

the 55 to 65 per cent 5G coverage of the worldwide projection by 2025.

In contrast to its apparent popularity, however, the new technology may not be welcomed by everyone. Some people appear to embrace this novel technology, whereas others dissent, as members of the public have perceived that exposure to electromagnetic (EM) waves from 5G network base stations poses potential health risks. The current deployment of 5G in many countries around the world has triggered heated debates and unsettledness in the general public (Broad, 2019b; Foster, 2019). Protests in Korea have delayed the construction of base stations (Jun, 2019), and anti-5G demonstrations have filled the streets in the United Kingdom (Hern, 2019) and Switzerland (Jones, 2020).

Problem Statement

Some portion of the population is concerned about potential health impacts from being exposed to 5G radiofrequency radiation (RFR) (Nyberg and Hardel, 2017), which may impact the deployment of 5G in this country, as experienced previously by some 5G pioneer countries. This project foresees two (2) major problems

associated with the perceived health risk among the Malaysian public due to 5G radiation:

1. Assumptions are being made that “many” Malaysians are against 5G and perceive the 5G radiation as harmful.

There is no structured study that provides answers to how many is “many” for Malaysians. There are discussions, statements, and claims that have been circulated online by Malaysians, especially in mainstream social media, but how much these have impacted the public’s perception of 5G radiation is simply unknown.

3. Sources of information that spread fake news and misconceptions about 5G to the public.

Authorities such as the World Health Organization (2020) made statements that EM waves from 5G network base stations would not cause substantial adverse health effects as their levels were well within the exposure limits; however, the public perception may not diminish much since the sources of misinformation about 5G are still circulating. Social media has been one (1) of the sources of 5G information, reliable or not. Malaysian public perception may be shaped by the existence of these sources, influencing the thinking and behaviour of readers.

Objectives

To gauge the public’s perception in Malaysia of the health effects of 5G EMF emissions.

To identify the sources of 5G EMF information referenced by the public and examine their contributions to the public’s perception.

To measure the level of public understanding of the implications of the 5G network base stations (BS) and consumer premise equipment (CPE) in their vicinity.

To provide recommendations for building public trust in the safety of 5G network BS and CPE.

Literature Review

5G Radio Frequency Radiation from Network Infrastructure and Consumer Premise Equipment

RFR is non-ionising radiation that involves waves with smaller energy that cannot ionise the cells, thus preventing severe impacts on the exposed cells. Nevertheless, the electromagnetic field (EMF) can cause the molecules to vibrate, leading to a possible heating effect on the exposed tissues, i.e., a thermal effect (Foster et. al., 2017). In this regard, regulatory authorities such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Federal Communications Commission (FCC) quantify the maximum allowable radio frequency (RF) exposure to limit the temperature rise of the exposed tissues (ICNIRP, 2020). Regarding the non-thermal long-term exposure to 5G, there is a debate in the community about whether it has adverse health impacts. However, no adverse effects have been proven for exposure that is consistent with the regulatory limits. The 5G cellular network promised to deliver high-data-rate communications for an increasing number of users. This can be done through network

densification, which means installing a massive number of base stations and small cells, as well as adopting millimetre-wave (mm-wave) frequency. This has led to concerns among the population about the potential health impacts of being exposed to 5G radiofrequency radiation (RFR) (Nyberg and Hardel, 2017). The impact is worrying because the arising doubts about 5G can delay the deployment of 5G in some countries, leading to unfavourable economic impacts, as reported by Jones (2020).

Additionally, network densification causes the space between users and the closest cell to close, increasing the perceived negative effects on health. EMF emissions result from both the expansion of customer premises equipment and network infrastructure (CPE). Nearly any end-user device nowadays qualifies as CPE. Telephone handsets, channel service units or data service units, routers or wireless access point devices, broadband, Ethernet, or DSL modems, cable set-top boxes, adapters for network services, local area network (LAN), or wide area network (WAN) devices, are just a few examples of the various types of equipment that qualify as CPE. Mobile phones and routers are common CPEs that emit EMF

that are included in this equipment. The deployment of CPE close to consumers may lead to perceived health problems among them.

The Use of 5G Beamforming Antennas to Minimise Exposure to RF-EMF

In order to increase network capacity and efficiency while lowering electromagnetic field (EMF) exposure, beamforming antennas are a crucial piece of technology utilised in 5G base stations (Larsson et. al., 2014; Ojaroudi et. al., 2020; and Betta et. al., 2022). It is a method for concentrating and directing electromagnetic signals in a particular direction that is utilised in wireless communication systems, including 5G. Beamforming directs signal energy toward the target receiver rather than dispersing it evenly in all directions, increasing signal intensity, coverage, and capacity. Instead of broadcasting their wireless signals in all directions, 5G base stations can focus them on the targeted users by employing beamforming. This makes it possible to utilise the energy transmitted more effectively, which lowers the total power needed for communication. Reduced power also reduces the amount of EMF exposure in the vicinity. To focus on certain

user devices, beamforming antennas can dynamically change the beam's shape and direction. By precisely directing the signal to a specific device, the base station can ensure the highest possible signal quality while using less unnecessary transmission power. Additionally, 5G base stations have the capacity to create numerous beams at once, improving the spatial reuse of the available spectrum. This increases network efficiency and lowers overall power consumption by allowing several customers to be served concurrently in the same frequency range. Depending on the user's position, movement, and communication needs, beamforming antennas can change the direction of their beams. By allowing for configurable coverage and capacity distribution, this flexibility makes it possible to retain the essential signal quality while minimising extraneous radiation in places where it is not required.

Although the need for communication systems with extremely dependable links and good coverage is undeniable, one (1) of the worries people have about the adoption of 5G technology is related to the potential biological impacts and health implications caused by electromagnetic exposure (Betta et. al., 2020). According to research, the general public is adamant that 5G densification causes an unchecked and undesirable rise in human exposure

levels (Chiarav viglio et. al., 2022). A correct evaluation of EMF exposure is crucial for these reasons.

Misinformation on 5G

Fake theories and hoaxes that are not supported by any scientific data may be the cause of the uncertainty surrounding 5G. It's possible that the telecommunications sector has experienced a misunderstanding of 5G operational principles before, as it did with earlier generations of communications, such as 4G. As always, misunderstandings about emerging technology could lead people to overestimate the dangers of 5G exposure to their health. There are various false beliefs about 5G that relate the spread of COVID-19 pandemic to exposure to 5G's EMFs. The World Health Organization (WHO) coined the term "infodemic" to describe the widespread spread of false information about COVID-19, which can have detrimental effects on the population due to the enormous number of hoaxes (WHO, 2020). In several nations, there have reportedly been a number of 5G tower sabotage incidents (BBC, 2020; Liverpool Echo, 2020). Numerous individuals have pushed for a vote to limit the radiation from mobile communications technology on the other side of the globe, where it was claimed

that thousands of people protested against 5G in Switzerland (Keystone, 2019a, 2019b). Given the alarmist assertions that frequently surface in the media, such as the one (1) that 5G "could kill you," this outrage may not be unexpected (Broad, 2019). Even though they are frequently broadcast on networks that are known for encouraging fake news and "selectively reporting the most sensational claims and giving a few marginal opponents of wireless technology a conspicuous new forum," such statements may cause fear and damage public trust (Broad, 2019). (Broad, 2019).

From the literature survey, to date, there have been some discussions and statements on the potential health risk of 5G; however, there has been no specific structured study on the perceptions among Malaysians regarding the matter at hand. The proposed project aims to look into the level of Malaysian public perception of 5G radiation emissions in selected pioneer regions in Malaysia with 5G infrastructure. The study will look into the public understanding factor, which includes information source characteristics (media exposure) as well as health-risk characteristics that take into account their perceptions of EMF emission from network infrastructure and consumer-premises equipment that they possess.

Health-related Risk of 5G EMF Emission

A nationwide study in Korea, reported in 2020, on factors affecting risk perception of electromagnetic waves from 5G network base stations (Koh et.al., 2020), found that EM waves from 5G network base stations were perceived as moderate health risks; the magnitude of the perceived risk was similar to that of EM waves from mobile phones, greater than that of household chemical products, but less than that of cigarette smoking. Some aspects of the study could be replicated in Malaysia.

There have been several studies conducted to investigate the public's perception of 5G radiation. One (1) such study was conducted by the Pew Research Center in the United States in February 2020, which surveyed over 10,000 Americans to gauge their views on 5G technology. The study found that while a majority of Americans (64 per cent) had heard about 5G technology, only 24 per cent understood it well, and 34 per cent had no opinion about the potential health effects of 5G technology. Another study was conducted in the UK by the research consultancy firm Ipsos MORI in December 2019, which surveyed over 2,200 UK adults to assess their attitudes towards 5G technology. The study found that 44 per cent of respondents were concerned about the potential health risks of 5G radiation, while 36 per cent were worried about the impact on the environment.

In France, a study conducted by the Harris Interactive research firm in November 2019 surveyed over 1,000 French people to assess their attitudes towards 5G technology. The aim of the study was to assess public attitudes towards 5G technology and the potential risks associated with its deployment. The study found that over half of the respondents (52 per cent) were concerned about the potential health effects of 5G radiation, while 58 per cent were worried about the environmental impact of 5G technology. Interestingly, the study also found that younger people were more likely to be concerned about 5G radiation than older people, with 59 per cent of respondents aged 18 to 34 expressing concern compared to 46 per cent of those aged 55 and over. The studies also suggest that while many French are aware of 5G technology and its potential benefits, there are concerns about the potential health and environmental risks associated with its deployment.

Overall, these studies suggest that while a significant portion of the public is aware of 5G technology, many people have concerns about its potential health and environmental impacts.

Methodology

Research Design

The approach used as methodology was a cross-sectional design, with participants completing a self-report survey to measure Malaysian public perception of EMF emissions from 5G network base stations and consumer equipment. The research instrument consisted of demographic questions, objective knowledge of 5G emissions and public policies, risk perception, and media exposure.

Research Instrument

Research instruments consist of segments on demographic questions, objective knowledge of 5G emissions and public policies, risk perception, and media exposure. The respondents will complete the survey by accessing an online form. Demographic questions include gender, age group, marital status, level of education, monthly household income, and occupation, and these are relevant for our analysis. A section on information resource characteristics measures the public's media exposure to the concept and implications of 5G EMF radiation. The questions were developed to identify the

sources of EMF information referenced by the public and get related information.

Health-related variables comprise knowledge, trust, and attitude questions, which include the level of perceived EMF emission exposures through common sources: mobile phones, microwave ovens, and smartwatches. Questions on how the subjects are handling mobile phone charging represent their attitude towards radiating equipment. The subject's objective knowledge of EMF emission, the implication of EMF radiation from base stations and on-premise equipment, as well as the level of knowledge of public policies on protection from EMF emission, are measured. Subjects were also asked to self-report their health status (healthy or unhealthy).

Sampling

The population consisted of Malaysians with an age spectrum from below 18 to above 60 years old, settled in all states of Malaysia. The survey was open to all states in Malaysia, providing a better sampling from the Malaysian perspective. Data collection involved self-administered questionnaires distributed online through

Google Forms. This project used four (4) selected areas KL, Putrajaya, and Selangor as pioneer cities to enjoy 5G coverage for population sampling calculation. Multi-stage cluster sampling involving two-stage cluster sampling and disproportionate stratified random sampling are practised. At the first stage, four (4) areas are identified, and at the second stage of sampling, each of the selected areas is represented by 100 respondents (100 respondents x 4 areas = 400 respondents). The number of respondents involved in the study is adequate, drawing on a sampling calculation in Raosoft based on a 95 per cent confidence level and five (5) per cent margin error. Even though the sampling calculation was initially based on the four (4) areas, the survey was made open to all states in Malaysia. This will provide a better sampling from a Malaysian perspective. The total number of respondents, N of 410, exceeded the sampling target of 400 respondents.

Data Collection

The questionnaires were built based on the objectives of the study. The self-administer method has been employed, and the questionnaires have been distributed to the selected respondents based on the identified areas using online distribution through Google Forms (<https://forms.gle/8qgVwFG6Gv9YosbD7>). The research team has monitored the data collection process to ensure that the required data can be gathered, and a total of 410 respondents were obtained from all over Malaysia.

Data Analysis

To achieve objectives 1, 2, and 3, descriptive analyses such as frequency, percentage, mean, and standard deviation have been performed. To achieve objective number 4, interpretation of the research findings has been performed.

Findings and Analysis

Demographic Information

All of the study subjects were Malaysians from below the age of 18 to over the age of 60; 57.8 per cent ($n = 237$) were male, and 42.2 per cent ($n = 173$) were female. For age group, 2.4 per cent ($n = 10$) were below 18 years of age, 35.9 per cent ($n = 147$) were between 18 and 30, 23.4 per cent ($n = 96$) between 31 and 40, 25.1 per cent ($n = 103$) between 41 and 50, 9.8 per cent ($n = 40$) between 51 and 60, and 3.4 per cent ($n = 14$) were above 60. For level of education, 9.2 per cent ($n = 38$) were secondary school graduates or less, 17.1 per cent ($n = 70$) have a diploma, 53.7 per cent ($n = 220$) are bachelor's degree holders, 11 per cent ($n = 45$) are master's degree holders, and 7.3 per cent ($n = 30$) are doctorates. The respondents' residential state covers 15 areas, with the majority of respondents, 46.1 per cent ($n = 189$), residing in Selangor. For the employment sector, 44.6 per cent ($n = 183$) were from the private sector. The distribution of monthly household income was unimodal, with 44.6 per cent ($n = 203$) earning below RM5000.

RESEARCH OBJECTIVE 1

Public Perception in Malaysia on the Health Effects of 5G EMF Emissions

Concerns on 5G

Respondents were asked if they have concerns generally about 5G, and the findings show that 56.6 per cent ($n = 232$) agree that they have concerns about 5G, and 43.4 per cent ($n = 178$) of the respondents do not have any concerns about 5G. The results may suggest mixed reactions to 5G, as more than half of the

respondents are comfortable with the new generation of communications networks. However, 43.4 per cent of the respondents may be significant to show that there are concerns around 5G among the Malaysian public.

The distribution of concerns regarding 5G is tabulated in Table 2. Table 1 shows the highest concerns about 5G were the health concerns about 5G radiation (69.4 per cent), followed by the cost that will be too expensive (41.5 per cent), the effect on the environment (37.5 per cent), and the stability of the connections (31.0 per cent). The findings were similar to the research

conducted in France by the Harris Interactive research firm in November 2019, where it was reported that over half of the French respondents (52 per cent) were concerned about the potential health effects of 5G radiation, while 58 per cent were worried about the environmental impact of 5G technology. This is also found in the UK; in a study conducted by the research consultancy firm Ipsos MORI in December 2019, 44 per cent of respondents were concerned about the potential health risks of 5G radiation, while 36 per cent were worried about the impact on the environment. Our findings exhibit that Malaysians' concern is much higher for health risks, and interestingly, cost has become the second biggest concern other than the environment.

CONCERN ON 5G	FREQUENCY (n)	PERCENTAGE (%)
Health concerns about 5G radiation	172	69.4
It will be too expensive	103	41.5
It will affect the environment	93	37.5
The connectivity is not stable	77	31.0
It will cause more social problems	74	29.8
It will drain phone battery	71	28.6
It will interfere with other technologies (satellites, aircrafts, etc)	69	27.8
It is not secured	66	26.6
House value will drop	50	20.2
Others	21	8.4

*Respondents can tick more than one (1) answer

Table 1: Distribution of Concerns on 5G (N = 410)

Perceived Level of 5G Radiation Exposure

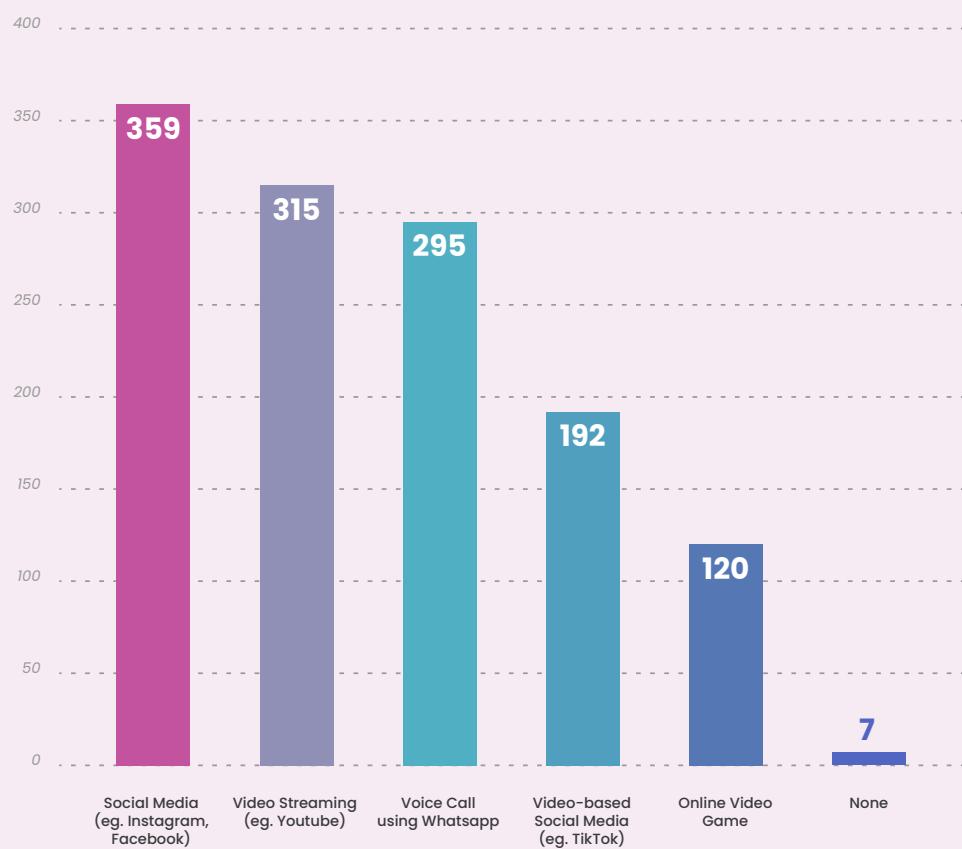
The results revealed that the majority of the respondents (32.4 per cent, n = 133) perceived that the level of 5G radiation exposure is low, 29.5 per cent (n = 121) perceived that they were exposed to moderate 5G radiation, and 21.7 per cent (n = 89) perceived that they were exposed to a high level of 5G radiation. 16.3 per cent (n = 16.3) of the respondents perceived that they were not exposed to 5G radiation. However, relating the perceived radiation exposure to the 172 respondents who have health concerns about 5G radiation, the majority of them (41.3 per cent) (n = 71) perceived a high level of 5G radiation exposure, 39.5 per cent (n = 68) moderate exposure, 16.3 per cent (n = 28) low exposure, and only 2.9 per cent (n = 5) perceived no exposure to radiation. These findings show that respondents who perceived high 5G radiation exposure are likely to have health concerns around 5G.

Attitude Related to EMF

The survey results show that 100 per cent of our respondents are mobile phone users, and the majority of them (72.4 per cent, n = 297) are microwave oven users. Meanwhile, only 31.5 per cent (n = 129) are smartwatch users. This data potentially shows that the respondents are familiar with other sources of electromagnetic wave radiation, such as microwave ovens and Bluetooth (smart devices). However, almost half of the respondents (46.3 per cent) charge their mobile phones nearby when asleep. This indicates the attitude toward handling devices with electromagnetic emissions in a less safe environment.

Respondents were also asked about mobile applications that they usually used and how much time they spent on these applications every day. According to Figure 1, social media applications (87.6 per cent, n = 359) are the top usual applications used on mobile phones, followed by video streaming (75.8 per cent, n = 315), voice calls using WhatsApp (72 per cent, n = 295), video-based social media (46.8 per cent, n = 192), and online video games (29.3 per cent, n = 120). The respondents mostly spend less than two (2) hours per day on social media, video streaming, and voice calls using WhatsApp. Video-based social media and online video games are less used by the respondents, and hence less time is spent on these applications. However, for each application, respondents spent more than four (4) hours daily, especially for video streaming applications like YouTube. Theoretically, this may contribute to a higher level of EMF exposure for the users.

Applications Used on Mobile Phones



Time Spent per day on Mobile Phones Applications

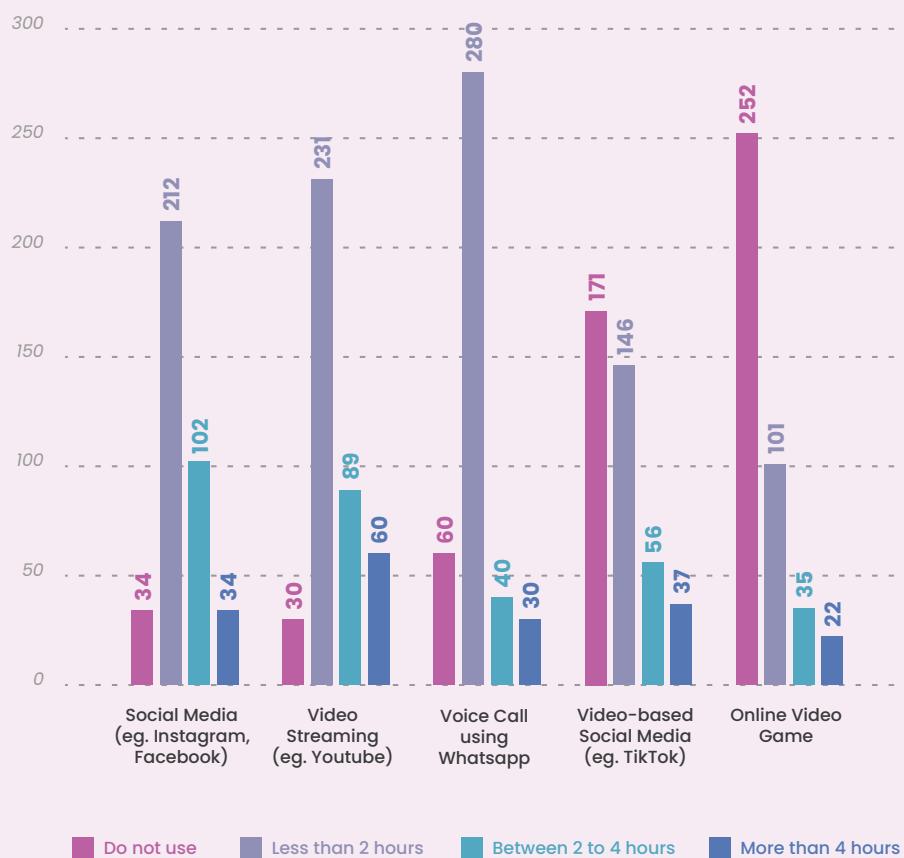


Figure 1: Usual Applications Used on Mobile Phone and Time Spent per Day on Mobile Phone Applications

Health-related Risk from 5G EMF Radiation

Table 2 shows a total of 18.3 per cent of respondents strongly agreed that 5G EMF radiation can cause headaches, cancer (17.1 per cent), harm the foetus during pregnancy (15.9 per cent), and impact fertility (14.6 per cent). On the other hand, more than half of the respondents (54.4 per cent) strongly disagree that vaccines contain 5G microchips. This is one (1) of the famous fake theories about 5G during the COVID-19 pandemic. From the table, it can be concluded that approximately 30 per cent of the population believes (from somewhat agreeing to strongly agreeing) that the fake theory regarding COVID-19 vaccines contains 5G microchips, this may be worth of an issue to be tackled to build public trust on vaccines.

Meanwhile, Table 3 shows the analysis of perceived health risks obtained in Table 2 in terms of the degree and severity of the perceived risks. Table 3 demonstrates that based on the mean risk score, the perceived health-related risk is at a moderate level (overall mean score of 2.64 and standard deviation of 1.34). These results provide insight into the degree of public perception of the health-related risk of 5G EMF radiation. Our study found that EM waves from 5G network base stations were perceived as moderate health risks. We hypothesised that the attitude of placing a mobile phone charger nearby while asleep would be associated with lower health-related risk perception as the behaviour is suggestive of indifference to exposure to EM waves; however, no significant relationship was observed as well.

ITEMS 5G EMF RADIATION	FREQUENCY & PERCENTAGE									
	SCALE									
	1	%	2	%	3	%	4	%	5	%
Can cause cancer	50	12.2	67	16.3	156	38.0	67	16.3	70	17.1
Vaccines contains 5G microchips	223	54.4	65	15.9	80	19.5	20	4.9	22	5.4
Can disrupt sleep	88	21.7	80	19.5	138	33.7	52	12.7	51	12.4
Can impact fertility	78	19.0	63	15.4	135	32.9	74	18.0	60	14.6
Can harm the foetus during pregnancy	81	19.8	63	15.4	135	32.9	66	16.1	65	15.9
Can increase the spread of COVID-19	242	59.0	64	15.6	65	15.9	16	3.9	23	5.6
Can cause skin diseases	119	29.0	75	18.3	135	32.9	47	11.5	34	8.3
Can cause headaches	60	14.6	52	12.7	135	32.9	88	21.5	75	18.3

Note: 1 = Strongly disagree, 2 = Disagree, 3 = Somewhat agree, 4 = Agree, 5 = Strongly agree

Table 2: Distribution of Perceived Health-related Risk from 5G EMF Radiation (N = 410)

ITEMS 5G EMF RADIATION	MEAN RISK SCORE RANGE & CLASSIFICATION		
	LOW (1.00 - 2.33)	MODERATE (2.34 - 3.67)	HIGH (3.68 - 5.00)
Can cause cancer		Mean: 3.10 SD: 1.22	
Vaccines contain 5G microchips	Mean: 1.91 SD: 1.19		
Can disrupt sleep		Mean: 2.75 SD: 1.28	
Can impact fertility		Mean: 2.94 SD: 1.30	
Can harm the foetus during pregnancy		Mean: 2.93 SD: 1.32	
Can increase the spread of COVID-19	Mean: 1.81 SD: 1.17		
Can cause skin diseases		Mean: 2.52 SD: 1.25	
Can cause headaches		Mean: 3.16 SD: 1.28	
Overall Mean Score (and SD)		Mean: 2.64 SD: 1.34	
Overall Perceived Risk Classification	Moderate		

Table 3: Perceived Health-related Risk from 5G EMF Radiation (N = 410)

RESEARCH OBJECTIVE 2

5G EMF Source of Information Referenced by the Public

Media Platform Pattern

According to Karlsen and Aalberg (2021), people go to social media to get their daily news updates. Findings show that the highest media used among Malaysian youths was YouTube (75.9 per cent), followed by Facebook (67.8 per cent), websites (64.6 per cent), and Instagram (59.8 per cent). Meanwhile, the least popular media platform was Reddit (0.5 per cent). According to the Digital Business Lab (2022), YouTube has the highest penetration compared to other social media platforms in Malaysia. Approximately half of Malaysian youths spend their time on YouTube. The study concluded that users are comfortable maintaining a presence across several media platforms.

Sources Used to Obtain News on 5G

Based on the findings, Table 4 shows that 60 per cent of the respondents browsed the website to get information on 5G. It is worth noting that the majority of the respondents stated that they read news about 5G on websites. Additionally, 43.4 per cent of the respondents always watched Facebook, and 35.4 per cent often watched

about 5G on television. The results also demonstrated that respondents used friends to get information on 5G (30.2 per cent). This finding was useful enough to understand that these users would use several channels to sustain their knowledge of 5G. Using a variety of sources can lead to more in-depth information. In Table 5, 58.8 per cent of the respondents said that local and international sources are the most trusted.

SOURCES	FREQUENCY (n)	PERCENTAGE (%)
Website	246	60.0
Facebook	178	43.4
Television	145	35.4
Friends	124	30.2
Instagram	95	23.2
Radio	94	22.9
Twitter	90	22.0
Printed media	86	21.0
Family	83	20.2
TikTok	75	18.3
LinkedIn	45	11.0
YouTube	8	1.9

*Respondents can answer more than one (1) answer

Table 4: Distribution of Sources on 5G EMF Emission (N = 410)

SOURCES	FREQUENCY (n)	PERCENTAGE (%)
Both sources (local and international)	241	58.8
International sources	75	18.3
Does not matter	55	13.4
Local sources	39	9.5
TOTAL	410	100

Table 5: Distribution of Most Trusted Sources on 5G (N = 410)

The findings reveal that a total of 26.3 per cent agreed that the information reported in the media regarding 5G EMF emissions is current. Furthermore, 23.2 per cent agreed that the information reported in the media regarding 5G EMF emissions can be trusted. However, half of the respondents (51.2 per cent) somewhat agree that the information reported in the media regarding 5G EMF emissions is accurate. Yet, the findings of this study indicate that only a handful (9.8 per cent) strongly disagree that the information reported in the media regarding 5G EMF emissions is easy to understand. This implies that the public understands and perceives media coverage of 5G.

RESEARCH OBJECTIVE 3

Public Understanding on the Implications of the 5G Network Base Stations (BS) and Consumer Premise Equipment (CPE) in Their Vicinity

Objective Knowledge in 5G Emission

Respondents' objective knowledge is measured, whether high or low, using a set of six (6) questions covering knowledge on emissions from the base station and mobile phone. The classification of high- or low-level knowledge is made based on the mean score obtained for all six (6) questions. 59.8 per cent ($n = 245$) are considered to have high objective knowledge on 5G emission based on the mean score of 2.81/6, whereas 40.2 per cent ($n = 165$) are considered to have low objective knowledge below the mean score of 2.81/6.

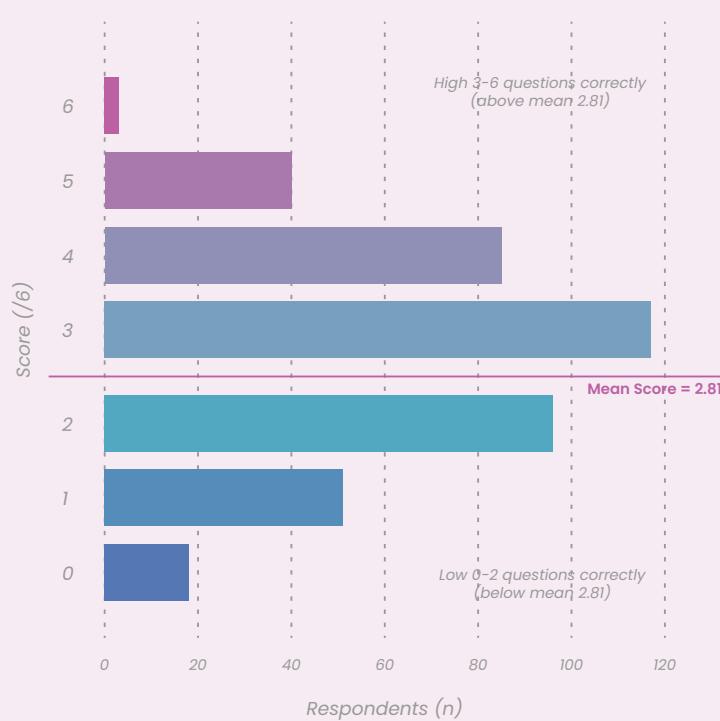


Figure 2: Scores for 5G Emission Objective Knowledge Test

Past studies on the association between objective knowledge and risk perception have shown mixed results. In our study, respondents who scored above the mean on objective knowledge considered EM waves from 5G network base stations as risky as those who scored below the mean. When it comes to perceived health-related risk, it is interesting to note that there is no difference between the respondents of high objective knowledge and low objective knowledge on 5G emission since the mean risk score for both groups is similar.

Trust in Public Policies in Protecting from EMF Exposure

The highest percentage of 43.9 per cent ($n = 180$) for perceived knowledge regarding potential health effects due to exposure to EMF radiation from 5G network base stations is for scale 3 (somewhat agree). From the summation of respondents on a scale of 3-5, it can be deduced that a total of 78.3 per cent believe that they are knowledgeable in this aspect. This may correlate to the fact that the majority of the population (almost 60 per cent) possess a high level of objective knowledge of 5G emissions. Research findings show that 76.6 per cent of the respondents agree (scale 3-5) that they know that there

are public policies or guidelines that provide protection from EMF exposure. This demonstrates that the policymakers (i.e., Malaysian Communications and Multimedia Commission MCMC)) have made good progress in informing the general public regarding the policies developed. This is further supported by 77.1 per cent of the respondents agreeing (on a scale of 3-5) that public policies provide protection from EMF exposure. Meanwhile, 79.8 per cent of the respondents agree (on a scale of 3-5) that the EMF radiation from the 5G base station and equipment is within the allowed range. This is a considerably high degree of public trust towards the policies, despite the concerns the public has about the health-related risk of 5G EMF emissions. However, around 20 to 23 per cent of respondents did not trust the policies developed to provide protection from EMF exposure, making it worthwhile for the research to recommend improvements to further build public trust in these policies and guidelines.

It is good to see from the results that the respondents agree that the public policies provide protection from EMF exposure and that the EMF radiation from the 5G base station and equipment is within the allowed range.

Recommendations

Most of the comments and suggestions left on the survey focus on education, awareness, information, and enforcement of 5G EMF emissions. Respondents suggested that more awareness programmes be available to educate the public on the safety aspects of 5G via trusted media platforms. The recommendations below are made based on the findings reported in the last sections, which may be useful to formulate future strategies and policies regarding 5G emissions to strengthen public trust in the technology.

RECOMMENDATION 1

Clear Communication of Safety Standards

Ensuring clear communication of safety standards and regulations related to 5G emissions is crucial. Our studies reported that the majority of the respondents agreed that they knew that there were public policies or guidelines that provided protection from EMF exposure and believed that the public policies did provide protection for them. Even though 79.8 per cent of Malaysians believe that the EMF radiation from 5G base stations and equipment is within the allowed range (79.8 per cent), there are around 23 per cent of respondents who strongly disagree with the majority and do not trust the policies developed to provide protection from EMF exposure. This data should not go unnoticed. For continuous quality improvement, regulatory bodies such as MCMC can provide accessible and

easy-to-understand information about the established safety standards and how they are enforced. This can help alleviate any concerns by assuring the public that 5G networks operate within safe limits.

RECOMMENDATION 2

Independent Research and Studies

Supporting and conducting independent research and studies on the health and safety aspects of 5G emissions can help address concerns and provide scientific evidence. Governments such as the Ministry of Higher Education and the Ministry of Health, together with other relevant organisations, can allocate resources to fund reputable research institutions to conduct comprehensive studies on the potential health effects of 5G emissions. The findings from these

studies can be shared with the public to demonstrate transparency and evidence-based decision-making.

This has also been practised in the United States, where the National Institutes of Health (NIH) allocated specific funding to support research on the potential health effects of 5G emissions. For example, the National Institute of Environmental Health Sciences (NIEHS), one (1) of the institutes under the NIH, has funded studies to investigate the biological effects of radiofrequency radiation, including those associated with 5G technology. These studies aim to provide valuable insights into the potential health implications of 5G and contribute to the scientific understanding of radiofrequency radiation's effects on human health.

Australia has developed a dedicated national centre for electromagnetic radiation studies. The Australian Centre for Electromagnetic Bioeffects Research (ACEBR) is a collaborative research initiative that brings together leading Australian research institutions and government agencies. ACEBR conducts research on the health effects of electromagnetic radiation, including research related to 5G technology. The centre receives funding from various sources, including the Australian government and industry partners, to support its research activities. Their studies focus on understanding the

biological effects of electromagnetic radiation and providing evidence-based insights into the potential health impacts of 5G technology.

A similar multi-institutional concerted effort can be done in Malaysia to address the concerns from the Malaysian public. Our research findings show that Malaysians put their trust more in international media reporting on 5G emissions compared to local media. The role of scientific studies done by Malaysian experts in an organised fashion may contribute to increasing public trust in the safety of 5G emissions.

RECOMMENDATION 3

Independent Safety Audits

Conducting independent safety audits of 5G infrastructure and equipment can provide assurance and build trust. Governments or regulatory bodies can establish procedures to verify compliance with safety standards and conduct regular audits of 5G networks. The results of these audits can be made publicly available to demonstrate adherence to safety guidelines. There are no publicly available audit reports available yet; this recommendation may be explored further in terms of its impact on network operators.

RECOMMENDATION 4

Continuous Monitoring of Emissions

The majority of the respondents in our study perceived low to moderate levels of 5G radiation exposure. However, respondents who perceived high 5G radiation exposure are likely to have health concerns about 5G. EM waves from 5G network base stations were perceived as moderate health risks. Hence, implementing continuous monitoring of 5G emissions can provide real-time data on radiation levels and ensure compliance with safety limits. MCMC and network operators can establish monitoring systems and publicly share the collected data. This transparency can help address concerns and show a commitment to maintaining safe radiation levels.

RECOMMENDATION 5

Health and Safety Awareness Campaigns

Launching targeted public awareness campaigns can help educate the public about the safety measures in place and address any misconceptions. These campaigns can provide accurate information about 5G emissions, debunk myths, and highlight the rigorous safety protocols followed during the deployment

of 5G networks. Collaborating with health professionals, experts, and community leaders can enhance the credibility and reach of these campaigns.

As an example, the 5GRIT programme in the UK aims to address the connectivity challenges faced by rural communities and demonstrate the benefits of 5G technology in these areas. The programme involves testing and trials of 5G solutions in rural locations, engaging with local communities, and providing accurate information about the technology. By showcasing the positive impact of 5G in rural areas, the programme helps to address concerns and build public trust.

Malaysians would use several channels to sustain their knowledge of 5G. Using a variety of sources can lead to more in-depth information. Our research findings show that the Malaysian public prefers YouTube, which is at the top of the list of most-used media. Meanwhile, websites and Facebook are the top sources for information on 5G, while YouTube is at the bottom of the list. To improve the dissemination strategy, it is recommended that MCMC and other agencies like the Ministry of Health leverage YouTube as a platform for multimedia content to educate and create awareness on safety measures and thus provide reliable local information on 5G emissions.

RECOMMENDATION 6

Public Demonstrations and Showcases

Organising public demonstrations and showcases is another effective way to manage perception. These events allow people to experience the benefits and potential applications of 5G technology first hand. Demonstrations may include showcasing high-speed downloads, augmented reality, virtual reality, and IoT applications. By providing interactive experiences, these events help alleviate concerns and generate positive interest in 5G. MCMC has organised use case demonstrations at several places in the country and published “5G MALAYSIA DEMONSTRATION PROJECTS FACTSHEET” in 2019. This effort is commendable. The demonstrations should be supported more with the involvement of various parties and are recommended to be continuously done and open to the public at large. This recommendation may act to balance benefits over concerns about the health risk of 5G EMF emissions.

It is hoped that these recommendations will help to build a positive narrative around 5G technology, promote responsible deployment, and maximise the benefits of this technology while minimising any potential risks

Conclusions

Our study concluded that the degree of perceived health-related risk is “moderate” among the Malaysian public, with many variables being studied as contributing factors. All the objectives are achieved with recommendations for relevant agencies, particularly MCMC, the Ministry of Health, higher education institutions, and telecommunication providers, to strengthen public trust towards 5G EMF emission and 5G technology in general. It is hoped that the results of our study will be reflected in the construction of an appropriate risk communication strategy in order to allow for a good spread of 5G technologies. It is also hoped that this pioneering research will spur more research on 5G EMF emissions, particularly technical research on the health effects and level of exposure that the Malaysian public is experiencing.

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TOPIC 02

Awareness, Perception, Acceptance, and Adoption of Malaysia's National Digital Identity Initiatives from Service Providers' Perspective.

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Abstract

Malaysia is implementing a National Digital Identity (NDI) system to provide secure and convenient access to online government and private services, reducing identity theft risks, improving service efficiency, and promoting economic growth. To realise the full potential of the NDI, it is important to understand the perspectives of service providers, such as their awareness, perception, acceptance, and adoption of the initiatives. This research intends to identify the factors influencing service providers' awareness and readiness to adopt Malaysia's NDI system. It aims to measure the level of NDI awareness among service providers, identify the factors that promote or hinder its adoption, assess the readiness to use NDI and provide recommendations to promote its adoption among specified service providers' categories. This research employs the Technology Acceptance Model (TAM) to understand factors influencing the acceptance and use of Malaysia's NDI system, which has two (2) constructs: perceived usefulness and perceived ease of use. A mixed-methods approach was used with a

survey questionnaire and semi-structured interviews. The questionnaire measured awareness, perception, acceptance, and adoption of the NDI initiatives, and the interviews explored service providers' perspectives on the initiatives. The sample size was 122 respondents, and the findings were analysed using frequency distributions and descriptive and inferential statistics. The most important factors are public awareness, privacy and data protection, proper enforcement, digital identity protection, IT infrastructure, and government transparency. An independent-sample t-test and a chi-square test of independence were conducted to evaluate the relationship between perception and acceptance of NDI and different socio-demographics. Only age, gender, and sector showed significant relationships with the perception of NDI, while all demographics were insignificant predictors of acceptance of NDI. The results suggest that more targeted interventions are needed to promote NDI literacy, and addressing the factors contributing to NDI literacy is essential to creating a more informed and inclusive society.

Introduction

In recent years, the Malaysian government has been actively working towards the development and implementation of an NDI system. The primary objective of this system is to provide citizens with a secure and convenient way of accessing government and private sector services online. By streamlining and enhancing the digital identity verification process, the NDI system aims to bring numerous benefits, including reducing the risks of identity theft, improving service delivery efficiency, and fostering economic growth through the promotion of e-commerce and digital transactions. However, the success of the NDI system hinges on the willingness of service providers to adopt and integrate it into their operations. Thus, it becomes imperative to investigate the awareness, perception, acceptance, and adoption of the NDI system from the perspective of these service providers.

The COVID-19 pandemic has significantly accelerated the scale and importance of digital interactions and services. For service providers, whether they offer products, services, or data, it has become more crucial than ever to ensure that the customer or partner at the other end of the interaction is genuine. This assurance is essential not only for digital interactions

but also for physical interactions that require verification of credentials, such as proving health status for international travel or age verification for purchasing restricted goods. As our physical and digital lives become increasingly intertwined, the need to identify and verify ourselves and the entities we interact with becomes paramount. This is where the concept of digital identity comes into play. Regardless of whether interactions occur in the physical or digital realm, digital identity provides a means for all parties involved in an exchange to prove their authenticity.

While various studies have explored the factors influencing the adoption of digital identity systems from the users' perspective, limited attention has been given to understanding the viewpoint of service providers. Therefore, comprehending the perspectives, views, and attitudes of service providers towards the NDI system is crucial in identifying potential barriers and enablers of adoption. Such insights will help in developing effective strategies to facilitate the successful implementation of the NDI system.

Problem Statement

The Malaysian government is developing an NDI system to support the growth of the digital economy across various service provider sectors. NDI aims to provide citizens with a secure and convenient way of accessing government and private sector services online. However, the success of the NDI system relies on service providers' willingness to adopt and integrate it into their operations.

However, despite the importance of service providers' adoption and integration of the NDI system, there is a lack of focus on service provider-centeredness in NDI development, with a predominant focus on technical aspects, security, and privacy issues. This lack of attention may result in infrastructure and standardisation barriers that hinder service providers from adopting the NDI system. Service providers play a crucial role in successfully adopting the NDI system, as they are responsible for integrating the system into their operations and providing services to citizens.

There is a need to understand the awareness, perception, acceptance, and adoption of Malaysia's NDI initiatives from the service providers' perspective to address these issues. The Public Consultation Report (PCR) on the NDI

Framework for Malaysia, published in August 2020, provided a foundation for investigating service providers' attitudes toward the NDI system. In addition to gathering user feedback, the PCR's questions about service providers and the advantages of NDI could serve as the foundation for a more thorough investigation into the specifics and problems surrounding service provider awareness, perception, and acceptance of Malaysia's NDI initiative.

Therefore, the barriers and enablers of service providers' awareness, perception, acceptance, and adoption of Malaysia's NDI initiatives should be investigated so that policymakers and stakeholders can address these factors to promote the successful adoption and integration of the NDI system into service providers' operations.

Research Objectives

This research aims to clarify the factors contributing to heightened awareness and readiness by service providers to adopt and use the NDI as part of Malaysia's digital aspirations. The specific objectives include:

To gauge the level of NDI awareness and understanding amongst service providers;

To identify the factors promoting and hindering the adoption of NDI amongst service providers;

To determine the level of readiness to take up and use NDI amongst service providers; and

Provide recommendations to promote awareness and adoption amongst specified service providers' categories.

Literature Review

Digital identification systems have the potential to simplify citizens' access to government services, including social welfare programmes and healthcare services, by reducing the reliance on paper-based documentation and streamlining the registration and verification procedures. This can lead to improved efficiency in service delivery and enhanced convenience for individuals seeking necessary services.

Furthermore, digital identification systems can alleviate government agencies' administrative burdens through automated registration and verification processes, real-time data validation, improved data sharing, and efficient monitoring and tracking systems.

By serving as a unique identifier, digital identification systems can establish connections with diverse service delivery programmes, such as banking, taxation and land registration. This integration augments service efficiency by enabling citizens to access multiple services using a single digital ID, eliminating the requirement for multiple identification documents. Consequently, it facilitates enhanced access to government services and benefits, fostering inclusivity and efficiency within society.

Numerous countries worldwide are in the process of implementing or have already implemented NDI systems. Examples include Aadhaar in India, e-Identity in Estonia, SingPass in Singapore, Väestörekisterikeskus in Finland, Canada Digital Identity Program in Canada, eDNI in Spain, and eIDAS in Germany.

Problems or issues with current digital identity system

NDI systems have the potential to enhance government services and mitigate fraud and leakage in welfare programmes. However, there are several important issues that require attention.

One concern relates to privacy. The collection and storage of biometric and personal information in a centralised database raise apprehensions about potential misuse and the risk of data breaches. Another issue revolves around inclusion and accessibility. Certain populations, such as residents in rural areas, the elderly, or individuals with disabilities, may face challenges in easily accessing NDI systems, leading to potential exclusion from government services and welfare programmes.

Dependence on NDI systems can also pose a problem. Relying extensively on these systems for various services can create dependency, making the situation problematic in case of system failures or other issues. Cost is another factor to consider. Implementing and maintaining NDI systems can be expensive, and these costs may be transferred to citizens and businesses in the form of fees or taxes. Furthermore, inadequate infrastructure and resources in certain countries can hinder the successful implementation of digital identity systems.

Potential for privacy violations and the need for strong security measures to protect personal information

National digital identification systems are a major concern because they have the potential for privacy violations and the misuse of personal information. Personal information is stored in a centralised database, and if not properly secured, it can be accessed, used, or shared without the individual's consent or knowledge. Additionally, the collection, storage, and use of personal identification information could enable governments or other organisations to track individuals'

movements, activities, and interactions, which could violate individual rights and freedoms.

To address this concern, it is important to have strict regulations and oversight mechanisms in place to ensure that the collection, storage, and use of personal identification information is done in accordance with the laws and is used for legitimate purposes only. Additionally, it is important to have a strict policy and technical measures for data retention and destruction that limit the period of time the data is kept and that it is permanently destroyed when no longer needed. Finally, an independent oversight body should monitor and investigate any potential misuse of personal identification information and ensure that an individual's rights and freedoms are protected.

The need for interoperability between different systems and legal and regulatory frameworks for national digital identity systems

Several key technical considerations shape the effectiveness of these systems, including identity verification, authentication, identity proofing, identity

management, interoperability, secure communication, blockchain technology, and biometrics.

Identity verification involves confirming that an individual's claimed identity aligns with their actual identity, while authentication verifies a user's claimed identity to grant access to a particular service or resource. Identity proofing encompasses the collection and verification of personal information to establish an individual's identity, and identity management involves maintaining and updating an individual's identification details throughout the system's lifespan. Interoperability refers to the system's ability to integrate and share information with other systems and services, while secure communication is vital for preventing unauthorised access and data tampering. The utilisation of biometrics is increasingly prominent in digital identification systems, offering a more secure and convenient means for individuals to authenticate their identity.

In addition to technical considerations, a robust legal and regulatory framework is imperative for NDI systems. Such frameworks ensure compliance with laws, safeguard citizens' rights and privacy, and maintain system integrity. Key issues within this framework include data protection and privacy laws, guidelines for the use and management of personal identification

information, transparency, accountability, clearly defined roles and responsibilities, access to justice, adherence to international standards, and flexibility.

The importance of involving various stakeholders in the design, development, and implementation of national digital identification systems

Diverse stakeholders must participate during the design, development, and implementation of NDI systems to ensure that the system effectively meets the needs of all involved parties and gains social and political acceptance. Engaging stakeholders in the system's design and development process fosters trust and support among all parties, strengthens security and privacy measures, tackles potential challenges and opportunities, evaluates feasibility and impacts, and promotes ownership and sustainability. Early involvement of stakeholders facilitates the identification of the system's effects on various groups and enables the assessment of its viability. Engaging government agencies, private sector entities (e.g., financial institutions,

telecommunication companies, and e-commerce providers), and citizens in the design and development of the digital identification system ensures that it caters to the needs of all stakeholders and addresses their specific concerns.

Government agencies bear the responsibility for implementing and managing the digital identification system, while private sector entities contribute valuable insights to its design and development. Citizens can actively participate through public consultations, focus groups, or user testing, ensuring that the system aligns with their requirements and addresses their apprehensions.

By involving all relevant stakeholders in the design and development process, the digital identification system can effectively cater to the needs of all parties, address their concerns, and enhance the likelihood of widespread adoption and usage by all stakeholders.

Methodology

This study utilised a mixed-methods research design, incorporating both quantitative and qualitative data collection methods. Survey questionnaires were employed to collect quantitative data, while personal interviews were conducted to gather qualitative data. The survey questionnaires were distributed among service providers in various industries in Malaysia, selected through purposive sampling. The closed-ended questions in the survey were adapted from Aceron V. P. (2021) and Muñoz-Rodríguez J. M et al (2020). A pilot test with 30 participants was conducted to ensure reliability. Personal interviews were then conducted with a subset of survey respondents, employing a semi-structured and open-ended approach. Descriptive statistics and thematic analysis (using NVIVO) were employed to analyse the quantitative and qualitative data, respectively. The mixed-methods approach was chosen to enable a comprehensive investigation and enhance the validity and reliability of the findings. The quantitative data provided a broad understanding of the respondents' attitudes, while the qualitative data offered detailed and context-specific insights into their experiences and perceptions. A survey questionnaire with multiple-choice and Likert scale questions was used to collect quantitative data on service providers' awareness, perception, acceptance, and adoption of Malaysia's NDI initiatives. A semi-structured interview guide with open-ended questions was developed to gather qualitative data on service providers' perspectives, experiences, benefits, challenges, and recommendations regarding the initiatives.

This research utilised purposive sampling to select participants from six (6) different categories of service providers in Malaysia: E-health, E-government, telecommunication, finance institutions, education, e-wallet, and e-commerce. The sampling approach targeted individuals with relevant knowledge and experience in the implementation of Malaysia's NDI initiatives within their respective sectors. Data collection involved the use of a questionnaire and

interviews to investigate the perceptions of individuals across various sectors. The questionnaire, administered online and in-person, comprised five sections, including demographic information and independent variables. The collected data was analysed using SPSS, employing frequency distributions, descriptive statistics, and inferential statistics such as chi-square tests and t-tests to identify patterns and significant differences.

The study acknowledged limitations, including a relatively small sample size and potential biases in data collection. Nonetheless, the research aimed to provide insights into sector-specific perceptions and inform strategies to enhance services. Furthermore, the research focused on evaluating four (4) crucial aspects of NDI implementation, including the level of knowledge and comprehension among service providers, factors influencing their adoption, readiness to accept and use NDI, and recommendations for raising awareness and adoption. The findings aimed to identify areas for improvement in

NDI implementation, facilitating Malaysia's digitisation efforts. The study has collected 44 responses from diverse service provider sectors. The questionnaire has been validated by experts, and reliability testing using Cronbach's alpha and Kuder-Richardson Formula 20 (KR-20) will be conducted on the received responses. The pilot test results (Table 1) indicate that Cronbach's alpha values for sections B, C, and D are acceptable, as they are all above 0.7. However, no reliability tests were conducted for the socio-demographic section and open-question section E.

SECTION	DETAILS	ITEMS	VALUE
A	Socio-demography	-	-
B	Level of awareness and understanding	Dichotomous items	0.811
C	Level of perception	5-point Likert Scale	0.965
D	Level of acceptance	Dichotomous items	0.731
E	Open Question		

Table 1: Pilot Test Results

Findings and Analysis

The data collection phase of the study involved obtaining respondents from six (6) sectors: e-commerce, e-wallet, e-health, education, e-government services, financial institutions, and telecommunication. A total of 122 service providers participated, with the majority falling within the age range of 21 to 40 years (see Figure 1(a)). There was a higher representation of female respondents (59 per cent) compared to males (41 per cent) (see Figure 1(b)). The largest number of respondents came from the e-government sector (49 per cent), followed by e-health (23 per cent), financial institutions (12 per cent), education and telecommunication (7 percent), and e-wallet and e-commerce (1 per cent each) (see Figure 1(c)). The respondents held various positions within their organisations, providing diverse perspectives on the NDI initiatives, primarily coming from the federal government (see Figure 1(d)). The majority of service providers were located in Negeri Sembilan (57 per cent), Selangor (16 per cent) and Perak (13 per cent) (see Figure 1(e)), and most of the respondents identified as Malays (88 per cent) (see Figure 1(f)). Regarding education, 45 per cent of the respondents held a degree, while 30 per cent had a diploma/STPM (see Figure 1(g)). When asked about their awareness

of NDI, 75 per cent of the respondents reported not having heard about it before, indicating limited knowledge or utilisation of NDI within the industry (see Figure 1(h)). These findings provide insights into the demographic characteristics and levels of awareness among service providers, informing the interpretation of the study's results.

The study aimed to assess the level of NDI awareness and understanding among service providers based on various socio-demographic factors. The findings of the study were analysed using chi-square tests of independence to determine the relationships between NDI awareness and understanding and factors such as age, gender, sector, employment, state, ethnicity, and education. The results indicated that age had a significant relationship with NDI awareness and understanding. Younger individuals were found to be more familiar with NDI compared to older individuals, suggesting the need for targeted interventions to improve NDI literacy among different age groups. However, no significant relationships were found between NDI awareness and understanding and gender, sector, employment, state, ethnicity, or education. This suggests that

individuals from different demographic backgrounds may have similar levels of NDI awareness and understanding. These findings highlight the importance of considering factors beyond demographics in promoting NDI literacy and developing inclusive strategies. It is worth noting that the lack of significant relationships may be influenced by factors such as measurement limitations, sampling bias, or unaccounted confounding variables. Therefore, while the findings provide valuable insights, they may not be generalised to all populations or contexts. Overall, the study emphasises the need for targeted interventions and comprehensive approaches to promote NDI literacy, considering various factors that contribute to individuals' awareness and understanding of NDI. By addressing these factors, policymakers and organisations can work towards creating a more informed and inclusive society regarding NDI.

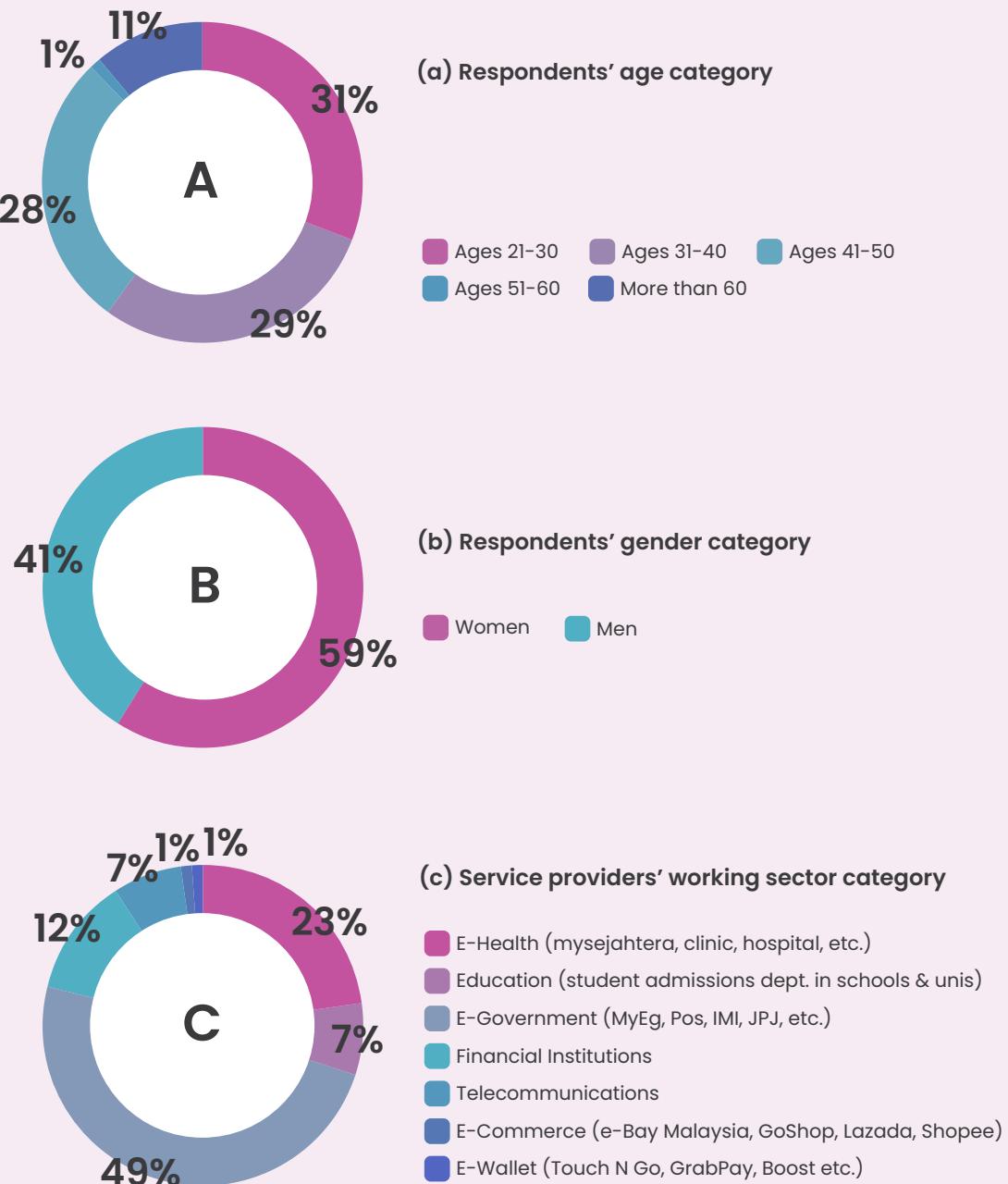
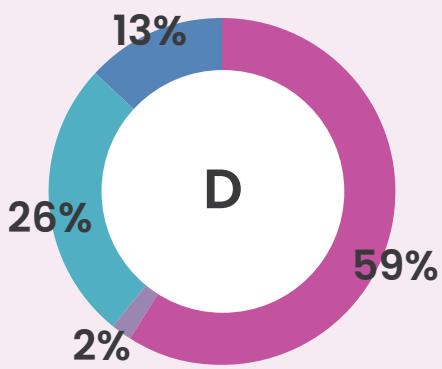
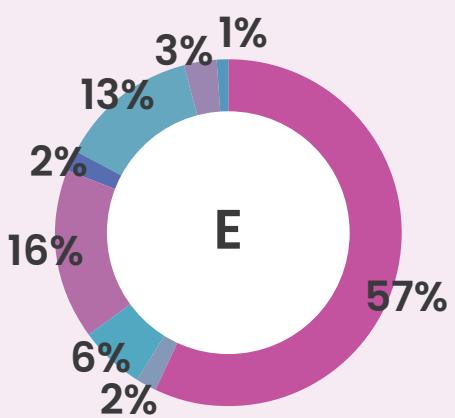


Figure 1: Socio-demographic of the respondents.



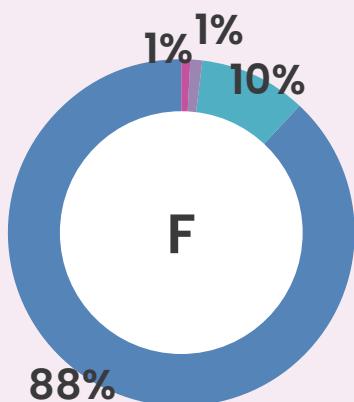
(d) Service providers' working division category

- Federal Government
- Own/Business
- Private Sector
- State Government



(e) State of Service providers

- | | |
|-------------------|-----------------------|
| ■ Negeri Sembilan | ■ Pahang |
| ■ Perak | ■ Selangor |
| ■ Terengganu | ■ Wilayah Persekutuan |
| ■ Johor | ■ Melaka |



(f) Respondents' race

- | | |
|---------------------------|----------|
| ■ Bumiputra Sabah Sarawak | ■ Indian |
| ■ Chinese | ■ Malay |

Figure 1: Socio-demographic of the respondents.

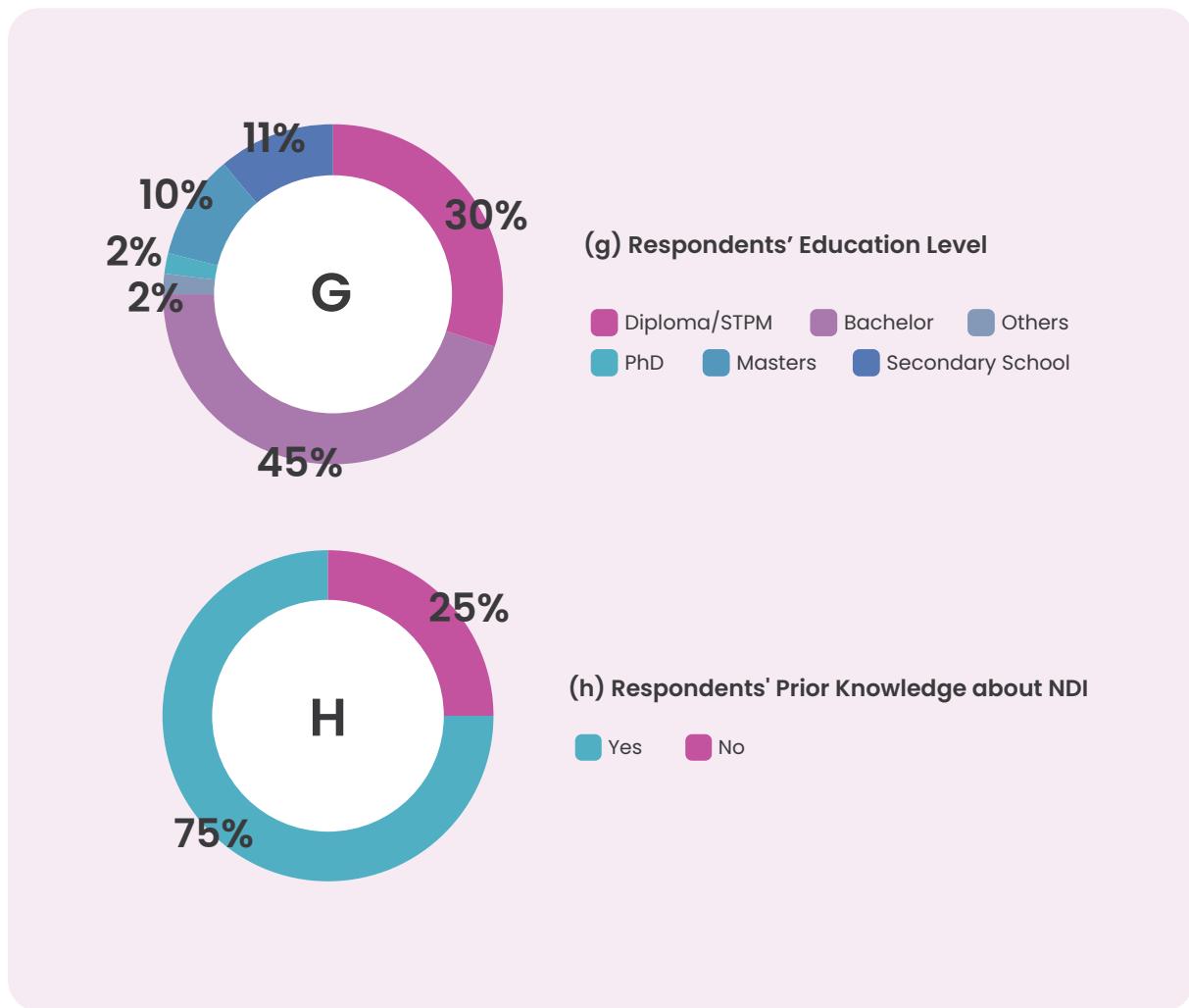


Figure 1: Socio-demographic of the respondents.

Figure 2 presents the percentage distribution of various factors in promoting the adoption of NDI. The highest percentage, at 19 per cent, is attributed to providing public awareness through information dissemination, seminars, and training. This emphasises the importance of educating the public about NDI to build trust and understanding. The next significant factors are secure privacy and data protection, each accounting for 14 per cent. Ensuring proper privacy measures and data protection is crucial to prevent unauthorised access and maintain trust in the NDI system. Proper enforcement of NDI implementation and enhanced digital identity protection share a percentage of 12 per cent each. These factors emphasise the need to enforce compliance, enhance security measures, and protect sensitive digital identity data to mitigate risks and promote trust. Availability of effective IT infrastructure and government transparency both represent nine (9) per cent. These factors play a vital role in ensuring smooth implementation, promoting trust, and preventing a digital divide. Ensuring accessibility, acquiring technical skills seeking best practices, and improving service features are at seven (7) per cent each. These factors address the need for inclusivity, knowledge, and continuous improvement to maximise the benefits of NDI. Concerns for good governance received the lowest percentage, at four (4) per cent. Good governance is essential to ensure fair, transparent, and equitable implementation of NDI policies and regulations. Overall, the figure highlights the importance of public awareness, privacy, enforcement, IT infrastructure, transparency, accessibility, technical skills, service improvement, and good governance in promoting the successful adoption of NDI.

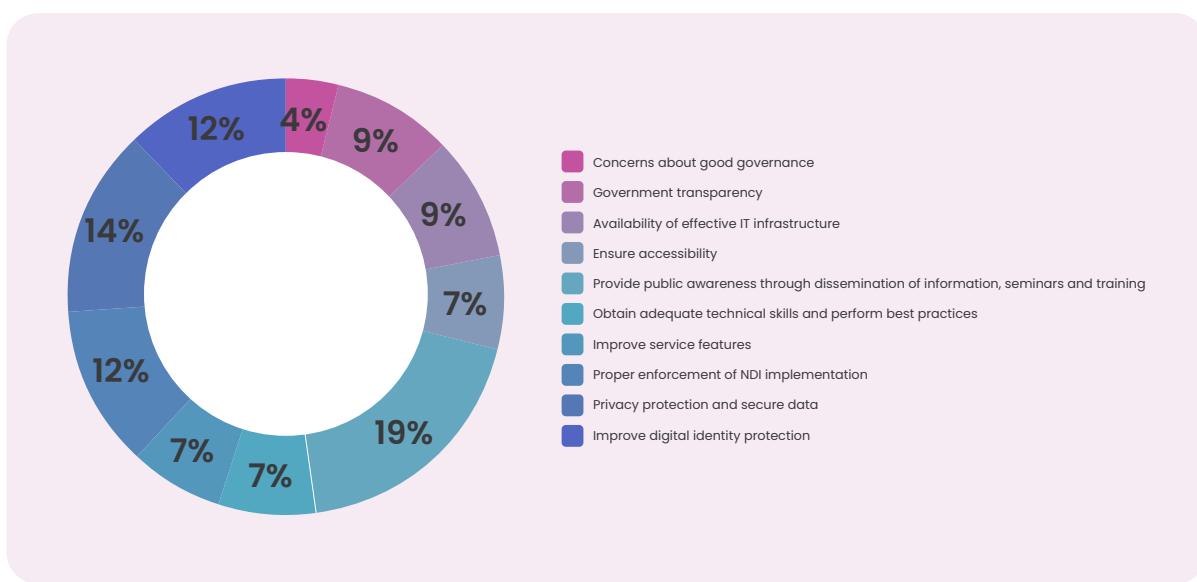


Figure 2: Factors promoting the adoption of NDI

The study conducted an assessment of service providers' readiness to adopt and utilise NDI while also examining the perception and acceptance of NDI based on various demographic factors. The findings revealed significant differences in perception based on gender and sector. In terms of gender differences, the study found that male participants demonstrated a higher perception of NDI compared to females. This gender disparity could potentially be attributed to prior experience and familiarity with digital technologies. It is possible that males have had more exposure to various digital tools, leading to a greater comfort level and understanding of NDI. Additionally, variations in the types of NDI applications used by males and females might contribute to this disparity, with males utilising NDI more frequently for tasks they perceive as important or relevant. However, it is important to note that these observations are preliminary and require further investigation to fully understand the underlying factors influencing the gender difference in NDI perception. In terms of the sector, the e-government sector demonstrated a higher perception of NDI compared to other sectors. This distinction can be attributed to the e-government sector's greater experience and resources in implementing and promoting NDI. The e-government sector may have invested more in training and

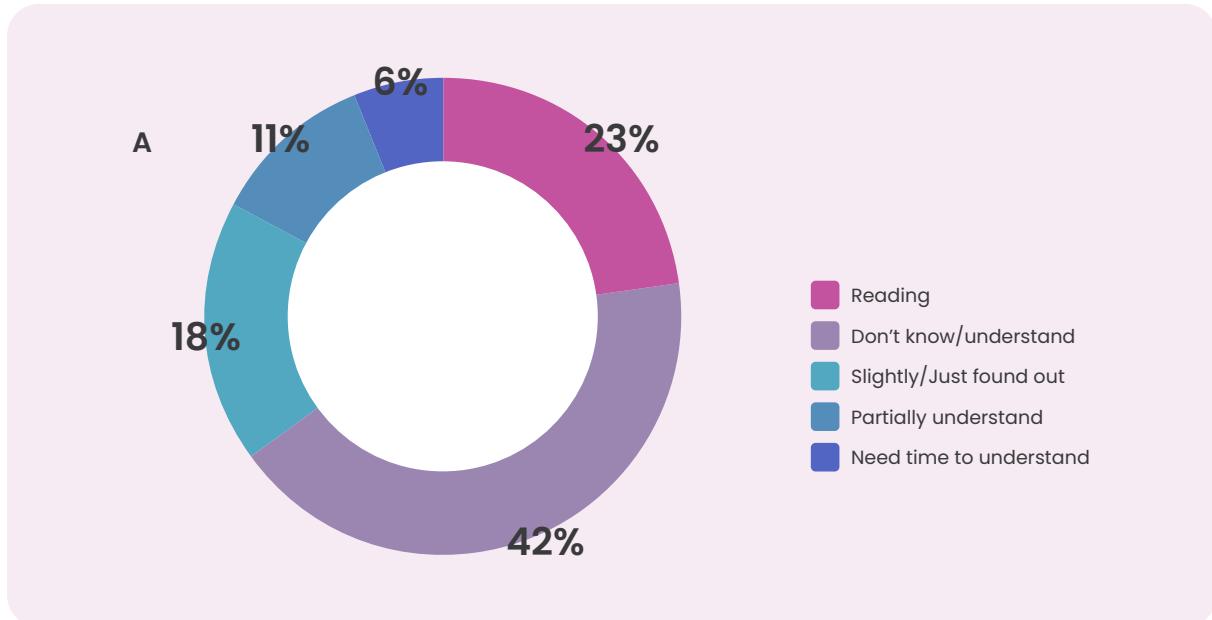
education on NDI, leading to enhanced levels of perception and understanding among its employees. Furthermore, the routine and frequent usage of NDI within the e-government sector may have fostered greater familiarity and comfort with the technology. On the other hand, other sectors may have limited exposure or experience with NDI, resulting in lower levels of perception and understanding. Disparities in training and education on NDI provided by each sector could contribute to these differing levels of perception. Overall, the study's findings highlight the importance of considering demographic factors such as gender and sector when promoting the adoption and utilisation of NDI. By recognising these differences in perception, policymakers and organisations can tailor their awareness campaigns, training programmes, and implementation strategies to address the specific needs and concerns of different demographic groups. Further research is needed to delve deeper into the underlying factors influencing these differences and to develop targeted interventions that can bridge the perception gap and promote widespread acceptance and adoption of NDI across all demographic groups and sectors.

On the other hand, age, employment, state, ethnicity, and education did not significantly influence the perception

or acceptance of NDI. This implies that individuals from diverse backgrounds, regardless of their demographic characteristics, are equally likely to accept NDI. This finding suggests a positive outlook for the implementation and adoption of NDI, as it indicates its potential for widespread acceptance across various demographics. Factors such as the recognition of NDI's importance and benefits, its ease of use, and its convenience might outweigh any demographic barriers. However, it is essential to continue exploring and understanding additional factors that could impact NDI acceptance, such as cultural aspects or personal values. Furthermore, the study identified significant relationships between acceptance of NDI and state as well as sector. This suggests that location and organisational type influence the acceptance level of NDI. Certain states or sectors may have greater exposure to and familiarity with NDI, leading to higher acceptance levels. This could be attributed to policies or initiatives within specific states or sectors that promote

NDI usage and acceptance. For instance, states or sectors with advanced digital literacy and infrastructure are more likely to exhibit higher acceptance levels due to their ease of using digital technologies. Similarly, states or sectors with a higher level of trust in the government and its institutions may be more receptive to NDI as a means of identification and authentication. In conclusion, the research findings demonstrate the varying levels of perception and acceptance of NDI based on gender and sector, while factors such as age, employment, state, ethnicity, and education did not significantly influence perception or acceptance. The results highlight the potential for widespread acceptance of NDI across diverse backgrounds and provide insights into the influence of location and organisational type on acceptance levels. Further research is necessary to delve deeper into the underlying factors and develop effective strategies for implementing and promoting NDI adoption in a comprehensive and inclusive manner.

(a) Five themes of being knowledgeable about NDI



(b) View on the implementation of NDI in the respective sector

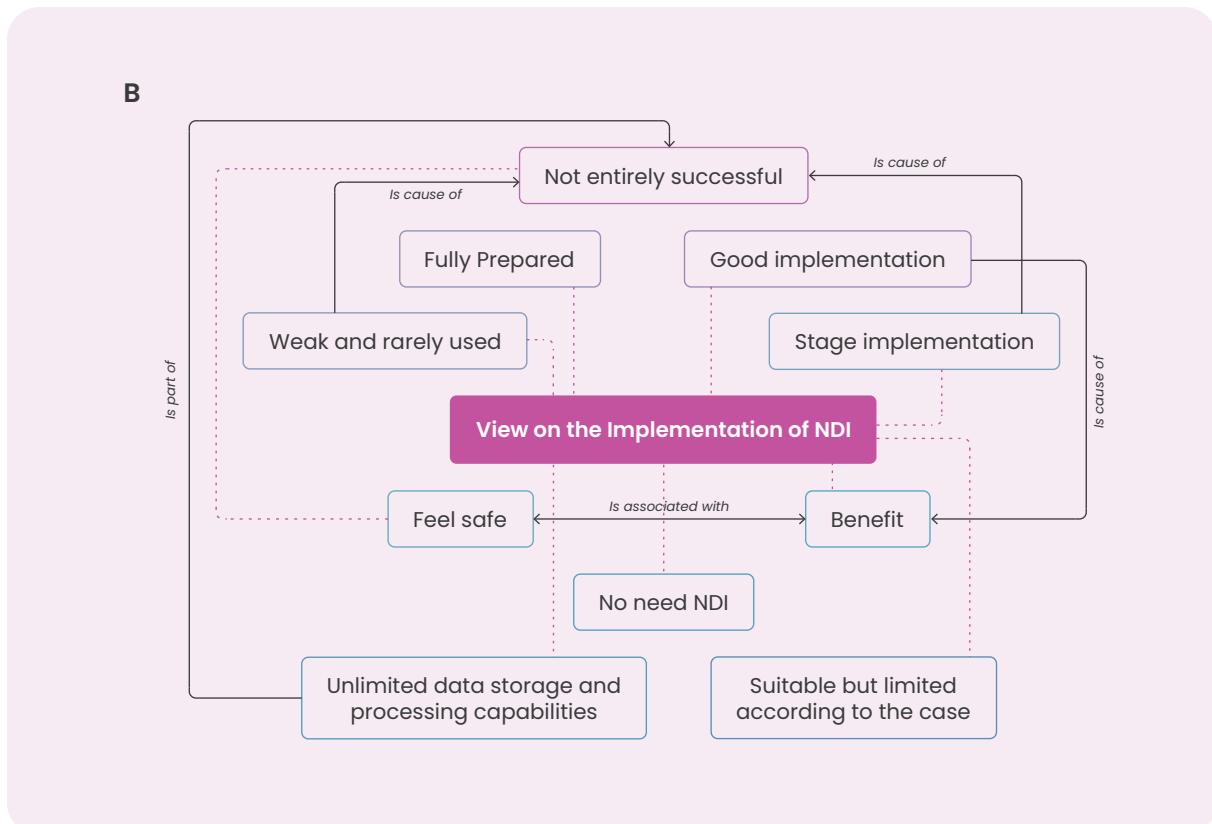
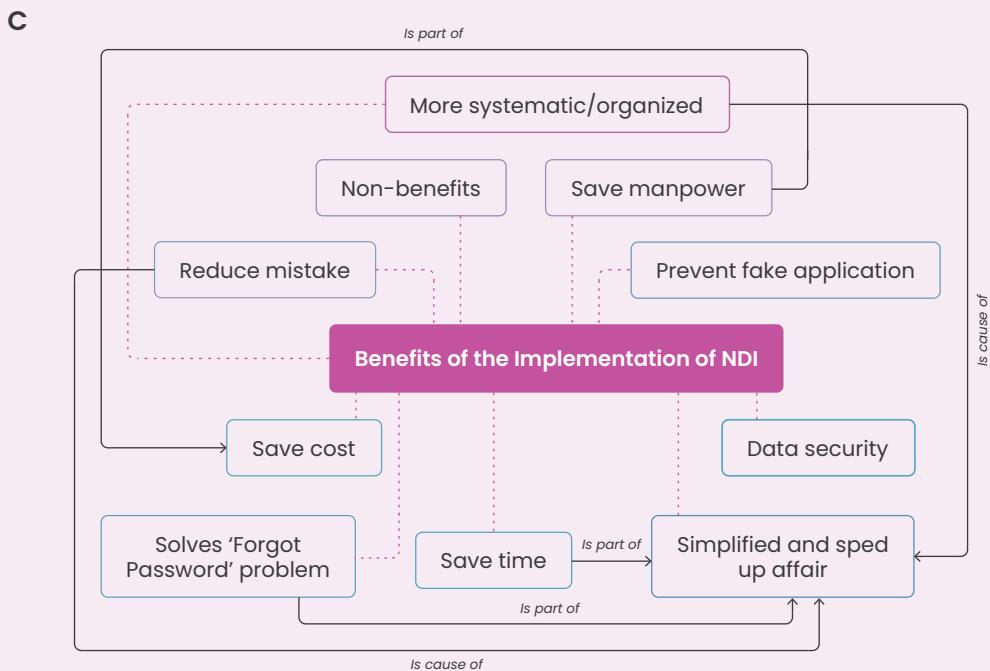
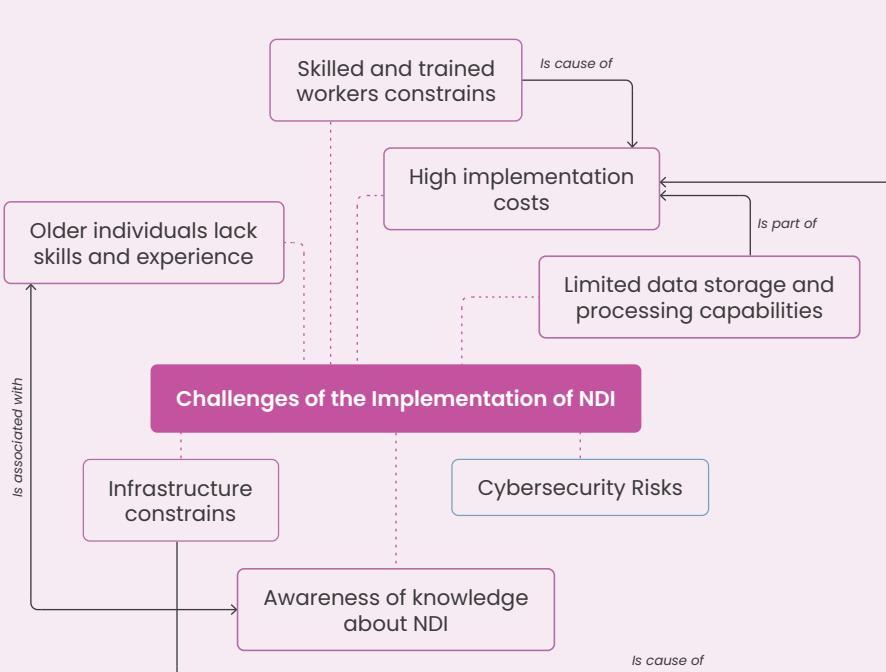


Figure 3: Qualitative findings

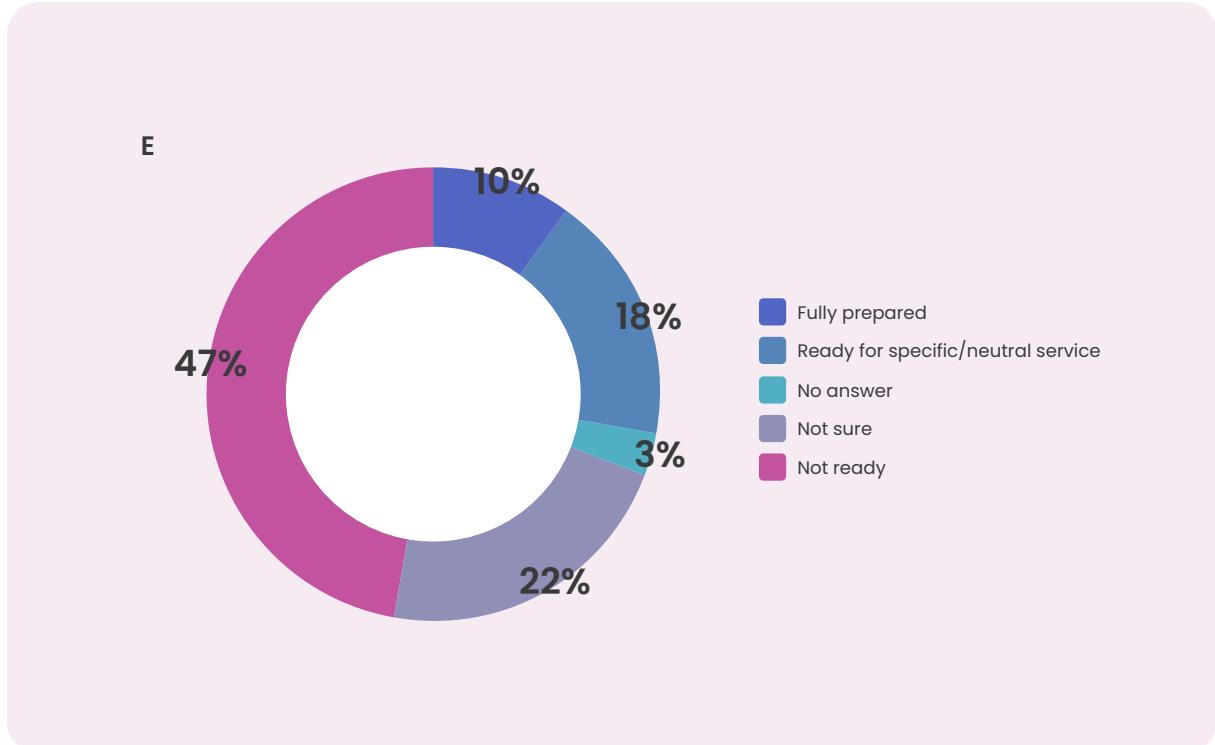
(c) Benefits of implementing NDI in certain aspects in the sector



(d) Challenges of implementing NDI in certain aspects of your sector



(e) 5 themes of readiness to implement NDI in certain aspects



The qualitative study aimed to provide recommendations for promoting awareness and adoption of NDI among specific service providers. Through interviews and analysis of responses, the researchers addressed several research questions. The study revealed that the level of knowledge about NDI among respondents varied (see Figure 3(a)). Some actively sought information about NDI, indicating a proactive approach to understanding the topic. However, a significant number of respondents reported being unaware or uninterested in NDI, highlighting a lack of awareness. Some respondents had recently learned about NDI by chance, while others had a partial understanding but desired more comprehensive comprehension. Overall, the findings indicated a mixed level of knowledge among respondents regarding NDI. Regarding the implementation of NDI, respondents recognised the potential benefits it could bring to various sectors (see Figure 3(b)). These benefits included increased efficiency, accuracy, decision-making, customer service, innovation, and cost savings. However, implementing NDI also presented challenges such as infrastructure shortcomings, lack of awareness or knowledge among users and customers, understanding by older individuals, and high implementation costs. To overcome these challenges, organisations were

advised to carefully assess the cost-benefit of NDI implementation, invest in the necessary infrastructure, provide training and support to users, raise awareness among customers, and ensure robust cybersecurity measures. The study also identified specific benefits of implementing NDI in various aspects of sectors (see Figure 3(c)). These benefits included improved efficiency through process automation, increased accuracy through automated data collection and analysis, better decision-making through real-time data and insights, enhanced customer service through faster response times and personalised interactions, cost savings through the elimination of manual processes, and increased innovation through new ways of working and business opportunities.

The study conducted a comprehensive assessment of the challenges associated with the adoption and utilisation of NDI and provided recommendations to overcome these challenges (see Figure 3(d)). Several key challenges were identified, including the need to upgrade existing systems, integrate different technologies, and ensure cybersecurity. Upgrading outdated systems was recognized as a significant hurdle in implementing NDI. Many organisations have legacy systems that may not be compatible with the new digital infrastructure

required for NDI. Upgrading these systems can be time-consuming and expensive, but it is essential to ensure smooth integration and functionality. Integrating diverse technologies, such as cloud computing, data analytics, and IoT, was also identified as a challenge. Implementing NDI often requires the integration of various technological components, and ensuring seamless compatibility and interoperability can be complex. Organisations need to develop strategies to integrate these technologies effectively and leverage their combined capabilities. Cybersecurity was another critical challenge highlighted by the study. Implementing NDI introduces new cybersecurity risks, and organisations must prioritise data protection and system security. Robust cybersecurity measures need to be in place to safeguard against potential threats and attacks, ensuring the integrity and confidentiality of user data. To address these challenges, the study recommended several strategies. Raising awareness among stakeholders was emphasised to ensure a comprehensive understanding of NDI and its benefits. Organisations should provide training and resources to equip employees with the necessary skills and knowledge to embrace NDI effectively. Engaging with technology vendors and service providers can also be beneficial in implementing NDI solutions. They can offer guidance, support, and expertise in navigating the complexities associated with NDI adoption. Additionally, evaluating the cost-benefit analysis of implementing NDI is crucial. Organisations need to assess the potential return on investment and weigh the benefits against the associated costs. This evaluation will help make informed decisions and prioritise resources effectively. The readiness of sectors to implement NDI varied among the respondents, depending on factors such as digitization level, skilled workforce availability, technology adoption, and the overall business environment (see Figure 3(e)). The study emphasised the need for continuous improvement in NDI implementation across sectors. It recommended staying updated on emerging technologies and opportunities to remain competitive and enhance operations. In conclusion, the study provided valuable insights into promoting awareness and adoption of NDI among specific service providers. By following the recommendations and addressing the challenges identified, organisations can successfully implement NDI and leverage its transformative potential in the digital era.

Recommendation

Based on the findings of the research, where the literacy factor emerged as a significant issue among Malaysians regarding the NDI initiatives, we would like to propose the following recommendations:

Public Awareness Campaigns

Develop comprehensive public awareness campaigns targeted at different segments of the population, emphasising the importance and benefits of the NDI initiatives. These campaigns should be designed to be easily understandable and accessible, utilising clear language, visuals, and examples to convey the key messages effectively.

Educational Initiatives

Collaborate with educational institutions, both formal and informal, to integrate digital literacy programmes into the curriculum. This could include workshops, seminars, or online modules aimed at improving digital skills, including understanding and navigating the NDI ecosystem. By empowering individuals with the necessary knowledge and skills, we can bridge the literacy gap and enhance acceptance and adoption of the NDI initiatives.

Simplify User Interfaces

Ensure that the user interfaces of NDI-related platforms and applications are user-friendly, intuitive, and designed with the needs of individuals with varying digital literacy levels in mind. Incorporate visual cues, step-by-step guides, and interactive elements to assist users in navigating and utilising the NDI services effectively.

Multilingual Support

Recognise and address linguistic diversity in Malaysia by providing multilingual support for NDI materials, websites, and user interfaces. This will help individuals with limited proficiency in the dominant language understand and engage with the NDI initiatives more easily.

Partnerships with Community Organisations

Collaborate with community organisations, NGOs, and grassroots initiatives to reach out to underserved communities and provide targeted support and training on digital literacy and NDI initiatives. These partnerships can facilitate localised efforts and ensure that the benefits of the NDI are accessible to all segments of society.

Continuous Evaluation and Feedback

Implement a system for continuous evaluation and feedback to monitor the effectiveness of awareness and literacy programmes. Regularly assess the impact of the initiatives and make necessary adjustments based on user feedback and emerging literacy needs.

By implementing these recommendations, we can proactively address the literacy factor as a major barrier to the adoption and acceptance of the NDI initiatives in Malaysia. Through targeted awareness campaigns, educational initiatives, simplified user interfaces, multilingual support, community partnerships, and continuous evaluation, we can enhance digital literacy levels and ensure a more inclusive and successful implementation of the NDI initiatives.

Conclusion

In conclusion, the findings regarding the awareness, perception, acceptance, and adoption of Malaysia's NDI initiatives among service providers based on different socio-demographics highlight the significance of age as a determining factor. Younger individuals exhibit higher levels of familiarity and comprehension of NDI compared to older individuals, possibly due to greater exposure or a higher inclination to seek information about NDI. This suggests the need for targeted interventions to improve NDI literacy across all age groups. On the other hand, factors such as gender, sector, employment, state, ethnicity, and education do not significantly predict NDI literacy, indicating that these demographic variables alone do not determine NDI awareness and understanding. However, this does not negate the importance of addressing these factors in promoting NDI literacy. Policymakers and organisations should consider tailored approaches that go beyond demographic factors to enhance NDI literacy and create an informed and inclusive society.

The research also explored factors that influence the adoption of NDI and emphasises the need to address them effectively. Public awareness and

education play a critical role in promoting understanding, trust, proper usage, and wider access to NDI. Privacy and data protection must be safeguarded to prevent unauthorised access and maintain trust. Proper implementation and enhanced digital identity protection are essential to avoid non-compliance, fraud, and security risks. Effective IT infrastructure, government transparency, and accountability are crucial to minimise service disruptions, scepticism, bias, and the digital divide. These findings underscore the importance of comprehensive interventions that encompass multiple factors beyond demographics to foster NDI adoption and ensure a secure and inclusive digital identity ecosystem.

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TOPIC 03

Public Awareness, Perception, and Acceptance of Malaysia's National Digital Identity Initiative

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Abstract

Malaysia's National Digital Identity Initiative (NDII) aims to revolutionise digital services and improve citizen engagement. This study investigates the awareness, perception and acceptance of National Digital Identity (NDI) among the Malaysian population. A quantitative research approach was used, employing cross-tabulation analysis, descriptive analysis and Rasch measurement analysis. The results show that targeted education campaigns are needed to ensure widespread understanding and acceptance of NDI. Demographic factors such as gender, age, marital status, ethnicity/race, education level and place of residence were associated with awareness of NDI. Privacy and security concerns emerged as significant barriers to uptake, highlighting the importance of robust security measures and transparent

data processing practices. User-friendly design and the inclusion of biometric authentication methods were identified as key factors influencing adoption. Based on these findings, recommendations are made to promote awareness and acceptance of NDI. These include education and awareness campaigns, inclusive design, integration with existing services and targeted outreach based on demographic factors. It also identifies future research areas such as policy and regulatory frameworks, user-centred design, stakeholder engagement, implementation strategies and technological considerations to support the successful implementation of the NDII. This study provides valuable insights for policymakers, researchers and stakeholders involved in the development and deployment of digital identity systems.

Introduction

Malaysia is preparing to launch the NDII, which aims to create a secure and reliable digital identity system for its citizens. The success of the NDII depends not only on a strong technological infrastructure but also on public awareness, perception and acceptance. This preliminary study aims to provide insights into the expected public opinion towards the NDII in order to support its effective planning and implementation.

In today's digital age, digital identity systems are becoming increasingly important as they provide individuals with secure access to online services and improve administrative efficiency (Hilowle et al., 2022; Zulkifli et al., 2023). The NDII is expected to revolutionise service delivery, streamline processes and foster a more connected and digitally literate nation. However, before embarking on such a transformative project, a comprehensive understanding of public awareness, perception and acceptance is essential.

This study recognises that the NDII has not yet been implemented and emphasises the need for forward-looking research to assess public expectations, concerns, and preferences. By collecting preliminary data, the study aims to inform policymakers, government agencies, and

stakeholders about potential challenges and opportunities associated with the NDII so that they can develop tailored strategies.

Using a survey-based approach, a diverse group of Malaysian citizens will be interviewed to measure their awareness of digital identity concepts, their perceptions of privacy and security, and their likely acceptance and adoption of the NDII. Conducting this pre-implementation survey will provide valuable insights that can support the development of targeted awareness campaigns, the removal of potential barriers and the improvement of user experience and satisfaction.

This paper presents the rationale and methodology for the pre-study, emphasising the importance of understanding public opinion before implementing the NDII. The following sections focus on the literature review, methodology, research findings, and discussions that provide insight into public awareness, perception, and acceptance of the NDII. The article concludes with recommendations for policymakers and stakeholders, highlighting the need for ongoing research and evaluation as the NDII moves forward.

Our aim with this preliminary study is to contribute to the successful implementation of the NDII in Malaysia by ensuring that public sentiments are taken into account, concerns are addressed and effective strategies are developed to maximise awareness, perception and acceptance among the Malaysian population.

Literature Review

Public Perspectives on Digital Identity and Privacy in Malaysia

Available studies on Malaysia's NDII and related issues offer insights into public perspectives and privacy concerns. This section provides an overview of the research conducted in Malaysia that addresses the NDI framework, public attitudes towards digital applications, privacy concerns and data security.

A 2020 public consultation report by PricewaterhouseCoopers was the only study on the NDI framework in Malaysia (PricewaterhouseCoopers, 2020). It aimed to introduce the NDI concept, and gather feedback and recommendations. However, the study primarily focused on raising awareness among public and

private sector employees through a limited survey.

Turner and Sofia Amirnuddin (2018) explored Malaysians' perspectives on social media responsibility, privacy and personal data security. Participants felt that multiple parties, not just the government, should protect online privacy. They also emphasised the responsibility of social media users to protect their own data.

Chua et al. (2021) examined how Malaysians' willingness to share personal information varies according to demographic factors. The study found significant differences in privacy concerns and intentions to disclose different types of personal data. Age, gender and industry of employment influenced willingness to share information on tracking, finance, authentication and health.

Nor and Fuat (2021) focused on understanding how Malaysian teenagers and young adults present themselves on Facebook. The study showed how individuals present themselves online and how they portray themselves. It emphasised the importance of educating adolescents, especially girls, about the consequences of their online persona and guiding them towards appropriate online behaviour.

Shalihah and Mohd Shariff (2022) explored privacy and data protection challenges in equity crowdfunding activities in Indonesia and Malaysia. The research aimed to improve existing laws and regulations. While Malaysia has regulations such as the Personal Data Protection Act (PDPA) of 2010, theft of personal data is more prevalent in Malaysia compared to Indonesia. The study highlights the need for ECF platform organisers to understand the provisions of the PDPA 2010.

These studies provide insights into the public's perspective, privacy concerns, and data protection challenges relevant to NDII in Malaysia. Policymakers and stakeholders can use these insights to promote public awareness, protect privacy, and ensure the successful implementation of the NDI framework.

International Perspectives on National Digital Identity Initiatives

The NDIs have gained prominence around the world as governments seek to provide secure and convenient digital services to their citizens. This literature review examines the implementation and impact of NDIs in Singapore, Canada, Morocco and the United Kingdom. By examining these international examples, valuable lessons can be learned for developing and improving similar initiatives in other countries.

The Singapore government introduced Singpass, a robust personal authentication system for online government services, in 2003 (Bank, 2022). Singpass offers multiple login methods, including fingerprint, facial recognition and passcode, and provides secure and flexible access to digital services (Singapore, 2023). Singpass Mobile, the country's mobile digital identity platform, has gained significant penetration, with over 2.1 million daily users. In addition, SafeEntry, an extension of Singpass used for COVID-19 check-ins, has further enhanced the platform's usability and reach.

In Canada, the Government of Canada's Digital Ambition sets the strategic vision for digital service delivery, cybersecurity, talent recruitment and privacy (Boysen, 2021). A survey conducted by VMware found that the use of online government services in Canada continues to grow (Canada, 2022). 88 per cent of Canadians have already used such services. However, the survey also showed that public perceptions of government digital services lag behind those of the private sector and trust in government's handling of personal data remains moderate.

Morocco's Digital Development Agency (ADD) and the Directorate of National Security (DGSN) have launched a national digital ID platform based on IDEMIA's eID card technology (The Kingdom of Morocco Introduces a National Digital ID Programme, 2022). This initiative aims to improve digital trust, security and convenience for Moroccan citizens. The uptake of the new eID is remarkable: since August 2020, more than 10 million electronic identity cards have been issued, representing approximately one-third of the country's population.

The Verify system was launched in the United Kingdom in 2016 as a digital identity platform (DI) that allows citizens to access government services online (Harbinja, 2017). The system worked by verifying

users' personal data with the help of a third-party identity provider. Although it successfully expanded access to digital services and reduced fraud, it was criticised for its complexity and ease of use (Forum, 2023). Concerns were also raised about the system's implementation costs and lack of support for smaller businesses. As a result, it was announced that the Verify system would be discontinued on 28 October 2022. From mid-December 2022, no new accounts were accepted and all Verify services were completely discontinued in April 2023.

Methodology

This study uses a quantitative research design to measure the extent of public awareness, perception and acceptance of the Malaysian NDII before its official launch. This section provides an overview of the theoretical framework used in the study, outlines the process of developing the research instrument, explains the sampling methodology and describes the data collection and analysis procedures. As the NDII has not yet been adopted in Malaysia, the results of the study will be important in assessing the public's readiness and identifying factors that may influence their willingness to accept and adopt this digital identity system.

Theoretical Framework

The methodology used in this study is based on two (2) established theories: the Technology Acceptance Model (TAM) and the Perception of Risks and Negative Consequences Theory. TAM focuses on users' attitudes and perceptions towards technology acceptance (Alshari & Lokhande, 2022), while the Perception of Risks and Negative Consequences Theory examines the influence of perceived risks on the intention to adopt and use technology (Koester et al., 2022). By integrating these theories, this study aims

to understand the factors that influence the acceptance and adoption of NDII services by Malaysians and contribute to the success of NDII in Malaysia.

Design of the Research Instrument

The research instrument consists of eight (8) questions developed based on the theoretical framework. The questionnaire aims to collect information on the public's awareness of the NDII system, acceptance of NDII services and perceptions of the benefits associated with it. It also explores the motivating factors for the adoption of the identity system and identifies effective strategies to promote the NDII and the use of its associated services.

Sample & Participants

The study targets adults aged 15 years and above residing in Malaysia. Probability sampling will be used to select a representative sample from the target population. The sample size will be determined using statistical power analysis to ensure that the research questions can be adequately answered.

Data Collection & Analysis

Data will be collected through an online survey addressed to the selected sample. The questionnaire contains demographic questions as well as questions on awareness, perception and acceptance of the NDII in Malaysia. The questionnaire was subjected to a pilot study with a small sample to ensure its validity and reliability. Descriptive statistics, such as means, modes and frequencies, are used to summarise the data. Inferential statistics, including cross-tabulations, are used to examine the relationships between

demographic variables and awareness, perception and acceptance of the NDII. Rasch measurement analysis may also be used to assess the psychometric properties of the research instrument.

Ethical Considerations

All participants will be informed of the purpose of the study, the nature of the questions, and their right to withdraw at any time. Informed consent will be obtained from all participants prior to participation in the survey. The data collected will be kept confidential and used for research purposes only.

Findings and Analysis

This section presents the comprehensive results and analysis obtained from a combination of descriptive analysis, Rasch measurement and cross-tabulation techniques. The aim was to explore the relationship between respondents' information and their awareness, perception and acceptance of NDI services.

The analysis began with descriptive statistics that provided an overview of respondents' characteristics and their level of familiarity with different identity systems. This initial exploration allowed us to identify trends and patterns in demographic factors such as gender, age, ethnicity/race, work status, employment sector, education level, income level and country of residence.

A Rasch measurement analysis was then conducted to gain a deeper understanding of respondents' attitudes, concerns and expectations regarding NDI services. The Rasch analysis provided us with insights into how the survey questions functioned differently and allowed us to assess the relative difficulty and distinctiveness of each item. This analysis helped us refine the measurement scales and ensure the validity and reliability of the data.

Building on the descriptive and Rasch

measurement analyses, cross-tabulation techniques were used to examine the relationships between respondents' statements and various aspects of NDI services. These analyses explored the relationships between demographic factors and awareness, perceived risks, expected benefits and preferences for NDI services.

By combining results from descriptive, Rasch measure and cross-tabulation analyses, we obtained a comprehensive understanding of how different demographic and socioeconomic factors influence awareness, perception and acceptance of NDI services. This integrated approach allowed for a nuanced examination of the data, revealing variations and trends that can inform targeted strategies and interventions.

Descriptive Statistics

A total of 1,014 people participated in this study, the majority of whom were female (77.2 per cent) and the remainder identified as male (22.8 per cent). The age distribution showed that the largest group fell into the 30 to 39 age group (52.8 per cent), followed by the 15 to 29 age group (32.8 per cent). Most participants were married (54.5 per cent), while a smaller percentage described themselves as

single (42.9 per cent) or divorced (2.6 per cent). In terms of ethnicity/race, the majority of participants reported being Malay (73.5 per cent), while a smaller percentage described themselves as Indian (3.5 per cent) or other (0.1 per cent). In terms of occupational status, managerial occupations were the most common (57.3 per cent), followed by skilled workers (10.1 per cent) and professionals (11.8 per cent). The majority of participants worked in the private sector (79.4 per cent), while a smaller percentage worked for the government (15.3 per cent). The highest level of education attained was a university degree (60.7 per cent), followed by a diploma (20.3 per cent) and a master's degree (12.0 per cent). Most participants lived in rural areas (70.8 per cent), while 29.2 per cent were from urban areas. In terms of household income, the majority reported a monthly income of less than RM4,850 (80.4 per cent). The most represented states of residence were Pahang (11.6 per cent), Sarawak (10.6 per cent) and Sabah (10.1 per cent), while Pulau Pinang (1.3 per cent), WP Kuala Lumpur (2.6 per cent), WP Labuan (2.2 per cent) and WP Putrajaya (2.2 per cent) were the least represented. These demographic findings provide valuable information for understanding the differences in awareness, perceptions and uptake of the NDII among the different groups and allow for targeted strategies to increase

uptake among the different demographic groups and maximise the success of the NDII system.

The descriptive analysis results provide valuable insights into respondents' awareness, concerns, expectations, and preferences regarding the NDII. The results show that a high percentage of respondents are familiar with various identity systems, such as password/ PIN, RFID, biometrics, IP address, and electronic signatures. This indicates that respondents have a good level of knowledge about these systems, which is an important factor for the successful implementation of the NDII.

When assessing the risks associated with identification systems, it was found that the majority of respondents expressed concerns about potential risks such as online behaviour tracking, information being used against them, fraudulent charges on their credit cards, identity theft, disclosure of private information and unauthorised access to personal data. A smaller percentage of respondents were concerned about the risk of data compromise by hackers. These findings highlight the need to address these concerns in order to increase awareness, acceptance and perceived usefulness of identification systems.

In terms of the benefits expected from a service such as NDII, most respondents indicated that they expected minimal user effort, ease of task completion, secure identification, cost savings, control over personal data and the ability to detect identity fraud. These expectations are consistent with the potential benefits of an efficient and secure digital identity system. These findings can be used in developing effective promotional strategies for the NDII to highlight the benefits to potential users.

The analysis also explored the factors that might motivate respondents to use identification systems. The availability of a single data set containing all their transactions, interactions, and traces to increase their awareness of their surroundings was found to be the most motivating factor. Other motivating factors included data verification, details about the identification system, compliance with data protection regulations, a verified security credential, and safeguards against disclosure of information to third parties. These factors can guide the development of the NDII to meet user expectations and increase adoption.

In terms of awareness of the NDI, the results showed that while a significant proportion of respondents were aware of the initiative, a significant number were

not aware of it. This suggests that efforts to increase awareness and promote the NDII are necessary to achieve the intended impact. The results also indicate that the majority of the respondents would use the NDII for various services such as e-health records, government aid authentication, online government services, financial institution verification, telecommunication service verification, e-hailing verification, education-related authentication, e-commerce verification and pension authentication. This shows the potential impact of the NDII on several sectors.

In terms of promotional methods, social media advertising, particularly on platforms such as Facebook, WhatsApp, Telegram, Twitter and TikTok, was cited as the preferred method of informing people about NDI services. Traditional media such as radio and television advertisements were also cited as effective advertising channels. These findings suggest that a combination of social media and traditional media approaches would be beneficial in promoting the NDII and increasing awareness and uptake among the target group.

Rasch Measurement

The Rasch model provides a robust framework for measuring latent characteristics and analysing item responses. The results provide a

comprehensive understanding of the participants' characteristics and the psychometric properties of the measurement instrument.

The mean total score of participants was 44.5, indicating moderate levels of awareness, perception and acceptance of NDI services. The standard error of the mean was 0.3, indicating the accuracy of the estimated mean. The standard deviation of the person (P. SD) and the standard deviation (S. SD) were both 10.7, reflecting the dispersion of participants' responses around the mean. The maximum score of 54.0 and the minimum score of 0.0 show the full range of responses observed in the data.

The Rasch analysis provides several indicators of the quality of the measurement. The real root mean square error (RMSE) was 0.81, which represents the average amount of residual variance between the model's predictions and the observed data. A lower RMSE indicates a better fit of the model to the data. The true standard deviation, distance and person reliability provide information about the reliability and precision of the measurement. In this study, the true standard deviation was 1.05, the distance was 1.30 and the person reliability was 0.63, indicating acceptable measurement properties.

In addition, the model RMSE, true standard deviation, separation and person reliability were also examined. The model RMSE, which measures the discrepancy between the observed data and the expected responses of the model, was 0.79, indicating a good fit. The true standard deviation was 1.06, similar to the previous analysis, indicating consistent measurement properties. The separation was 1.34, indicating the ability of the measurement instrument to discriminate between individuals with different expressions of the latent trait. The person reliability of 0.64 indicates an acceptable level of measurement reliability.

The correlation between the raw score and the measured score was 0.91, indicating a strong positive relationship. This result indicates that the items of the measurement instrument effectively capture the underlying construct of awareness, perception and acceptance of NDI services. The high Cronbach's alpha (KR-20) of 0.92 demonstrates the internal consistency and reliability of the measurement, indicating that the items measure the same construct and consistently provide reliable responses. The standardised reliability coefficient of 0.77 further confirms the good reliability of the measurement.

The analysis also identified certain items that were misfits in relation to the Rasch model. These inappropriate items, ranked by their degree of misfit, can be revised or removed to improve the validity of the measurement instrument. In addition, Differential Item Functioning (DIF) analysis revealed significant differences in item performance between men and women on several items. This suggests that gender factors may influence people's responses to the items and should be taken into account in further research or when interpreting the results.

Cross Tabulation

The cross-tabulation analysis between the respondents' statements and the questions on awareness, perception and acceptance of NDI services revealed several important findings.

Significant differences were found in the use of identity systems, particularly RFID, biometrics, and electronic signatures, based on demographic and socio-economic factors. Gender, marital status, ethnicity/race, work status, employment sector, education level, place of residence, income level, and country of residence were found to play a role in the use of identity systems. However, factors such as password/ PIN and IP address were not influenced by demographic factors.

In terms of the warned risks of identification systems, most factors showed no significant association, with the exception of gender, which was associated with the risk of unauthorised access to personal data.

Awareness of the NDII was significantly related to gender, age, ethnicity/race, work status, employment sector, education level, income level and country of residence. Targeted efforts are needed to increase awareness of specific demographic groups.

Across all demographics, the expected benefits of services such as the NDI, such as minimal user burden, ease of task completion, secure identification, cost savings, control of personal information and identity fraud, were found to be significant. Demographic considerations are important for the development and marketing of similar services.

Factors such as ethnicity/race, work status and income level had the greatest impact on the attractiveness of NDI users. Providing options for managing personal data, ensuring complete confidentiality and using biometrics were identified as effective strategies. Gender, age, marital status, education level and place of residence were less important in attracting

users. To attract more users, the NDI service should prioritise the management of personal information, confidentiality and the integration of biometric data, while taking into account factors such as ethnicity/race, work status and income level.

In terms of gender, women were more familiar with identity systems, with the exception of IP addresses. Password/ PIN and biometrics were the most familiar, while RFID and electronic signatures were the least familiar. Women also expressed more concern about risks and expected more benefits from NDI. Preferences for a free service with options to manage personal data, shorter waiting times, a simple registration process, complete confidentiality, annual system audits and the integration of biometrics were expressed more often by women than by men.

In terms of age, the 15 to 29 age group was familiar with passwords/ PIN, RFID and biometrics, while the 30 to 39 age group was well familiar with all identity systems. Familiarity decreased with age and concern about risk was high across all age groups, with the 30 to 39 age group showing the greatest concern. Those aged 30 to 39 also gave the most positive responses about the benefits of NDI. Across all age groups, the reasons cited for attracting more users were

the free provision of the service, control of personal data, shorter waiting times, an easy sign-up process, confidentiality, system audits and the integration of biometrics. Those aged 30 to 39 and 40 to 49 gave more positive responses for control of personal information, ease of subscription and system audits.

Among the different marital status groups, married people had the highest positive responses for all identity systems and risks. Divorced participants showed the lowest positive responses and a lower preference for biometrics.

In terms of race/ethnicity, Malays had the highest familiarity and most positive responses for multiple systems and risks, while Chinese respondents showed scepticism in certain areas. Malays also gave the most positive responses on benefits, followed by Bumiputra from Sabah/Sarawak. All ethnic groups preferred a free service and absolute confidentiality. Biometrics, personal information management, shorter waiting times, an easy registration process and system audits were only moderately important.

In terms of occupational status, respondents in managerial positions were the most familiar with identity systems, while pensioners had the least familiarity with them. Skilled workers had the highest number of respondents who were not familiar with any system. All occupational groups were aware of the risks associated with identification systems, with hacking being the biggest problem. Respondents in managerial positions showed the highest awareness of risk, while pensioners and non-professionals showed the lowest. Respondents in senior positions also gave the most positive responses for all benefits, and preferences for a free service, control of personal data, shorter waiting times, an easy login process, confidentiality, system audits and biometrics were the same across employment, with respondents in senior positions giving the most positive responses.

Among the different employment sectors, the private sector had the highest familiarity with all identity systems, followed by the government sector. Perceptions of risk varied across sectors. The private sector expressed more concern about embarrassing details and credit card fraud, while the government sector focused on unauthorised access and misuse of information. Private sector respondents gave the most positive responses for all benefits. Preferences

for a free service, control over personal data, shorter waiting times, an easy sign-up process, confidentiality, system audits and biometrics were the same across all sectors, with the private sector giving the most positive responses.

Respondents with higher levels of education, especially diploma and university graduates, were more positive about all identity systems. Higher levels of education were also associated with greater awareness of the risks associated with identification systems. However, a significant proportion of respondents at all education levels expressed uncertainty about the risks, indicating a need for further education and awareness-raising. Among the education groups, respondents with a university degree had the highest number of positive responses and showed the most positive attitudes towards the benefits and policies of the NDI service.

In terms of place of residence, both urban and rural residents reported being familiar with passwords/PINs, but were mostly unaware of RFID. Biometrics and IP addresses were more familiar to rural residents. In terms of benefits, rural respondents were more likely to agree with minimal user effort, simplification of tasks, secure identification, cost savings, control of personal data and detection of identity fraud. Both urban and rural respondents

agreed that providing the service for free, managing personal data, reducing waiting time, simplifying the enrolment process, ensuring confidentiality, conducting system checks and using biometrics for self-verification attracted more users.

Respondents showed familiarity with different identity systems, with passwords/PINs and RFID being the most familiar. Familiarity varied by income level, with higher-income individuals more familiar with most systems. Respondents with higher incomes were more aware of the risks associated with identification systems. Respondents with a household income of less than RM4,850 had the most positive responses. Most respondents from all income levels believed in the benefits of NDI-like services. The factors that attract more users were the same across all income strata.

In terms of state of residence, passwords/PINs were the most popular identity system in all states, with Pahang having the highest usage. RFID, biometrics, IP addresses and electronic signatures were less popular. Respondents were aware of the risks, with differences between states. Kelantan had the highest number of positive responses among the resident state groups. Most respondents agreed with the benefits, such as minimal user effort, simplicity of tasks, secure identification, cost savings, control of personal information and detection of identity fraud. Responses varied by strategy, with Pahang and Kelantan receiving the most positive responses in some cases. Biometrics for self-verification was generally preferred, with differences between states.

Recommendations

The study's findings and analysis have significant implications for promoting awareness and adoption of the Malaysian NDII. Targeted awareness campaigns are essential to ensure widespread understanding and acceptance of the NDI. The study shows that demographic factors such as gender, age, marital status, ethnicity/race, education level, and place of residence are associated with awareness levels. Policymakers should tailor their outreach efforts to specific demographic groups, drawing on the effectiveness of targeted campaigns demonstrated in previous research.

Addressing privacy and security concerns is critical to building trust and acceptance of the NDII. Participants expressed significant concerns about online privacy and data security. To address these concerns and build public trust, policymakers should prioritise robust security measures, transparent data processing practises and clear privacy information. This is in line with the findings of previous research, such as the study by Elaswad and Jensen (2016), which highlights the importance of addressing privacy and security concerns in strengthening public trust in digital identity systems. Policymakers should prioritise the implementation of robust

security measures, transparent data processing practises and clear privacy information to address concerns and increase trust in the NDII.

The study highlights the importance of a user-friendly design for the NDII. Participants emphasised minimal user effort, ease of task execution and secure identification. Policymakers should prioritise intuitive interfaces, streamlined processes and clear instructions to ensure easy navigation and use of NDI services. This emphasis on ease of use and usability is consistent with previous studies that have shown it to have a significant impact on the adoption and acceptance of digital identity systems (Sule et al., 2021). Policymakers should prioritise intuitive interfaces, streamlined processes and clear instructions to ensure that citizens can easily navigate and use NDI services, thus improving user acceptance and adoption.

The use of biometric technologies in the NDII can increase security and user convenience, leading to greater adoption. Participants were positive about identification systems that incorporate biometrics. Policymakers should consider incorporating biometric authentication

methods such as fingerprint or facial recognition based on the findings and recommendations of previous research. Previous research, such as the study by Nnamoko et al. (2022), suggests that the inclusion of biometrics in digital identity systems can increase security and user convenience, leading to greater adoption. Policymakers should consider using biometric technologies such as fingerprint or facial recognition as part of the NDII to provide secure and user-friendly authentication methods.

Several recommendations are made to promote awareness and acceptance of the NDII. First, the Malaysian government should launch a comprehensive education and awareness campaign targeting all age groups, genders, and income levels. Messages should be tailored to the needs of specific groups to maximise effectiveness. In addition, the NDII should be inclusive and accessible to all. People with disabilities and those who are not computer literate should receive support. User-friendly interfaces and assistance should be provided to facilitate use.

Integrating the NDII with existing services such as banking and health services would increase convenience and reduce duplication of personal data. This integration would result in faster service and less paperwork for citizens. In addition,

demographic-specific recommendations can optimise awareness and acceptance efforts. Targeted outreach programmes should be implemented for women, different age groups, couples and families, different ethnic groups and communities, employed and unemployed people, specific employment sectors, different levels of education and regions with lower digital literacy.

The implementation of these recommendations will help overcome barriers, raise awareness, address concerns and promote acceptance and adoption of the NDII. In this way, Malaysia can create a secure and user-friendly digital identity ecosystem that benefits all citizens.

Conclusion

In conclusion, the study's findings and analysis provide valuable insights into the factors that influence awareness, perception, and acceptance of the Malaysian NDII. The study highlights the need for targeted awareness campaigns aimed at specific demographic groups, building on previous research that emphasises the effectiveness of such campaigns in increasing public awareness and knowledge of digital identity schemes.

Privacy and security concerns emerged as significant barriers to the adoption of the NDII. This highlights the importance of implementing robust security measures, transparent data processing practices and clear communication about privacy. The study also highlights the importance of user-friendly design. Participants emphasised minimal user effort, ease of task completion and secure identification. The use of biometric technologies in the NDII is recommended due to the positive perception of such authentication methods by the participants.

To promote awareness and acceptance of the NDII, it is recommended to launch comprehensive education and awareness campaigns for all demographic groups, ensure inclusion and accessibility through user-friendly interfaces and support for people with disabilities, and integrate the NDII into existing services to increase convenience. Demographic-specific recommendations further optimise awareness and acceptance efforts.

As the Malaysian government prepares to implement the NDII, future research is recommended to address various aspects and challenges. These include exploring the policy and regulatory frameworks needed to support the initiative, focusing on user-centred design to improve the user experience, engaging stakeholders and conducting public awareness campaigns, developing implementation strategies and a comprehensive roadmap, and considering technological aspects such as digital infrastructure, interoperability and emerging technologies.

Addressing these research areas can help policymakers and stakeholders gain valuable insights into the development, implementation, and roll-out of the NDII in Malaysia. This will help create a secure and user-friendly digital identity ecosystem that benefits all citizens by providing convenient access to services and promoting trust in the digital world.

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TOPIC 04

How Ready Are Higher Education Providers to Implement Communications and Multimedia Micro-Credentials?

An Assessment of Challenges and Readiness of Higher Education Providers

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Abstract

The rise of online learning has brought about a close connection between micro-credentials (MCs) and lifelong learning, employability, and new digital education models. MCs are considered instrumental in transforming higher education today. This research has three (3) main aims. Firstly, it seeks to assess the level of MC adoption in Malaysia, particularly from the perspective of Higher Education Providers (HEPs). Secondly, the study aims to elucidate the challenges faced by local learners and MC developers, bridging the gap in comprehension and implementation. Lastly, it seeks to identify the obstacles HEPs encounter when offering MCs, encompassing technological, organisational, and people-related hindrances. By analysing empirical data, this research intends to propose a conceptual framework that can guide the

successful adoption and implementation of MCs within educational institutions. The research endeavours to analyse empirical data to formulate a conceptual framework for the effective adoption and integration of MCs within educational institutions. These recommendations, once implemented, can empower HEPs in Malaysia to successfully incorporate MCs into their academic fabric. This not only promises an enriched learning journey for students but also contributes significantly to the broader transformation of higher education. It aligns academia with the dynamic demands of the digital age, fostering a culture of perpetual learning and skill enhancement.

Keywords: Micro-Credentials; Adoption Readiness; Technological Management; Educational System; Higher Education Provider; Quality Education

Introduction

Micro-credentials (MCs) are officially recognised records that demonstrate the completion of learning objectives during shorter, less time-consuming educational or training events. They concentrate on validating competency-based knowledge, outcomes, and/or skills using trustworthy assessments and open standards, which can improve graduates' chances of finding employment. An institution or organisation may accept MC for credit or as an attestation for potential employers. Initially, MCs were first established in online discussion forums and other social media platforms to differentiate average users from advanced users by awarding digital badges to the respondents who completed the necessary assessments and assignments, for the purposes of upskilling, as well as learning new skills (McGreal & Olcott, 2022). Eventually, learners can earn a digital badge and advance to the next selected digital badge once the MCs are completed (Rottmann & Duggan, 2021).

Higher education institutions should focus on formalising the position for micro-credentialing in their programmes by developing policies and associated taxonomies to guide this effort within their institutions. Nevertheless, underlying the factors of these flourishing concepts, it is essential to look at the efforts and policy before further implementation to ensure that the programmes are inherently suitable and add value.

Problem Statement

MCs are gaining importance in Malaysia as they promote flexible learning. This study aims to assess the readiness of Malaysia to adopt MCs and determine the most suitable adoption model. Higher Education Providers (HEPs) can then implement appropriate support and policies to overcome challenges and ensure successful implementation, providing quality learning experiences.

The current higher education system has limitations in terms of cost and duration, posing a challenge for working adults seeking academic qualifications or new skills. However, the emergence of MCs offers an alternative educational option with shorter completion times. Many institutions have developed MC programmes to retrain and educate the workforce,

providing working adults with opportunities for promotion and skill expansion within a shorter timeframe. These certification programmes can be advantageous for individuals to enhance their academic and personal development before entering the job market.

As technology evolves, many skills related to IT and other fields are becoming outdated and require different skill sets to meet new job requirements and roles. This is where MCs play a crucial role. MCs offer a way for individuals to quickly acquire specific skills and knowledge needed in these emerging roles. They are agile and responsive to industry demands, making it possible for graduates to upskill or reskill efficiently.

MCs can bridge the skills gap by providing targeted, industry-relevant education. They enable graduates to adapt to evolving job requirements, enhancing their employability and reducing the risk of job mismatch. This flexibility in learning and skill acquisition is vital in the fast-changing landscape of work, helping individuals stay competitive and aligned with the demands of modern careers. As technology continues to reshape industries, MCs will play an increasingly important role in preparing graduates for the jobs of the future.

Aims & Objective

The research questions of this study focus on assessing the readiness of Malaysia to adopt MCs and determining the most suitable adoption model for implementation. It aims to investigate the challenges faced by HEPs in offering MCs and understand the perspectives of learners and developers in the local context.

This research aims to provide valuable insights into the current state of MC adoption in Malaysia, as well as to examine the demand for MCs in the country. Additionally, it seeks to assess the readiness of HEPs to implement MCs from the perspectives of technological, organisational, and people readiness. Furthermore, the research objectives include proposing a best adaptation model or conceptual framework based on empirical evidence for the successful adoption and implementation of MCs within educational institutions. Lastly, the framework will be tested and validated through hypotheses. By addressing these research questions and objectives, this study contributes to enhancing the quality and accessibility of flexible learning options in Malaysia, specifically focusing on the adoption and implementation of MCs within the higher education sector.

Literature Review

Background of Micro-Credentials (MC) in Malaysia

MCs allow learners to gain specific skills in a shorter time. MCs offer learners the opportunity to acquire targeted skills in a more condensed timeframe. What sets them apart from traditional education is the ability to track and display a learner's achievements through digital badges (Kiiskila et al., 2022). Conventional degrees, in contrast, are often being compared for their inability to effectively convey a learner's specific competencies. For instance, the employees can track and verify their skills obtained with digital badges that are transferable between stakeholders (Lim et. al., 2018). To this extent, the MC programmes represent evidence of competence, including the level of progression achieved. Besides, MCs have increased the opportunities available in terms of flexibility and competencies to learn in their own space. For example, learners can choose between MCs and conventional degrees according to their requirements and preferences.

The Malaysian government's dedication to MCs has indeed yielded positive results,

with a notable increase in the presence of these programmes within the Malaysian higher education system. The Malaysian Qualifications Agency (MQA) has played a pivotal role in this endeavour by introducing a comprehensive framework that provides invaluable guidelines for the seamless implementation and development of MCs in HEPs (MCMC, 2022). Furthermore, collaborative efforts from various stakeholders in shaping the MC landscape in Malaysia should be acknowledged, too. Through the adoption of MQA guidelines, HEPs have also been actively involved in designing and offering MC programmes that cater to the diverse needs of learners and industries. In this regard, industry experts and industries have contributed significantly through constant feedback and engagement in discussions. Thus, ensuring that MCs align with the evolving demands of the job market. Additionally, professional bodies and accreditation agencies have played a pivotal role in validating the quality and relevance of these credentials, enhancing their recognition and value. This collaborative approach ensures that MC courses offered remain adaptable, credible, and valuable assets in the dynamic landscape of higher education and the job market in the country.

Organisations have played a crucial part in enabling the development and spread of MCs amongst Malaysian HEPs. Their contribution has been vital in establishing the required infrastructure, including digital platforms and support systems, for efficiently delivering MCs. In addition, institutions have actively worked together with industry partners to ensure that the MCs offered meet the expectations and demands of the industry. The designing process of MC is important for enhancing and revitalising individual skill sets. Therefore, it is crucial to go beyond the methodology and design when considering each specific level of credentialing (Hernandez et al., 2014). To this extent, the key factor is to improve the relationship between the credential products and evaluating whether an organisational structure is in place to assess the quality of the MC course and align with the necessary skills and competencies.

Micro-Credentials Related to Communications and Multimedia

Communications and Multimedia (C&M) encompass different aspects of using communications technology to transfer various types of media data, such as continuous and discrete media. For example, leveraging digital innovation, basic telecommunication infrastructure and 5G technology for the seamless transmission of multimedia content (Duklas, 2020). This is because digital communication involves sensitive information and data, policy and regulation, network security and others that is a crucial role to ensure the confidentiality and integrity of the communication process (Salloum et al., 2018). The primary goal of the Malaysian Communications and Multimedia Commission (MCMC) is to promote a competitive and efficient

communications and multimedia industry in Malaysia (MCMC, 2022). By focusing on the development and regulation of communications and multimedia, MCMC plays an important role in encouraging innovation and ensuring the communications sector meets the evolving social and economic needs in Malaysia.

Communications and Multimedia Advancements Necessitate Enhanced Learners' Digital Literacy Competencies

In Malaysia, ongoing advancements in communications and multimedia have necessitated a profound redesign of strategies for mediating its impacts and

ensuring digital literacy implementation. The impact of communications and multimedia extends across various domains, including social interaction, education, and the creative industry. The prevalence of digital communication platforms necessitates digital literacy for privacy protection, responsible online behaviour, and critical thinking to combat misinformation. Secondly, multimedia's role in education is pivotal, with e-learning platforms and webinars becoming indispensable. Digital literacy empowers students and professionals to engage effectively with these resources, enhancing learning outcomes and employability. Moreover, the dynamic landscape of communication and multimedia underscores the importance of digital literacy in Malaysia, affecting everything from social interactions to education and economic opportunities. Therefore, promoting digital literacy is crucial for the country's continued success in the digital era.

MCs are valuable tools for students seeking to develop their digital literacy skills. These skills are crucial both in academic and employment contexts. MC programmes have proven effective in helping learners establish their professional identities and use digital badges as incentives (West & Cheng, 2022). These badges symbolise learners' dedication and the

time they invest in their learning journeys, encompassing various learning materials and activities. By utilising MCs, learners can improve their digital literacy and overall digital skill set.

Higher Education Providers Micro-Credential Challenges

The scope of MCs in the field of communications and multimedia requires the need for formal standardisation. Standardisation in MC programmes is essential to ensure HEPs, employers, and employees alike are benefited. For HEPs, establishing a clear framework for designing and delivering these credentials will ensure consistency and quality across various offerings. Standardisation also assists employers by providing a recognised benchmark for assessing an individual's digital communication and multimedia skills, making the hiring process more transparent and efficient. Additionally, employees benefit as standardised MCs can enhance their credibility and mobility in the job market, validating their expertise in this rapidly evolving field.

Failing to address standardisation can carry significant risks. Without clear standards, there is a risk of inconsistency

in the content and rigour of MC programmes, potentially diminishing their value. Employers may face challenges in evaluating the skills of job applicants, leading to hiring challenges and ineffectiveness. For employees, a lack of standardised MCs potentially opens the risks of investing time and money on non-standardised MCs that do not align with industry needs and do not favourably advance their career prospects.

The content and tracking of information within digital badges are important considerations for learners when deciding which badges to pursue (Lemoine & Richardson, 2015). The specific details carried by the badges and the responsible organisations for updating, storing, and displaying the information are crucial factors (Pollard & Vincent, 2022). Learners often compare digital badges earned to assess their value and credibility. To facilitate this process, it is essential to establish a standardised technological infrastructure for verifying and validating badges. This standardisation would simplify decision-making for learners and ensure transparency and consistency in badge assessment.

In the context of this study, organisational readiness refers to the preparedness of institutions or management to adopt MCs effectively. In Malaysia, institutional

preparedness for the effective adoption of MCs is impacted by several vital factors. Government support and policy development, which sets the regulatory framework for institutions and robust technology infrastructure and faculty training to ensure seamless MC delivery. Institutional preparedness also includes recognising MCs within the job market, emphasising accreditation and industry recognition. Lastly, HEPs must embrace data analytics for programme assessment. These interconnected factors collectively drive organisational readiness and institutional preparedness, enabling the successful integration of MCs into Malaysia's educational landscape.

One important aspect is maintaining the quality of the tasks or assessments required to earn digital badges. This includes ensuring that the staff involved in designing and evaluating these tasks are properly trained and equipped with the necessary knowledge and skills (Pollard & Vincent, 2022). Additionally, organisations need to establish effective process controls to ensure the consistency and reliability of the assessment process. This involves implementing clear guidelines and standards for evaluating and awarding digital badges, as well as conducting regular quality assurance checks to uphold the integrity of the credentials.

Education leaders must be more highly skilled and professional to educate students to navigate society successfully. Educators need to invest in accessible and relevant professional development to advance their skill sets (Darling-Hammond & Hyler, 2020). For example, HEPs need to strengthen the standards of administrators and educators by enhancing their skills and knowledge. In addition, the adult learning theory is largely ignored, as the efforts also ignore the important trend of educators to be competent enough to transfer the relevant skills to the learners (Rubin & Brown, 2019). As technology evolves, educators must adapt to the trend to push learning experiences based on the latest learning technology methods.

Issues Identified Pertaining to Micro-Credential Implementation

The private sector is making an investment in many trainings and learning offers, through a distinctive number of perspectives; one is either as employers to support the process of upskilling/ reskilling the workforce or as content developers for MCs to be competitive with regards to response and demand (Bideau & Kearns, 2022). The IR 4.0 revolution has

moderated the inception of massive open online courses (MOOCs) facilitated by many learning institutions, by which there is a collaboration between education, the Industrial workforce, students and HEIs (Ghasia et al., 2019). Hence, the unavailability of a global and recognised credentialing system has put forth an opportunity for the industrial sector, professional bodies, and licensing organisations to offer credentialled services that are recognised globally (Oliver, 2019) as depicted in Figure 1.

Ensuring global acceptance and usefulness of MCs poses a significant challenge in terms of establishing consistent terminology in course design (Ministry of Communications and Digital, 2023). These MC courses should be tailored to meet the demands of learners seeking specific skill sets and knowledge required for reskilling, upskilling, interpersonal skill development, or Industry 4.0 competencies (Desmarchelier & Cary, 2022). The COVID-19 pandemic has accelerated the need for a digitalised and flexible lifestyle, leading to evolving personal and professional situations. This unprecedented situation presents an opportune moment to re-evaluate the education system and prepare society for technological advancements.

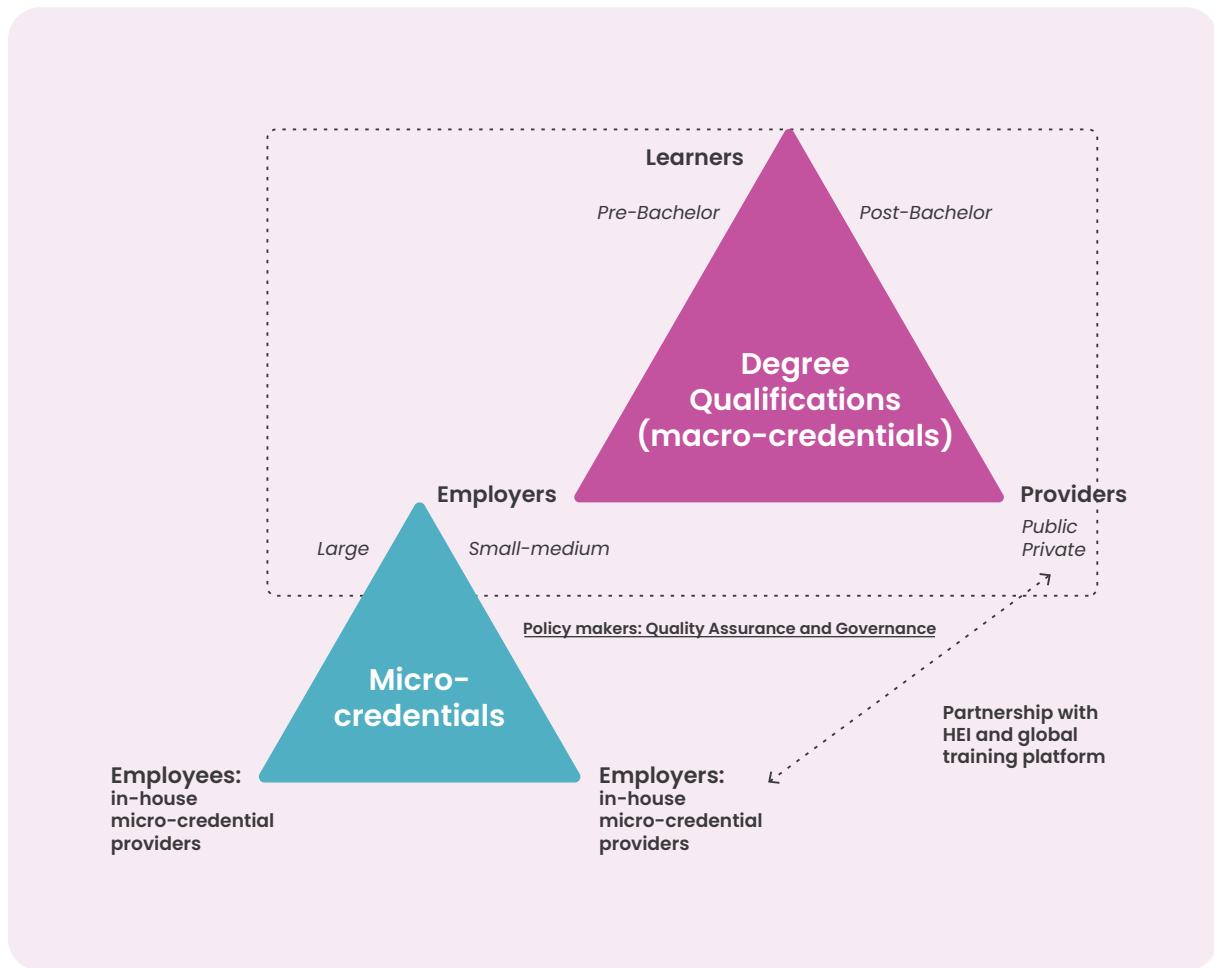


Figure 1: Evolution of MC Ecosystem (Oliver, 2019)

Ensuring global acceptance and usefulness of MCs poses a significant challenge in terms of establishing consistent terminology in course design (Ministry of Communications and Digital, 2023). These MC courses should be tailored to meet the demands of learners seeking specific skill sets and knowledge required for reskilling, upskilling, interpersonal skill development, or Industry 4.0 competencies (Desmarchelier & Cary, 2022). The COVID-19 pandemic has accelerated the need for a digitalised and flexible lifestyle, leading to evolving personal and professional situations. This unprecedented situation presents an opportune moment to re-evaluate the education system and prepare society for technological advancements.

Identification of Critical Success Factors

Critical Technological Factors

MCs are digital badges or certifications that demonstrate a learner's skills or knowledge in a specific area of interest. The increasing popularity of MCs has led to a need for technological infrastructure readiness to support their delivery and management. (Lockley et al., 2016) emphasise the investment in key infrastructure in technology, in addition to curriculum, policy, processes, and training. The technology ecosystem needs to be robust enough to reduce manual work for both issuers and learners, ensure quality and authenticity, and facilitate visibility and compatibility of needs for employers (Markowitz, 2018). Some successful badges are co-created between the potential employer and the university (Leaser & Gallagher, 2017), thus ensuring the quality for the possible future employer from the beginning.

Recent studies have also focused on emerging technologies that could enhance the technological competency of MC design and delivery. In addition, due to the wide array of terms and definitions presently being used for MCs, an up-to-date taxonomy is needed. Blockchain hosting of credentials, controlled by the students, is another technology that needs more research (McGreal et al., 2022).

MCs have gained popularity in recent years as a way for individuals to acquire specific skills and knowledge that employers recognise. These issues include data privacy, credential fraud, platform reliability, and cybersecurity. For example, (Infante-Moro et al, 2020) emphasise the importance of data privacy in the design and delivery of MCs. They suggest that micro-credentialing platforms should use secure data management practices and provide learners with control over their personal information.

Critical Organisational Factors

The organisational factor within HEPs plays a pivotal role in shaping collective beliefs and attitudes toward MCs. The perception of educators and their willingness to embrace these credentials is a fundamental aspect of course success (Woods & Woods, 2021). Establishing a collaborative environment and fostering networking among HEPs during the development

of MCs is essential to ensure mutual support. This necessitates that every stakeholder within HEPs comprehends their roles and actively contributes to driving a transformative shift in learning (Kohl, 2019).

In addition, the management of HEPs is the guideline for the implementation process for MC. Management support is crucial to ensure effective leadership to provide supportive strategies such as financial commitment, policy implementation and investment (Howard & Babb, 2022). Apart from the supportive management team, strategic alignment with MC development is important. Therefore, the management team needs to have a continuous investment in MC practices and procedures (Rossiter & Tynan, 2019). For instance, having a monthly meeting to check the strategies implemented to ensure the progress is on track.

Critical People Factors

Learners' motivation is a key element for the success of MCs, as they proved to be more engaged and more likely to complete their course and apply the skills learned (Kizilcec et al., 2013). The support and guidance provided to learners also play an essential role in the success of MCs (Green & Liem, 2019). For example, learners who received feedback and personalised coaching were more likely to complete their courses. Besides, learners who receive support from instructors are more likely to apply the skills in their work. The recognition and validation of MCs by HEPs and other stakeholders can enhance the credibility and reputation of the courses. In short, MCs are claimed to be the factors to affect learners' job aspirations.

Higher Education Providers Framework for Micro-Credential Readiness

Based on the comprehensive evaluation conducted, a framework has been identified and proposed to assess the readiness of HEPs in implementing MCs, taking into consideration the technological, organisational, and people-related factors.

As discussed in previous sections, the significance of MCs in the educational landscape has been established (Table 1). This framework (Figure. 2) aims to identify and understand the impact of each factor on the successful implementation of MCs within HEPs. By considering the technological advancements, organisational strategies, and the involvement of various stakeholders, the framework provides a comprehensive and holistic approach to assess the readiness of HEPs and guide them in effectively implementing MCs.

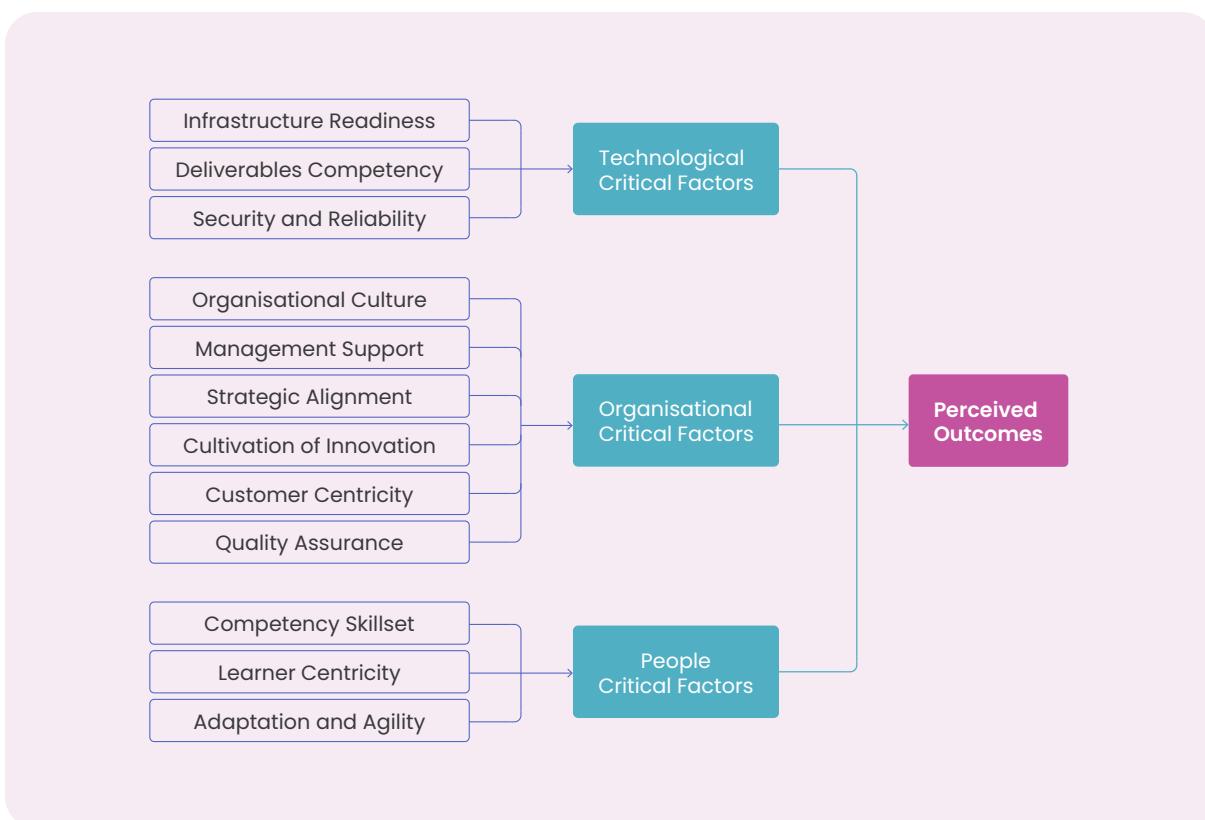


Figure 2: HEPs Framework for MC Readiness

CHALLENGES	SUMMARY	LITERATURE SUPPORT
Critical Technological Factors	<p>Implementing MCs by HEPs requires robust technology infrastructure for seamless delivery, accessibility, and data management.</p> <p>The key challenges include the need to ensure compatibility with existing systems, address potential security concerns, and provide technical support.</p> <p>There are technological challenges in ensuring adaptable, user-friendly platforms and tools which enable MCs to align with diverse HEP ecosystems.</p>	Infante-Moro et al., 2020; Leaser & Gallagher, 2017; Lockley et al., 2016; Markowitz, 2018; McGreal et al., 2022
Critical Organisational Factors	<p>HEPs face the task of reshaping their organisational culture, policies, and practices to accommodate MCs effectively. This includes redefining roles, establishing clear governance structures, and ensuring coordination across departments.</p> <p>Central organisational challenges are overcoming resistance to change, aligning curricular offerings, and creating a conducive environment for innovation.</p>	Fischer et al., 2022; Howard & Babb, 2022; Kohl, 2019; Rossiter & Tynan, 2019; Selvaratnam & Sankey, 2019; Shanahan & Organ, 2022; Woods & Woods, 2021
Critical People Factors	<p>Encouraging educators and learners to accept MCs requires addressing a range of people-related challenges. The need to provide adequate training and professional development opportunities, ensure support from faculty, and foster a culture of lifelong learning.</p> <p>Overcoming scepticism, facilitating collaboration, and motivating learners to engage with MCs are critical aspects of managing people-related challenges.</p>	Green & Liem, 2019; Kizilcec et al., 2013; McGill et al., 2020

Table 1: Summary of Factors by Literature Support

Hypothesis Development

A comprehensive set of hypotheses has been put forward for the purpose of testing and evaluating the readiness of HEPs to successfully implement MCs. These hypotheses are designed to assess various aspects and factors that contribute to the capability of HEPs to adopt and integrate MCs into their existing educational systems. Through rigorous examination and analysis, these hypotheses aim to provide insights into the level of preparedness and potential challenges that HEPs may face when embarking on the implementation of MCs. By systematically testing these hypotheses, valuable information can be gathered to inform decision-making processes and ensure the effective implementation of MCs within the higher education landscape. The hypotheses' relationship between factors and the description of each element have been concluded in Figure 3 and Table 2.

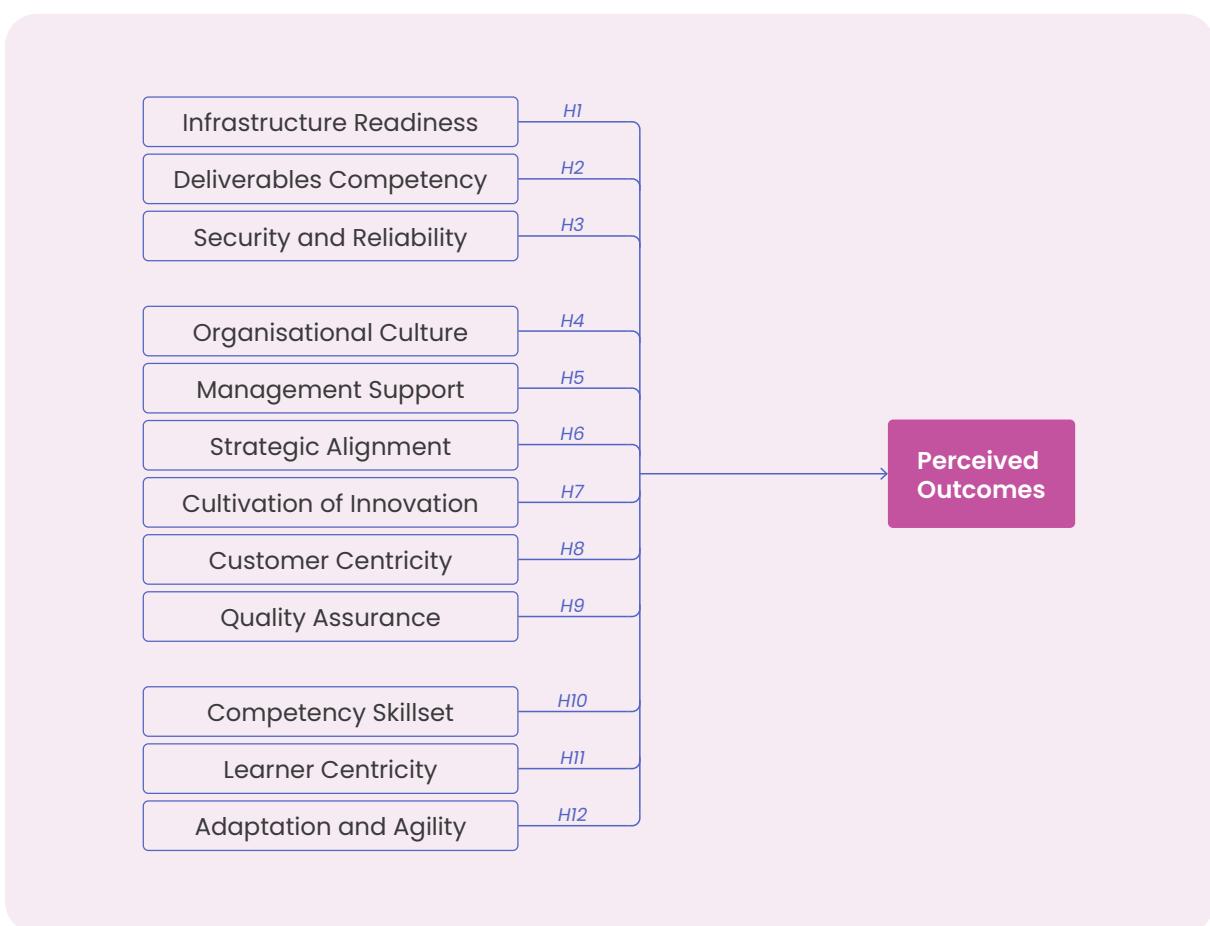


Figure 3: Hypothesis Development for Testing and Evaluating the Readiness of HEPs

CRITICAL FACTORS	HYPOTHESIS	DESCRIPTION
Critical Technological Factors (H1, H2, H3)	H1	The possession of an infrastructure readiness set will greatly enhance the perceived outcome when implementing MCs.
	H2	The possession of the Deliverable Competency set will greatly enhance the perceived outcome when implementing MCs.
	H3	The possession of Security and Reliability set will greatly enhance the perceived outcome when implementing MCs.
	H4	The possession of Organisational Culture set will greatly enhance the perceived outcome when implementing MCs.
Critical Organisational Factors (H4, H5, H6, H7, H8)	H5	The possession of Management Support set will greatly enhance the perceived outcome when implementing MCs.
	H6	The possession of Strategic Alignment set will greatly enhance the perceived outcome when implementing MCs.
	H7	The possession of Cultivation of Innovativeness set will greatly enhance the perceived outcome when implementing MCs.
	H8	The possession of Customer Centricity set will greatly enhance the perceived outcome when implementing MCs.
Critical People Factors (H9, H10, H11, H12)	H9	The possession of Quality Assurance set will greatly enhance the perceived outcome when implementing MCs.
	H10	The possession of Competency Skillset set will greatly enhance the perceived outcome when implementing MCs.
	H11	The possession of Learner Centricity set will greatly enhance the perceived outcome when implementing MCs.
	H12	The possession of Adaptation and Agility set will greatly enhance the perceived outcome when implementing MCs.

Table 2: Description of Each Hypothesis

Methodology

Introduction

Acceptance and adoption of MCs amongst HEPs remains relatively low compared to other types of programmes offered. To gather data on the acceptance and adoption of MCs in Malaysia, a descriptive survey research approach will be utilised. This survey will help identify the challenges faced by Malaysian HEPs in delivering high-quality MC content (El-Farra et al., 2022). Additionally, the descriptive research will provide a comprehensive analysis and description of the current status of MCs by HEPs in Malaysia.

To gain deeper insights into the research questions and explore the main challenges surrounding MCs and their importance amongst Malaysian HEPs, an exploratory research method will be employed. Exploratory research is particularly useful

when investigating a new topic with limited existing research (Swedberg, 2020). The theoretical framework developed with the support of exploratory research will explain the challenges encountered by institutions in providing MCs to learners. The combination of these two (2) research methods will provide a more comprehensive understanding of the implementation status of MCs in Malaysia (Figure. 4 & Figure 4.1).

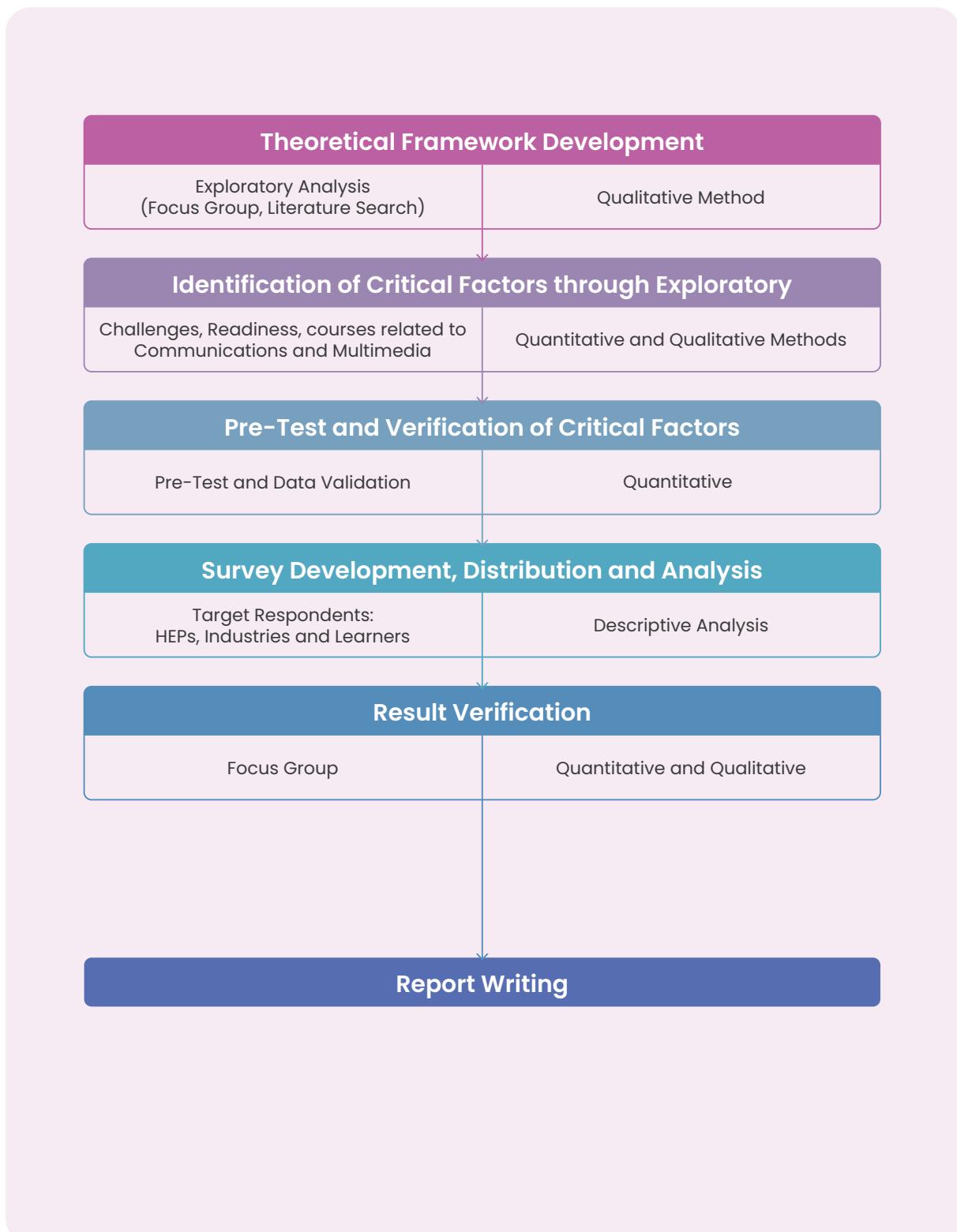


Figure 4: Research Process

A cross-sectional study was designed to study and investigate the research objectives at a point in time. A mixed-method approach was designed to integrate quantitative and qualitative data within a single study. The mixed-method study is particularly advantageous in collecting rich and comprehensive data. For example, perception of the MC often integrates quantitative data (scores determining prevalence) with qualitative data by sharing of emotions and expression. To obtain quantitative data, a survey questionnaire is adopted in this present study, supported by the qualitative study through interviews within focus groups. The main reason behind integrating a mixed-method approach in this study is to allow researchers to explore different perspectives and uncover relationships related to the research questions (Shorten & Smith, 2017). The quantitative data from this study helps in analysing data regarding the demands of MC in multimedia and communication fields. In addition, the qualitative study provides opportunities for participants to reflect and share feelings and experiences MC in multimedia and communication fields. Through this method, qualitative study can help to explain quantitative data with enriched evidence and enable research questions to be answered more deeply (Shorten & Smith, 2017).

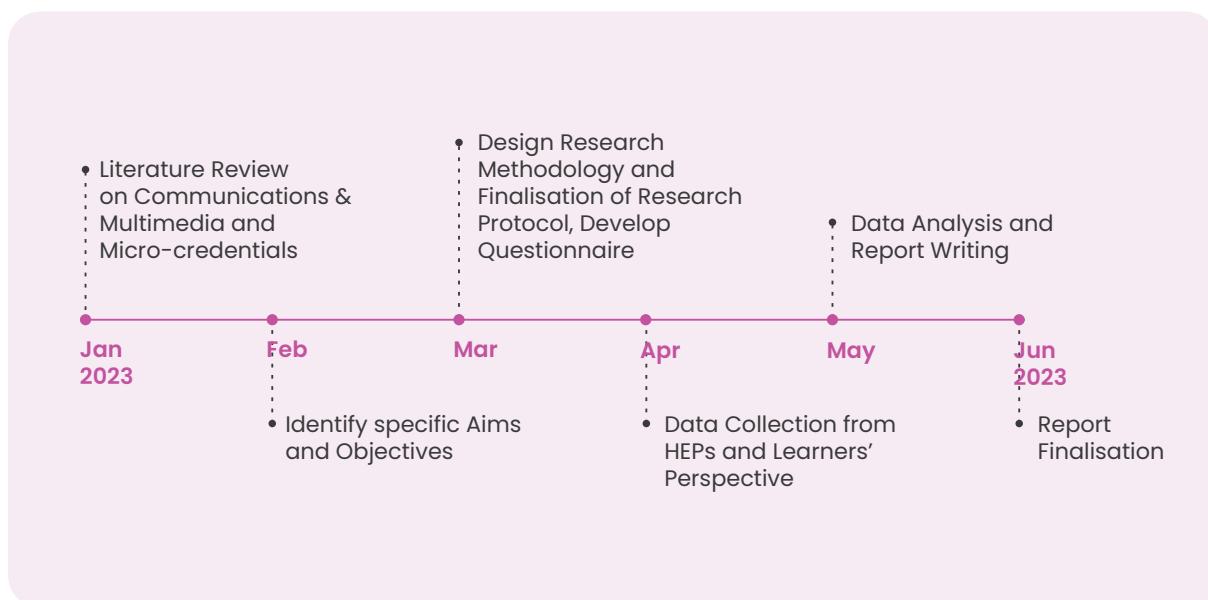


Figure 4.1: Project Timeline

Target Respondents

A priori G* power analysis (Lakens & Caldwell, 2021) was used to generate the minimum sample size required to detect medium effect size, with 0.80 desired statistical power level. Given the structural complexity of the model, the minimum sample size required to detect the effect was 150. 200 participants were targeted for this study, assuming less than 30 per cent of incomplete or missing data may be excluded from the study. The target groups are those who fulfilled the inclusion criteria below:

- HEPs (Management and Educator).
- Industry relevant to communications and multimedia.
- Individuals aged 18–60 years old.
- Able to provide consent (verbal/written) to participate.
- Understand Bahasa Malaysia or English

Statistical Analysis

Data was analysed using IBM SPSS Statistics for Windows, version 22 (IBM Corp, Armonk, NY, USA). The analysis followed a per-protocol approach, which means that only participants with valid baseline data and those who have completed at least one (1) of the endpoint assessments according to their assigned groups will be included in the analysis.

Findings and Analysis

Descriptive Analysis

Types of Higher Education Providers Targeted

558 respondents participated in the online survey to study the readiness of HEPs to implement MCs from the perspectives of Technological, Organisational, and People Readiness. The HEPs participating comprised public universities, private universities, vocational colleges, polytechnics, private colleges, community colleges and skills institutes. The breakdown of the institutions is summarised in the bar chart below (Figure 5). Based on the bar chart, the highest number of respondents were from public universities (25.9 per cent), private universities (19.18 per cent), and vocational colleges (17.03 per cent).

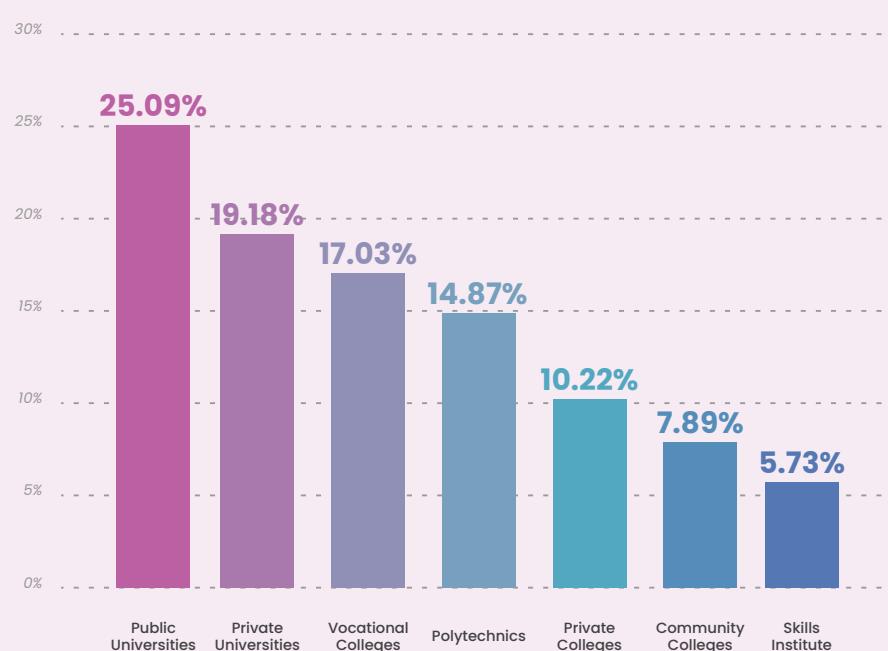


Figure 5: Types of HEPs which Participated in the Survey (%)

Types of Platforms

The bar chart below (Figure 6) shows the online learning platforms (OLPs) which the HEPs preferred or intended to use when implementing MCs. Based on the bar chart, most of the institutions indicated a preference and intention to use Google Classroom (22.65 per cent) as the platform for implementing MCs followed by Moodle (18.93 per cent), Udemy (15.68 per cent), and Coursera (13.82 per cent) as second, third and fourth choices respectively. In order of preference the bar chart below also clearly shows that Blackboard (4.3 per cent) is the least preferred online platform for MC implementations.

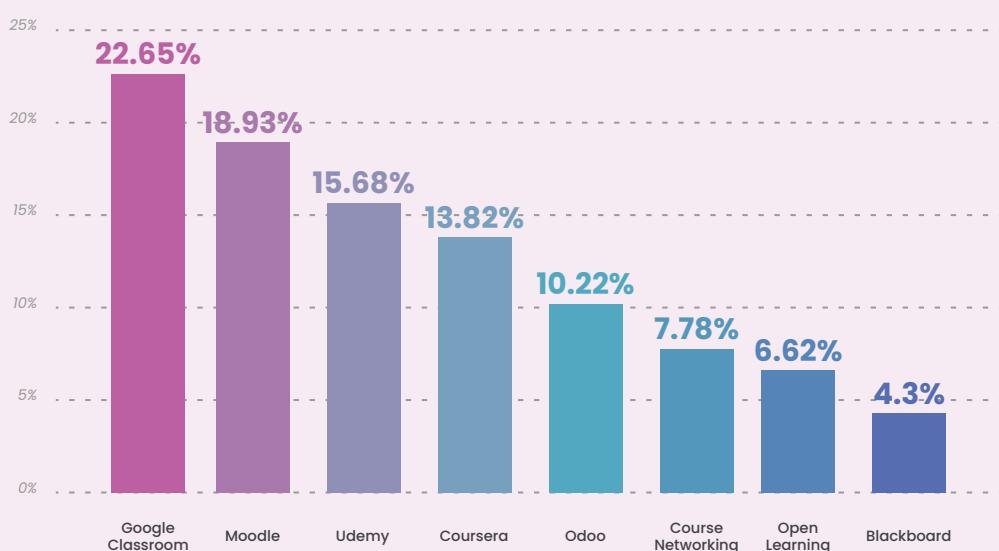


Figure 6: HEPs OLPs preference and intention to use for deploying MCs (%)

Current Implementation of Micro-Credentials amongst Higher Education Providers in Malaysia

In this study, the status of MC adoption rate in Malaysia has been investigated where the institutions were asked to describe the institutional MC implementation or availability status via survey. The current status of the MCs implementation stage across institutions is shown in the table below. The respondents were asked to rate between 0 to 4, and the representation of the rating is shown below (Figure 7). At present, 6.99 per cent of the HEPs do not intend to implement MC, while 15.41 per cent of the HEPs are going to implement MC programmes in the next 12 months. On the other hand, 26.88 per cent of HEPs are in the preliminary stage, 14.70 per cent are in the intermediate stage, and 36.02 per cent are in the maturity stage.



Figure 7: Total Institutions in Each Stage (%)

Current Micro-Credential Implementation Status by HEP Segment

Based on the findings of MC implementation status (Figure 8), 36.04 per cent of the skills institutes are planning to implement MCs in the next 12 months. In the case of vocational colleges, they are mostly in the in the maturity stage where there are 32.34 per cent of them have all programmes offered in MCs form. In contrast, there are only 10.26 per cent of the vocational colleges have no intent to implement MCs (Level 0) for the time being. With regards to community colleges 12 per cent are at the preliminary stage of implementation (Level 2). 17.91 per cent of the polytechnics are at the mature status level for MC programme implementation (Level 4). In the case of private colleges, 12.67 per cent of them are in the preliminary stage (Level 2), while only 4.48 per cent are in the maturity stage (Level 4). Furthermore, nearly a third of all private universities (32.67 per cent) are in the preliminary stage (Level 2), while for public universities, 27.86 per cent of them are in the maturity stage (Level 4).

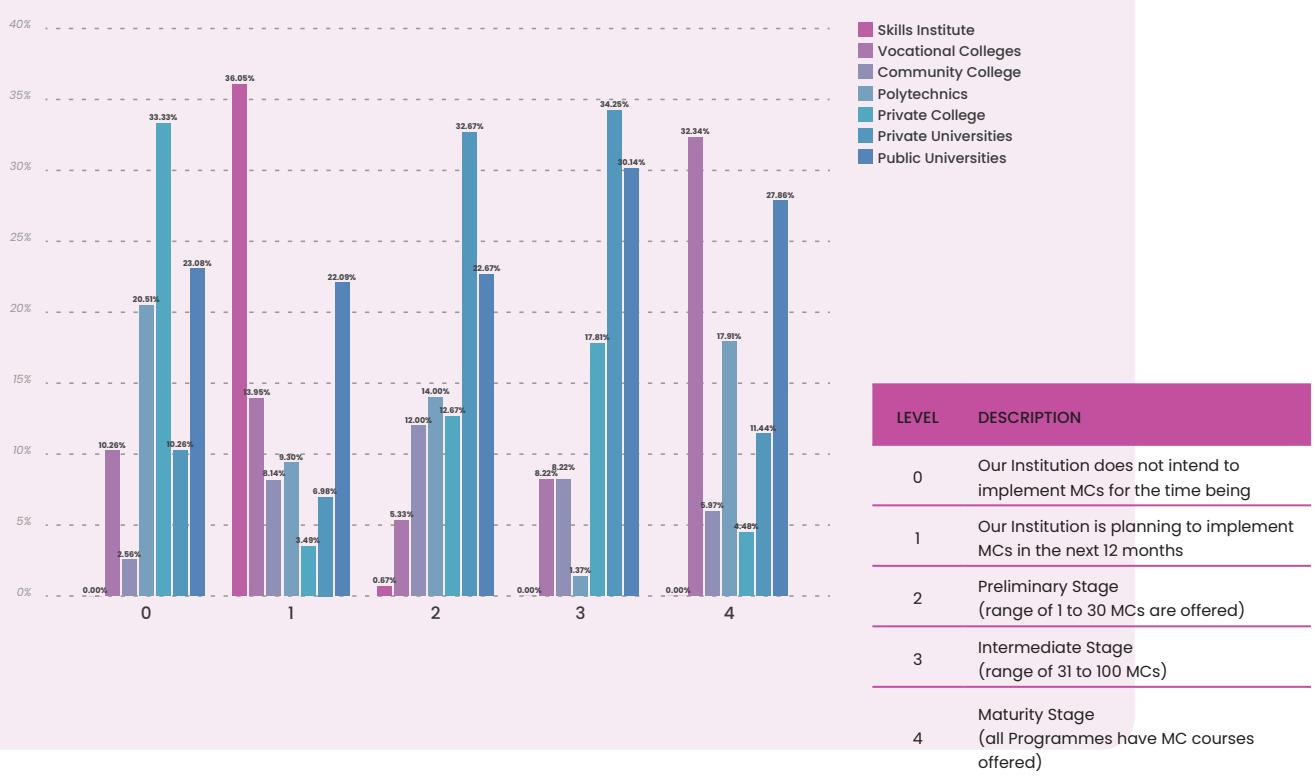


Figure 8: MC Implementation Status by HEPs Segment (%)

Disciplines of Micro-Credentials Offered

The disciplines in which the institutions prefer to offer MC were investigated through the survey. Figure 9 shows the disciplines that the HEPs wish to offer as MCs. Based on the results obtained, most of the institutions preferred to offer MCs in medical sciences followed by engineering, Mathematics and Statistics. Based on Hernandez et al. (2014), professional practice in science, technology, engineering, and mathematics (STEM) fields is expected to build students' conceptual knowledge and understanding of engineering and technology. This indicates that STEM subjects may be suitable for MC implementation, as they require practical skills and knowledge. Hence, most institutions preferred to offer MCs related to STEM.

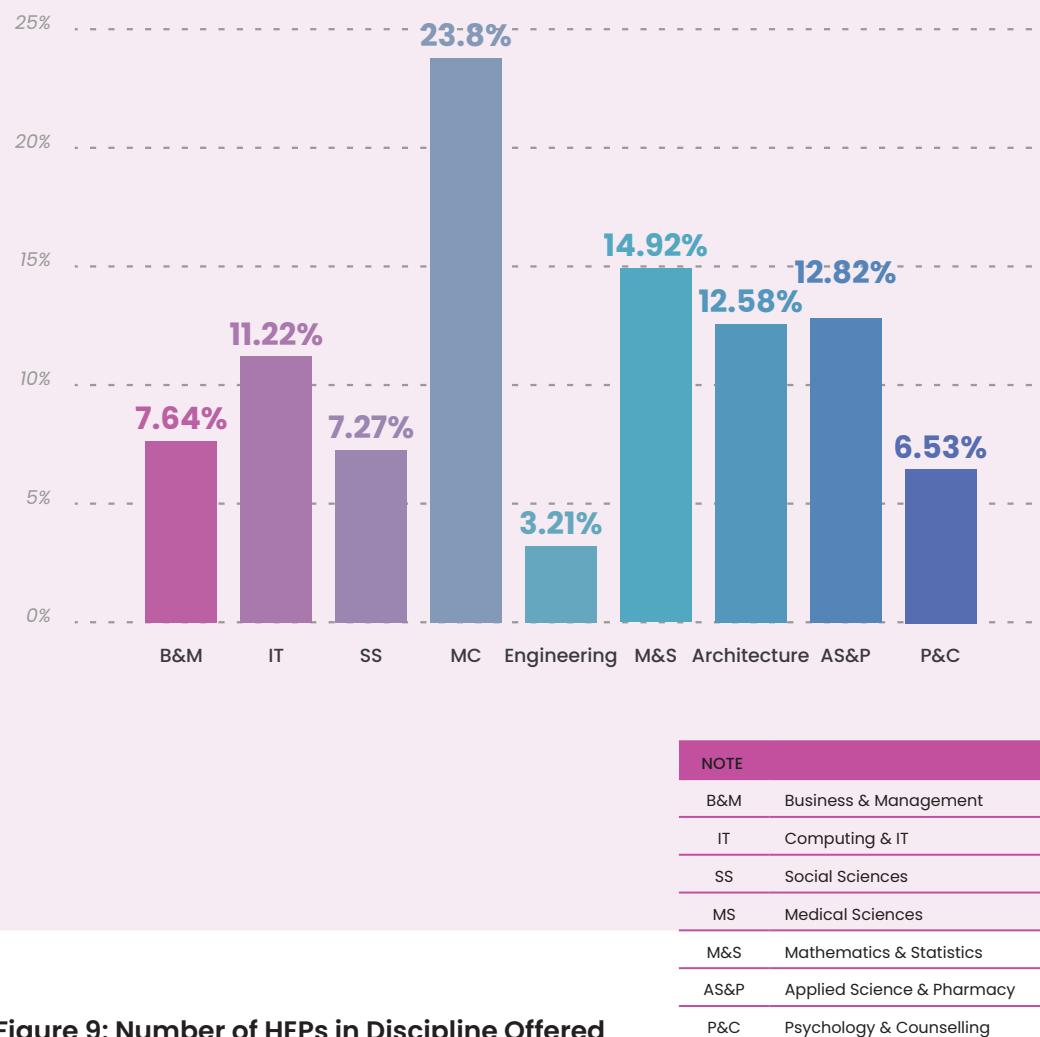


Figure 9: Number of HEPs in Discipline Offered

Communications and Multimedia Related Micro-Credentials

Courses Offered by Higher Education Providers

The institutions were asked about the Multimedia and Communication MCs courses that are or will be offered in their institutions. Nine choices of Communication and Multimedia related courses, namely Data Communication and Networking, Multimedia Related Courses, Information Technology and Multimedia, 4G and 5G Standards, Technologies and Architecture, Modulation, Channel Equalisation and Diversity Techniques for Mobile Radio Communication Systems, Data Communications and Networking, Data & Network Security, Advanced Signal Processing, and Multimedia-Based Instructional Design were provided in the survey. Figure 10 shows the number of votes received for each of the course choices. Based on the results obtained, most of the institutions mentioned that their institutions are or will be offering Information Technology and Multimedia followed by Modulation, Channel Equalisation and Diversity Techniques for Mobile Radio Communication Systems, 4G and 5G Standards, and Technologies and Architecture courses.

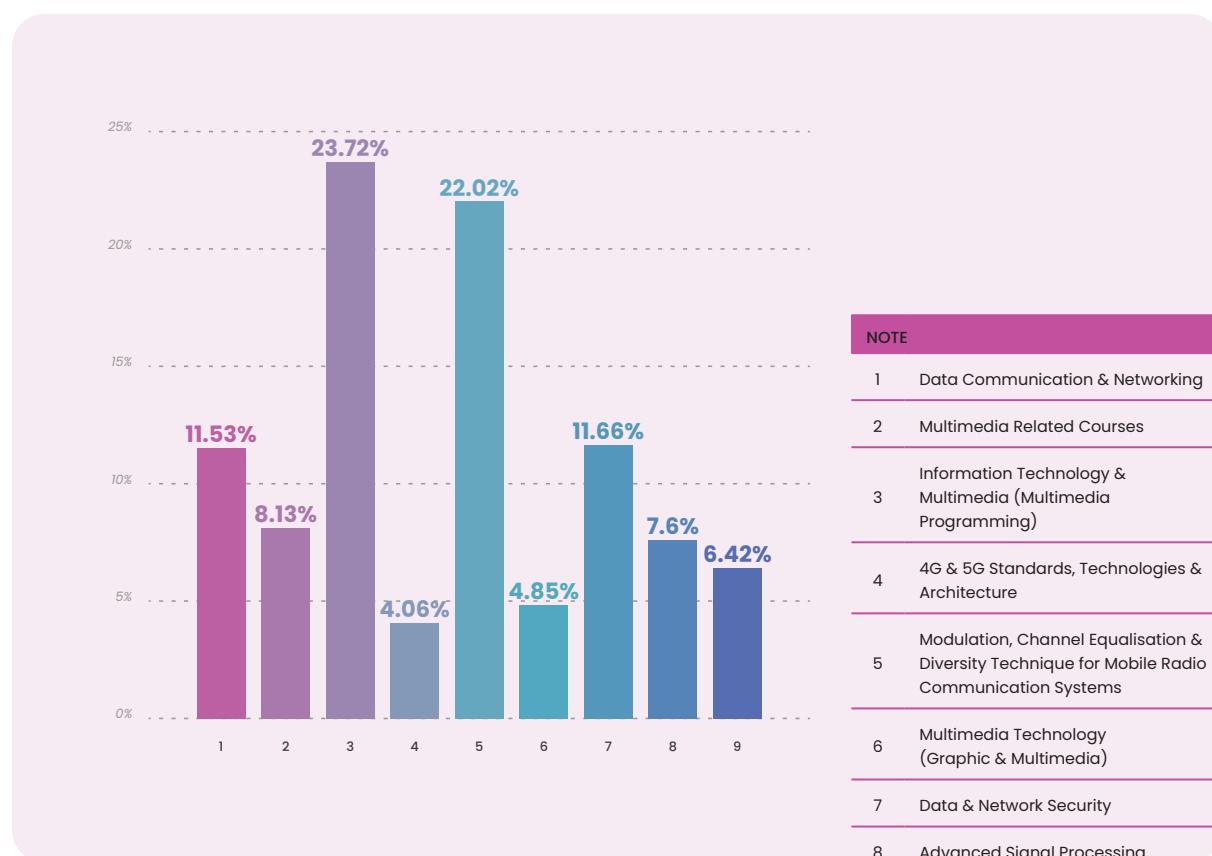


Figure 10: C&M MC Courses by Number of HEPs

Reasons for Higher Education Providers to Implement Micro-Credential

To understand the role of MCs from the higher education providers' perspective, the reasons for the institutions to implement these courses were investigated. Figure 11 shows the data obtained for this study. Most of the HEPs offered MCs as a sample of diploma / undergraduate programmes. On the other hand, institutions offered MCs since there are market needs from industries which prefer MCs to conventional degree certificates. This is because MCs are seen as a way of meeting upskilling requirements for individuals looking to advance their careers and to provide a skilled workforce for rapidly changing industries (Desmarchelier & Cary, 2022; Oliver, 2019). Some of the offerings in terms of MCs are Modulation, Channel Equalisation and Diversity Techniques for Mobile Radio Communication Systems and Information Technology and Multimedia (multimedia programming).



Figure 11: Reasons for HEPs to Implement MC Programmes

Construction Validity and Reliability Test

Initially, this study proposed a set of 12 factors that were expected to impact the implementation of MCs. However, it was found that six (6) of these factors had a Cronbach's Alpha value lower than 0.7, indicating a weak interrelatedness among the items (Ekolu & Quainoo, 2019). This implies that the questionnaire used in the study did not include enough questions, and the items with low alpha should be eliminated due to their poor correlation (Tavakol & Dennick, 2011). Furthermore, the factors with poor alpha values also resulted in insignificant outcomes. Consequently, a step-by-step approach was taken to remove the items with weak correlation one by one, as depicted in Figure 12, until all remaining items achieved a Cronbach's Alpha value higher than 0.7.

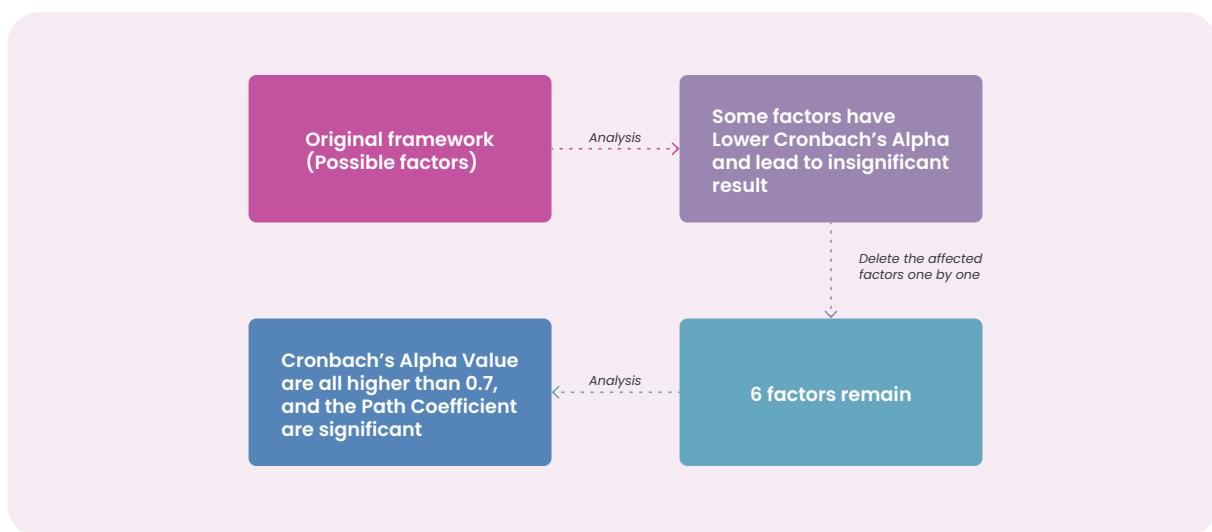


Figure 12: The Analysis Process of the Research

Outer loading is important for the relationship between construct and observable items. The accepted value for outer loadings should be 0.4 and above, values of 0.7 are good (Hair Jr. et al., 2021). As Table 2 shows, all items are higher than 0.4, and a majority of them are greater than 0.7. Besides, the construct validity such as composite reliability (CR) and Cronbach's alpha are used to measure whether the

collected items are measuring the same characteristic consistently (Barbera et al., 2020; Schrepp, 2020). One (1) way to determine the construct validity is to have CR that is larger than 0.7, it is the same as Cronbach's alpha. As Table 3 shows, both composite reliability and Cronbach's alpha are all greater than 0.7. In other words, this is a good sign of variance for a construct held towards the measurement

error. While Average Variance Extracted (AVE) is a measure of the variance captured by a construct in a relationship due to the measurement error. The accepted value for AVE is any value higher than 0.5, while any value less than 0.5 with CR higher than 0.6, the convergent validity for a construct is still sufficient (Huang et al., 2013; Lam, 2012). As Table 7 shows, the values of CR are all higher than 0.6, and the AVE with 0.4 are accepted. This indicated that the construct validity and reliability are both satisfactory.

CONSTRUCT	ITEMS	OUTER LOADINGS	COMPOSITE RELIABILITY	CRONBACH'S ALPHA	AVERAGE VARIANCE EXTRACTED (AVE)
Deliverables Competency	DC1	0.481	0.769	0.704	0.414
	DC2	0.753			
	DC3	0.483			
	DC4	0.869			
	DC5	0.533			
Infrastructure Readiness	IR1	0.662	0.817	0.701	0.529
	IR2	0.741			
	IR3	0.714			
	IR4	0.786			
Learner Centricity	LC1	0.672	0.815	0.727	0.424
	LC2	0.697			
	LC3	0.628			
	LC4	0.672			
	LC5	0.623			
	LC6	0.608			
Management Support	MS1	0.724	0.817	0.702	0.528
	MS2	0.719			
	MS3	0.702			
	MS5	0.763			
Perceived Outcome	Out1	0.665	0.8	0.702	0.401
	Out2	0.678			
	Out3	0.632			
	Out4	0.633			
	Out5	0.575			
	Out7	0.609			
	QA1	0.717			
Quality Assurance	QA2	0.624	0.823	0.731	0.482
	QA3	0.712			
	QA5	0.725			
	QA7	0.687			
	TC1	0.612			
Competency Skillset	TC2	0.579	0.807	0.713	0.411
	TC3	0.673			
	TC4	0.700			
	TC5	0.628			
	TC6	0.650			

Table 3: Construct Validity and Reliability

Discriminant Validity Analysis

The Discriminant validity test is to determine whether the construct is truly distinct from each other by empirical standards. According to Henseler et al. (2015), the HTMT value should be smaller than 1 to indicate that the true correlation of the constructs is different from one and another. Another way to access discriminant validity is to examine the value of the Fornell-Larcker criterion, in which the accepted value should be higher than the other correlation (Franke & Sarstedt, 2019). As Table 4 shows, all the HTMT values are smaller than 1, indicating a construct is different from the others. Table 5 indicates the value of the Fornell-Larcker criterion is all larger than other correlations. To this extent, it can be concluded the results proved the existence of discriminant validity in this study.

CONSTRUCT	COMPETENCY SKILLSET	DELIVERABLES COMPETENCY	INFRASTRUCTURE READINESS	LEARNER CENTRICITY
Competency Skillset	0	0	0	0
Deliverables Competency	0.154	0	0	0
Infrastructure Readiness	0.900	0.168	0	0
Learner Centricity	0.968	0.165	0.933	0
Management Support	0.941	0.148	0.974	0.951
Perceived Outcome	0.956	0.211	0.963	0.934
Quality Assurance	0.895	0.162	0.86	0.809

Table 4: Heterotrait-Monotrait Ratio (HTMT)

CONSTRUCT	COMPETENCY SKILLSET	DELIVERABLES COMPETENCY	INFRASTRUCTURE READINESS	LEARNER CENTRICITY	MANAGEMENT SUPPORT	PERCEIVED OUTCOME	QUALITY ASSURANCE
Competency Skillset	0.641	0	0	0	0	0	0
Deliverables Competency	0.126	0.644	0	0	0	0	0
Infrastructure Readiness	0.636	0.147	0.727	0	0	0	0
Learner Centricity	0.651	0.14	0.669	0.698	0	0	0
Management Support	0.666	0.133	0.686	0.678	0.727	0	0
Perceived Outcome	0.679	0.187	0.633	0.677	0.659	0.686	0
Quality Assurance	0.647	0.138	0.621	0.593	0.626	0.647	0.694

Table 5: Fornell-Larcker Criterion

Multicollinearity Analysis

Multicollinearity is present where there is a correlation between multiple independent variables which can impact the regression results (Gujarati, 2011). Besides, the importance of multicollinearity analysis is to ensure that the framework can be run correctly (Shrestha, 2020). Checking on the Variance Inflation Factor (VIF) is one (1) of the measurements for multicollinearity. Therefore, any value greater than 5 refers to the existence of a multicollinearity issue. MS4 and Out6 were removed due to the higher VIF, Table 6 shows, that the VIF value for all items is smaller than 5 which means there are no multicollinearity issues in this study.

DELIVERABLES COMPETENCY		INFRASTRUCTURE READINESS		LEARNER CENTRICITY		MANAGEMENT SUPPORT		PERCEIVED OUTCOME		QUALITY ASSURANCE		COMPETENCY SKILLSET	
ITEMS	VIF*	ITEMS	VIF*	ITEMS	VIF*	ITEMS	VIF*	ITEMS	VIF*	ITEMS	VIF*	ITEMS	VIF*
DC1	1.272	IR1	1.251	LC1	1.367	MS1	1.354	Out1	1.310	QA1	1.310	TC1	1.254
DC2	1.419	IR2	1.446	LC2	1.537	MS2	1.383	Out2	1.386	QA2	1.386	TC2	1.280
DC3	1.415	IR3	1.333	LC3	1.345	MS3	1.338	Out3	1.319	QA3	1.319	TC3	1.398
DC4	1.408	IR4	1.514	LC4	1.506	MS5	1.474	Out4	1.341	QA5	1.341	TC4	1.485
DC5	1.278	-	-	LC5	1.368	-	-	Out5	1.285	QA7	1.285	TC5	1.306
-	-	-	-	LC6	1.309	-	-	Out7	1.257	-	-	TC6	1.402

Note: VIF represents Variance Inflation Factor

Table 6: Multicollinearity Analysis

Hypothesis Testing

The hypothesis framework and each relationship are shown in the figure below (Figure 13). It is believed that the Infrastructure Readiness and Deliverables Competency under Technological Factors have an impact for the HEPs to adopt MCs. Secondly, as mentioned above, the Organisational Factors, including Management Support and Quality Assurance are significant for HEPs to prepare for MC adoption. Lastly, the People Factors such as Competency Skillset and Learner Centricity are suggested to have a positive effect on the HEPs to adopt MCs.

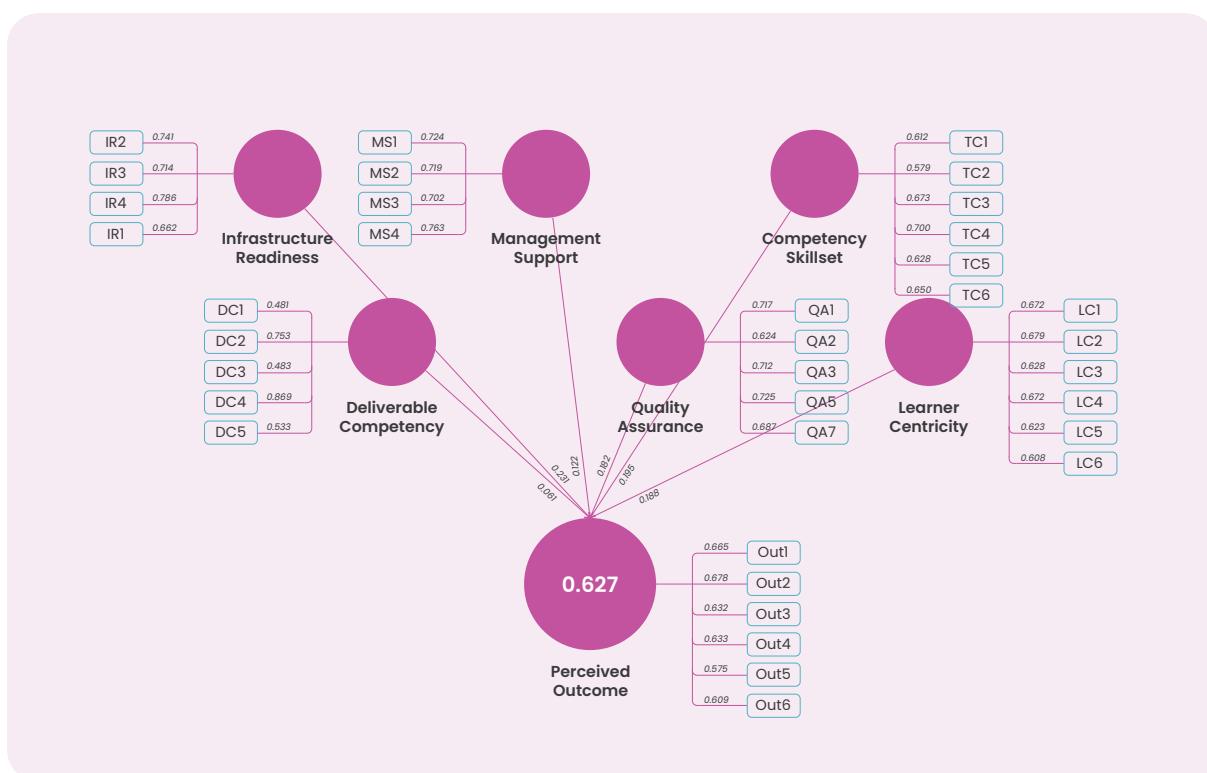


Figure 13: Hypothesis Testing

Hypothesis testing is used to determine the relationship between each variable for a random sample, with a two-tailed 95 per cent confidence level. The hypothesis test enables the evaluation of the strength of the various hypotheses before implementing the framework (Emmert-Streib & Dehmer, 2019). As shown in Table 7, the hypotheses were tested, and some of the factors are insignificant. Therefore, there are only 4 hypotheses which are significant (i.e. Infrastructure Readiness (H1), Organisational Culture (H4), Customer Centricity (H8), and Quality Assurance (H6)).

	HYPOTHESIS	BETA	SE	T STATISTICS	P-VALUE	DECISION
H1	Infrastructure Readiness → Perceived Outcome	0.145	0.144	2.812	0.005*	Accepted
H2	Deliverables Competency → Perceived Outcome	0.051	0.057	1.942	0.052**	Not Accepted
H3	Security and Reliability → Perceived Outcome	0.029	0.029	0.515	0.607**	Not Accepted
H4	Organisational Culture → Perceived Outcome	0.105	0.105	2.238	0.025*	Accepted
H5	Management Support → Perceived Outcome	0.061	0.062	1.141	0.254**	Not Accepted
H6	Strategic Alignment → Perceived Outcome	0.032	0.033	0.572	0.567**	Not Accepted
H7	Cultivation of Innovation → Perceived Outcome	0.07	0.067	1.28	0.201**	Not Accepted
H8	Customer Centricity → Perceived Outcome	0.145	0.142	2.735	0.006*	Accepted
H9	Quality Assurance → Perceived Outcome	0.121	0.123	2.613	0.009*	Accepted
H10	Competency Skillset → Perceived Outcome	0.075	0.075	1.302	0.193**	Not Accepted
H11	Learner Centricity → Perceived Outcome	0.107	0.108	1.742	0.082**	Not Accepted
H12	Adaption and Agility → Perceived Outcome	0.084	0.089	1.852	0.064**	Not Accepted

*A P-value less than 0.05 is deemed to be statistically significant and the null hypothesis should be rejected.

** A P-value greater than 0.05 is deemed NOT to be statistically significant, and the null hypothesis should NOT be rejected

Table 7: Hypothesis Testing

Discussion from Higher Education Providers' Perspective

H1 has pointed out the significant relationship between infrastructure readiness and the adoption of MCs. This is the most significant factor for HEPs to implement MCs. HEPs should allocate enough funds to acquire appropriate technology infrastructure to provide the best online learning experience for learners (Che Ahmat et al., 2021; Fischer et al., 2022). For instance, the internet connectivity of the online platforms is fundamental for online learning. Furthermore, collaborations with third parties to provide subscriptions would be beneficial in handling troubleshooting when users utilise the OLPs used in delivering MCs (McGreal et al., 2022). For example, HEPs could collaborate with providers of leading OLPs such as Moodle, Google Classroom and Open Learning to provide the best and smoothest learning experience for learners. Besides, H2 shows a positive relationship between deliverables competency and perceived outcome. This requires the HEPs to implement a supportive and computing online learning environment to deliver knowledge and skills to the learners (Mugayitoglu et al., 2021). An example of a supportive learning environment could employ the use of interactive video recordings and the inclusion of built-in exercises to aid the learning of difficult topics. Furthermore, convenient, and organised platforms are important in delivering competencies for learners (Kumar et al., 2022). For example, the HEPs need to ensure their online learning platforms are smooth and supportive to ensure the maximum effectiveness of the online learning experiences.

In relation to critical organisational factors, H5 shows that management support is significant for MC implementation. Top-level management support in technical capabilities and funding for support systems is critical for MC implementation (Mathur et al., 2018). For example, the leadership perception to support MC implementation is important and needs to be communicated across the HEPs. In addition, the HEPs' management should put in more effort including admission, recruitment, professional educators training and many more to ensure the quality of MC provided (Ahsan et al., 2023). For instance, the financial support from top management for MCs is critical. H9 refers to the positive relationship between quality assurance and MC implementation. The quality assurance of MCs is critical when it comes to the recognition of the new education forms. In other words, this means the HEPs should establish a recognised and standardised value for the MCs to improve the MCs status (Fisher & Leder, 2022; Resei et al., 2019). For example, the recognition of learning assessment across HEPs and industries needs to be communicated and to agree on a standard examination to recognise the digital badge earned. In addition, HEPs should improve the teaching quality, to further analyse the operation of MCs internationally. Besides, HEPs should also implement

quality assurance systems for online education including sharing mechanisms, evaluation systems and operation models to ensure the learning experience provided (Brown et al., 2021). To this extent, learners can choose high-quality MCs to maximise their learning experience.

As the results show, H10 indicates the greater the competency skillset, the larger the readiness for HEPs to adopt MCs. This is because the HEPs should have higher skills to educate learners successfully. For example, the usage of blockchain technology by HEP educators can provide better guidance for learners during online learning (Alsobhi et al., 2023). In addition, the professional tools set usage of educators can minimise the learners' training time and cost to achieve effective and efficient learning outcomes (Wheelahan & Moodie, 2021). H11 shows that learner centricity has a positive impact on MC implementation. This is because the HEPs need to provide learning options comprising online and face-to-face sessions to meet learners' needs. Many of the HEPs have focused on implementing online learning during COVID-19 and forced the students to remain online. Therefore, the ownership of choosing the option between online and face-to-face can generate a better MC result that led to effective learning outcomes (El-Farra et al., 2022; Rof et al., 2023). In addition, the communication between educators and learners can establish a trust-based relationship that can smoothen the learning experience (Ramlall & Cross, 2021). For example, with support from educators, learners can achieve professional standards by having academic freedom such as learning engagement.

Summary & Implications

Policy Implications for Micro-credential Adoption

Findings from the study have pointed out the importance of MCs and the challenges faced by HEPs during the implementation process. As such, it becomes critical that the development and implementation of MCs at the HEP level be monitored and quality assured (Tham & Chong, 2023). There have also been calls for more centralised and standardised management of MCs to ensure the equivalency and recognition of MCs throughout HEPs in Malaysia (Sabtu & Ismail, 2022).

On this note, the Malaysian Qualification Agency (MQA), the education accreditation body and agency tasked with the responsibility of ensuring HEPs' quality assurance, has continuously been a strong facilitator and supporter of flexible education in Malaysia. One such initiative in support of flexible education was the development of the Guidelines to Good Practices: MCs (GGP) in 2020¹. The GGP was developed with the intention to serve as a reference to the HEPs in the development of MC-based programmes or courses. The GGP aimed to (1) support the implementation of flexible learning by providing references to the stakeholders on the introduction of MCs; (2) to facilitate and empower all types of MCs whether it is used as supplementary or substituting contents; and (3) to provide a policy on breaking down content for recognition of stand-alone awards and credit transfer purposes.

Higher Education Providers Readiness

In conclusion, while the popularity of MCs amongst the general Malaysian population is still relatively low owing to poor marketing and awareness levels, the degree of readiness amongst Malaysian HEPs indicates a favourable upward trend with more recognising the potential of MCs in meeting the evolving needs of learners and the

¹ Malaysian Qualifications Agency, Guidelines to Good Practices: Micro-Credentials (2020) accessed on 1 August 2023 (<https://www2.mqa.gov.my/qad/v2/garis panduan/2020/GGP per cent20Micro-credentials per cent20July per cent202020.pdf>)

job market both domestically and internationally. This is especially seen in rapidly evolving technological fields such as healthcare, C&M, and engineering.

In conclusion, while the popularity of MCs in the general Malaysian population is still relatively low owing to poor marketing and awareness levels, the degree of readiness amongst Malaysian HEPs is definitely indicating an upward trend with more and more recognising the potential of MCs in meeting the evolving needs of learners and the job market both domestically and internationally. This is especially seen in rapidly evolving technological fields such as healthcare, communications & multimedia and engineering.

Recommendations

Government facilitation and policy

The current study proposes several recommendations to enhance the recognition and value of MC programmes in the field of communications and multimedia. Firstly, it is recommended that government agencies and universities establish a centralised system for recognising and accrediting MC programmes. This would create a transparent ecosystem where industry players and service providers can ensure the widespread acceptance and value of these programmes for learners. Efforts should be made to develop a framework that guarantees the quality and rigour of MCs, ensuring their recognition by employers, educational institutions, and other relevant stakeholders. Involving industry players in the development of programme content can ensure that the programmes align with the demands of the global market, thereby enhancing the reputation and recognition of MC programmes.

Additionally, the government could, through its various agencies, implement policies which facilitate and promote the take-up of MCs. For instance, this could be done by enabling flexible learning pathways through the implementation of "Training Leave". Currently, learners often have to take personal leave to attend different

MC programmes. However, MCs offer the advantage of flexible learning, allowing individuals to acquire skills and credentials at their own pace and convenience. By leveraging online platforms and digital technologies, accessible and personalised learning experiences can be provided. Therefore, by introducing policies that allow employees to utilise "Training Leave" for upskilling purposes, both employers and employees can benefit. This approach would enhance the competitiveness and competency of Malaysia's workforce in the globalised market.

Overall, these recommendations aim to establish a recognised and valued ecosystem for MCs in Communication and Multimedia, promote flexible learning pathways, and empower employees to enhance their skills and competencies in alignment with the demands of the modern job market.

The Malaysian Qualifications Agency (MQA) plays a pivotal role in the implementation of MCs within HEPs. Firstly, MQA should take on the responsibility of monitoring and ensuring quality assurance for the development of MCs at the HEPs' level. This would involve rigorous assessment and evaluation to maintain high standards in MC programmes. Secondly, MQA can contribute significantly to the promotion of flexible education in Malaysia by actively

supporting the integration of MCs into the educational landscape. Additionally, MQA should take the lead in establishing a clear and comprehensive definition of MCs while outlining key principles for their development and delivery, ensuring consistency and clarity across the board. Lastly, MQA could mandate HEPs to register their MC programmes, thereby embedding quality assurance measures into the design and delivery of these credentials, ultimately enhancing the value and credibility of MCs within the Malaysian education system.

Collaborative Approach in Ensuring Value and Alignment

HEPs play a crucial role in the successful integration of MC programmes in Malaysia. To begin with, there is a pressing need for HEPs to enhance the promotion of MC programmes, as awareness and marketing efforts have been inadequate thus far. Moreover, fostering collaborative relationships between HEPs, industry experts, and employers is imperative to bridge the significant gap between academia and the dynamic job market. HEPs should allocate sufficient financial resources and invest in digital technologies to facilitate MC learning effectively. Equally

important is the continuous training and development of educators to equip them with the skills necessary to design and deliver interactive, engaging, and effective MC-based lessons, ensuring that learners derive maximum benefit from these innovative programmes.

Moving forward for the future direction for MCs in Malaysia involves a multi-stage approach. To propel the implementation of MC programmes effectively, it is imperative to establish a harmonised integration between conventional degree programmes and MC offerings, creating diverse and flexible learning pathways. Additionally, the focus should be on enhancing industry recognition and credibility and aligning MC programmes, employers' needs, and expectations. Promoting lifelong learning within the workplace is essential to facilitate continuous professional and career

development, making MC an integral part of this journey. Furthermore, leveraging technological advancements for secure and efficient MC delivery is crucial.

In the development of new MC programmes, collaboration with industry stakeholders through group discussions is vital to identify the specific skills and knowledge demanded by the job market. Standardising syllabi ensures transparency and consistency across MC offerings. Exploring options to cover MC learning fees under the Human Resources Development Cooperation (HRDC) can boost acceptance and motivation among learners, making MCs a more accessible and appealing choice for professional development. These recommendations and strategies pave the way for a promising future for MCs in Malaysia's educational landscape.

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TOPIC 05

Public and Governmental Sector Adoption of Digital Signature Usage for E-Government Initiatives

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Abstract

This research study aimed to assess the adoption of digital signatures among governmental agencies in Malaysia and provide recommendations to improve its uptake. The research findings highlight the current status of digital signature adoption, identify the challenges governmental agencies face, and propose actionable recommendations to enhance its utilisation. The research employed a mixed-methods approach, combining surveys and open-ended questions with key stakeholders from various governmental agencies. The findings indicate that while there is a growing awareness of digital signatures, the overall adoption rate among governmental agencies remains relatively low. Several key challenges were identified, including limited knowledge and understanding of digital signatures, concerns about security and compatibility, and organisational resistance to change.

Based on the research findings, the following recommendations are proposed to improve the adoption of digital signatures among governmental agencies in Malaysia, including awareness and training, simplifying the implementation process, enhancing security measures, forging close interagency collaboration, strong regulatory support, and engagement with stakeholders. By implementing these recommendations, governmental agencies in Malaysia can significantly enhance the adoption and utilisation of digital signatures. This will result in streamlined processes, improved efficiency, enhanced data security, and agency cost savings. Additionally, it will pave the way for a digital transformation journey in the government sector, aligning with the nation's vision of a digital and connected Malaysia.

Introduction

Digital signatures are a crucial way to protect digital data and ensure its confidentiality, integrity, security, and non-repudiation. Unlike electronic signatures, which rely on a simple image of a person's signature, digital signatures use cryptography to create a unique signature for each individual, making them more secure. They also eliminate the need for physical meetings to authorise documents, which is especially important during the COVID-19 pandemic. E-government initiatives in Malaysia, such as Electronic Procurement (eP), Project Monitoring System (PMS), Electronic Services (eServices), Human Resources Management Information System (HRMIS), Generic Office Environment (GOE), E-Syariah, and Electronic Labour Exchange (ELX), have increasingly turned to digital signatures to adapt to remote working. However, the adoption of digital signatures among public and government agencies in Malaysia is still low, and it is important to measure society's awareness of digital signature technology to encourage greater adoption. In supporting Malaysia's aspirations under the MyDIGITAL Blueprint to transform the country into a digitally-driven, high-income nation and regional leader in the digital economy, the Malaysian Communications and

Multimedia Commission (MCMC) is desirous of supporting further and more intensive take-up of digital signatures by the government and public sector. To support Malaysia's transformation into a digitally driven, high-income nation and regional leader in the digital economy, MCMC aims to promote greater uptake of digital signatures in the government and public sectors. This study will examine the level of awareness, implementation, and impact of digital signatures on public and government agencies in Malaysia. This report is prepared to study the adoption of digital signature usage for e-government initiatives in the public and governmental sectors.

The research aims to measure, assess, and evaluate the factors influencing the usage level of digital signatures in e-services among government and public sectors, which will provide a holistic understanding of the current implementation and potential implementation of digital signatures in e-government initiatives. It also intends to measure the awareness level amongst government and public sectors on digital signatures. It also aims to identify factors influencing the adoption of digital signatures among public and government agencies and provide

recommendations to increase awareness and adoption of digital signatures. The research objectives (ROs) are as follows:

RO 1

To categorise the potential use cases of digital signatures relevant to identified government and public sector users.

RO 2

To determine the level of awareness amongst government and public sectors on digital signatures.

RO 3

To determine the level of digital signatures, feasibility, planning, implementation, and impact of digital signatures adoption on usage amongst government and public sectors.

RO 4

To identify the factors encouraging and hindering the take-up of digital signatures by the government and public sector.

RO 5

To provide recommendations on measures to increase awareness and adoption of digital Signatures targeting identified government and public sectors.

Literature Review

E-government refers to using the Internet to provide high-quality government services and activities and to enhance communication with citizens, organisations, processes, and systems. According to V. Kumar et al. (2007), it is a way of improving the delivery of government services to citizens, businesses, and community members by transforming how information is managed. The implementation of e-government can offer several advantages to government management, assist in narrowing the gap between the government and citizens, and engage citizens in decision-making or policy-making processes. In accordance with Maznorbalia and Awalluddin (2021), e-government is the application of information and communication technologies (ICTs) within the government to improve managerial efficiency, encourage democratic principles and mechanisms, and establish a regulatory framework that promotes information-based initiatives and fosters a society based on knowledge.

E-government also refers to the use of Internet and multimedia technologies to facilitate the exchange of information and transactions between government officials, citizens, and organisations in a more

accurate, effective, and efficient manner (Lin et al., 2011). Although e-government initiatives are being implemented globally, developing countries are slower in embracing its implications and status compared to developed nations (Bwalya, 2009; Carter et al., 2016). The primary goal of e-government is to enhance government-citizen relationships, promote collaboration between governments, businesses, and citizens, and improve service delivery to the people of Malaysia (Shuib et al., 2019).

While Canada and the United States are considered the most successful developed nations in terms of e-government implementation (Lin et al., 2011), developing countries still face challenges due to their immature adoption status of e-government (Al-Hujran et al., 2015). Despite this, governments are making efforts to enhance their services and gain the trust of citizens who are increasingly aware of the Internet's unique offerings (Carter et al., 2016). In Malaysia, e-government originated in 1996 with the Multimedia SuperCorridor (MSC) and is a priority under the Malaysian Vision 2020 to offer seamless online services to users, businesses, and the government (Shuib et al., 2019). The e-government

flagship in Malaysia includes seven (7) pilot projects that are the core of e-government applications such as eP, PMS, e-Services, HRMIS, GOE, E-Syariah and ELX. Other government agencies have also implemented online services to increase efficiency and ease of public service, such as Public Services Portal (myGovernment), e-Tanah, e-Consent, e-Filing, e-Local government (e-PBT), e-Kehakiman, Custom Information System (SMK), Pensions Online Workflow Environment (POWER), and Training Information System (esILA) (Maznorbalia & Awalluddin, 2021).

E-government simplifies bureaucracy, increases efficiency and transparency, improves information dissemination, and empowers citizens. Most countries have adopted e-government to develop their countries because it enhances service delivery, improves information flows, and increases accountability, transparency, citizen involvement, efficiency, and cost reduction (Mohd et al., 2011). As part of e-government initiatives, public services have undergone digitalisation and paperless processes to cater to a broad range of services (Gonzalez et al., 2020).

In addition, electronic document sharing through the network has the advantage of reducing costs and speeding up searches, but traditional signatures and stamps are still necessary for verifying authenticity (Civelek et al., 2017; Makhsud, 2021). However,

determining the legitimacy of electronic documents can be challenging because it is difficult to confirm the author's identity and ensure that the document has not been altered. Manual processes are still needed, such as circulating the document for signing, inspecting paper documents, signing the document, and then digitising it (Makhsud, 2021). The objective of document authentication is to safeguard against criminal activity (Makhsud, 2021).

Digital signatures are often utilised in e-commerce transactions to guarantee message authenticity and integrity. Digital signatures provide benefits such as confidentiality, integrity, and authenticity for electronic data. Despite the technical security benefits provided by digital signatures, legal issues related to their usage have not been adequately addressed (Freddy Busroh & Khairo, 2020). The creation of digital signatures involves using cryptographic technology to generate a sequence of letters that verifies the source and integrity of transmitted text (Zhang, 2010). Public and private keys are used to create digital signatures, while a public-key certificate is used to verify the signer's identity. Digital signatures protect data from unauthorised access and manipulation by providing operations such as authentication, privacy, non-repudiation, and integrity (Aydin et al., 2018). The practice of creating digital signatures

can be traced back to centuries-old cryptographic techniques used to secure information during communication (Sinha & Singh, 2003). A digital signature is created by encrypting a message using a secret key known as a "digital envelope," which is then sent along with the encrypted message. Combining the digital signature and message digest allows a user to "digitally sign" a message. The purpose of digital signatures is to provide a unique characteristic to a message (Abidin et al., 2014). Digital signatures offer numerous advantages, such as faster transactions, reduced costs, increased security, official use, easy tracking, non-repudiation, fraud prevention, and time stamping (Aydin et al., 2018).

However, bureaucracy lacks an open culture of reform and a humanist service approach, resulting in several licences and signatures that must be done in person, causing a slow legality process (Lionardo & Nasirin, 2020). This issue poses a problem of trust. Despite several policies, the management services are not entirely digitised yet (Freddy Busroh & Khairo, 2020). The success of e-government services is not solely dependent on government support but also on user adoption, which is currently low (Maznorbalia & Awalluddin, 2021). Developing countries often experience high failure rates in e-government projects,

with less-than-expected outcomes. This is not just due to weak government policies, inadequate infrastructure, and political will but also due to citizens' reluctance to adopt e-government services (Abdulkareem & Ramli, 2021).

The purpose of e-government implementation in Malaysia is to modernise and enhance public service delivery (Maznorbalia & Awalluddin, 2021). The development of e-government in Malaysia aims to improve government service delivery and information processes and involves all stakeholders (Shuib et al., 2019). While e-government is a crucial component of public service delivery, privacy, security, and technical maintenance issues need to be addressed to increase adoption. Numerous studies have explored the implementation and effectiveness of e-government services worldwide. According to Agbabiaka (2018), citizen feedback is essential to justify investments in e-government. It is also important to consider the role of citizens' access to ICT in moderating the relationship between e-government use and performance. Aydin et al. (2018) investigated the factors influencing the adoption of digital signatures at Atatürk and Gümüşhane universities. Their findings showed that academic and administrative personnel had mixed reactions to the digital signature system,

with some regarding it as an excellent idea and others seeing it as a bad one.

In a study by Freaddy Busroh and Khairo (2020), the adoption of digital signatures was analysed to enhance the investment climate in Indonesia, with the aim of facilitating investment development. Their results indicate that the implementation of digital signatures is expected to have a positive impact on investment-related regulations in Indonesia. The study used the normative juridical research method, which examines legal issues and proposes solutions through legislation in Indonesia. Quantitative research methods were employed by Lionardo and Nasirin (2020) to measure the impact of digital signature service quality on the performance of the District Government of Palembang, Indonesia. The findings indicate that digital signatures significantly enhance administrative services at the sub-district level, resulting in increased efficiency and improved public service. The study supports the efforts of the Central Government to revamp public services and improve organisational communication and administration.

According to Maznorbalia and Awalluddin (2021), citizens in Sintok display a favourable disposition towards e-government services, which is influenced by factors such as technology performance and social

influence. The likelihood of e-government service adoption is higher when people perceive that it saves time and reduces costs. Social influence is also a significant factor in e-government adoption, as citizens are more inclined to use a system recommended by their friends or colleagues. Access to resources such as the Internet is crucial for e-government adoption, and citizens require appropriate skills and support to utilise information technology infrastructure. Shuib et al. (2019) examine factors influencing citizens' adoption and satisfaction with e-government applications in Malaysia using an integrated model based on the Technology Acceptance Model and Diffusion of Innovation, as well as trust in the government, information quality, computer self-efficacy, and customer satisfaction constructs. Data was collected from 801 Malaysian urban poor citizens, revealing that compatibility, relative advantage, image, trust in the government, computer self-efficacy, and customer satisfaction have significant impacts on e-government application use and that customer satisfaction is positively influenced by use. The study highlights critical factors for enhancing adoption and satisfaction with e-government applications and indicates citizens prefer online government applications that are compatible with their preferred interactions and provide relative benefits.

Ayob et al. (2021) examined how information literacy moderates the effect of supply-demand factors on the effectiveness of e-government in Malaysia. A survey was conducted among 178 adults, and the results showed that social influence positively affects the frequency of use and perceived usefulness of government websites, while web security and political trust affect only one (1) of the two (2). Additionally, a weak relationship was found between information literacy and frequency of use. The study provides a comprehensive model of supply-demand factors on e-government effectiveness. Abdulkareem and Ramli (2021) conducted research in a developing country to assess the effectiveness of the DeLone and McLean IS success model. They explored the role of citizens' access to ICT as a moderator in the relationship between actual e-government use, citizen satisfaction, and the public value of e-government. Their study utilised PLS-SEM for data analysis and demonstrated that citizens' access to ICT is crucial for successful e-government services. The study provides theoretical and policy implications, emphasising the importance of improving e-services quality and bridging the digital divide gap to promote good governance.

Sun et al. (2013) identified various theories used to study technology adoption or

use, including TAM, TRA, TPB, UTAUT, DOI, IS Success Model, and Task-Technology Fit. However, Alzahrani et al. (2017) and Rana et al. (2015) proposed that TAM is the most appropriate and commonly used model in e-government studies. For instance, Husin et al. (2017) adopted TAM to examine e-government use in Malaysia by comparing the developed prototype with the existing Malaysian e-government services.

Similarly, Warkentin et al. (2018) utilised TAM to survey undergraduate students' perceptions of the iVoting system in three (3) large universities in the United States. However, Chen et al. (2002) and Karavasilis et al. (2010) have suggested that TAM could be combined with other adoption and diffusion theories to improve its explanatory and predictive power. Shuib et al. (2019) found in a review of 14 e-government adoption studies that ten studies used TAM alone, while four (4) combined TAM with DOI.

Studies on technology adoption have expanded beyond the traditional constructs of TAM and DOI to include additional factors such as trust, perceived quality, self-efficacy, and citizen satisfaction, as shown in various studies, including those by Shuib et al. (2019), Alzahrani et al. (2017), Carter et al. (2016), Liu et al. (2014), Lallmahomed et al.

(2017), Shareef et al. (2011), and Hung et al. (2013). Several studies have also investigated e-government adoption in different countries, such as India (R. Kumar et al., 2018), Africa (Verkijika and De Wet, 2018), Israel (Rosenberg, 2019), and Jordan (Abu-Shanab, 2017). However, there is a significant gap in the literature regarding e-government adoption by citizens in Malaysia, which requires further research as citizens' perceptions are essential to the success of e-government (Al-Hujran et al., 2015; Carter & Bélanger, 2005).

There are two (2) proposed research models for this study. One model has been proposed based on the Knowledge, Attitude and Practice (KAP) framework and another based on the Technology-Organisational-Environment (TOE) framework.

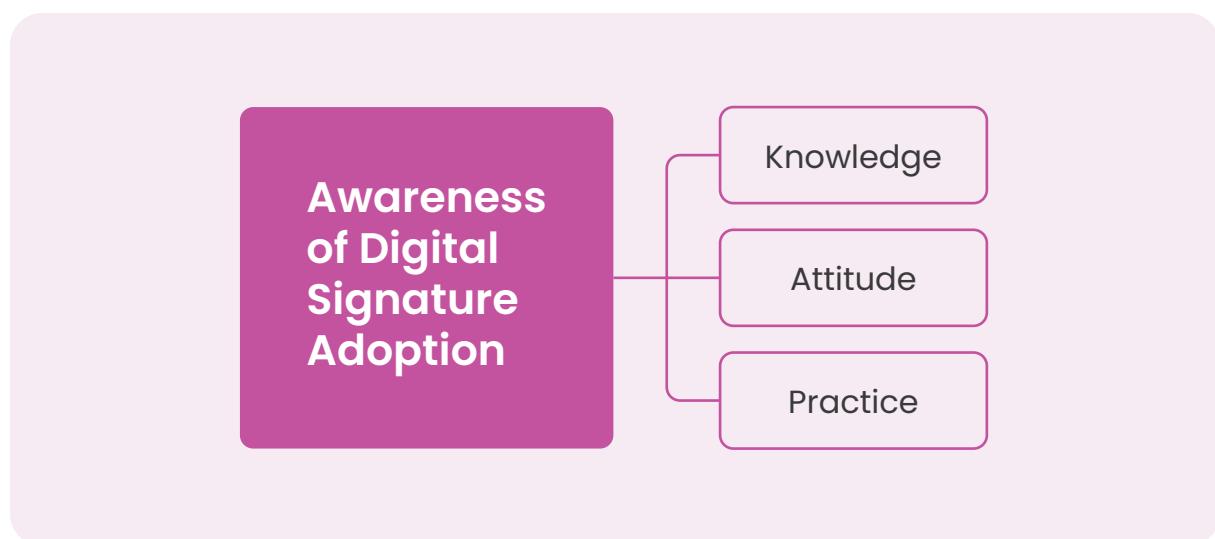


Figure 1: KAP framework

The KAP framework serves as the basis for the first research model, depicted in Figure 1.0. This model aims to assess the level of knowledge, attitude, and practice of digital signature use among the public and government sectors and the impact of these factors on awareness of digital signature adoption. Figure 1.0 illustrates the initial research model, which includes three (3) hypotheses related to the awareness of digital signature adoption among the public and government sectors:

- H1: Knowledge has a positive relationship towards awareness of digital signature adoption
- H2: Attitude has a positive relationship towards awareness of digital signature adoption
- H3: Practice has a positive relationship towards awareness of digital signature adoption

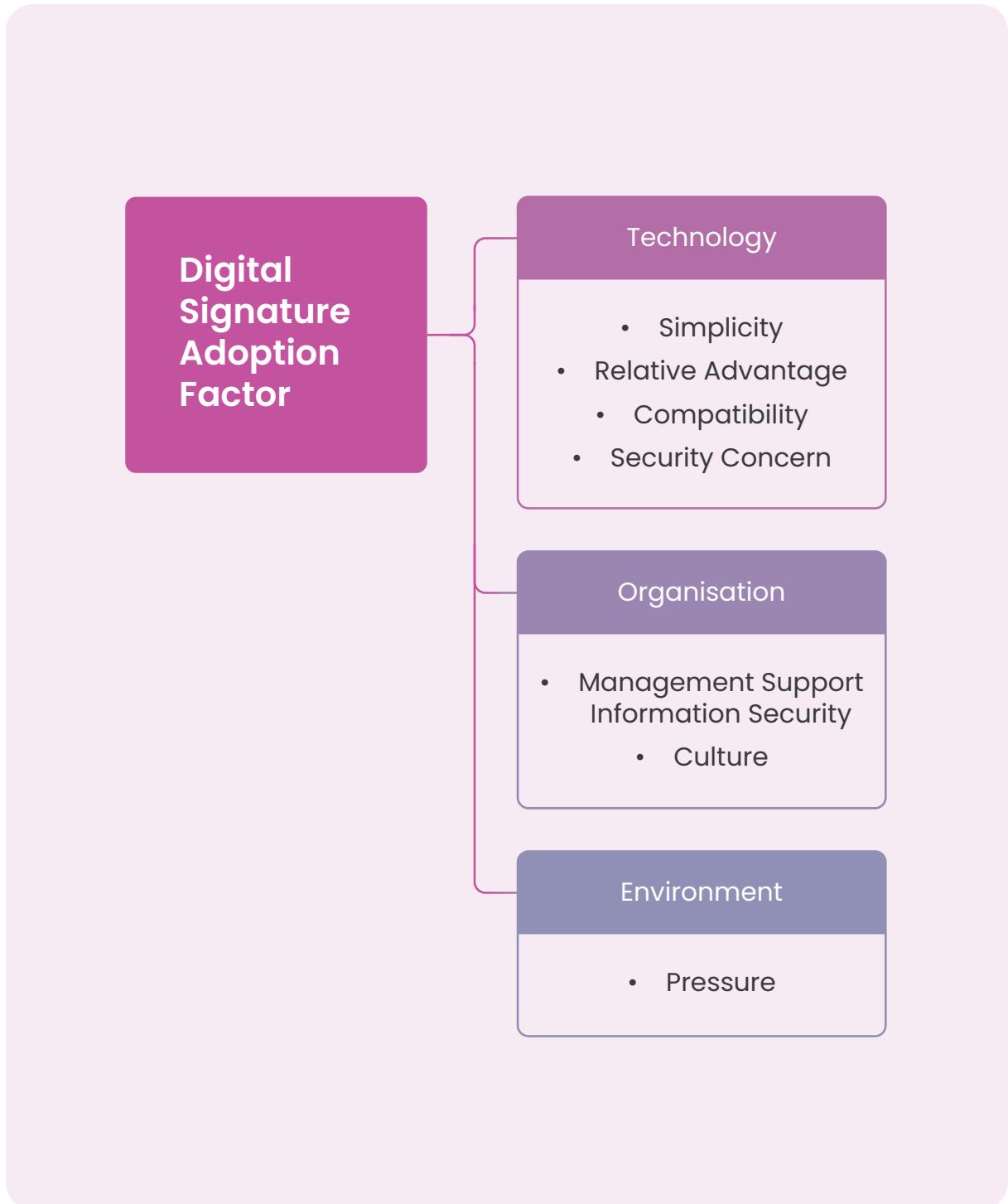


Figure 2: TOE Framework

Figure 2.0 illustrates the second research model based on the TOE (Technology, Organisation, and Environment) framework. This model explains the factors that impact the adoption of digital signatures in e-government initiatives. The factors have been categorised into three (3) groups: technology, organisation, and environment. There are four (4) factors under technology, namely simplicity, relative advantage, compatibility, and security concern, which positively or negatively influence the adoption of digital signatures in e-government initiatives. Under the organisation category, two (2) factors, namely management support and information security, positively or negatively influence digital signature adoption. Lastly, the pressure factor under the environment category may positively or negatively impact the adoption of digital signatures.

The hypotheses related to research model 2 are as mentioned below:

- H4: Simplicity has a relationship towards digital signature adoption
- H5: Relative advantage has a relationship towards digital signature adoption
- H6: Compatibility has a relationship towards digital signature adoption
- H7: Security concern has a relationship towards digital signature adoption
- H8: Management support has a relationship towards digital signature adoption
- H9: Information security culture has a relationship towards digital signature adoption
- H10: Pressure has a relationship towards digital signature adoption
- H11: Risk assessment has a relationship towards digital signature adoption

Methodology

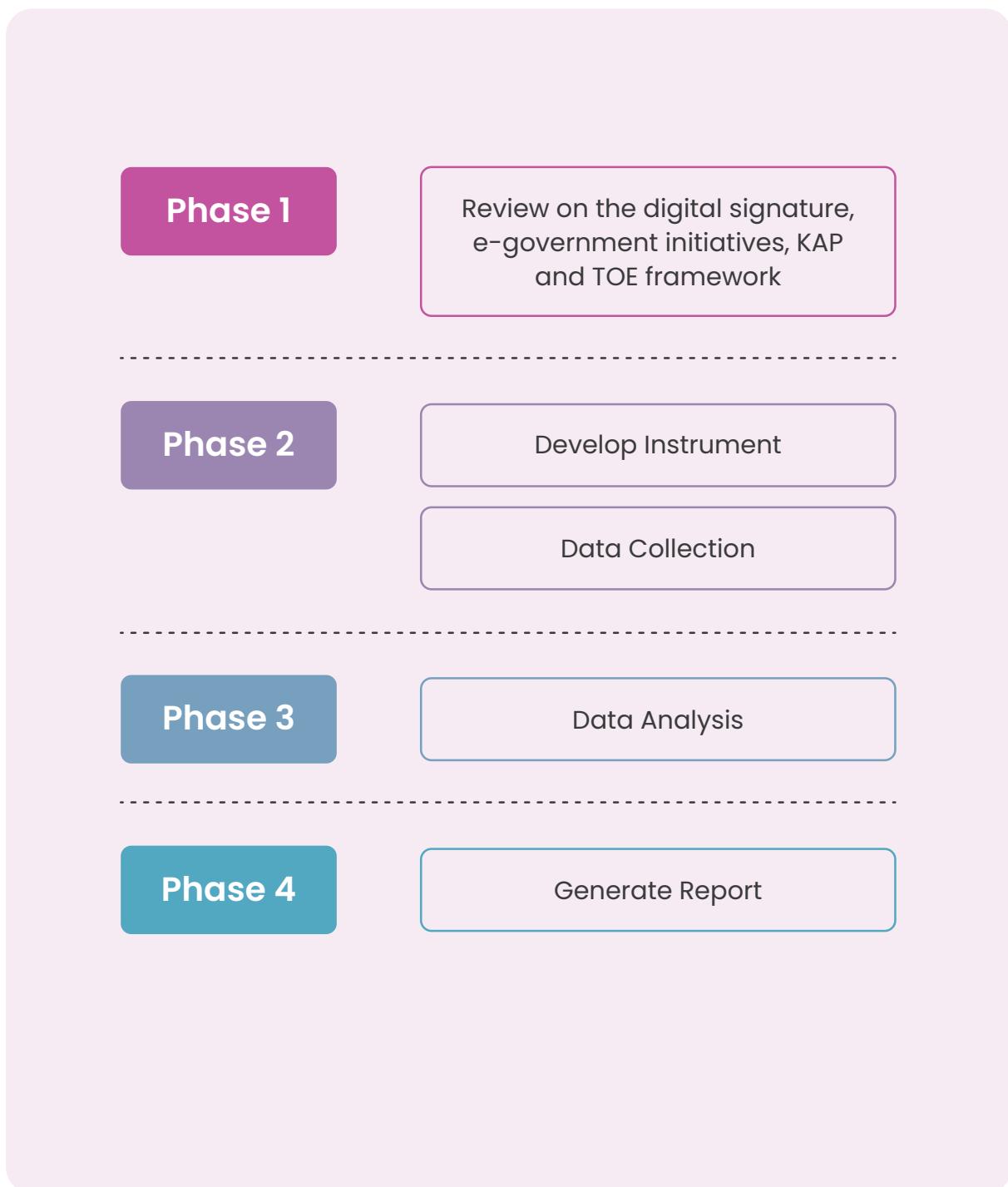


Figure 3: Research Methodology

The research methodology for this study has been divided into four (4) phases, as shown in Figure 3.0. The first phase of this study focuses on understanding digital signature technology based on the literature to formulate its important criteria. It also focuses on understanding the e-government initiatives, including the objectives, functions and implementations. Another important task in this phase is to study the KAP and TOE framework to properly develop the questionnaire construction used in Phase 2. Information gathered in Phase 1 has been used as input for instrument development in Phase 2. The instrument is used to measure awareness, feasibility, planning, implementation and impact of digital signature adoption amongst government and public sectors. It is also used to identify factors that influence digital signature adoption. Two (2) sets of survey questions have been developed to achieve Research Objectives 2, 3, and 4. Questionnaires presented to respondents consist of four (4) parts as below:

PART A Profile of the respondent

PART B Awareness of digital signature adoption

PART C Digital signature feasibility, planning, implementation and impact

PART D Digital signature adoption factors

The questionnaires, which are included in Appendix A, were developed using the KAP and TOE frameworks.

In phase 2, a pilot study has been carried out as part of the data collection method. An email invitation has been sent out to potential respondents. These respondents consist of participants who attended the digital signature seminar conducted by MCMC and other respondents from various governmental agencies. The objective of the pilot study is to evaluate the questionnaire and finalise instruments from the KAP and TOE framework. Then the questionnaire was finalised to be distributed to respondents.

In phase 3, the collected data then be analysed in the third phase. This research uses two (2) sampling methods, purposeful sampling and snowball sampling, for data collection. In purposeful sampling implementation, a few government agencies have been identified and contacted to participate in this study. Email also had been sent to a list of participants who had attended previous digital signature seminars to answer questionnaires. Through snowball sampling, respondents who participated in this study have been requested to suggest other participants among government and public agencies. A total of 345 respondents from 22 ministries participated in this study.

The analysis has been done using mixed method analysis which quantitative questions in survey questions are analysed with statistical analysis, including mean, standard deviation and percentage. Meanwhile, open-ended questions are analysed with the inductive method. The data analysis phase in this study has been divided into a few tasks based on research objectives:

STEP 1 Using inductive methods to identify possible use cases of digital signature within e-government initiatives. This will contribute to achieving Research Objective 1.

STEP 2 Using statistical analysis, include mean, standard deviation and percentage to analyse data regarding the level of awareness, feasibility, planning, implementation and impact of digital signature adoption amongst public and government sectors. This will contribute to Research Objectives 2 and 3.

STEP 3 Use statistical analysis, including mean, standard deviation, and percentage, to analyse data regarding factors influencing digital signature adoption amongst the public and government sectors. This will contribute to Research Objective 4.

STEP 4 The analysed information from steps 2 and 3 will be used to rank crucial factors for recommendation and to identify the level of awareness, feasibility, planning, implementation and impact of digital signature adoption.

In the final phase, the study's outcome will reveal the many aspects of the adoption of digital signatures among the public and government sectors.

Findings and Analysis

Introduction

In this study, 345 replies from 22 Malaysian ministries were gathered. 54.2 per cent of responders are men, and 45.8 per cent are women. The respondents participated in the study voluntarily, comprising 5.5 per cent of top management, 46.1 per cent of middle management and 48.4 per cent of IT services. Approximately 2.6 per cent of respondents were between the ages of 19 and 29 years, while roughly 10.1 per cent were between 30 and 39. The majority, or 84.6 per cent, were aged 40 to 49. Less than three (3) per cent of the population was under 50. Most people have between 10 and 19 years of employment experience, while seven (7) per cent were between 20 and 29 years and less than 10 years, respectively. Less than one (1) per cent of people had experience spanning more than 30 years.

The distribution of respondents based on their involvement with the e-government initiative, was as follows: eP (2.3 per cent), PMS (0.9 per cent), eServices (1.4 per cent), HRMIS (3.2 per cent), GOE (76.8 per cent), E-Syariah (0.3 per cent), JobMalaysia (0.9 per cent), and none of the above (14.2 per cent).

An analysis was also conducted to gauge the respondents' experience with digital signatures. The findings concluded that most respondents—199, or 57.7 per cent—selected sometimes, 67 (19.4 per cent) selected always, and 79, or 22.9 per cent, selected never.

Use Cases of Digital Signature

This research aims to categorise the potential use cases of digital signatures for identified government and public sector users. This study shows that the usage of digital signatures can be expanded to various fields such as human resources, administration, finance, law, information technology, and audit. The most highly suggested fields are administration and finance.

In the administration field, most respondents suggest that digital signatures be used in any activity involving letter generation. Among the suggested letters are admission letters, acceptance letters, offer letters, consent letters, authorisation letters, invitation letters, and memos. In addition, digital signatures are also suggested to

control the generation of government documents such as certificates, scrolls, licenses, birth certificates, Memorandums of Understanding (MoUs), and land titles to ensure faster and more secure government services. A few new administration applications have been suggested that might benefit from the adoption of digital signatures, such as a digital document management system, a commercial vehicle permit application, meeting invitations, and asset management. Another category of digital signature usage in the administration field is process approval, which includes the endorsement of documents, the approval of project or programme proposals, the approval of building plans, and the approval of permits. Digital signatures can also be applied in statement declarations such as statutory declarations and integrity declarations.

Meanwhile, in finance, digital signatures can be adopted in various areas, including financial process approval and financial document generation. Most respondents suggest the adoption of digital signatures in the preparation of agreements and contracts. They also suggest the adoption of digital signatures in financial form applications such as claim applications, overtime applications, and tender submissions. Digital signatures can also be used to prepare financial documents,

including invoices, payment vouchers, bank statements, invoices, purchase orders, quotations, bills, and receipts. Financial process approval, such as for budgets, investments, loans, procurement, goods receipt, payment, and payroll, can also be done using digital signatures.

In addition, the respondents also suggested the adoption of digital signatures in the human resources field, especially in handling processes and documents. Human resources processes need to be transformed into digital applications and approval processes, especially for job applications, leave applications, work orders, attendance, and career development. Digital signatures can also be implemented in the production of certified information, such as staff service records.

Other than that, digital signatures can also be adopted in handling processes and documents in other specific areas such as information technology, law, and audit. Documents that require verification, such as user acceptance tests, final acceptance tests, technical reports, court cases, court orders, summonses, and audit reports, are highly recommended. It can also be adopted in several online applications, such as online data sharing and purchasing, weapon withdrawal permission, and system access. This shows

tremendous areas that can be improved to provide more efficient and secure digital services to public and government agencies.

Level of Digital Signature Awareness

The second objective of this research (RO2) is to determine the level of awareness amongst the government and public sectors regarding digital signatures. Statistics for the awareness model (RO2) are presented in Table 1.

NO.	DIMENSION	MEAN	SD	RANK	LEVEL
1	Knowledge	7.79	1.783	3	Mostly agree
2	Attitude	8.10	1.804	1	Agree
3	Practice	7.94	1.777	2	Mostly agree
4	Awareness	6.46	2.335	4	Mostly agree

Table 1: Descriptive Statistics for Awareness Model (RO2)

Table 1 presents the average scores of three (3) interrelated aspects of awareness, namely knowledge (7.79 ± 1.783), Attitude (8.10 ± 1.804), and Practice (7.94 ± 1.777). The mean score for Attitude is above eight (8) out of 10, while Knowledge and Practice have mean scores below eight (8) points. Typically, an average score of eight (8) to ten (10) indicates agreement with the statement represented by the dimension, while six (6) to eight (8) points indicate mostly agreement, three (3) to six (6) points mostly disagreement, and less than three (3) points indicate disagreement. In Table 2, the statistics for the awareness dimension are presented.

NO	DIMENSION OF AWARENESS	MEAN	SD	RANK	LEVEL
1	I am aware of the existence of digital signatures.	8.57	1.821	1	Agree
2	I know what a digital signature looks like.	8.18	2.099	2	Agree
3	I know the difference between an electronic signature and a digital signature.	7.46	2.434	4	Mostly agree
4	I know the cost of adopting a digital signature is reasonable	6.74	2.521	5	Mostly agree
5	I would recommend digital signatures to others.	8.03	2.152	3	Agree

Table 2: Descriptive Statistics for Awareness Dimension (RO2)

The average level of awareness among the respondents was 6.463 ± 2.3350 . Table 2 provides a breakdown of the awareness dimension. The highest average score was associated with the presence of digital signatures (8.57 ± 1.821), followed by the resemblance of digital signatures (8.18 ± 2.099) and the likelihood of recommending digital signatures (8.03 ± 2.152). Ranking fourth and fifth were knowledge about the distinction between digital and electronic signatures (7.46 ± 2.434) and the cost of adopting digital signatures (6.74 ± 2.521). These two (2) aspects received mean scores below 8 out of 10 points, indicating the need to emphasise them to potential clients of digital signatures.

A deeper analysis has been done to study the relationship between the experience of using digital signatures with knowledge about the distinction between digital signatures and electronic signatures and the cost of adopting digital signatures. Table 3 shows the mean score for the analysis.

EXPERIENCE IN USING DIGITAL SIGNATURE	I KNOW THE DIFFERENCE BETWEEN AN ELECTRONIC SIGNATURE & A DIGITAL SIGNATURE	I KNOW THE COST OF ADOPTING A DIGITAL SIGNATURE IS REASONABLE
Always	9.25	8.70
Sometimes	8.34	7.54
Never	6.85	6.19
Overall	8.18	7.46
One-way ANOVA (Hypothesis: There is a difference in mean score between three groups of experience)	F-test P-value	21.962 .000
		15.138 .000

Table 3: Descriptive Statistics for Experience on using digital signature towards Awareness Dimension (RQ2)

Based on the mean score, the difference between these two (2) items is related to their experience using digital signatures. Those who constantly use digital signatures obtain a high score on knowledge about the distinction between digital signatures and electronic signatures and the cost of adopting digital signatures. Meanwhile, those who sometimes used digital signatures got a high score for knowledge about the distinction between digital and electronic signatures but a lower score for the cost of adopting digital signatures. Finally, those who had never used digital signatures obtained low scores in both knowledge about the distinction between digital signatures and electronic signatures and the cost of adopting digital signatures. The significant difference among the three (3) groups is supported by a one-way analysis of variance (ANOVA) where both p-values are less than the significance level (0.05).

Level of Digital Signature Feasibility, Planning, Implementation and Impact

The primary focus of the third research objective (RO3) is to assess the extent of digital signature adoption and its feasibility, planning, implementation, and impact within the government and public sectors. Table 4 below tabulates the study's findings.

ITEM	CATEGORY	FREQUENCY (N=344)	PER CENT (%)	RESULTS
Feasibility	None	25	7.3	Good
	Less	102	29.7	
	Enough	78	22.7	
	Good	139	40.4	
Utilisation	Never	63	18.3	Sometimes
	Often	67	19.5	
	Sometimes	176	51.2	
	Always	38	11.0	
Positive Impact	None	5	1.4	High
	Low	32	9.3	
	Moderate	149	43.2	
	High	159	46.1	
Planning to implement	Currently implementing	123	35.8	Currently implementing
	Less than 6 months	31	9.0	
	Between 6-12 months	7	2.0	
	Between 1-3 years	102	29.7	
	Later than 3 years	81	23.5	

Table 4: Descriptive Statistics for feasibility, planning, implementation and impact of digital signature within government and public sectors (RO3)

Overall, the table suggests that the respondents generally considered the feasibility of digital signatures as good and believed in their positive impact.

40 per cent of the respondents are at a good level meanwhile, 23 per cent are at enough level of feasibility study on digital signature implementation. However, 37 per cent is still less or not feasible for digital signature implementation. However, utilisation varied, with a significant percentage sometimes using digital signatures. Additionally, there were varying timelines for implementing digital signatures, with 35.8 per cent of respondents currently implementing digital signatures. 11 per cent plan to implement digital signatures within a year, meanwhile 53.2 planning to do so in the further future.

Digital signature adoption factors

Table 5 below contains information about different dimensions related to digital adoption and their corresponding mean scores, standard deviations (SD), ranks, and levels.

NO	DIMENSION	MEAN	SD	RANK	LEVEL
1	Simplicity	7.743	1.8927	5	Mostly Agree
2	Relative advantage	7.992	1.8791	2	Mostly Agree
3	Compatibility	7.694	1.8803	6	Mostly Agree
4	Security concern	7.92	2.052	3	Mostly Agree
5	Management support	7.67	1.995	7	Mostly Agree
6	Information security	7.78	2.064	4	Mostly Agree
7	Pressure	6.31	2.117	8	Mostly Agree
8	Digital adoption	7.83	2.014	1	Mostly Agree

Table 5: Descriptive Statistics for Digital Signature Adoption Factor (R03)

Overall, the dimensions with the highest mean scores and ranks are "Digital adoption" and "Relative advantage," indicating that respondents perceive these aspects positively. On the other hand, "Pressure" received the lowest mean score, suggesting less perceived pressure for digital adoption. The simplicity, compatibility, security concerns, management support, and information security levels are relatively high.

The fourth objective of the research (RO4) is to determine the factors that facilitate or impede the adoption of digital signatures in the government and public sector. To achieve this objective, the study utilises two (2) frameworks: KAP and TOE. Linear regression enables us to measure and quantify the linear relationship or connection between the awareness of digital signatures and three (3) independent variables: Knowledge, Attitude, and Practice. Table 6 provides the Regression Analysis for the Awareness Model.

NO	HYPOTHESIS	T-STATISTIC	P-VALUE	RESULT
1	H1: Knowledge has a positive relationship towards awareness of digital signature adoption	6.513	.000	Significant
2	H2: Attitude has a positive relationship towards awareness of digital signature adoption	1.862	.063	Not significance
3	H3: Practice has a positive relationship towards awareness of digital signature adoption	5.588	.000	Significance

R-square = 0.57, F-test = 153.638, p-value=0.001

Table 6: Regression Analysis for Awareness Model (RO4)

Knowledge and Practice variables had statistically significant predictive power for awareness of digital signature (R^2 -square = 0.57, F-test = 153.638, p-value = 0.001). However, only knowledge was found to be significant in predicting awareness ($p < .05$), while Practice did not demonstrate significance. According to the TOE framework, the factors that facilitate or impede the adoption of digital signatures in the government and public sector can be categorised into three (3) main factors: technology, organisation, and environment.

Linear regression is employed to quantify the linear relationship between the adoption of digital signatures, and seven (7) sub-factors categorised

under Technology (Simplicity, Relative Advantage, Compatibility, Security Concern), Organisation (Management Support, Information Security), and Environment (Pressure). These variables successfully predicted the adoption of Digital Signature, with an R^2 -square value of 0.755, an F-test value of 152.068, and a p-value of 0.001. Among the seven (7) independent variables, four (4) demonstrated statistical significance in predicting the adoption of digital signatures ($p < .05$). The four (4) significant sub-factors encouraging the adoption of digital signatures are Relative Advantage, Compatibility, Security Concern, and Information Security Culture. Table 7 depicts the regression analysis for the digital signature adoption factor (RO4).

NO	HYPOTHESIS	T-STATISTIC	P-VALUE	RESULT
TECHNOLOGY				
1	H4: Simplicity has a relationship towards digital signature adoption	1.440	.151	Not Significant
2	H5: Relative Advantage has a relationship towards digital signature adoption	2.877	.004	Significant
3	H6: Compatibility has a relationship towards digital signature adoption	2.820	.005	Significant
4	H7: Security Concern has a relationship towards digital signature adoption	7.398	.000	Significant
ORGANISATION				
6	H8: Management Support has a relationship towards digital signature adoption	1.659	.098	Not Significant
7	H9: Information Security Culture has a relationship towards digital signature adoption	2.330	.020	Significant
ENVIRONMENT				
8	H10: Pressure has a relationship towards digital signature adoption	-.708	.479	Not Significant

Table 7: Regression Analysis for Adoption Factor Model (R04)

Among the technology factors, Relative Advantage, Compatibility, and Security Concerns were found to have a significant relationship with digital signature adoption. Among the organisation factors, only Information Security Culture showed a significant relationship. The pressure from the environment did not demonstrate a significant relationship. A detailed analysis has been done to study the view of respondents towards ease of use of digital signatures. Respondents who

have experienced using digital signatures have been selected and 70 per cent of them agree, 25 per cent mostly agree while five (5) per cent disagree that digital signature is easy to use. Figure 7.0 shows the level of ease of use of digital signatures amongst experienced public and government sector users. This shows that digital signature is easy to use so the improvements of digital signature can be focused on other factors.

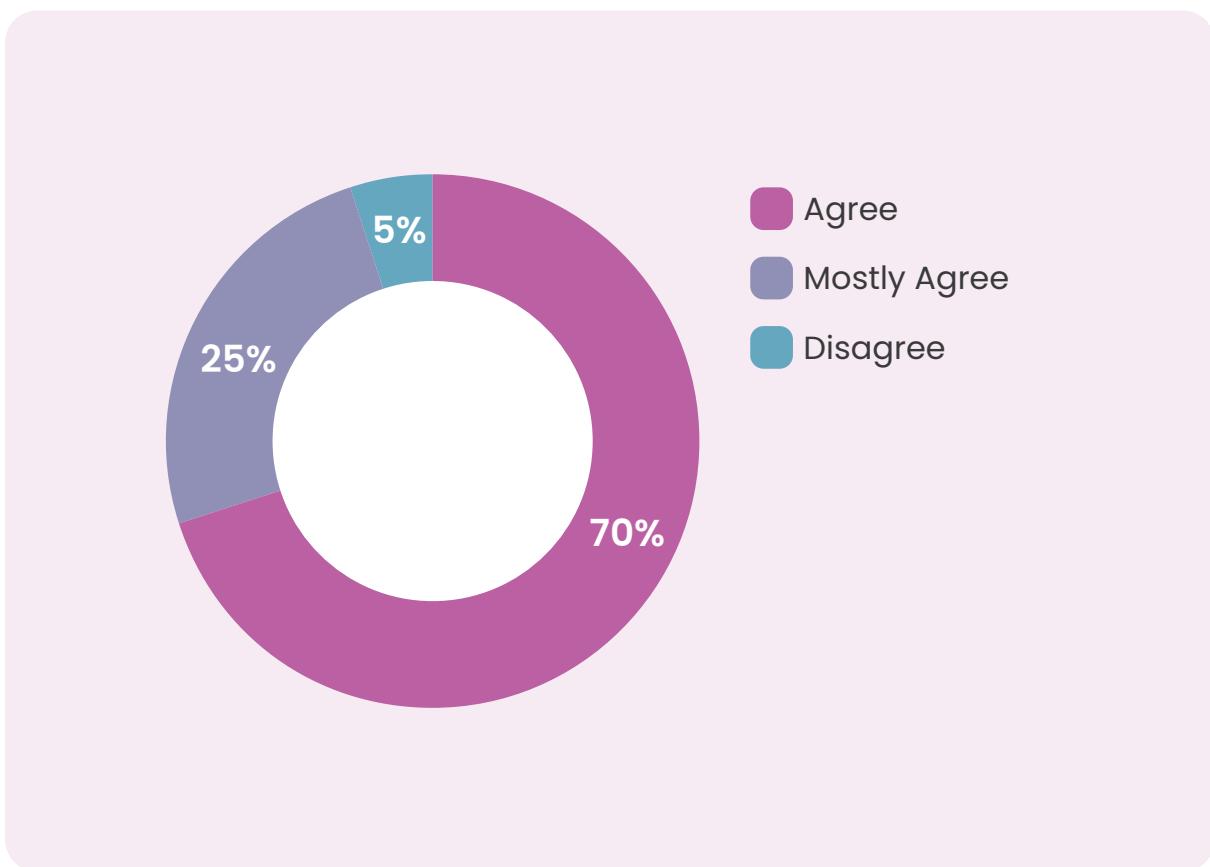


Figure 7: Level of ease of use of digital signatures amongst experienced public and government sector users

In the subsequent analysis, linear regression was employed to measure the linear relationship between the adoption of digital signatures and three (3) independent variables: Technology, Organisation, and Environment. These variables successfully predicted digital signature adoption with statistical significance ($R^2 = 0.745$, $F\text{-test} = 335.579$, $p\text{-value} = 0.001$). Both Technology and Organisation demonstrated statistical

significance in predicting the adoption of digital signature ($p < 0.05$) among the three (3) independent variables. However, the variable Environment did not exhibit statistical significance in this regard. Table 8 shows the regression analysis for technology, organisation and environment as digital signature adoption factors.

NO	HYPOTHESIS	T-STATISTIC	P-VALUE	RESULT
TECHNOLOGY				
1	H11: Technological has a relationship towards digital signature adoption	11.485	.000	Significance
2	H12: Organisation has a relationship towards digital signature adoption	4.463	.000	Significance
3	H13: Environment has a relationship towards digital signature adoption	1.615	.107	Not Significance

$R^2 = 0.745$, $F\text{-test} = 335.579$, $p\text{-value} = 0.001$

Table 8: Regression Analysis for digital signature adoption factor (R04)

In this report, we dissect and discuss the findings of the research exercise. Firstly, it was noted that 57.7 per cent of the respondents stated that they sometimes use digital technology, while 22.9 per cent stated they have never used it. From this perspective, we feel this trend is due to several factors. One factor is that digital signatures are still a relatively new technology in Malaysia and it has taken some time for them to become widely adopted. While many e-government initiatives have been implemented, the uptake among the general public is relatively low. Also, based on this study it was discovered that people may simply be unaware of the benefits of using digital signatures. They may not realise that digital signatures can help protect their privacy and security or make it easier to do business with others. In terms of awareness, this study concluded that attitude, practice, knowledge, and awareness are all important factors in digital signature awareness. However, they are not all equally important.

This study shows that the attitude is the most important factor. The findings show that users will have a positive attitude towards digital signatures when they are more likely to use them. This is attributed to the fact that they will be more likely to believe that digital signatures are secure, efficient, and convenient. Practice is the

second most important factor. If users have used digital signatures in the past, they are more likely to use them again in the future. Familiarity and ease of use play an important factor in digital signature uptake.

The third factor is knowledge. In our study, it is evident that when users have knowledge about digital signatures, they are more likely to use them. This is because they will understand how digital signatures work and they will be able to see the benefits of using them. Finally, our study shows that awareness is ranked as the least important factor. If users are aware of digital signatures, they are more likely to consider using them. However, awareness alone is not enough to convince users to use digital signatures. They also need to have a positive attitude towards digital signatures, and they need to have some knowledge about how they work. This is also an alarming concern as users are not able to differentiate between electronic signatures and digital signatures, which has led to low adoption of digital signatures. In terms of feasibility, the respondents generally considered the feasibility of digital signatures as good and believed in their positive impact. However, utilisation varied, with a significant percentage sometimes using digital signatures. Additionally, there were varying timelines for implementing digital

signatures, with a considerable number already implementing them and others planning to do so in the future.

This study on adoption factors shows that users are generally positive about digital signatures. They see them as being easy to use, having a number of advantages over traditional paper-based signatures, and being compatible with their current work processes. However, they are also concerned about the security of digital signatures and whether or not their management supports their use. Overall, users are adopting digital signatures, but they are doing so cautiously. Based on these findings, these are some additional thoughts on digital signature adoption. The adoption of digital signatures is likely to continue to grow in the future. This is due to a number of factors, including the increasing use of electronic communication, the growing demand for secure transactions, and the increasing awareness of the benefits of digital signatures.

Organisations that want to encourage the adoption of digital signatures should focus on addressing the concerns that people have about security and management support. They should also make it easy for people to use digital signatures and provide training on how to use them.

The use of digital signatures can help organisations improve their efficiency and productivity. Digital signatures can speed up the process of signing documents, reduce the risk of fraud, and improve compliance with regulations.

The fourth objective of the research (R04) is to determine the factors that facilitate or impede the adoption of Digital Signatures in the government and public sector. This study identified that both knowledge and practice facilitate the adoption of digital signatures, while attitude plays a lesser important role. Knowledge and practice play a more significant factor in digital signature adoption when compared with attitude because they are more directly related to the ability to use digital signatures. Knowledge allows people to understand how digital signatures work and what benefits they offer, and this understanding can help people overcome their fears and concerns about digital signatures and see them as valuable tools.

To investigate the linear relationship between the adoption of digital signatures and seven (7) subfactors, linear regression was used in this study. These subfactors are categorised under Technology (Simplicity, Relative Advantage, Compatibility, Security Concern), Organization (Management Support, Information Security), and Environment (Pressure). The variables

were able to predict the adoption of Digital Signature with an R-square value of 0.755, an F-test value of 152.068, and a p-value of 0.001. Among the seven (7) independent variables, four (4) of them demonstrated statistical significance in predicting the adoption of Digital Signatures ($p < .05$). The four (4) significant subfactors encouraging the adoption of Digital Signatures are Relative Advantage, Compatibility, Security Concern, and Information Security Culture. Table 7 depicts the Regression Analysis for the Digital Signature Adoption Factor(RO4).

In simpler terms, the study used linear regression to measure the relationship between digital signature adoption and seven (7) factors. The study found that the four (4) factors that significantly impact digital signature adoption are relative advantage, compatibility, security concern, and information security culture. The study also concluded that the following factors significantly impact digital signature adoption. Relative advantage refers to the perceived benefits of using digital signatures over traditional paper-based signatures. Meanwhile, compatibility refers to the extent to which digital signatures can be used in conjunction with existing work processes. The next factor is security concerns that refer to the perceived security of digital signatures. Information security culture refers to the organisation's overall attitude towards information security.

The study did not find that pressure from the environment significantly impacted digital signature adoption. Finally, the study also found that the two (2) factors that significantly impact digital signature adoption are technology and organisation. The environment factor did not have a significant impact on digital signature adoption. A more detailed explanation of the three (3) factors is as follows:

- The technology factor refers to the perceived benefits of using digital signatures over traditional paper-based signatures and the extent to which digital signatures can be used in conjunction with existing work processes.
- The organisation factor refers to the organisation's overall attitude towards information security, as well as the level of management support for digital signature adoption.
- The environment factor refers to the pressure from the environment, such as government regulations or industry standards, to adopt digital signatures.

Recommendations

Based on the study's findings, here are some recommendations for enhancing the awareness and adoption of digital signatures.

Improve awareness: Focus on Knowledge & Practice

Through informative campaigns, training programmes, and workshops, enhance knowledge about the benefits, features, and functionalities of digital signatures.

Provide information about the legal status of digital signatures in Malaysia and how they can be used to comply with regulations.

Highlight the security benefits of using digital signatures, such as their ability to prevent fraud and forgeries.

Demonstrate how digital signatures can be used to streamline business processes and improve efficiency.

Encourage individuals and organisations to practise using digital signatures through hands-on training sessions and practical demonstrations.

Enhance digital signature adoption: Focus on Technology & Organisation

Enhance awareness of security aspects such as the level of data security and privacy. The explanation shall elaborate on how digital signature is safer than other methods and how it reduces security risk.

Enhance digital signature adoption: Focus on Technology & Organisation (cont.)

Provide support and resources for organisations to implement digital signatures smoothly, including guidance on the compatibility of digital signatures to be blended in with the current platform and their integration with other running systems.

Work with organisations to develop policies and procedures for the use of digital signatures.

Provide training to employees on how to implement and use digital signatures effectively.

Create a culture of trust and security within organisations to support the adoption of digital signatures.

Emphasise the interdependence between components: Awareness, Knowledge, Practice, and Adoption

Recognise the interdependence between awareness, knowledge, practice, and adoption of digital signature.

Develop comprehensive strategies that address all four (4) components to foster sustained adoption and utilisation of digital signatures.

Measure the effectiveness of awareness and adoption initiatives to track progress and make necessary adjustments.

Strengthen collaboration with public and government agencies to ensure sustainable adoption.

Collaborate with the public and government agencies to align initiatives and promote the adoption of digital signatures at a national level.

Establish ongoing communication channels to provide updates, share best practices, and address any challenges or concerns related to digital signature adoption.

Furthermore, the research findings indicate a positive correlation ($r = 0.506$, $p\text{-value} < 0.001$) between awareness and digital signature adoption. Therefore, it is crucial to focus on increasing awareness as it directly contributes to higher levels of digital signature adoption.

Conclusion

Digital signatures are a way to protect digital data and ensure its confidentiality, integrity, security, and non-repudiation. They are more secure than electronic signatures, which rely on a simple image of a person's signature. In Malaysia, E-government initiatives increasingly use digital signatures to adapt to remote working. However, the adoption of digital signatures among public and government agencies in Malaysia is still low.

The study concluded that several factors significantly impact digital signature adoption: compatibility, security concerns, and information security culture. Pressure from the government, however, poses minimal impact on the adoption of digital signatures.

Organisations can help address the gaps found in this study by enhancing awareness and adopting digital signatures. This can lead to a number of benefits, such as increased efficiency, improved security and reduced cost.

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TOPIC 06

Public Awareness of Malaysian Communications & Multimedia Commission Label for Communication Devices

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Abstract

Raising awareness about the safety of communication devices, including the potential risks of using devices in a safe and responsible manner, is very significant. The use of a communication device without an Malaysian Communications & Multimedia Commission (MCMC) label may not be safe as it could come with a substandard charger, not in compliance with the safety requirements and may lead to electric shock or, worst-case, fire. Therefore, Check-Your-Label (CYL) campaign promotional activities and platforms are strictly endorsed to direct users' attention and to improve public awareness. When consumers understand the importance of using safe and compliant communication devices that meet relevant regulatory requirements and bear appropriate labels or certifications, they can make more informed purchasing decisions. The study aims to measure public awareness of MCMC labels for communication devices, evaluate the effectiveness of the CYL campaign, and provide suggestions for improving the CYL campaign among public consumers. The mixed research approach was used in this study, with a questionnaire distributed to 233 Malaysian consumers

and 16 people participating in the focus group discussion. The results showed that consumer awareness and knowledge about MCMC labels and consumer self-regulation are positively related to the CYL campaign effectiveness. It has also been observed that the effectiveness of the CYL campaign mediates the relationship between consumer awareness and knowledge about MCMC labels and consumer self-regulation. The practical recommendations have been made to the CYL campaign key challenges, such as integrating the use of creativity in marketing strategies, engaging university students, promoting MCMC awareness into student's tech curriculum or lessons, and compromising the use of interactive methods to make the learning experience enjoyable to reach a wider audience. In conclusion, the study raises awareness about the importance of adhering to MCMC labels, and by applying these recommendations, MCMC may develop a more informed and engaged consumer base, which will influence the societal growth of the multimedia and communication industry.

Introduction

MCMC is a regulatory body which is responsible to govern the communications and multimedia industry according to the authority provided under the Malaysian Communications and Multimedia Commission Act 1998 and the Communications and Multimedia Act 1998. MCMC has also taken initiatives to promote digital knowledge and skills in the present age of information technology. MCMC is actively promoting digital literacy among public consumers on the ability to effectively access digital media while accessing relevant information, analysing the authenticity and reliability of the information, as well as an ethical consideration in using digital media.

MCMC launched the CYL campaign in 2015, as an awareness campaign to educate on the importance of purchasing communication devices with a valid MCMC label. One (1) aspect of this campaign is to guide consumers in verifying the validity of MCMC labels on communication devices that have been proven to be effective in promoting customer self-regulation and encouraging them to take important measures to promote the safe and effective use of communication devices. The campaign has enabled the public to understand that purchasing

communication devices without MCMC labels can be detrimental to them, may not be safe as it could come with substandard chargers not in compliance with the safety requirements and hence may lead to electric shock or worst-case, fire. This is where the promotion of the CYL campaign and promotional activities are significant to raise awareness and influence the consumer's perception and guide decision-making processes.

Problem Statement

MCMC certification mark is important as it indicates that the devices have met the standards of safety, and quality, or meet regulations of Communications and Multimedia (Technical Standards) Regulations 2000. Using communication devices without an MCMC label can pose several risks, as these devices may not meet the necessary safety and technical requirements set forth by MCMC. Devices without an MCMC label may not be safe since they do not comply with safety requirements. Moreover, there can be serious issues when using non-compliant communication devices. Accidents might occur when using non-certified devices such as electric shocks and fire outbreaks. Non-certified communication devices

may not be compatible with local networks, and consumers may experience frequency interference, compromising the device's quality and performance. In order to promote awareness, the CYL campaign which was initiated by MCMC provides resources to help consumers verify the certification status and validity of MCMC labels on communication devices. The CYL campaign plays an important role in educating consumers on MCMC labels to ensure consumer safety and communication device compliance with legal requirements. However, the public's acceptance of the CYL campaign and MCMC labels is ambiguous when there is no past study focused on the association between customer awareness and knowledge about MCMC labels, as well as the effectiveness of the CYL campaign is argued, hence requires further investigation.

Research Objectives

The following research objectives are established:

RO 1

To measure public awareness and knowledge of the importance of certified communication devices among consumers.

RO 2

To evaluate the effectiveness of the CYL campaign among consumers.

RO 3

To explore the challenges of the CYL campaign and provide recommendations for enhancing the effectiveness of the CYL campaign among consumers.

Literature Review

Overview of Malaysian Communications & Multimedia Commission Labels and Check-Your-Label Campaigns in Malaysia

The Malaysian government has recognised the importance of consumer protection by implementing a few initiatives to ensure that the appropriate labelling of communication devices is implemented. One (1) of these initiatives is the MCMC label and CYL campaign. It has been regulated that certified communication devices shall hold MCMC labels to declare that they comply with standards and legal MCMC requirements. MCMC labels are awarded to products that meet all safety and quality requirements set by the Malaysian authorities. At the same time, the CYL campaign is a consumer education programme aimed at guiding them in certifying the validity of communication devices. The campaign was designed to educate consumers on the importance of reading the labels on products and services. The campaign also encourages consumers to ask questions and to seek further information when

purchasing communication devices. The CYL campaign is designed to educate the public about their consumer rights and empower them to make informed purchases. There are various methods that MCMC offers in CYL campaign apps where in checking the label, the most efficient and fastest way is to have the app that can be downloaded through Google App Store, Apple App Store and Recee.my website. There are only four (4) steps that a consumer should follow to check the label, which are, look for an MCMC label before buying, download the CYL mobile application or go to eComM website, find the IMEI number or device's serial number, key in to retrieve the device or approval information, and confirm device's approval information displayed. MCMC Label and CYL campaign have successfully promoted consumer protection in Malaysia hence resulting in a greater awareness of the importance of product labelling among consumers and increased consumer confidence in the products purchased.

Consumer Awareness and Knowledge about MCMC Labels

Consumer awareness and knowledge of MCMC labels are essential to ensure the safety and quality of products that are being bought by consumers. Thus, consumers should be made aware of the different categories of labels, as well as the requirements for each category of the label. Being aware of the importance of MCMC labels empowers consumers to make informed choices and purchase products that comply with standards and regulations, thereby protecting their rights as consumers.

Understanding the safety, security, and quality of products and applications can be crucial for consumers, and this knowledge often relies on awareness of labels, including those issued by MCMC. According to a past survey conducted in Malaysia, it was found that the vast majority of respondents were aware of the MCMC label and able to express the correct option when asked about the purpose of the label. This suggests that while awareness of the MCMC label is high, the knowledge about the purpose of the label and its implications is relatively low. The results of this survey suggest that more efforts should be made to educate

consumers about the purpose of MCMC labels. Hence, the CYL campaign has to be circulated around public spaces for instance (train stations, inside LRTs, MRTs, or even buses) to get mass awareness of the public to conduct the CYL campaign on the products that they have purchased or will purchase in the future.

Theory of Effectiveness

The theory of effectiveness was introduced by Smith and Schwartz (1985) where he administered the effectiveness in terms of organisation. This theory supports the association between consumer knowledge and MCMC labels with the effectiveness of the CYL campaign. This could be explained when consumers have high motivation and the ability to process information, they are more likely to engage in central route processing. Consumer knowledge about the importance of MCMC labels can serve as a central cue that influences consumers to pay more attention and carefully process the information in the CYL campaign. On the other hand, the MCMC label, being a recognised regulatory requirement for product safety and quality, serves as a credible source of information for consumers. When consumers are aware of the importance of MCMC labels, they are more likely to perceive the CYL campaign, which promotes checking MCMC labels,

as credible and trustworthy. Thus, this perception enhances the effectiveness of the CYL campaign.

Metacognitive Theory

According to Moshman (2018), metacognitive theories are based on the integration of one's knowledge regarding the regulation of cognition. The theory supports the association between consumer awareness and knowledge of MCMClabelsandconsumerself-regulation. The metacognitive theory also escalates the phenomenon related to self-regulation or planning. John Flavell (1979) presented the theory as thinking regarding thinking or more comprehensively explained that metacognitive explains one's information that shapes one's cognitive procedures on something associated with them (Dayan, 2022). The theory supports the relationship between consumer awareness as an increment and an additional behaviour that escalates his self-regulation behaviour. The concept is related purely to self-cognition, so according to the theory, the rationale or sequential procedure to ponder upon thinking before finalising or concluding a certain behaviour is an approach conveyed by metacognitive theory.

Self-Regulation Theory

The theory elaborates on the aspect of psychology and perception as self-regulation theory decreases the frequency and intensity of the impulses by self-regulation of stress or the negative environmental effects (Vohs & Baumeister, 2016). This theory potentially backs the relationship between the effectiveness of the CYL campaign and consumer self-regulation. The more effective the CYL campaign is, the better the impact of consumers' self-regulation behaviour. The person's thoughts are guided according to the concept of this theory which also backs the relationship because the effectiveness of the CYL campaign is associated with its consumer's self-regulation.

Methodology

This research has applied a mixed research method in which qualitative and quantitative techniques have been used to analyse the involved constructs and draw accurate results. Mixed method research is also beneficial because more appropriateness is achieved in results when it is tested from two (2) distinct methods. This research has thus formulated three (3) research objectives based on the measurement of public awareness and knowledge of the related MCMC significance label for communication devices and the evaluation of an effective CYL campaign among consumers followed by the exploring different challenges related to the CYL campaign along with suggestions to increase the CYL campaign effectiveness among consumers. The accomplishment of each one would involve further data collection and analysis tools.

The research population for this study has been identified based on the group that mainly focuses on the interest of this research. This is aligned with the use of quota sampling, which ideally accommodates the respondent's specific traits and qualities, and saves data collection when it represents the distribution of target population. The

survey was conducted in six (6) major states of Malaysia at concerned locations, such as Selangor, KL, Johor, Sabah, Pahang, and Sarawak, which intends to record the perceptions of consumers regarding the significance of MCMC label and CYL campaign. The survey was launched in mid-January until the end of February 2023 on various online platforms, such as MCMC social media, the university's page and linkages, and the research teams' contacts.

For the qualitative mode of data collection, the targeted population has been identified for focus group interviews, including 16 participants: two (2) representatives from MCMC, another two (2) from SIRIM Qas International and the rest (12) consisting of public consumers and shopkeepers. They were contacted/approached to collect detailed perceptions and information and to provide appropriate recommendations for the CYL campaign.

Findings and Analysis

The chapter illustrates the empirical findings of this study. For the quantitative part, the confirmatory factor analysis (CFA) was used to examine the convergent and discriminant validity of the variables. Data analysis and path modelling were performed by using PLS-SEM (Partial Least Square-Structural Equation Modeling) with Smart PLS 4 software, and SEM was employed to assess the hypotheses. The qualitative part follows suit thematically to reveal the result of focus group discussions.

Quantitative Analysis and Findings

CONSTRUCT	MEAN	STANDARD DEVIATION (SD)	CRONBACH'S ALPHA	COMPOSITE RELIABILITY (CR)	AVERAGE VARIANCE EXTRACTED (AVE)
Public Awareness and Knowledge of MCMC Label	3.326	1.249	0.868	-1.040	0.819
Effectiveness of CYL Campaign	3.342	1.090	0.881	-.682	0.894
Consumer Self-Awareness	3.676	.922	0.948	-.092	0.765

Table 1: Descriptive, Reliability and Validity

Table 1 describes the characteristics of data and presents the descriptive statistics of the study variables. It shows the mean values and standard deviations of all under-study variables with an acceptable range of Alpha values. The mean values of Public Awareness and Knowledge of MCMC Label, Effectiveness of CYL Campaign, and Consumer Self-Awareness are 3.326, 3.342, and 3.676, respectively. It shows that most of the respondents agreed with the given statements. Moreover, data reliability and scale validity are other important factors before proceeding to hypothesis testing. Reliability implies the inter-item consistency of the scale. The reliability of instruments was assessed by calculating the alpha coefficients and inter-item correlation of under-study variables. Table 1 indicates that the data for all the variables is reliable, as the alpha value for all constructs is greater than 0.70. Table 1 also proved that there is no issue of convergent validity of the scales as all the values of AVE are greater than 0.50. Thus, there is no issue of reliability and validity.

CONSTRUCT	EFFECTIVENESS OF CYL CAMPAIGN (EC)	PUBLIC AWARENESS & KNOWLEDGE (PAK)	SELF-REGULATION (SRA)
Effectiveness of CYL Campaign (EC)			
Public Awareness & Knowledge (PAK)	0.701		
Self-regulation (SRA)	0.778	0.705	

Table 2: Discriminant Validity (HTMT Ratio)

Table 2 shows the discriminant validity, and results identified that there is no discriminant validity issue in this study as all the values are less than the maximum threshold of 0.9, hence validity has been established for all the variables.

	RELATIONSHIPS	BETA	SD	T VALUE	P VALUES	LL	UL	DECISION
H1	PAK → EC	0.701	0.038	18.373	P<0.05	0.621	0.772	Supported
H2	PAK → SRA	0.29	0.062	4.709	P<0.05	0.163	0.402	Supported
H3	EC → SRA	0.552	0.054	10.169	P<0.05	0.446	0.658	Supported

Note:

EC =Effectiveness of CYL Campaign;
 PAK = Public Awareness & Knowledge;
 SRA = Consumer Self-Regulation

Table 3: Hypotheses Testing

Table 3 and Figure 4.1 shows the results of hypothesis testing. It was found that all three (3) hypotheses are supported statistically. Results proved that public awareness and knowledge of MCMC labels significantly impact the effectiveness of CYL campaigns in Malaysia. Similarly, it was revealed that public awareness and knowledge of MCMC labels significantly positively affect the self-regulation behaviours of the public in Malaysia. Results highlighted that the effectiveness of CYL campaign is also positively related to public self-regulation behaviours. Lastly, it was evident that the effectiveness of the CYL campaign significantly mediates the relationship between public awareness and knowledge about MCMC labels and consumer self-regulation.

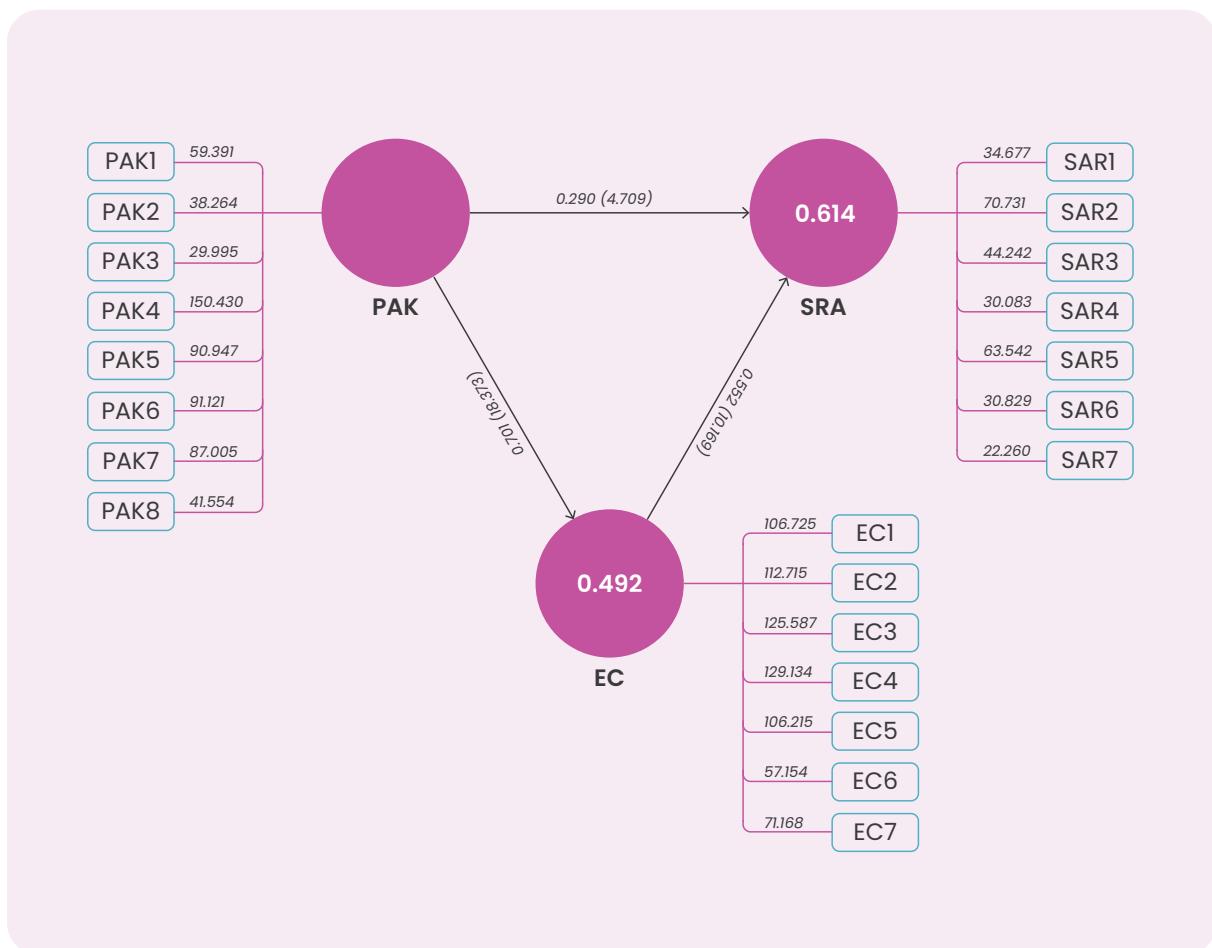


Figure 4.1: Structural Model Assessment

-
- H1** Public awareness and knowledge of MCMC labels significantly impact the effectiveness of the CYL campaign in Malaysia.
-
- H2** Public awareness and knowledge of MCMC labels significantly affect the self-regulation behaviours of the public in Malaysia.
-
- H3** Effectiveness of the CYL campaign is positively related to public self-regulation.
-
- H4** Effectiveness of the CYL campaign mediates the relationship between public awareness and knowledge about MCMC labels and consumer self-regulation.
-

RQ1: What is the association between public awareness and knowledge about MCMC labels, consumer self-regulation and the effectiveness of CYL campaign?

Three (3) formulated hypotheses (H1, H2 and H3) were tested to address this research question. The results obtained from this study showed that consumer awareness and knowledge about MCMC labels are positively related to the

effectiveness of the CYL campaign and self-regulation. It has also been observed that CYL campaign effectiveness is positively related to consumer self-regulation. It has been observed that improved consumer knowledge helps influence their purchasing behaviours and attitudes. The awareness programmes help in promoting self-regulation without force. According to Niosi, A. (2021), consumers seek information regarding the products or brands before purchasing them. This explains the need to promote the effectiveness of different awareness programmes which help promote transparency of various company policies and regulations. Therefore, consumer

knowledge and awareness about MCMC labels was vital in improving their knowledge and encouraging them to make effective purchase decisions.

RQ2: What is the mediating impact of the effectiveness of CYL in the relationship between public awareness and knowledge about MCMC and consumer self-regulation?

In order to answer this RQ, H4 was tested. The results obtained from this study showed that the effectiveness of the CYL campaign mediates the relationship between public awareness and knowledge about MCMC labels and consumer self-regulation. The promotion of an effective CYL campaign is crucial to improve the knowledge of customers regarding the significance of the MCMC label. According to scholars, effective information helps improve customers' self-determination and autonomy, encouraging them to make their own purchase decisions based on the provided information. As a result, consumers become more vigilant as they have various sources to cross-check the

given information. Thus, the effectiveness of the CYL campaign is crucial to improve consumer self-regulation.

RQ3: How can the challenges of CYL campaign be overcome to increase the effectiveness of CYL campaign among public consumers?

The results obtained from the focus group interviews showed that different challenges were faced by the CYL campaign, which impacted the effectiveness of this campaign. The CYL campaign failed to gain an effective response from the public and received backlash due to different transparency and accessibility issues. To resolve these issues, important innovative and effective strategies must be promoted such as improving the transparency of the policies and regulations of MCMC by using e-platforms, raising consumers' feedback for CYL campaign, and encouraging them to focus on MCMC labels before purchasing any communication device. This will help improve the efficiency of this programme.

Qualitative Analysis and Findings

The information regarding the two (2) participants' groups was recorded via audio during the focus group interviews and later transcribed. From these discussions, various basic and organising themes emerged and were subsequently combined to form an overarching theme of the 'CYL Campaign', which is displayed in Figure 4.2 below.

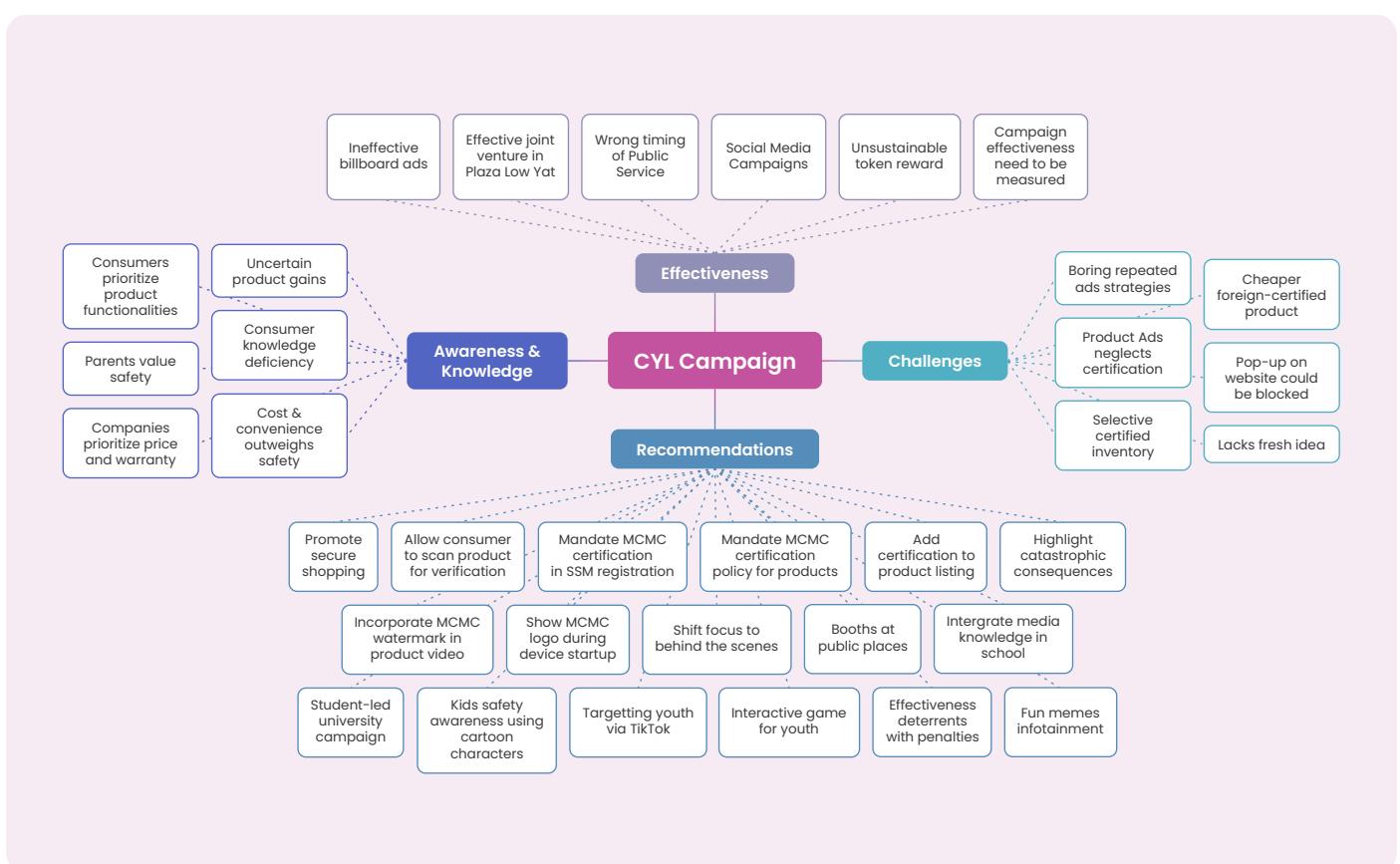


Figure 4.2: Thematic Network Map

RQ1: How much are consumers aware of and how well do they understand the importance of MCMC labels for communication devices?

Due to inflation, some merchants selectively certify their products, while others are only familiar with the SIRIM label and MCMC certification but not the CYL campaign. Consumers prioritise convenience and price over product safety, whereas parents prioritise safety and dependability. Meanwhile, parents are willing to pay extra for approved communication tools, even if unauthorised alternatives are less expensive. To ensure the best value for money and to protect against malfunctions or faults, sellers of communication devices prioritise pricing and warranty over MCMC certification.

RQ2: How effective has the CYL campaign connected with and influenced consumers?

The billboard ads for CYL campaign were ineffective due to high-speed highway traffic and gained people's short-term attention. However, a joint venture between MCMC and Plaza Low Yat resulted in an impressive response. The campaign captured the attention of previously unaware tenants, who gradually showed interest and searched for more information about MCMC labels. Then, MCMC produced Public Service Announcements (PSAs) with radio and television stations, starring Malaysian musician Dato' Siti Nurhaliza, although they were not shown during prime time due to free messaging. This resulted in inefficiency because most individuals were sleeping at the time. To combat this, MCMC moved its focus to social media platforms, engaging with influencers and celebrities like Izzue Islam and Cik Manggis. Interactive campaigns with prize incentives resulted in a successful engagement approach.

RQ3: What are the key challenges faced by the CYL campaign, and what recommendations can be provided to improve its effectiveness among consumers?

KEY CHALLENGES

Online purchasing is preferred by consumers because of lower pricing and foreign certification. Pop-ups are a powerful advertising approach, but they may be difficult to install and irritating to users. The CYL campaign is facing a challenge in terms of resources and new ideas for improvement, as previous techniques may lose freshness and appeal to the target demographic. The absence of innovative and effective ideas might lead to a decrease in campaign performance and impact. End-users and viewers may become bored with repeating techniques. Collaboration with influencers and authorities may not give the novelty and innovation required to re-energise efforts. Consumers frequently ignored MCMC labels in communication device advertising, preferring to focus on other aspects such as price, brand, and processor. MCMC certification is not available for all goods because only a few have gone through the certification process.

RECOMMENDATIONS

Here are some of the participants' recommendations to improve the effectiveness of the CYL campaign and raise awareness about the importance of MCMC certification.

EFFECTIVENESS OF CYL CAMPAIGN

Promote smart purchase system: Emphasise the need for MCMC certification of communication devices to ensure its interoperability and safety.

Allow consumers to scan products for verification: Use QR code scanning instead of manually keying in the code.

Add certification to product listing: Ensure all products are certified and safe with clear descriptions and customer support.

Student-led university campaign: Engage university students to lead campaigns targeting 18 to 24-year-olds.

Booths at public places: Set up educational booths in malls, schools, or universities with interactive elements.

Highlight catastrophic consequences: Emphasise catastrophic consequences safety and security services such as disruption of emergency communication services and air traffic control and encourage checking for certification status before purchase.

Targeting youth via TikTok: Use different advertising methods for different audiences (traditional for older consumers, digital for younger).

Interactive game for youth: Use interactive games and offer age-specific incentives for using CYL apps, such as coins or points for popular games like Roblox or Minecraft for youth.

Shift focus to behind the scenes: Educate consumers about the certification process and the significance of purchasing certified products.

RAISING AWARENESS OF MCMC CERTIFICATION

Effective deterrents with penalties: Impose fines for non-compliance with regulations for older adults.

Show MCMC label during device startup: Displaying a protection message during transactions or device activation, and preloading MCMC label on smartphones before sale.

Integrate media knowledge in school: Integrate MCMC awareness into the tech curriculum of “Reka Bentuk dan Teknologi (RBT)” to educate students.

Kids safety awareness using cartoon characters: Make learning enjoyable for young children with familiar characters and interactive methods.

Fun memes Infotainment: Use creative marketing strategies (videos, social media, humour) to captivate attention.

Recommendations

Researcher's Recommendations

Here are some of the researchers' recommendations to improve the effectiveness of the CYL campaign and raise awareness about the importance of MCMC certification.

Effectiveness of CYL Campaign

- "MCMC certification of all communication devices is required to guarantee the safety of their use in terms of device interoperability." This needs to be emphasised by the communication device seller. Not all consumers are equally concerned about product safety. The campaign can be improved by creating tailored messages for specific groups of consumers, such as parents, seniors, or people who have been injured by unsafe products. The campaign should highlight how MCMC certification can specifically address their concerns and ensure the safety of their loved ones. QR codes are mobile-friendly, a quick and easy way for consumers to verify the authenticity of a product. They are also more secure than manually keying in a code, as there is less risk of human error. An MCMC certification status with a check mark next to the communication device should be added on product listings, this helps consumers make informed decisions about which products to buy. The benefits of doing this include increasing customer trust, which can lead to better sales.
- The suggestion to engage university students to lead a campaign targeting 18 to 24-year-olds is a good idea. MCMC should also partner with influencers who have a strong following within this target demographic. These influencers can help spread awareness among these youngsters about the campaign through their social media platforms, blogs, or YouTube channels, effectively reaching a wider audience.

- University students are a large and engaged demographic, and they are more likely to be aware of and interested in campaigns that are led by their peers. A student advisory board can be set up and student volunteers can be recruited to develop and implement the campaign. The board can provide feedback on the campaign's goals, message, and materials.
- Setting up educational booths in public places with interactive elements is a good way to improve the campaign's reach, engagement, and retention. Booths can reach a large audience of people who might not otherwise be aware of the campaign. Interactive elements can help to engage people and to get them interested in the campaign. People who interact with the campaign are more likely to remember it and take action.
- Highlighting the catastrophic consequences of using non-certified devices such as disruption of emergency communication services and air traffic control. Thus, consumers should be encouraged to check for certification status before purchasing. Use real-world examples that have been caused by unsafe products. This will help to make the dangers more real and tangible for consumers. Use strong visuals, such as photos or videos, to illustrate the dangers of unsafe products. Visuals can be a powerful way to grab attention and communicate a message.
- Use traditional advertising methods for older consumers. Traditional advertising methods, such as TV commercials, print ads, and radio ads, can be effective in reaching older consumers. These consumers are more likely to watch TV, read newspapers, and listen to the radio, so these channels can be a good way to reach them. Use digital advertising methods for younger consumers. Digital advertising methods, such as social media ads, search engine ads, and email marketing, can be effective in reaching younger consumers. These consumers are more likely to use the internet, so these channels can be a good way to reach them.
- Using interactive games and offering age-specific incentives is a good way to improve the campaign's reach, engagement, and learning. Games can be a fun and engaging way to teach young people about safety. This can help to increase engagement, motivation and improve learning and retention with the CYL app.

- By creating behind-the-scenes content, it helps consumers to understand the certification process and the significance of purchasing certified products. By educating consumers about the certification process, it helps to increase awareness of the issue among consumers; increase demand for certified products and improve public perception of MCMC.

Raising awareness of MCMC certification:

- Displaying MCMC labels during device startup is a good way to raise awareness of MCMC certification and its importance to consumers. When consumers see the MCMC label, they can be confident that the device has been tested and meets safety standards. This can help to increase consumer confidence in the device and in the company that manufactured it. Companies that show MCMC labels can improve their brand reputation by ensuring interoperability in communication devices. This can help them attract new customers and retain existing customers.
- Integrating MCMC awareness into the tech curriculum of RBT is a good idea. This will help to educate students about the importance of MCMC certification and its role in guiding users' purchase of communication devices. The following lessons can be included in the curriculum:
 - A lesson to discuss the potential dangers of using unsafe electronic devices and the importance of purchasing devices that have been certified by an appointed MCMC certifying agency;
 - A lesson to teach students how to look for MCMC label on electronic devices and how to verify that the device has been certified by an appointed MCMC certifying agency;
 - A lesson on the importance of following the manufacturer's instructions.
- Using cartoon characters and interactive methods to raise awareness of MCMC certification among young children is a good idea. This helps to make learning about MCMC certification enjoyable and engaging for children. Interactive

content, such as a cartoon video about MCMC certification, a mobile app that includes educational game quizzes and activities and hosting local community events using cartoon icons to feature fun activities, games, and prizes, are effective ways to teach children about MCMC certification and raise awareness among young children.

- The suggestion to use creative marketing strategies, such as videos, social media, and humour, to raise awareness of MCMC certification is a good idea. This will help to captivate attention and make the information more memorable.

Conclusion

Advancements in ICT have accelerated Malaysia's communication and multimedia industry growth, leading to the introduction of MCMC labels to ensure product safety and authenticity. This has encouraged MCMC and other regulatory bodies to promote important regulations and policies for providing safe and cost-effective products to the public to improve customer satisfaction. In this regard, the MCMC label was introduced, ensuring the product's safety and authenticity. According to the guidelines of MCMC, any communication devices without MCMC label are not safe or authentic and might also impact the service quality. To encourage self-regulation, MCMC launched the CYL campaign, an awareness programme that has been beneficial in increasing consumer self-regulation. A current study revealed that promoting MCMC certification and generating awareness can be accomplished through a variety of means, including increasing the visibility of MCMC label, targeting specific audiences, assuring product safety, and strengthening CYL campaign platform. Reaching a larger audience requires creative marketing methods, engaging university students, and engaging young children. TikTok, as one of the most popular social media platforms among Malaysian youth, can also be utilised to promote MCMC certification to younger generations. This will assist in providing the public with the necessary information regarding the MCMC label, which will ultimately lead to transparency, promoting customer satisfaction and improving the multimedia and communication industry's social growth.

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TOPIC 07

Gaining Insights on Micro-credential Courses in Facilitating Capacity Building in Areas of Communications and Multimedia

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Abstract

Micro-credentials are emerging as a vital solution to facilitate professional development, particularly in the Communications and Multimedia (C&M) industry. This short-term educational format offers targeted and flexible learning opportunities, allowing professionals to adapt to the ever-changing industry demands. This study aimed to explore the role of micro-credential courses in enhancing capacity building in the C&M sector in Malaysia. The study adopted a mixed-method approach and convergent design to (i) merge, (ii) compare and interpret the results, and (iii) triangulate the perspectives of the stakeholders. Questionnaires, focus group discussions, interviews, reports and literature reviews were based on the following dimensions: inquiry, reflection, integration, and outcome assessments. It was found in this study that micro-credential courses are integral to the capacity-building ecosystem of the industry. Based on our conservative analysis, it is estimated that 450,000 individuals have the potential to enrol in such courses, driven by the need for career development and job-relevant skills. Despite the benefits, there

are challenges too. Local universities offer a limited range of C&M-focused micro-credentials, and there is a mismatch between supply and demand, especially in specialised areas like Network & Communication, IoT, Cloud Computing, Applied Multimedia, and Security. Working adults show significant interest in these courses, signalling room for growth. However, several challenges need to be addressed for sustainable implementation: identifying suitable courses for niche markets, securing expertise, gaining recognition from professional bodies and employers, developing appropriate assessment methods, training educators, and managing learning platforms. Micro-credentials offer a promising pathway for skill development and employability in the C&M sector. They fill crucial gaps in the traditional education system by providing quick and relevant upskilling opportunities. However, to fully unlock their potential, especially in the Malaysian context, there needs to be a concerted effort to address various challenges, from course availability to industry recognition.

Introduction

In the last decade, there has been a proliferation of learning programmes and credentials positioned as “alternatives” to traditional formal education programmes. Research has shown that this convergence is easier to accomplish by universities than trying to unbundle traditional degrees (Selvaratnam & Sankey, 2019). It also accords university partnerships, especially those that leverage employment opportunities for graduates. These alternative credentials have been defined by the Organisation for Economic Co-operation and Development (OECD) as “credentials that are not recognised as stand-alone formal educational qualifications by relevant national education authorities” (Kato, Galán-Muros and Weko, 2020).

Alternative credentials include academic certificates, industry certifications and digital badges. The expansion of alternative credentials has taken place in the context of increasing cost of higher education for both learners and providers, rapid labour market changes, accelerating skills obsolescence and growing demand for more flexible learning opportunities. One (1) form of alternative credential gaining increasing policy attention is the micro-credential. Although it may still be a somewhat contested term,

the most compelling definition thus far is that proposed by Emeritus Professor Beverly Oliver, from Deakin University, who describes it in the following way: a micro-credential is a certification of assessed learning that is additional, alternate, complementary to or a formal component of a formal qualification (Oliver, 2019). Malaysian Qualifications Agency (MQA) (2020) defines micro-credential as: “digital certification of assessed knowledge, skills and competencies in a specific area or field which can be a component of an accredited programme or stand-alone courses supporting the professional, technical, academic and personal development of the learners”.

Problem Statement

The rapid evolution of the communications and multimedia sector, driven by advances in networking, cybersecurity, wireless technology, cloud solutions, and AI-enhanced systems, has led to groundbreaking technological shifts and innovations. However, this accelerated growth has also resulted in a pronounced skills gap in the workforce, as the pace of technological advancement outstrips the rate at which professionals can acquire the necessary expertise (Carnevale, A.P., Smith, N., & Strohl, J., 2013).

With considerable time and resource commitments, conventional educational and training programmes have struggled to keep pace with these rapidly evolving requirements. In this landscape of continuous change, micro-credentials have emerged as a key solution. They offer flexible, targeted learning opportunities that enable professionals to keep up with the industry's changing demands. This way, they provide the means for constant skills adaptation and evolution within the dynamic C&M domain. However, despite the clear benefits of micro-credentials, there is still a need for a deeper understanding of their potential and how they can best be tailored to meet the specific needs of the C&M sector. To bridge the skills gap effectively, examining the industry's unique challenges is crucial, identifying the specific skillsets required, and developing a robust understanding of how micro-credential courses can best serve the C&M domain. Therefore, the emphasis should be on exploring and comprehending the potential of micro-credentials in widening the scope of learning and addressing the skills mismatch in the rapidly evolving C&M industry.

Research Objectives (RO)

The general aim of this proposed research is to gain insights on micro-credential courses in facilitating capacity building in areas of Communications and Multimedia (C&M). The specific objectives of the proposed research are given below.

RO 1

To understand the role of micro-credential programmes in complementing the capacity-building ecosystem;

RO 2

To explore the available C&M-related micro-credential programmes offered by the local universities;

RO 3

To canvass the availability and factors contributing to take-ups and demand for micro-credential programmes in other countries;

RO 4

To explore how micro-credentials could support employability in the C&M industry and forecast the potential number of working adults who would be interested in pursuing C&M-related micro-credentials;

RO 5

To identify and recommend potential micro-credential programmes for the C&M industry; and

RO 6

To understand the challenges faced by Malaysian Universities in developing and implementing micro-credential programmes.

Literature Review

Over the past 10 years, we have seen a significant increase in learning programmes and qualifications that present themselves as alternatives to conventional formal education courses. Gallagher (2016) reveals the evolving markets which, although currently separate, are merging, particularly in the area of micro-credentials and the present short-term offerings that are not officially recognised. Studies suggest that this convergence is more readily achieved by universities as compared to the process of breaking down traditional awards (Selvaratnam & Sankey, 2019). Importantly, this allows for university collaborations that capitalise on job prospects for graduates.

According to Kato, Galán-Muros, and Weko (2020), the Organisation for Economic Co-operation and Development (OECD) characterises alternative credentials as "credentials that lack acknowledgment as independent formal educational qualifications by the relevant national education authorities". These encompass academic certificates, industry certifications, and digital badges. The rise of alternative credentials has occurred against a backdrop of escalating higher education costs for both learners and providers, rapid shifts in the labour market accelerating skill obsolescence, and increasing demand for more flexible learning options.

Micro-credentials, one (1) type of alternative credentials, have been garnering heightened policy interest. Although there may be ongoing discussions surrounding the term, Emeritus Professor Beverly Oliver from Deakin University provides a convincing explanation. In her view, a micro-credential is a certified recognition of assessed learning that is additional, alternative, supplementary, or an integral part of a formal qualification (Oliver, 2019). The Malaysian Qualifications Agency (MQA) (2020) further elaborates on micro-credentials as "digitally issued certifications that validate evaluated knowledge, skills, and competencies in a specific area or field. They can serve as a component of an accredited programme or standalone courses that support learners' professional, technical, academic, and personal development."

Many individuals actively pursue educational credentials for future job opportunities or to enhance their existing employment prospects. As shown in Figure 1, there are several types of educational credentials, all of which are closely tied to employability.

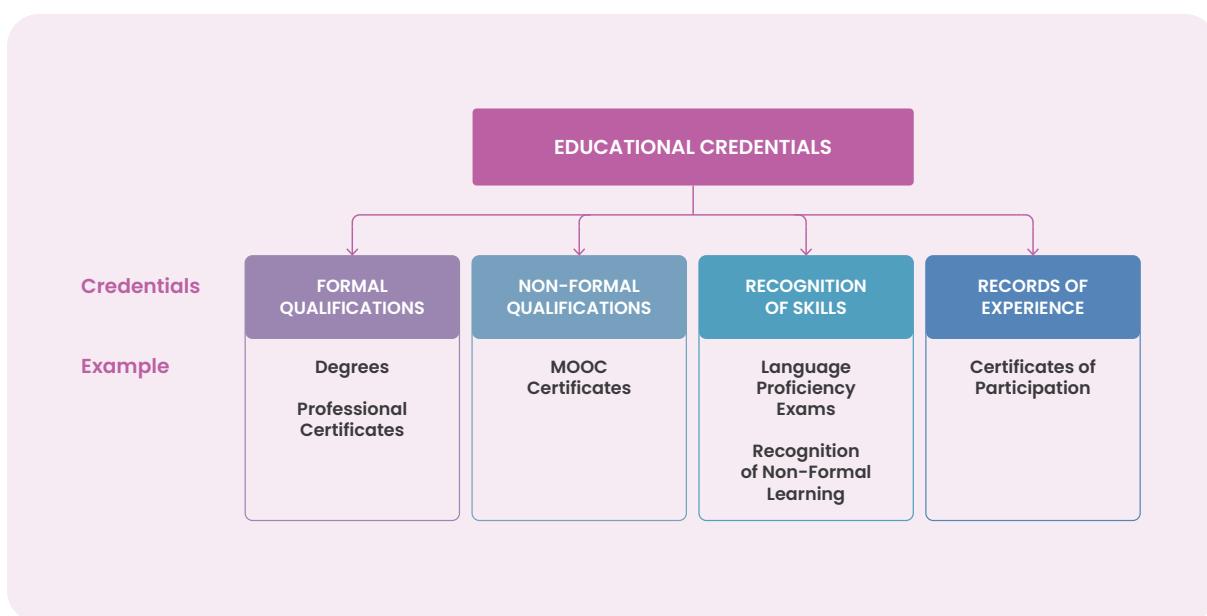


Figure 1: Types of educational credentials

(Modified from Camilleri and Rampelt, 2018)

Employability has emerged as an area of concern, a trend that is expected to persist for the foreseeable future. To counteract this, suitable credentialing is seen as a potential solution to address certain skill shortages (Calonge et al., 2019). Consequently, universities and governments worldwide are contemplating their strategies to handle the impact of artificial intelligence and the acceleration of automation in the future work landscape (World Economic Forum, 2018).

Micro-credentialing stands as a significant part of the solution to this challenge, and its importance is rapidly growing across many nations. As stated in a UNESCO report, the term 'micro-credential' is a blanket term that "covers various types of credentials, such as 'nano-degrees', 'micro-masters credentials',

'certificates', 'badges', 'licenses', and 'endorsements'" (UNESCO, 2018, p.10). The merging of emerging markets for micro-credentials and short courses (Gallagher, 2016), that facilitates the unbundling of traditional awards (Selvaratnam & Sankey, 2019), grants universities the opportunity to form partnerships connected to employment possibilities for graduates. Countries like Australia have government funding linked to employability outcomes (Department of Education, 2016). It has also been anticipated by governments worldwide that micro-credentials could offer adult learners the chance to stay relevant by enhancing and updating their skills for the workforce (Tehan, 2019; OECD, 2019; Pichette et al, 2021) and align learning outcomes more closely with occupational goals (Saray & Ponte, 2019). Several national systems already exist to support credential portability and validation (SkillsFuture, 2019; Valideringsdelegationen, 2019) and also between countries on a regional level (CEDEFOP, 2019). The right technological approach is crucial to ensure easy portability of credentials (Czerniewicz, 2019) and a meaningful way to understand what these credentials signify for stakeholders like employers (EDUCAUSE, 2018), primarily through proper verification (McArthur, 2018), whether by blockchain technology (Jirgensons & Kapenieks, 2018), or regional central repositories (eQuals, 2019). This work is

largely within the digital realm (Roosevelt Institute, 2016), including digital badging (Ifenthaler et al, 2016) and related forms of open badging (Liyanagunawardena et al, 2017; IMS Global Consortium, 2019).

Closely related to this is the role of massive open online courses (MOOCs) in this area, which has been well-documented historically (EdSurge, 2018) due to the widespread popularity of these courses over the last decade or more. Another evolving aspect is the precision in searching for credentials. To facilitate this, substantial investment is required in technology ecosystems (West & Lockley, 2016), which includes developing automation capabilities for both issuers and learners (Markowitz, 2018) to promote wider adoption. As a consequence, employers evaluating these credentials (Callaghan, 2019) require assurances of quality (Krupnick, 2019; Jagger, 2019; Leaser & Gallagher, 2017).

Methodology

The study adopted a mixed-method approach and convergent design to merge, compare and interpret the results, to triangulate the perspectives of the stakeholders Higher Learning Institutions (HLIs), Human Resource Development Corporation (HRD Corp), Talent Corporation Malaysia Berhad (TalentCorp), Malaysia Digital Economic Corporation Sdn. Bhd. (MDEC) and the workforce). Questionnaires, focus group discussions, interviews, reports, and literature reviews were based on the following dimensions: inquiry, reflection, integration, and outcome assessments.

Research Design

This study was carried out in three (3) stages using qualitative and quantitative approaches.

STAGE 1: Sourcing from the literature on the offerings of micro-credential courses locally, factors contributing to take-ups and demands in other countries and challenges faced.

The first stage, which is the document analysis stage and qualitative in nature, dealt with the identification of the micro-credential course offerings locally, factors contributing to take-ups and demands in other countries, as well as roles and challenges in facilitating capacity building ecosystem and employability in areas of C&M based on the existing body of knowledge in journals and books.

STAGE 2: Sourcing from the Focus Group Discussion (FGD) sessions on the offerings of micro-credential courses and challenges, as well as employability in the C&M industry at selected Malaysian universities, HRD Corp, TalentCorp, and MDEC.

This stage was also qualitative in nature and began with the Focus Group Discussion (FGD) sessions. The FGD was deemed necessary in order to have deeper engagement with a smaller number of participants. They were invited based on their expertise in micro-credential courses, roles they play in the C&M industry, experience in either planning or offering micro-credential courses and the positions they held in their respective organisations. The topic was told beforehand to them via emails so that they are eased into the subject matter with the researchers. The researchers guided the conversation

by asking open-ended questions and encouraged the participants to share their experiences, opinions and current practices. The goal was to generate rich and diverse insights into the topic, such as the need for a capacity-building ecosystem, as well as the importance and effectiveness of micro-credential courses to provide employees in C&M industry with updated knowledge and skills to complement and upgrade the employees' current qualifications. The members of the Focus Group Discussion sessions comprised of senior administrators from the focus sectors, which included the local universities and key Government stakeholders represented by HRD Corp, TalentCorp and MDEC. The researchers conducted in-depth interviews to get more insights from the stakeholders regarding

the topic of research. The FGD sessions were recorded on paper with the consent of the participants, but the identity of the participants is withheld due to requests for anonymity.

STAGE 3: Insights on Micro-credentials obtained from the local workforce

In the third stage, which is quantitative in nature, a questionnaire was generated based on previously conducted surveys (Survey on Micro-credential examples (2023), Employer and Employee Perceptions of Micro-Credentials (2023)) as well as refined factors and their measurements from the first and second stages. This survey instrument comprised closed-ended and open-ended questions.

Research Instrument

Table 1 outlines the means that were used to achieve the research objectives.

RESEARCH OBJECTIVES	INSTRUMENTS	DATA SOURCES
RO 1 To understand the role of micro-credential programmes in complementing the capacity-building ecosystem.	Literature Reviews	→ Published Reports
	Focus Group	→ HRDCorp Talent Corp MDEC
RO 2 To explore the available C&M-related micro-credential programmes offered by the local universities.	Observation	→ HLI Wellness
RO 3 To canvass the availability and factors contributing to take ups and demand for micro-credential programmes in other countries.	Literature Reviews (International context)	→ Published Reports Whitepapers
	Survey (Local context)	→ Working Adults
RO 4 To explore how micro-credentials could support employability in the C&M industry and forecast the potential number of working adults who would be interested in pursuing C&M-related micro-credentials.	Literature Reviews	→ Published Reports
	Focus Groups	→ HRDCorp Talent Corp MDEC
RO 5 To identify and recommend potential micro-credential programmes for the C&M industry.	Focus Group	→ HRDCorp Talent Corp MDEC
	Survey	→ Working Adults
RO 6 To understand the challenges faced by Malaysian Universities in developing and implementing micro-credential programmes.	Focus Groups	→ HLIs

Table 1: Means used to achieve the research objectives

For the survey addressing RO3 and RO5, the researchers employed purposeful sampling, selecting participants actively engaged in the workforce across various sectors (C&M, computing and non-C&M areas). The survey garnered responses from 1,464 employed adults (against the targeted 2,000).

All standard research method processes and practices were observed, including obtaining permission, using third-party individuals between the researcher and respondents to collect responses, seeking voluntary participation and ensuring research ethics are not compromised during the distribution and collection of the questionnaires.

Findings and Analysis

The role of micro-credential programmes in complementing the capacity-building ecosystem

Micro-credential programmes are poised to enhance employee engagement and foster a culture of lifelong learning, thereby supporting the organisations they are part of. Historically, education has been viewed as a single path, leading to long-term employment in a specific field or industry. However, rapid transformations due to innovation and technological advancement necessitate constant upskilling to tackle new challenges in the workplace. Micro-credentials offer an ideal solution for those aiming to enhance their skills as part of their lifelong learning journey. The advantages of micro-credentials include:

- Quick completion times to facilitate knowledge expansion or enhancement
- Flexibility, allowing a wider population to access them
- Alignment with industry and workforce requirements, ensuring relevance
- Compatibility with other forms of learning
- Ultimate result being a pool of skilled workers ready for new roles

When individuals can access micro-credentials that flexibly fit into their work, family, and other commitments, they are more likely to seize learning opportunities at various stages of their careers. Now is an opportune moment for Malaysian organisations to adopt micro-credential programmes and utilise them for employee skill development. As digital technologies have notably begun to play an even more critical role in the economy, it is increasingly clear that there is a real need to prepare talents – newly graduated or now in the workforce – for digital jobs. This urgency is accentuated by the advent of 5G technology, which is set to revolutionise various industries, consequently highlighting and potentially widening the existing skills gap. Preparing for this new landscape means upskilling in current digital roles and developing expertise in emerging fields directly impacted by 5G. Companies are investing heavily in digitising their processes and facilitating hybrid work. This transition necessitates upskilling, enabling employees to learn to use new software. This is particularly relevant as technologies

like 5G come to the forefront, requiring a new set of skills that many current employees may lack. By adopting micro-credentials, which is a more flexible and skills-focused approach, companies can better prepare their workforces for the challenges and opportunities presented by emerging technologies like 5G.

Micro-credential programmes can alleviate challenges across many industries, positively impacting their employability. A LinkedIn survey conducted in 2021 shows that 38% of the surveyed companies were more likely to hire skilled candidates over those with qualifications and experience. In this regard, in today's rapidly evolving technological landscape, employers should consider a paradigm shift from relying solely on traditional degrees to embracing micro-credentials as valid and valuable markers of skill. Viewing this approach as a long-term investment can address immediate skills gaps and create a culture of continuous learning within the organisation, also known as a 'learning organisation'. To successfully implement this shift, employers can take several facilitative steps. Firstly, they should make information about relevant micro-credentials easily accessible, possibly even partnering with higher learning institutions to offer these courses at discounted rates. Secondly, employers can provide "learning hours" within the regular workweek, allowing employees to engage in upskilling without feeling pressed for time. Lastly, by clearly illustrating how the acquisition of micro-credentials aligns with career advancement opportunities within the organisation, employers can provide incentives to motivate employees to embrace this new learning model.

Indeed, micro-credential programmes play a crucial role in reskilling and upskilling existing workers, equipping them with additional knowledge to improve their work efficiency, take on new tasks, or transition seamlessly into new jobs. Micro-credential courses serve as a key asset in human capital development, thereby enhancing workforce competencies and facilitate capacity-building (as depicted in Figure 2). Moreover, the flexibility while pursuing micro-credentials facilitates lifelong and life-wide learning, supporting continuous knowledge acquisition among employees.

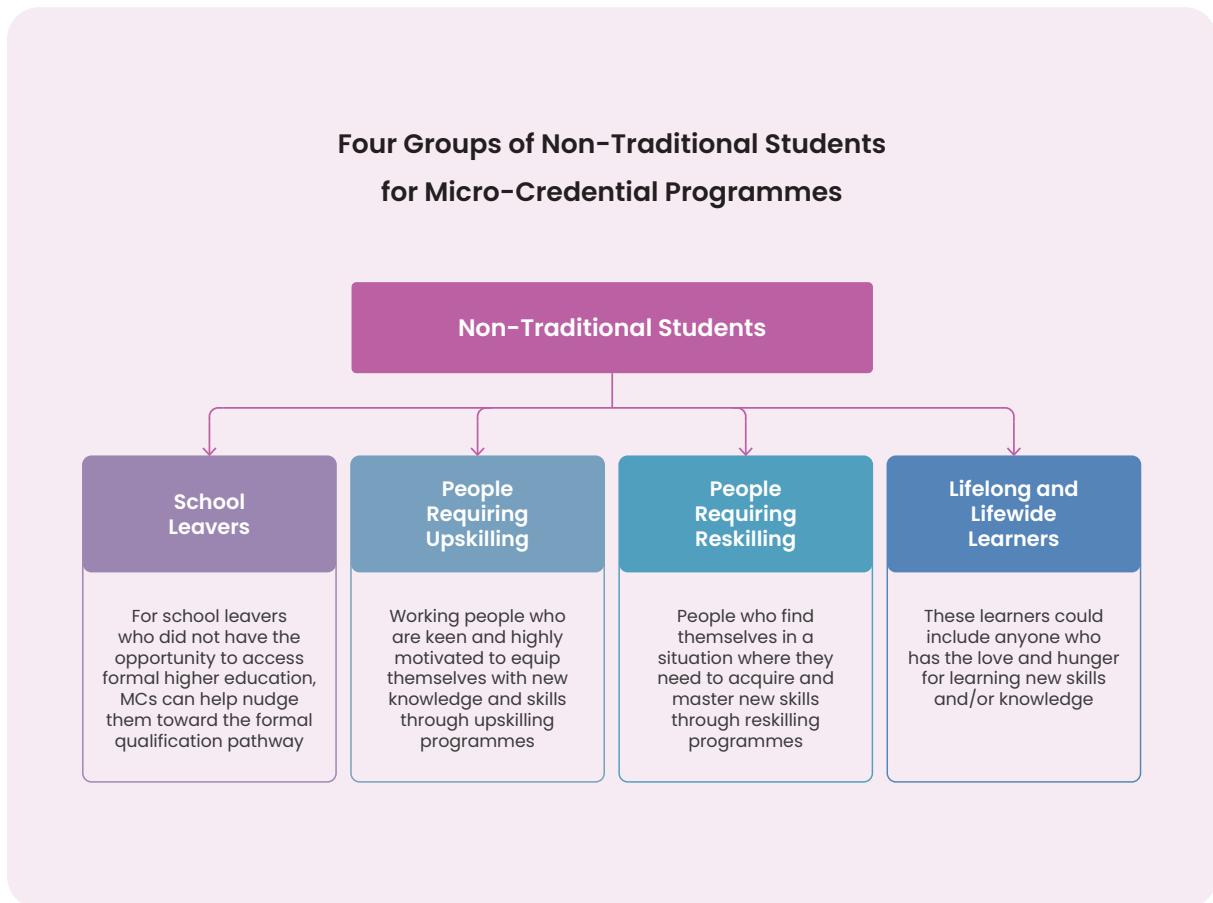


Figure 2: Micro-credential roles in supporting and complementing human capital development (Modified from Abd Karim, 2021)

Further, to gain a deeper understanding of micro-credentials' role in complementing the capacity-building ecosystem in Malaysia, the researchers approached three (3) key agencies: TalentCorp, HRDCorp and MDEC for their insights. TalentCorp, HRDCorp and MDEC place substantial emphasis on the transformative potential of micro-credential courses. TalentCorp highlights these programmes' aptitude for targeted, industry-specific skill development, facilitated through a time-efficient learning path compared to traditional education routes. HRDCorp, meanwhile, champions the progressive possibilities that micro-credentials herald for our nation's learning culture, facilitating formal education for professionals in stride with their career progression. MDEC also highlighted that bite-size learning might encompass the knowledge that an individual

gains, focus on skills that are relevant to their daily practices, pick up and move toward mastery, focus on discrete skills related to their practice, and collect the evidence to demonstrate ability in that specific skill.

Comparatively, micro-credential courses emerged as a preferred approach to capacity-building over traditional methods like workshops, seminars, and long-term courses. HRD Corp, TalentCorp and MDEC agreed that micro-credentials offer an amalgamation of focused, up-to-date, and hands-on learning, a blend hard to replicate through conventional methods. These entities acknowledged micro-credentials' role in complementing existing capacity-building ecosystems and catering to the modern C&M workforce's needs. HRD Corp, TalentCorp and MDEC highlighted the practical and relevant nature of these courses, their speed and adaptability proving essential to meet the IT industry's rapid evolution.

C&M-related micro-credential programmes offered by local universities

As the demand for skilled professionals in the C&M industry continues to grow, Malaysian universities have responded by offering a wide range of micro-credentials to help learners acquire the necessary skills and knowledge. Malaysian universities have recognised the importance of offering micro-credentials in various computing domains, including C&M, to keep up with the rapidly evolving industry. These courses provide learners with the opportunity to acquire in-demand skills quickly, making them valuable assets in the job market. These courses are targeted at both beginners and experienced professionals looking to expand their skills, as these micro-credentials can be an effective way to stay competitive and relevant in the field. The summary of the micro-credential courses offered by some selected local universities is given in Table 2.

COURSES / HLIs	UM	USM	UUM	UTM	UKM	UPM	UNIMAS	UTEM	UMPSA	UMS	UNITEN	TAYLOR'S	SUNWAY	APU
PROGRAMMING			✓				✓		✓		✓		✓	
SECURITY	✓			✓					✓			✓		
DATA ANALYTICS & AI					✓	✓	✓	✓	✓			✓		✓
MULTIMEDIA*		✓		✓		✓								
BUSINESS & ENTREPRENEURSHIP			✓											
COMMUNICATIONS & NETWORKS*											✓		✓	
WEB DEVELOPMENT	✓			✓		✓								
SOFTWARE DEVELOPMENT														
OTHER COMPUTING AREAS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓

*C&M based courses

LEGEND

ACRONYM	HLIs	ACRONYM	HLIs
UM	Universiti Malaya	UTEM	Universiti Teknikal Malaysia Melaka
USM	Universiti Sains Malaysia	UMPSA	Universiti Malaysia Pahang Al-Sultan Abdullah
UUM	Universiti Utara Malaysia	UMS	Universiti Malaysia Sabah
UTM	Universiti Teknologi Malaysia	UNITEN	Universiti Tenaga Nasional
UKM	Universiti Kebangsaan Malaysia	TAYLOR'S	Taylor's University
UPM	Universiti Putra Malaysia	SUNWAY	Sunway University
UNIMAS	Universiti Malaysia Sarawak	APU	Asia Pacific University

Table 2: Micro-credential courses in various areas, including C&M, as offered by selected local universities

The analysis of course offerings from Malaysian universities highlights the diversity of micro-credential programmes available to students. The emphasis on information security, programming, data analytics, and artificial intelligence reflects the growing importance of these fields. Additionally, universities recognise the need to integrate technology with other disciplines, such as business and design. This diverse range of courses equips students with the skills and knowledge required to meet industry demands and contribute to Malaysia's technological advancement.

Availability and factors contributing to take-ups and demand for micro-credential programmes

A global Coursera survey found that both employers and students appreciate micro-credentials that certify job-relevant skills and experiences. The survey, carried out by research firm Dynata, involved 3,600 students and employers in eight (8) countries. A vast majority of students (89 per cent) believed earning an entry-level professional certificate or micro-credential would enhance their appeal to employers and secure jobs post-graduation. Similarly, 92 per cent of employers agreed that a professional certificate strengthens a job application, and they were 76 per cent more likely to hire a candidate with an industry micro-credential. The survey's results were consistent in the US as well. 86 per cent of US students believed that earning an industry micro-credential would make them more attractive to employers, and 81 per cent said micro-credentials would help them excel at their job. Among US employers, 86 per cent agreed that a micro-credential strengthens a candidate's job application, and 74 per cent believed

micro-credentials enhance a candidate's performance in an entry-level role. In the OECD Survey of Adult Skills, which included participation from various OECD countries and economies, it was found that about 70 per cent of the participants aged between 25–65 years who were involved in non-formal education and training, engaged in programmes linked to their jobs. More precisely, approximately half took part with the intention to enhance their job performance or career prospects (refer to Figure 3).

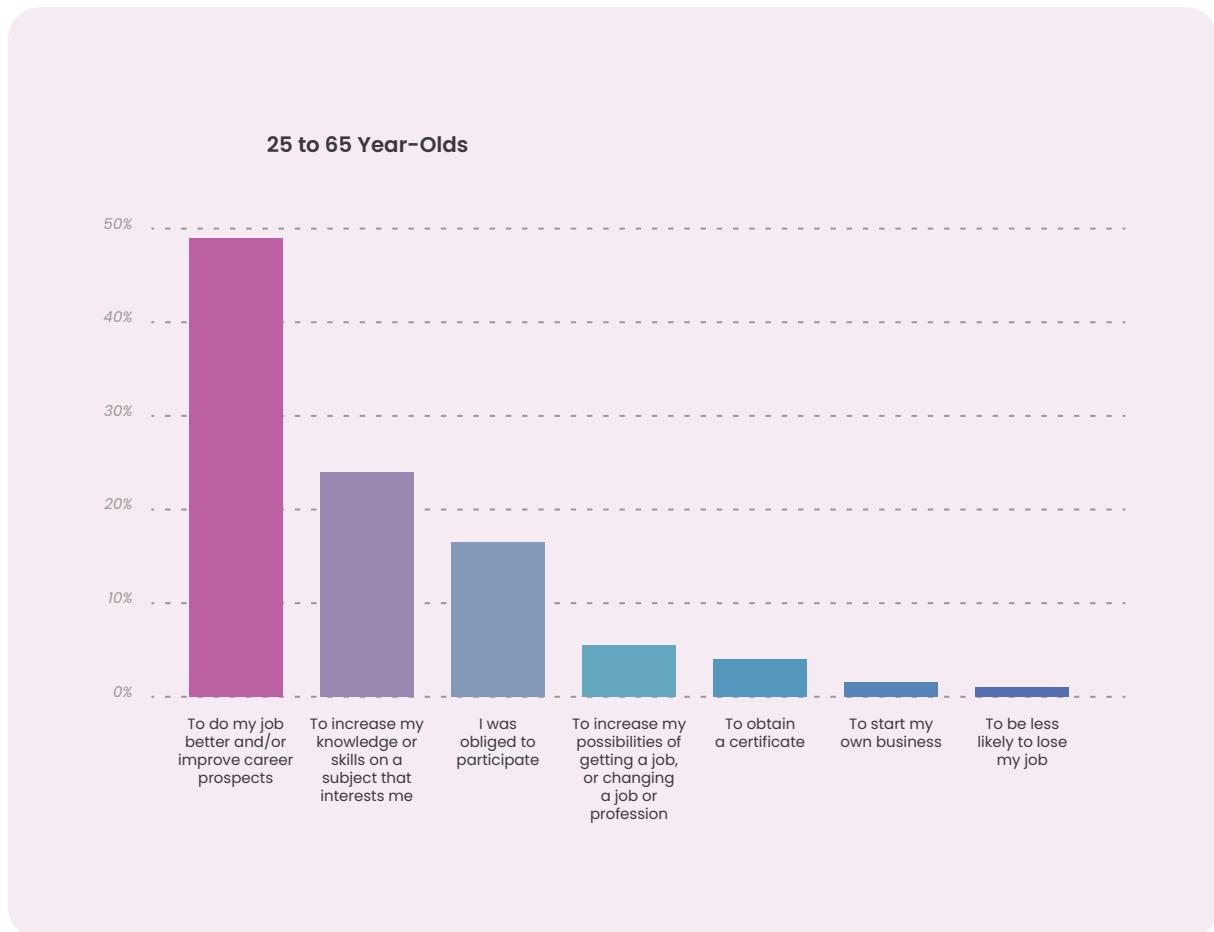


Figure 3: Reasons for participating in non-formal education and training in OECD countries and economies (2012, 2015 and 2018)

Source: OECD (2019), Survey of Adult Skills (PIAAC), www.oecd.org/skills/piaac/

In the course of this study, we conducted an online survey that garnered responses from 1,464 individuals currently employed in the workforce. It was found that the primary motivations for undertaking micro-credential courses revolved around career development, enhancement of knowledge or skills, and personal interest (Figure 4).

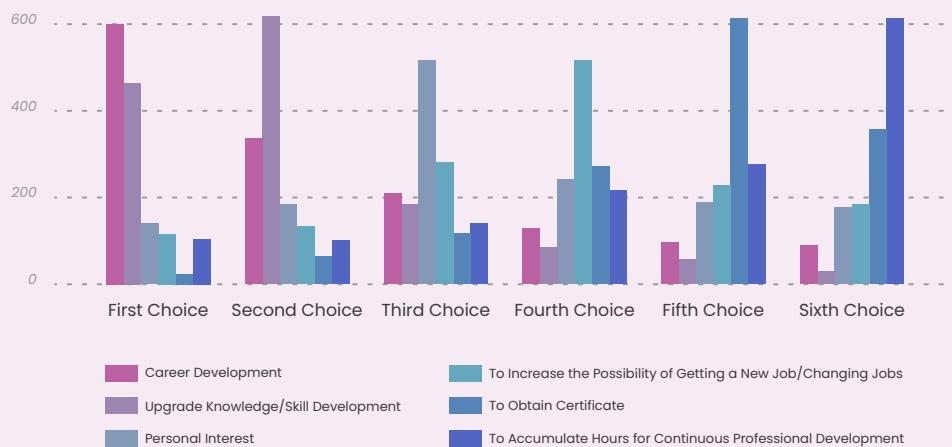


Figure 4: The primary motivations or factors that influenced respondents' decision to pursue a micro-credential course

(Likert Scale: 1 [strongly disagree] – 4 [strongly agree])

These motivations echoed global trends and demonstrated a clear alignment with the worldwide responses. Further insights from the survey of 1,464 respondents revealed that many of them consider micro-credential courses as a significant factor in enhancing their employability or career prospects (Figure 5).

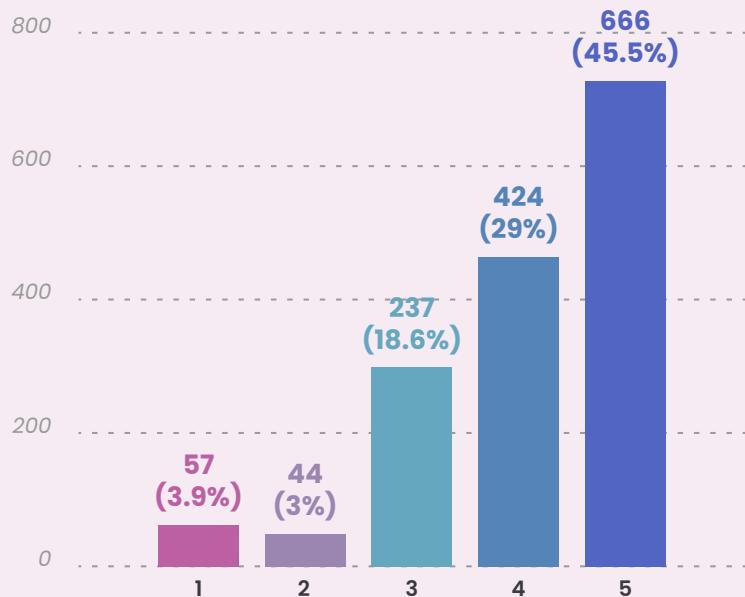


Figure 5: Respondents' feedback on whether micro-credential course can enhance their employability or career prospects

(Likert Scale: 1 [strongly disagree] – 5 [strongly agree])

The reputation and credibility of micro-credential courses and their providers stood out as pivotal considerations for these respondents when contemplating enrolment in such programmes (Figure 6).

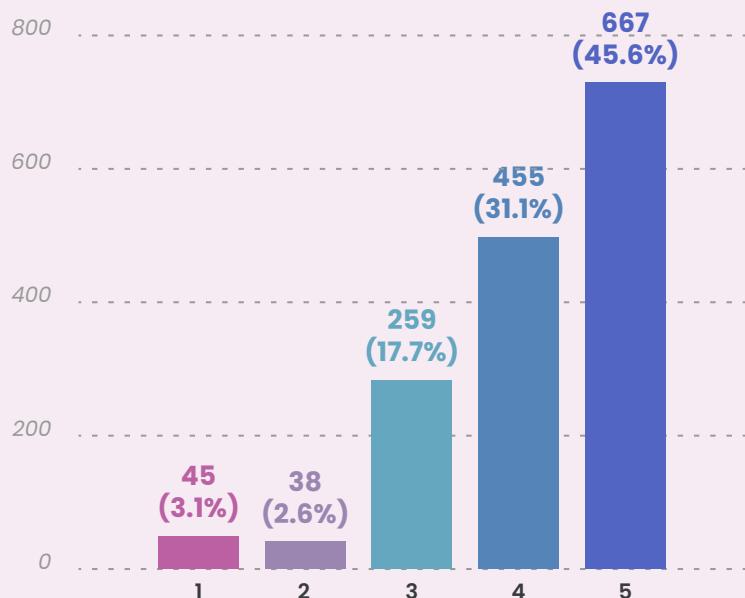
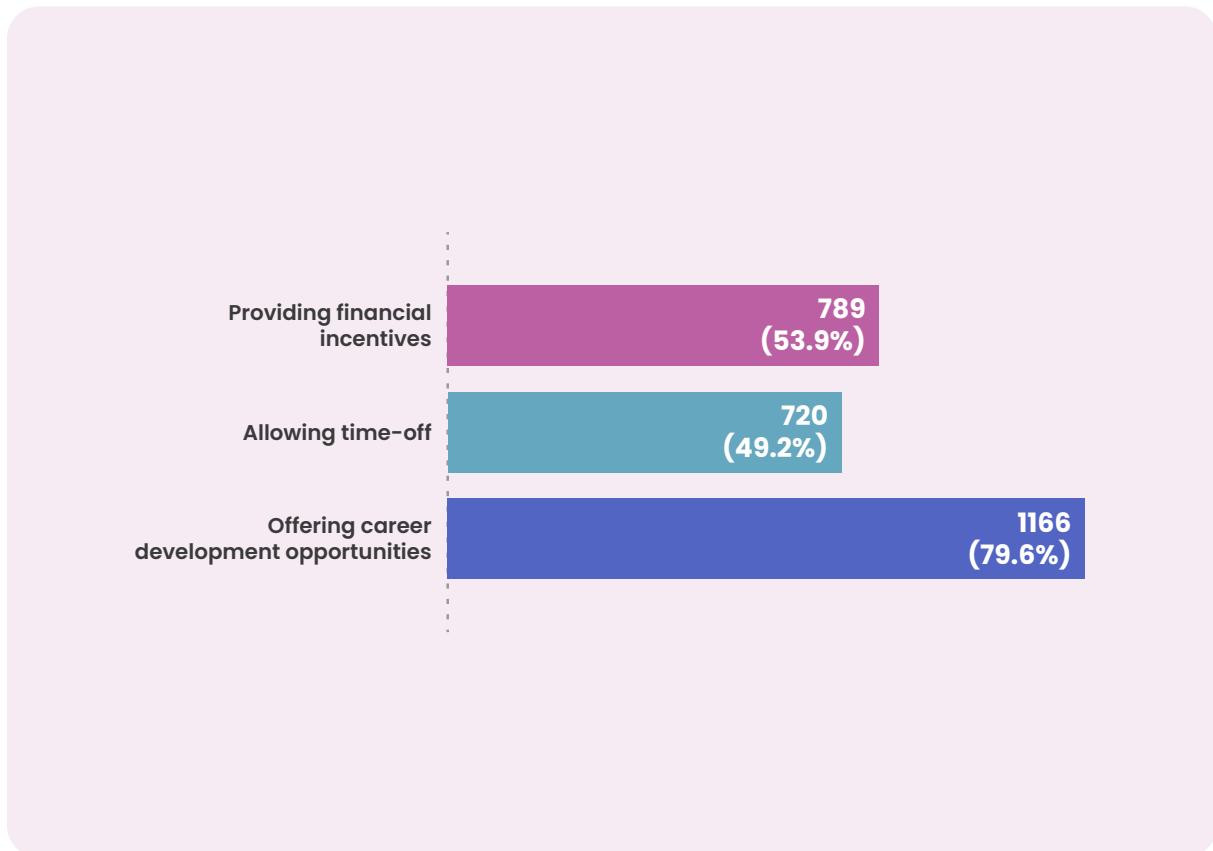


Figure 6: Respondents' feedback on whether the recognition and credibility of micro-credential courses and their providers are important for them when considering enrolling in such a course

(Likert Scale: [1 strongly disagree] – 5 [strongly agree])

Respondents pointed out the crucial role employers should play in facilitating the uptake of micro-credential courses among their workforce, as indicated in Figure 7. They outlined key employer responsibilities such as offering career development opportunities tied to micro-credentials, providing financial incentives for course completion, and allowing dedicated time off for pursuing these educational initiatives. Additionally, the survey participants stressed the importance of the accessibility of micro-credential courses in influencing their decision to enrol. They particularly emphasised the value of features like online learning, self-paced courses, and modular content, indicating that these factors make such courses highly suitable for working professionals balancing work commitments and continuous learning aspirations.



**Figure 7: Respondents' feedback on the role employers should play in supporting and promoting the uptake of micro-credential courses
(only the top three (3) responses are given)**

Thus, employee objectives for earning a micro-credential appear motivated predominantly by internal progression and the enhancement of skills and knowledge for their current role. Less emphasis was placed on micro-credentials as a means of furthering formal education or in seeking a new role. Furthermore, when asked what they might do with a micro-credential, only 31 per cent said they would look into using it as a pathway to a larger qualification. Similarly, employers saw micro-credentials to recognise and reward personal growth and progression among the workforce, rather than quantify existing skills or increase competitiveness. Connecting micro-credentials with strategic competence and continuing professional development was notable in its absence by employer respondents.

Micro-credentials and employability in the C&M industry

Micro-credentials are vital in supporting employment in the C&M sector by facilitating quick and relevant upskilling, serving as an employment asset, and expanding the C&M industry's ecosystem to create more job opportunities. However, it is crucial to continue exploring and understanding their potential and best practices for maximising their impact on employment in the C&M industry. Micro-credentials offer a compelling solution to support employment in the fast-evolving C&M sector. They allow for rapid upskilling, equipping employees with new skills necessitated by changes in business processes or automation. This enhances productivity and improves employee retention by keeping their skills relevant and up-to-date. According to the National Economic Blueprint, it is projected that approximately 500,000 new jobs¹ will be generated in the digital economy and ICT field, with a particular focus on the C&M areas. Furthermore, it is estimated that about 90 per cent of the employees in these new roles will require reskilling or upskilling². Considering this scenario, it is anticipated that around 450,000 individuals have the potential to enrol in C&M-based micro-credential courses. These micro-credential courses would provide them with the necessary skills and knowledge to meet the demands of the evolving job market and secure employment in the ICT sector. By offering micro-credential courses that address the industry's specific needs, it is expected that a significant portion of the workforce can acquire the relevant qualifications and contribute to the growing ICT job opportunities outlined in the National Economic Blueprint.

Potential micro-credential programmes for the C&M industry

Therefore, considering the insights from HRD Corp, TalentCorp and the current industry trends, the authors recommend that the development of micro-credential courses in Malaysia's C&M area should prioritise these identified skill sets as highlighted in Table 3.

¹ <https://hrmasia.com/malaysia-aims-to-create-500000-jobs-in-the-digital-economy-by-2025/>

² <https://www.humanresourcesonline.net/nine-in-10-malaysian-employees-surveyed-want-upskilling-opportunities-from-their-employers>

AREA	SPECIFIC SKILLS
Network & Communication	Network architecture and design, cellular networks, network security, wireless networking or cloud networking. They could also cover specific networking technologies and protocols, like TCP/IP, DNS, VPNs, or IoT networking.
Internet of Things (IoT)	5G & IOT, Smart Infrastructure
Cloud Computing	Edge Computing, Serverless Computing, Cloud Security, Tools
Applied Multimedia	Metaverse, Augmented Reality, Virtual Reality
Security	Cybersecurity, Information Security, Application Security, Network Security, Cloud Security, Data Privacy and Security

Table 3: Recommended areas for future micro-credential courses development for C&M area

Challenges faced by Malaysian universities in developing and implementing micro-credential programmes

This section examines the challenges faced by local universities in implementing micro-credential courses. Micro-credentials are specialised credentials that target specific skills and competencies, providing learners with focused education and recognition. The report in this section aims to identify the key challenges involved in offering micro-credential courses and their potential impact on Malaysian universities.

Emerging Trend of Micro-credential Courses

Micro-credentials, being a relatively recent innovation in the education sector, present both opportunities and challenges to universities and education providers. These institutions are currently navigating the process of pinpointing those fields where micro-credential programmes can deliver maximum value and meet pressing workplace needs. This endeavour proves particularly complex in the realm of C&M. C&M is inherently intricate as a discipline, and encapsulating its breadth and depth within a micro-credential framework is daunting. This field necessitates a profound understanding of theoretical underpinnings and practical competencies, which may prove challenging to effectively distil into the compact structure of a micro-credential course. Therefore, the development of micro-credential offerings in the C&M sector requires thoughtful design and strategic planning to ensure the complexity of the field is addressed while providing meaningful and industry-relevant learning outcomes.

Expertise

Developing and delivering micro-credential courses requires specialised expertise. Universities may face challenges finding faculty members with the necessary knowledge and skills to design and teach these focused courses. It can be a challenge to identify faculty academics who are well-versed in the specific domain and possess practical industry experience, ensuring the courses meet the required standards and are relevant to learners' needs.

Recognition

Micro-credentials are still emerging credentials and their recognition can vary across industries and regions. Local universities may encounter challenges in gaining widespread recognition for their micro-credential courses. This can affect the perceived value of these credentials by employers and other educational institutions, potentially limiting the opportunities available to micro-credential holders.

Assessment & Evaluation

Assessing and evaluating micro-credential courses presents unique challenges due to their focused nature. Universities need to design robust assessment methods that effectively measure learners' mastery of the targeted skills or competencies. Creating assessments that accurately reflect real-world applications and allow reliable evaluation can be demanding. Ensuring consistency, fairness, and reliability in the assessment process is crucial for maintaining the credibility of micro-credential courses.

Platform Issues

Implementing micro-credential courses for C&M often involves utilising digital platforms for content delivery, simulation, interaction, and assessment. Universities may face challenges related to learning management platform selection, technical capabilities, and infrastructure. Ensuring that the chosen platform supports the specific needs of micro-credential courses, such as secure authentication, seamless user experience, and reliable data management, can be complex. Technical issues, such as platform compatibility and accessibility, must be addressed to provide a smooth learning experience for learners.

Training for Faculty Members

Providing faculty members with adequate training and support for designing and delivering micro-credential courses is essential. Local universities may encounter challenges in equipping faculty with the necessary pedagogical strategies and technical skills to teach micro-credential courses effectively. Training programmes need to be designed to help faculty members understand the unique characteristics of micro-credentials, develop

competency-based assessments, and utilise innovative teaching methods that align with the goals of micro-credential education. Implementing micro-credential courses in local universities comes with challenges related to expertise, recognition, assessment and evaluation, platform issues, and training. Addressing these challenges requires identifying and developing faculty expertise, establishing widespread recognition for micro-credentials, designing effective assessment methods, selecting suitable platforms, and providing appropriate training to faculty members. Overcoming these challenges is crucial for the successful implementation of micro-credential courses, ensuring their quality, relevance, and recognition within the educational and professional landscape.

Discussion

The role of micro-credentials in complementing the Communication and Multimedia capacity-building ecosystem

This research study on micro-credential courses in the C&M industry provides important analysis and discussion regarding the role of these courses in supporting employability and addressing skill gaps. One (1) key finding is the crucial role that micro-credential courses play in complementing the capacity-building ecosystem within the C&M industry. These courses offer targeted skill development opportunities, allowing individuals to enhance their knowledge and competencies in specific areas that are relevant and in demand within the industry. This aligns with the growing emphasis on lifelong learning and the need for professionals to continuously upskill and adapt to evolving industry trends.

Malaysian HILs adopting a proactive approach to diversify Communication and Multimedia-related courses

The study also highlights the proactive approach taken by local universities in offering a diverse range of C&M-related micro-credential courses. This demonstrates their recognition of the importance of these courses in meeting the specific needs and demands of learners in the industry. The availability of such courses indicates a positive response from educational institutions to bridge the gap between academic knowledge and practical industry requirements.

Factors supporting take-up of micro-credential courses

Factors driving the demand for micro-credential courses in the C&M industry are another important aspect discussed in this study. The need for career development and the quest for practical knowledge and skills directly relevant to job requirements emerge as key drivers. This reflects the industry's dynamic nature, where professionals seek to enhance their employability and gain a competitive edge in the job market through targeted learning experiences. Moreover, the study explores international practices and identifies factors contributing to the take-up and demand for micro-credential courses. This global perspective provides valuable insights into best practices and allows benchmarking against international standards. Understanding the international landscape can help inform local universities and policymakers in shaping their strategies for developing and implementing effective micro-credential programmes. The significant interest expressed by working adults highlights the need for flexible and accessible learning opportunities that cater to their professional development needs. This finding suggests a positive outlook for the growth and adoption of micro-credential courses in the C&M industry, as it meets the demands of diverse learners.

Addressing challenges

Based on the research findings, the study identifies several recommended micro-credential courses for the C&M industry, such as communications and networks, programming, data science, and artificial intelligence. These courses align with emerging trends and address the skill gaps within the industry. The recommendation of these specific courses showcases the potential for micro-credentials to bridge the industry's needs with the desired competencies of

learners. However, the study also highlights challenges faced by Malaysian universities in developing and implementing micro-credential courses. These challenges include:

- acquiring the right expertise,
- ensuring recognition and accreditation,
- determining appropriate assessment methods,
- providing training for educators, and
- managing the micro-credential platforms effectively.

Addressing these challenges is crucial to ensure the successful implementation and long-term sustainability of micro-credential courses in the Malaysian higher education landscape. Overall, the analysis and discussion provided in the research study offer valuable insights into the role, demand, and challenges of micro-credential courses in the C&M industry. The study provides a comprehensive understanding of the current landscape and identifies areas for improvement and growth. The findings can guide Malaysian universities and policymakers in developing effective strategies and policies to harness the potential of micro-credential courses, ensuring their relevance and impact in supporting the professional development and employability of individuals in the Communication and Multimedia field.

Recommendations

To enhance the state of micro-credentialing within the C&M sector, we offer the following strategic recommendations drawn from the data and insights gathered during our research. We believe these tailored suggestions will offer valuable guidance in crafting effective strategies, ultimately leading to triumphant results in the dynamic field of micro-credentialing.

1. Collaboration between universities and industry:

Foster strong partnerships between local universities and C&M industry stakeholders. This collaboration will help ensure that micro-credential courses are aligned with industry needs and emerging trends, enhancing their relevance and value.

2. Faculty development and expertise:

Provide training and professional development opportunities for educators and faculty members to develop expertise in designing and delivering micro-credential courses. This will ensure that the courses are of high quality and effectively address the specific skill gaps in the C&M industry.

3. Recognition and accreditation:

Work towards establishing recognition and accreditation mechanisms for micro-credential courses. Collaboration with accreditation bodies, qualification agencies and industry associations can help establish credibility and increase the recognition of these courses locally and internationally.

4. Flexible assessment and evaluation:

Design flexible assessment and evaluation methods for micro-credential courses that align with the nature of the skills being developed. Explore alternative assessment approaches such as project-based assessments, portfolios, or real-world case studies to comprehensively evaluate learners' capabilities.

5. Marketing and awareness campaigns:

Launch targeted marketing and awareness campaigns to promote the benefits and value of micro-credential courses in the C&M industry. These campaigns should highlight the potential career advancement opportunities, industry demand, and the practical skills gained through micro-credentials.

6. Continuous industry engagement:

Establish mechanisms for ongoing industry engagement to ensure the courses remain up-to-date and relevant. Regular consultations with industry professionals, periodic reviews of course content, and incorporating industry feedback will help maintain the currency and effectiveness of micro-credential courses.

7. Dedicated support services:

Develop dedicated learner support services for individuals pursuing micro-credential courses, such as career counselling, mentorship programmes, and mutual networking opportunities. These services can enhance the overall learning experience and help individuals make informed decisions about their career paths in the C&M industry.

8. Funding and incentives:

Explore funding opportunities and incentives for individuals interested in pursuing micro-credential courses. Scholarships, grants, and financial aid programmes can encourage more individuals, especially working adults, to participate in these courses and enhance their employability. Additionally, the government might contemplate offering tax incentives to individuals who pursue and successfully complete micro-credential courses, thus encouraging further participation and investment in such skill-enhancing programmes.

9. Research and monitoring:

Encourage further research and monitoring of the effectiveness and impact of micro-credential courses in the C&M industry. Continuously assess the outcomes and employability of individuals who have completed these courses and use the findings to further refine and improve the programmes.

Implementing these recommendations will contribute to successfully developing and implementing micro-credential courses in the C&M industry. By addressing the challenges and leveraging the opportunities identified in this research study, universities and policymakers can effectively support the capacity-building ecosystem and enhance the employability of individuals in the C&M field.

Conclusion

In conclusion, capitalising on the promise of micro-credentials in the C&M sector necessitates concerted action across a variety of interconnected domains. Strong partnerships between local universities and industry stakeholders form the bedrock of successful micro-credential programmes. These alliances will ensure that course design aligns with real-world industry needs and emerging trends, enhancing these credentials' immediate relevance and long-term value. Equally important is the professional development of educators and faculty members. By equipping these key players with the necessary expertise to design and deliver high-quality micro-credential courses, we ensure that such programmes address the precise skill gaps prevalent in the C&M industry, enhancing their efficacy. Recognition and accreditation mechanisms for micro-credential courses are instrumental in establishing their credibility and fostering their wider acceptance. Collaborative efforts with accreditation bodies and industry associations can elevate the standing of these courses, both at the national and international levels, thus increasing their attractiveness to potential participants. Micro-credential courses must also integrate flexible, innovative assessment and evaluation methods that align with the nature of the skills being developed. This may involve using project-based assessments, portfolios, or real-world case studies to offer a well-rounded evaluation of learners' capabilities, making their learning outcomes more reflective of industry needs. Effective marketing and awareness campaigns are vital to promote the benefits and value of micro-credential courses in the C&M industry. These campaigns can highlight the career advancement opportunities and practical skills associated with micro-credentials, drawing attention to their potential to meet industry demands.

The dynamic nature of the C&M industry necessitates continuous engagement with industry professionals. Regularly updating course content based on industry feedback and periodic reviews can maintain

the relevance and effectiveness of micro-credential programmes. Further, dedicated learner support services, such as career counselling, mentorship programmes, and networking opportunities, can enhance the overall learning experience and guide individuals in their career paths within the C&M industry. Exploration of funding opportunities and incentives can facilitate greater participation in micro-credential courses. Scholarships, grants, and financial aid programmes can help to motivate individuals, particularly working adults, to enhance their skills and employability.

Finally, ongoing researches and monitoring of the effectiveness and impact of micro-credential courses in the C&M industry are essential. This data-driven approach will help in the continuous refinement of the courses to meet the shifting demands of the sector and ensure the courses are achieving their intended outcomes.

Through the strategic implementation of these recommendations, we can foster a thriving, adaptable micro-credentialing ecosystem. This ecosystem will not only respond to the current challenges but also anticipate future trends, thereby enhancing the employability of individuals in the ever-evolving C&M field and ensuring the industry's sustained growth and innovation.

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TOPIC 08

Factors Promoting and Hindering the Implementation of PUDO Services Related to Courier Services Deployed at PEDI Centres in Southern Sarawak

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Abstract

This study aimed to identify the factors contributing to and hindering the effective deployment of pick-up and drop-off (PUDO) services related to courier services in *Pusat Ekonomi Digital* (PEDi) in Sarawak by employing both quantitative and qualitative methods. An interview was conducted with PEDi managers who are currently operating PUDO services and service providers to gather information for the development of an index instrument that was used to identify suitable PEDi to deploy the PUDO service. Additionally, to determine factors contributing to and hindering the effective deployment of the service, a survey was conducted on the PUDO users from four (4) PUDO@ PEDis. The study found that factors contributing to the effective deployment of PUDO services included reliability, responsiveness, affordability, consumer assurance, empathy with the consumer, and trust in the service. Factors hindering the effective deployment of PUDO services identified from the study included a need

for more awareness and understanding among customers and the availability of several competitors in the community. In the interest of identifying suitable PEDi for courier service providers to deploy PUDO services, factors such as human resources, business space and storage availability and condition, internet and telecommunication network services, security factors, the concentration of digital entrepreneurs in the community, community size, competitors, and availability and numbers of local products were considered. Based on these findings, the study provides recommendations for courier service providers to deploy PUDO services at PEDi located in Sarawak effectively. In conclusion, this study provides valuable insights into the factors contributing to and hindering the effective deployment of PUDO services related to courier services in PEDi in Sarawak. Courier service providers can use the findings of the study to improve their PUDO services and deploy them effectively in Sarawak.

Introduction

The parcel point network, also known as PUDO (Pick-Up and Drop-Off) was created as one of the measures for attaining e-commerce industry sustainability. The service enables customers to pick up their packages whenever it is convenient for them, especially if they are unable to receive them at home. PUDO is a central delivery and collecting system and its utilisation is expected to increase the use of e-commerce and the need for courier services in both markets. Sarawak needs intervention to raise the national parcels per capita, particularly for rural areas, according to the total parcel volume for Quarter 1, 2022 (MCMC, 2022). The supply and accessibility of PUDO services at PEDi across Sarawak have been noted as a critical priority under this plan. The Malaysian Communications and Multimedia Commission (MCMC) has developed PEDi as a dynamic centre where it serves as an innovation-driven centre and is critical in developing digital entrepreneurship and empowering rural and suburban communities by providing access to ICT facilities and training.

PUDO services have gained popularity in the courier industry as a simple and efficient approach to meet the needs of consumers in both urban and rural

areas. Globally, it has become a key trend in the last mile logistic (Kawa, A., 2020). While PUDO services have been effective in urban regions, their deployment and uptake in rural and suburban areas, particularly in Sarawak, confront distinct hurdles. With its wide land area and dispersed population, Sarawak provides various obstacles for courier services regarding timely and efficient delivery. By investigating the factors that support and hinder the deployment of PUDO services in PEDi centres in Sarawak, this study attempts to identify solutions to Sarawak's last-mile delivery difficulties. Apart from that, while e-commerce has changed the way people shop, its benefits are sometimes limited to urban regions with well-established delivery networks. Residents in Sarawak's rural and suburban areas frequently face higher delivery charges with minimal alternatives, making acquiring the products and services available through e-commerce platforms difficult. This research intends to improve e-commerce accessibility for residents of Sarawak's rural and suburban areas by analysing the deployment of PUDO@PEDi services, thereby encouraging inclusive economic growth.

The digital divide between urban and rural

areas is a global concern. This study aims to bridge the urban-rural divide regarding access to e-commerce, logistics, and courier services by researching the installation of PUDO services in PEDi centres in rural and suburban areas of Sarawak. The study's findings can help close the gap by encouraging the use of PUDO@PEDi services and offering a platform for increased connection and economic prospects in rural and suburban regions. Some of these centres need to be more utilised, which limits their ability to serve as development catalysts. In rural and suburban areas, underutilised PEDis represent an untapped resource. By examining the potential of PUDO services in these locations, this study examines strategies to maximise their use and generate more value for the local community, with the motivation to transform these centres into lively hubs that provide a wide range of services, drawing more customers and building a sustainable ecosystem that benefits the entire community by incorporating courier services.

The outcomes of this study can be used to assist PUDO service providers and stakeholders in determining the most efficient methods for delivering PUDO@PEDi services to support the Sarawak Digital Economy project and in better understanding the needs and

preferences of customers in various geographic locations. Apart from that, the findings of this study can aid in the general improvement of courier services in Sarawak, hence resulting in a more effective and efficient distribution of goods and services, which would help the Sarawak Digital Economy thrive.

The objectives of this paper are to:

- i. Identify the factors contributing to the effective deployment of PUDO services at PEDi centres located in Sarawak by courier service providers.
- ii. Identify the factors hindering the effective deployment of PUDO services at PEDi centres located in Sarawak by courier service providers.
- iii. Identify and recommend suitable PEDi centres in Sarawak for courier service providers to deploy PUDO services.
- iv. Provide recommendations for the courier service providers to effectively deploy PUDO services at PEDi centres located in Sarawak.

Conceptual Understanding

a. Theoretical Framework

The framework of this study was mainly constructed based on the marketing theory created by E. Jerome McCarthy (1960), as cited in Kotler, P., and Keller, K. L. (2016). The framework offers a thorough approach to marketing by considering additional factors crucial for successful marketing strategies, which consider the 7Ps components: product, price, place, promotion, people, process, and physical evidence. The "Place" component of the 7Ps concept is particularly pertinent for determining prospective pick-up and drop-off places. The distribution and accessibility of goods or services to clients are the main topics of this component. In this situation, choosing appropriate pick-up and drop-off locations necessitates an awareness of the target market's geography, preferences, and convenience.

b. Factors Contributing To and Hindering the Effective Deployment of PUDO Services

Several factors support the adoption of PUDO services in PEDi for courier services. The main forces behind the introduction of PUDO services, according to Ainin et al. (2018), are the provision of a robust and dependable logistics network, better accessibility to internet centres, and

practical pick-up and drop-off possibilities, which will enhance courier services' overall effectiveness. Before implementing this service, the service provider needs to analyse the consumer's profile and match the implementation techniques with the consumer's customised demands, as customer demand and increasing e-commerce activities have also promoted the implementation of PUDO services in internet centres. According to Chen et al. (2018), location convenience, innovation, and people's expectations of the service positively impact their desire to utilise self-service parcel delivery services.

Additionally, customer perception of service quality impacts how effectively PUDO services are deployed (Carrillat et al., 2007; Gulc, 2021). The study also noted that evaluating company performance based on customer-perceived service quality, where perceived quality was defined as the degree to which the service delivered fits the customer expectation, frequently impacts competitive advantage. According to the relational model of courier service quality in the B2C e-commerce sector (Gulc, 2021), a study conducted in Poland highlighted the following factors that ensure the effectiveness and quality of courier services.

- i. Quick and efficient order processing.
- ii. On-time delivery.
- iii. Effective delivery.
- iv. Positive customer relationships and experiences.
- v. Courier company's responsiveness to reported issues.
- vi. Communication between courier company employees and clients.
- vii. Easy contact with the courier company.
- viii. Lack of damage to the shipment.
- ix. Choosing the form of sending or delivery.
- x. Cultured and courteous behaviour of courier company employees.
- xi. Flexibility in the choice or change of date and place of service.
- xii. Compliance and completeness of order.

Furthermore, the successful implementation of new services depends on customers' willingness to adopt them. According to Al-Azzam and Siam (2014), service quality significantly impacts customers' adoption of new services, affecting their perceived value. In a study by Baharom and Rahman (2017), service quality was found to significantly impact customer satisfaction. The study found that service quality greatly influences customers' perceived value, affecting their satisfaction with the new service. The customers' satisfaction with the new service positively influences their intention to adopt it (Baharom and Rahman, 2017). Apart from that, Abdullah et al. (2018) claim that the qualities of the service provider also influence client acceptance of new services. The study discovered that customers' adoption of new services is highly influenced by service providers' knowledge, reputation, and trustworthiness. The study also found that consumers' intentions to use new services are highly influenced by how much they trust service providers. Evidence and compatibility are identified to positively associate with the adoption of innovation (Wisdom et al., 2014). Hence the evidence of practice efficacy, compatibility with practice norms, and adaptability to suit needs are essential in introducing a new intervention to the community member. To explore this in the implementation of pick-up and drop-off service, it is necessary to gather information on views on the service quality and its effectiveness.

Moreover, the convenience of PUDO services has also been identified as a significant factor in promoting the implementation of PUDO services related to courier services. Customers can choose to pick up their parcels at a convenient location and time, thus saving time and effort

(Tan et al., 2020). PUDO services have been found to reduce delivery costs for courier companies (Omar et al., 2020). This cost reduction can result in a more competitive pricing strategy, increasing market share. According to Alsharif, Mokhlis, and Aziz (2020), PUDO services can also enhance the security of parcel delivery by reducing the risk of parcel theft and damage during transit.

Despite the benefits of PUDO services, several factors have been identified in the literature as hindering the implementation of PUDO services related to courier services deployed in Malaysia. Firstly, inadequate infrastructure has been found to inhibit PUDO implementation significantly (Tan et al., 2020). The lack of proper facilities, such as adequate parking spaces, signage, and safety measures at PUDO locations, can make it difficult for customers to access the service. Secondly, Omar et al. (2020) suggested that customer unawareness significantly hinders PUDO implementation. Many customers need to be made aware of the availability of PUDO services or how to use them. Lastly, the need for more standardisation in PUDO services across courier companies is also one of the hindrances to PUDO implementation (Alsharif et al., 2020). The lack of standardisation can create confusion among customers and reduce the efficiency of PUDO services.

c. Identifying the location for PUDO@PEDI centres

In identifying the location for the deployment of PUDO at PEDI centres in Sarawak, the contributing and hindering factors should be considered. Apart from that, according to France by Morganti, Banlanc, and Fortin (2014), the location of a PUDO point can be identified by taking into account the characterisation of pick-up points, such as the capacity to reduce delays in deliveries and providing competitive prices and make sure the service coverage was not only in urban areas but also in less dense areas such as suburban and rural areas with different delivery volumes.

From the perspective of the courier service operator, an effective pick-up and drop-off service can mitigate many issues related to traditional home delivery, such as missing delivery, complex routing planning, and traffic delivery (Zenezini et al., 2018). The location for pick-up and drop-off sites can be decided through a two-stage process; firstly, dividing the area into macro-zones based on administrative criteria, and secondly, conducting zoning based on catchment areas to estimate the potential flow of parcels (Morganti et al., 2014). Other than that, information on internet penetration should also be considered in identifying suitable locations (Morganti et al., 2014).

Methodology

This study combines qualitative and quantitative methods to examine the use of pick-up and drop-off (PUDO) points by consumers, store owners, and PEDI managers. The results of the qualitative study were then used to develop a questionnaire for PUDO@PEDI users. Both approaches were used to determine appropriate actions or strategies to implement the initiative.

Research Design

This research used a descriptive cross-sectional design with both qualitative and quantitative approaches to gain a comprehensive understanding of the topic under study and to provide a more informed recommendation for practice. Based on the responses and observations, an assessment was made using scoring rubrics and an index score was calculated.

The quantitative method is a user survey in which questionnaires were given to PUDO@PEDI users. In this case, the qualitative data from the interviews and observations were analysed thematically to identify patterns and themes. In contrast, the quantitative data from the survey were analysed statistically to identify correlations and associations between variables. Finally, the qualitative and quantitative data can be integrated to provide a more nuanced understanding of the research question.

The research process of this study began with identifying the research problem by reviewing the relevant literature on the factors that influence the effective use of PUDO@PEDI services, the challenges of using PUDO@PEDI services and identifying PUDO@PEDI sites. The literature review focused on two (2) types of information search, namely the theories and concepts used in previous studies and the findings and methodology used in the study. In developing the research design, the purpose of the study, the nature of the study, the unit and time frame of analysis, and the research design of previous studies analysed in the literature review phase are considered. Based on these considerations, a cross-sectional study was conducted using interviews, observations, and surveys to collect data from the selected individuals and the community.

Research Instrument

There were three (3) instruments used in this research, namely an interview questionnaire for the interview with PUDO@PEDI staff, a PUDO user survey which was divided into seven (7) sections, as outlined in Table 1, and a PEDI Suitability Index Instrument. The information gathered in the interview with the PUDO@PEDI staff was used to develop the PEDI Suitability Index instrument that assesses the suitability of PEDI to deploy PUDO service. The PUDO user survey instrument was adapted and modified from similar studies conducted in Malaysia and other countries. A few changes were made to the questionnaire items to ensure the suitability of its content with the situation in the local community and to answer the purposes of this study.

SECTION	CONSTRUCTS	NO OF ITEMS
1	Reliability	13
2	Responsiveness	4
3	Assurance	7
4	Empathy	3
5	Trust	7
6	Affordability	2
7	Adoption	2
8	Respondent Profile	9

Sources:

Malaysian Communications and Multimedia Commission (MCMC). (2019). Consumer Satisfaction Survey for Courier.

Yuanye D. (2021). Evaluating the Service Quality of Courier Companies: An Empirical Study from the Canadian E-commerce Customers' Perspective. HEC Montréal.

Ejdys, J., & Gulc, A. (2020). Trust in courier services and its antecedents as a determinant of perceived service quality and future intention to use courier service. Sustainability, 12(21), 9088.

Table 1: Sections in PUDO User Survey Instrument

Sampling

The sample for the user satisfaction survey was taken from the four (4) PUDO@PEDI communities using purposive sampling. As for the PUDO suitability study, all PEDIs from four (4) out of 12 Sarawak divisions which are Kuching, Samarahan, Sri Aman, and Betong, were approached. This research employed purposive sampling in identifying regions in Sarawak to be studied and the PUDO@ PEDI to be interviewed.

Data Collection

There were three (3) phases of data collection for this study. In the first phase, four (4) PUDO@PEDI managers and service providers were interviewed to gather information for PUDO Suitability Index Instrument development and gather preliminary information on the factors contributing to and hindering the effective deployment of PUDO service at PEDI. After that, a PUDO@PEDI suitability study was conducted on 58 PEDIs in Kuching, Samarahan, Sri Aman, and Betong to assess the suitability of PEDI to deploy PUDO service. Finally, in the last data collection phase, a PUDO user survey was conducted to explore users' satisfaction with the service and confirm the service adoption factors in Sarawak. This survey was participated by users from four (4) PUDO@PEDI in Sarawak.

Findings and Analysis

PUDO@PEDI User Survey: Factors contributing to the effective deployment of PUDO services at PEDI centres located in Sarawak by courier service providers.

The participants of the PUDO@PEDI user survey consist of eight (8) entrepreneurs (17.4 per cent) and 38 non-entrepreneur (82.6 per cent). In terms of age group distribution, 14 of the participants are aged below 26 years old (30.4 per cent), 17 of the participants are in an age group of 26 years old to 35 years old (37 per cent), and 15 of the participants are older than 35 years old (32.6 per cent).

A Pearson Correlation test was done to determine whether there are significant relationships between the attributes with the user's intention to continue using the service or to encourage others to use the service. The test results show statistically significant associations between all attributes of the service adoption. (See Table 2)

CONSTRUCTS	SERVICE ADOPTION		
	PERSON'S R	DF	P-VALUE
Reliability	0.840	45	< .001
Responsiveness	0.797	45	< .001
Assurance	0.651	45	< .001
Empathy	0.666	45	< .001
Trust	0.797	45	< .001
Affordability	0.828	45	< .001

Sources: Pearson Correlation test conducted in 2023

Table 2: Pearson correlation test results

The results show that all constructs significantly affect PUDO service adoption at PEDi centres with a highly positive correlation. Therefore, to ensure the effectiveness of PUDO@PEDi services, the service provider must provide these aspects to be optimised. The findings suggest that the following elements can help courier service providers operate pick-up-drop-off (PUDO) services at PEDi locations in Sarawak:

i. Service reliability

It is important to build consumer confidence in the PUDO service. Deliveries of goods must be made in a secure and safe manner, and courier service providers must guarantee the dependability of their PUDO services regarding pick-up and delivery schedules.

ii. Response time of the PUDO to user inquiries and service-related issues

The PUDO service provider is required to answer user inquiries and address service-related issues in a timely manner. They must have a dedicated customer care team that can respond quickly to any issues or complaints with reference to PUDO services.

iii. Consumer assurance

The PUDO service provider needs to provide assurance to their clients that their shipments are in capable hands. This is made feasible by tracking tools and delivery confirmation alerts. Additionally, the PUDO service provider must guarantee that the products are delivered to the intended recipient, on time, and at the proper location.

iv. Empathy for the customer

The PUDO service provider should be considerate of the customer's requirements and preferences. They should consider the convenience and preferences of the consumer when offering pick-up and delivery services. The PUDO service provider may, for instance, offer consumers a flexible delivery window or allow them to choose a delivery time that fits within their schedule.

v. Confidence in the service

The PUDO service provider should be reliable, have a strong reputation, and excellent client reviews. In order to cover missing or damaged packages during delivery, the PUDO service provider may also consider offering a warranty or insurance.

vi. Service accessibility

The PUDO service provider must offer an accessible service to attract clients by ensuring that the service is worthwhile and that the charges are fair. The PUDO service provider may consider providing discounts or promotions to entice new customers or retain existing ones.

PUDO@PEDI interview: Factors hindering the effective deployment of PUDO services at PEDI centres located in Sarawak by courier service providers.

Numerous obstacles may arise in the successful implementation of PUDO services by courier service providers at PEDI centres in Sarawak. Based on the PUDO@PEDI Manager's interview, comments from the courier service providers and literature reviews, the difficulties include:

i. Lack of community awareness and comprehension of the service

The community's lack of knowledge and comprehension of the service is one of the primary obstacles that could obstruct the proper deployment of PUDO services. People are less likely to use a service if they are unaware of its existence or do not comprehend how it operates. To promote the PUDO services and inform the community about how it functions, courier service providers must therefore make a significant financial investment in marketing and educational initiatives.

ii. Lack of digital entrepreneurship

The efficient implementation of PUDO services may be hampered by a lack of digital entrepreneurship in the local area. Digital entrepreneurship refers to the process of developing, launching, and expanding new businesses or services using digital technologies. The adoption of PUDO services could be delayed, and the service might not be able to live up

to its full potential without a robust digital entrepreneurial culture.

iii. Competitors in the neighbourhood

The availability of competitors in the neighbourhood may affect how well PUDO services work. It could be challenging for a new service provider to achieve market share if there are already well-established courier service companies in the area. In this situation, the new provider may need to offer a distinctive value proposition in order to stand out from the competition.

iv. Limited service that does not meet community needs

The effectiveness of PUDO services may be hampered if they are too narrow in scope or do not meet community needs. Providers of courier services must be aware of the community's unique demands in order to customise their PUDO offerings.

v. Staff motivation (workload, work procedure, incentive)

The efficacy of the service also depends on the motivation of the staff working at PUDO centres. Staff members' motivation may be impacted by an excessive workload or difficult work procedures, which will ultimately impair the level of service they deliver. Therefore, courier service providers must offer sufficient training, assistance, and rewards to maintain employee motivation.

vi. Equipment and facilities

The effective deployment of PUDO services depends on the availability of suitable facilities and equipment. The level of service offered to consumers may suffer if the PUDO centre is under equipped or does not have appropriate amenities. In order to offer consumers high-quality services, courier service providers must make sure that their PUDO facilities are maintained and furnished with the appropriate tools.

vii. Delivery area

Sarawak is distinguished by its dispersed areas and difficult road conditions, which pose substantial challenges to the effective and timely transportation of goods. Due to the region's dispersed character, there are large distances to cross between different areas, making it difficult for courier services to reach every corner of Sarawak. Furthermore, adverse

road conditions, such as rugged terrain, small routes, and insufficient infrastructure, impede the smooth flow of parcel delivery. These factors contribute to courier service delays and constraints in Sarawak. Due to these geographical limitations, delivery firms may struggle to provide complete coverage and timely deliveries across the entire region. As a result, consumers in remote or inaccessible places may have constraints in the availability and speed of courier services.

PUDO@PEDI Suitability Index: Suitable PEDI centres in Sarawak for courier service providers to deploy PUDO services.

Based on the findings from the interview and literature review, the study found out that for a PEDI centre to operate a PUDO service, the factors that should be taken into consideration are; adequacy of human resources, business space availability and condition, storage availability and condition, security system, occurrences of vandalism, marketing approaches, number of PEDI users, number of residents in the community, number of entrepreneurs and digital entrepreneurs, availability of

other courier services or PUDO points in the community, the distance of the nearest courier service, internet service, telecommunication network, availability of local products, accessibility to the PEDI location, and staff's willingness to operate PUDO.

Besides that, factors listed, product, place, promotion, and people are among the components of effective marketing strategies, according to Kotler, P., and Keller, K. L. (2016). Choosing appropriate locations requires considering elements like customer convenience, closeness to target customers, accessibility, and

the reach of the distribution network. The objective is to choose locations that maximise operational effectiveness for the service provider while making it simple for customers to get to them. Hence, considering these factors, the suitable PUDO@PEDI location can be identified objectively based on the evaluation.

An index instrument was developed to generate the PUDO@PEDI Suitability index score that determines the readiness of the PEDI to deploy PUDO services. The results are presented by the PUDO suitability index and construct acceptability index described in Table 3 and Table 4.

PSI CATEGORY	COLOUR INDICATOR
Highly Recommended	Green
Recommended	Cyan
Less Recommended	Yellow
Inadvisable	Red

Table 3: PUDO Suitability Index (PSI) Indicator

CAI CATEGORY	COLOUR INDICATOR
Excellent	Green
Good	Cyan
Fair	Yellow
Poor	Red

Table 4: Construct Acceptability Index (CAI)* Indicator

*Construct Acceptability Index consists of Business Space (BS), Security (S), Prospective Users (PU), Competition (C), Facilities (F), Local Product (LP), Accessibility(A), Readiness (R).

PEDis are classified into four (4) categories (Highly Recommended, Recommended, Less Recommended, and Inadvisable) based on their suitability for PUDO services deployment. This suitability is measured by considering eight (8) enabling/hindering factors: Business Space (BS), Security (S), Prospective Users (PU), Competition (C), Facilities (F), Local Product (LP), Accessibility (A), and Readiness (R). Results are presented in the following tables.

NO	PEDI NAME	PSI	BS	S	PU	C	F	LP	A	R
1	Kampung Gedong	85.33	77	93	83	80	80	90	80	100
2	Kampung Hilir Maludam	81.73	73	100	73	100	68	80	70	100

Table 5: Highly Recommended PEDI to deploy PUDO service

NO	PEDI NAME	PSI	BS	S	PU	C	F	LP	A	R
1	Kpg Darul Belimbing Islam	74.86	80	87	90	40	58	100	77	67
2	Sibuluh	73.25	73	87	73	40	80	80	70	93
3	Kampung Tanah Hitam, Sematan	72.68	73	87	73	73	73	63	80	77
4	Kampung Niup Pekan Samarahan	71.15	73	77	80	40	80	70	77	80
5	Tebedu	70.46	80	87	73	30	70	78	73	93

Table 6: Recommended PEDI to deploy PUDO service

NO	PEDI NAME	PSI	BS	S	PU	C	F	LP	A	R
1	Kg Pandan	69.9	80	87	60	63	63	70	80	83
2	Kg Sampadi	68.82	53	87	60	60	73	75	80	70
3	Kg Biawak	68.24	67	87	80	23	83	68	73	80
4	Skio	68.15	77	87	63	57	73	73	60	73
5	Lubok Antu	67.87	57	80	67	50	75	75	67	73
6	Kg Peninjau Baru	67.54	90	93	57	30	60	80	80	90
7	Bogag	67.33	87	87	67	60	33	80	80	73
8	Kg Tgh Tebelu	67.27	63	80	67	50	63	65	80	87
9	Quop	67.22	70	87	60	80	80	55	53	70
10	Krokong	66.7	87	93	70	53	65	68	67	60
11	Kg Braang Bayur	66.63	80	87	63	70	50	60	70	83
12	Kampung Lebor	65.84	73	80	57	80	63	45	73	87
13	Serasot	65.79	80	87	73	57	40	65	80	73
14	Lundu	65.64	87	87	77	13	75	68	80	70
15	Batu Lintang	65.53	80	100	50	97	43	48	70	87
16	Kampung Pinang	65.12	47	87	83	20	88	68	80	50
17	Pekan Asajaya	64.97	80	80	47	10	88	90	80	67
18	Bengoh	64.58	73	87	27	80	73	68	80	63
19	Kampung Kalok	64.28	63	73	63	27	88	63	73	77
20	Tebakang	63.78	53	87	67	40	88	65	80	40
21	Kampung Tanjung Bundung	63.42	80	73	83	20	43	70	73	83
22	Kampung Tangga Plaman	62.88	90	87	53	10	88	75	80	57
23	Batang Maro	62.83	70	80	53	90	50	53	40	87
24	RPR Taman Sri Wangi	62.4	73	87	63	20	63	78	80	60
25	Sungai Bandung	61.1	83	80	73	10	28	83	80	80
26	Melugu	61.06	63	87	47	67	73	43	80	67
27	PPR Taman Dahlia	60.48	77	80	50	10	80	70	90	60

Table 7: Less Recommended PEDI to deploy PUDO service

NO	PEDI NAME	PSI	BS	S	PU	C	F	LP	A	R
1	Spaoh	59.66	53	93	70	23	70	50	80	67
2	Sadong Jaya	59.22	80	73	70	10	68	70	80	43
3	Kg Ta'ee	59.00	80	80	57	37	43	48	83	93
4	Lingga	58.95	73	70	17	77	58	60	80	73
5	Kabong	58.88	53	93	43	43	73	50	83	70
6	Taman Sepakat Jaya	58.81	80	87	67	57	78	10	80	70
7	PPR Batu Gong	58.21	73	77	47	37	80	35	83	80
8	Pekan Roban	58.11	80	93	47	7	85	53	70	83
9	Telaga Air	57.87	80	77	43	83	68	48	80	17
10	Kampung Sri Tajo	57.72	60	80	60	40	35	70	80	57
11	Tg Bowang	57.10	80	87	27	80	68	30	80	67
12	Kampung Bungey	56.24	50	93	70	27	63	40	70	70
13	Kampung Baru Hilir Sri Aman	55.45	50	80	70	23	43	53	70	77
14	Kampung Pangkat Stumbin	55.31	80	80	53	57	55	40	50	67
15	Engkilili	54.23	80	80	63	10	50	45	77	77
16	PPR Taman Malihah	54.21	57	87	47	47	65	35	83	57
17	Kg Pasir Pandak	53.70	80	50	67	53	63	10	80	63
18	Bako	53.29	80	87	60	63	50	10	80	60
19	Kampung Pichin	50.56	53	87	40	10	50	53	80	77
20	Kampung Sungai Mata	48.90	67	70	57	20	35	40	77	67
21	Kg Stungkor Baru	45.62	80	60	27	23	55	38	73	60
22	Balai Ringin	43.93	67	80	20	80	58	0	73	43
23	Pejabat Daerah Lama Simunjan	43.72	47	37	23	10	88	20	80	73
24	Sebandi Ulu	42.91	40	80	47	10	45	43	80	33

Table 8: Inadvisable PEDi to deploy PUDO service

Based on the initial results, seven (7) PEDis are recommended to deploy the service with an overall PUDO suitability index score above 70.

Based on the scores, an assessment was conducted on three (3) critical criteria which are local product, competition, and prospective users for PEDis that fall under the 'less recommended PEDI' group to determine if there are more centres suitable for the deployment of the PUDO service. The cut-off value for the Critical Criteria is based on the 50th percentile. Values more than 59 are considered "Above Average". The results show that 12 out of 27 PEDis can be considered for the deployment of the service, as follows:

NO	PEDI NAME	CCS	LP	C	PU	RECOMMENDATION
1	Bogag	70	80	60	67	Recommended
2	Kg Sampadi	66	75	60	60	Recommended
3	Kg Pandan	65	70	63	60	Recommended
4	Skio	65	73	57	63	Recommended
5	Lubok Antu	65	75	50	67	Recommended
6	Serasot	65	65	57	73	Recommended
7	Quop	64	55	80	60	Recommended
8	Krokong	64	68	53	70	Recommended
9	Kg Braang Bayur	64	60	70	63	Recommended
10	Batang Maro	64	53	90	53	Recommended
11	Batu Lintang	63	48	97	50	Recommended
12	Kg Tgh Tebelu	61	65	50	67	Recommended
13	Kampung Lebor	59	45	80	57	Improvement needed
14	Bengoh	59	68	80	27	Improvement needed
15	Kampung Tanjung Bundung	59	70	20	83	Improvement needed
16	Kg Biawak	58	68	23	80	Improvement needed
17	Kg Peninjau Baru	58	80	30	57	Improvement needed

Table 9: Recommended PEDI based on critical criteria score

*CCS: Critical Criteria Score; LP: Local Product; C: Competition; PU: Prospective User

NO	PEDI NAME	CCS	LP	C	PU	RECOMMENDATION
18	Kampung Pinang	58	68	20	83	Improvement needed
19	Tebakang	58	65	40	67	Improvement needed
20	Sungai Bandung	58	83	10	73	Improvement needed
21	RPR Taman Sri Wangi	56	78	20	63	Improvement needed
22	Lundu	54	68	13	77	Improvement needed
23	Pekan Asajaya	53	90	10	47	Improvement needed
24	Kampung Kalok	52	63	27	63	Improvement needed
25	Melugu	51	43	67	47	Improvement needed
26	Kampung Tangga Plaman	49	75	10	53	Improvement needed
27	PPR Taman Dahlia	46	70	10	50	Improvement needed

Table 9: Recommended PEDI based on critical criteria score (cont.)

*CCS: Critical Criteria Score; LP: Local Product; C: Competition; PU: Prospective User

Therefore, the final recommendation list (in descending recommendation order) is as follows;

- | | |
|---------------------------------|---|
| 1. Kampung Gedong | 17. Batang Maro |
| 2. Kampung Hilir Maludam | 18. Batu Lintang |
| 3. Kpg Darul Belimbing Islam | 19. Kg Tgh Tebelu |
| 4. Sibuluh | |
| 5. Kampung Tanah Hitam, Sematan | |
| 6. Kampung Niup Pekan Samaraham | In summary, the index instrument has indicated that 19/58 (32.8 per cent) PEDis are ready for the immediate deployment of PUDO service, 15/58 (25.9 per cent) PEDis will need some improvement before deploying the service, and 24/58 (41.4 per cent) PEDis are not ready to deploy the service at the moment, mainly due to no or lack of local product, lack of prospective users and the availability of another courier service nearby the centre. |
| 7. Tebedu | |
| 8. Bogag | |
| 9. Kg Sampadi | |
| 10. Kg Pandan | |
| 11. Skio | |
| 12. Lubok Antu | |
| 13. Serasot | |
| 14. Quop | |
| 15. Krokong | |
| 16. Kg Braang Bayur | |

Recommendations for the courier service providers to effectively deploy PUDO services at PEDi centres located in Sarawak.

The findings of the study led to several recommended strategies for the courier service providers to effectively deploy PUDO services at PEDi centres, which include operational efficiency, customer acquisition, and staff development and motivation, as summarised in Table 10.

NO	CATEGORY	STRATEGY	PRIORITY
1	Operational Efficiency	i. Establish standardised standard operating procedures (SOP) and policies for the courier services deployed in PUDO.	High
		ii. Ensure that the PUDO system and equipment are up-to-date and functioning properly.	High
		iii. Enable remote system maintenance to ensure immediate action can be taken in case of any issues and engage with users to obtain feedback and improve the system accordingly.	Medium
		iv. Invest in a fleet of vehicles that are suitable for navigating difficult road conditions.	Low
		v. Establish strategically located hubs	Low
		vi. Optimise delivery schedules	Low
		vii. Resource sharing between courier services.	Medium
		viii. Integrate the PUDO system so that there is no need for separate systems for different courier services and tracking.	Low
2	Customer Acquisition	i. Expand the range of services provided to include both inbound and outbound deliveries.	High
		ii. Increase awareness of the services provided among community members.	High
		iii. Deploy PUDO services in communities with a high potential for digital entrepreneurs.	Medium
		iv. Offer attractive promotions to customers and establish collaborations with local businesses and stakeholders to expand the customer base.	Medium
		v. Develop a robust marketing strategy	Medium
3	Staff Development & Motivation	i. Enhancing Staff Competency for the Digital Age	High
		ii. Provide a more competitive reward system for the staff.	High
		iii. Review staff workload and consider redistributing it.	Low

Table 10: Strategies for effective deployment of PUDO service at PEDi centres located in Sarawak

Conclusion and Implications of the Study

The effective deployment of PUDO services at PEDi centres in Sarawak is highly affected by the reliability of the services, responsiveness of the PUDO on user inquiries and issues related to the service, the assurance given to the consumer, empathy to the consumer, user trust on the service, and the affordability of the service. This study confirmed the previous findings on the effect of service quality on the effective deployment of courier service (Abdullah et al., 2018; Carrillat et al., 2007; Gulc, 2021). It also supported the study by Baharom and Rahman (2017), who found that service quality has a significant impact on customer satisfaction, hence increasing the intention of the user to continue using the service or encourage others to use the service.

The successful implementation of PUDO services by courier service providers at PEDi centres in Sarawak may encounter several challenges, which include a lack of community awareness and comprehension of the service, lack of digital entrepreneurship, competitors, the limited scope of PUDO services, staff demotivation, and equipment and facilities. The findings are supported

by the previous study that found that inadequate infrastructure (Tan et al., 2020) and customer unawareness about the service Omar et al. (2020) are significant hindrances to PUDO implementation.

This study suggested that product, place, price, people, potential flow of parcels, and internet penetration are crucial in identifying the location of PUDO points. Besides that, the information gathered in the interview with relevant stakeholders, such as PUDO@PEDi managers and courier service providers, was also considered. A discussion with a panel consisting of experts in the relevant field concluded that by order of importance, local product, competition and prospective users are the critical factors, and readiness, facilities, business space, accessibility, and security are the other aspects to be considered in the evaluation. The deliberation by the expert panel ensures that the results generated from the PUDO@PEDi suitability index are valid and concise. The application of this index has identified 19 PEDis in Sarawak's southern region with a score of PUDO@PEDi suitability index above 70 per cent suggested to be ready to deploy PUDO services.

Based on the findings, the study suggests several recommendations for optimising the identified factors, resulting in an efficiently deployed PUDO service at PEDi facilities in Sarawak. The recommendations are divided into three (3) categories: operational efficiency, client acquisition, and employee development and motivation. To improve operational efficiency, the service provider should develop standardised standard operating procedures (SOP) and policies for the courier services offered by PUDO. This will boost customer satisfaction by ensuring consistency in service delivery and reducing errors and delays. Furthermore, introducing resource sharing across courier services can effectively reduce costs, increase productivity, and widen service areas. For example, sharing workers, warehouse space, and cars can improve the sector's overall efficiency and competitiveness. The service provider should also ensure that the PUDO system and equipment are up-to-date and functioning properly. Regular maintenance and remote system monitoring can help avoid service interruptions, increase customer loyalty, and enable quick response in the event of an issue. Aside from that, the integration of the PUDO system can give clients a consistent experience. A centralised platform that provides tracking information and delivery status for numerous courier services can

help to streamline operations, increase effectiveness, and improve customer happiness.

In terms of client acquisition, the service provider should deploy PUDO services in communities with a high potential for digital entrepreneurs and internet penetration. This will cater to digital entrepreneurs' needs and improve last-mile delivery's effectiveness. Besides that, broadening the scope of services offered to include both inbound and outgoing deliveries is also one of the significant considerations to be taken by the service provider. This flexibility attracts more customers and expands revenue streams for PUDO providers. The service provider can also offer enticing promotions to customers and collaborate with nearby businesses to expand the customer base. Promotional activities and partnerships with local businesses can increase customer satisfaction, loyalty, and overall adoption of PUDO services. The staff operating the PUDO@PEDi service should raise awareness of the PUDO service among the community through various means such as social media, word of mouth, and advertisements. Increased awareness will encourage more people to use the service and contribute to its success. Hence, there is a need for a robust marketing strategy that targets the intended audience and emphasises the benefits of PUDO services. A well-executed

marketing strategy can increase brand awareness, attract new customers, and retain existing ones.

Staff motivation and development are also crucial in ensuring the effective deployment of PUDO at PEDi centres. To boost staff motivation, the service provider could examine the workload of their staff and provide a competitive reward system. This could inspire the staff and boost their productivity. Other than that, the management should invest in training and development programmes aiming to enhance staff competency for the digital age, increase their knowledge and awareness of the digital economy, and educate them on how to use the PUDO service. This will provide them with the skills they need to promote service and digital entrepreneurship and foster the growth of additional digital entrepreneurs in the neighbourhood.

Lastly, it is recommended to collaborate with local stakeholders to resolve challenges such as a need for more resources or infrastructure in PEDi centres. This will help to leverage local knowledge and resources to overcome these challenges and ensure the sustainability of PUDO services in Sarawak.

Recommendations for Future Research

Further research extending the study to other divisions of Sarawak should be conducted to identify potential areas or communities for digital entrepreneurship and e-commerce growth. This will help determine if other PEDi centres in the rest of the regions have a high potential for growth and to what extent PUDO services can support the Sarawak Digital Economy. Secondly, future research should consider incorporating community needs assessment in the PUDO suitability assessment for the service. This will help to tailor the PUDO services to the specific needs and preferences of consumers in different regions, thus increasing their effectiveness and adoption.

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In Memory of

Professor Dr Shahren Ahmad Zaidi Adruce

who passed away on 21 June 2024.

Professor Dr. Shahren was the Vice Chancellor of i-CATS University College and had a PhD in Information Science and Technology from Syracuse University, New York. In terms of research, Professor Dr. Shahren secured several research grants which were widely published and won the highest award for impact factor publications for the social sciences during his tenure at Universiti Malaysia Sarawak.

TOPIC 01

5G Digitalisation Benchmarking for Smart Industries in Malaysia

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Abstract

The emergence of 5G high-speed wireless access enables unprecedented connectivity, allowing industries to digitise their operations on an exceptional scale. The research aims to establish the relationship between 5G adoption and digitisation in two (2) sector verticals: smart cities (within its smart government) and smart agriculture. Technology adoption was evaluated using the Technology, Organization, and Environment (TOE) framework by assessing technological constructs such as hardware ease of use and perceived usefulness. The organisational construct evaluates organisations' financial capacity, skilled workforce, and 5G awareness. The external environmental construct examines the regulatory environment and the role of 5G service providers. These constructs provide a comprehensive understanding of the factors influencing the adoption of 5G technologies for digitisation. An international benchmarking of top countries with extensive 5G deployment within the TOE framework is elaborated by examining the opportunities and challenges they encountered and their strategies. The deducted findings and recommendations elucidate valuable insights for Malaysia and other countries to contextualise and adopt best practices based on these three (3) constructs.

Keywords: 5G benchmarking, Smart Verticals, Technology, Organisation, and Environment (TOE) Framework, Malaysia.

Introduction

5G technology differentiates from previous mobile evolutions by offering enhanced mobile broadband with speeds up to 20 times faster than 4G, ultra-reliable and low-latency communications ideal for real-time response applications, and massive machine-type communications that can handle a more significant number of devices simultaneously, crucial for Internet of Things (IoT). 5G services also improve reliability, allowing network slicing for customised services, enabling network virtualisation for easier management and deployments, and leveraging edge computing to reduce latency and improve performance. Moreover, 5G introduced private networks, providing dedicated wireless connectivity for specific organisations, catering to enterprises or industrial use cases that require high bandwidth, low latency, and secure connectivity.

On 22 February 2021, Malaysia announced the deployment of the 5G spectrum and infrastructure instead of relying on private telecom carriers (Shukry, 2021); the execution is implemented by the establishment of the Special Purpose Vehicle (SPV) called Digital Nasional Berhad (DNB). It is a government-owned entity that grants access to frequency within the

5G spectrum to Mobile Network Operators (MNOs) (Olofsgård & Göransson, 2022). The impact of a 5G network deployment by DNB is projected to contribute RM122 billion to the Gross Domestic Product (GDP) and create 148,000 jobs by 2030, with varying impacts across sectors in GDP increases and a challenging employment landscape with net job losses (DNB, 2021). Additionally, PETRONAS's pioneering use of a 5G private network at Regasification Terminal in Sungai Udang, Melaka, exemplifies the nation's commitment to digital innovation and operational efficiency, aligning with the Ekonomi MADANI and the New Industrial Master Plan 2030. The country has achieved over 70 per cent 5G coverage in populated areas and is targeting 80 per cent by 2023.

Problem Statement

Implementing 5G private networks for different industry verticals can support many new and innovative services. As Malaysia is currently investing and deploying the nation's 5G infrastructure, to address the specific opportunities and challenges in implementing 5G, there needs to be a study on the best practices implemented in other countries

in deploying specific 5G private networks. In addition, it needs to be clarified how different countries are approaching the digitisation of their industries concerning 5G. This research addresses this gap by benchmarking the 5G implementation and digitisation opportunities for selected vertical industries.

Research Objectives

The following section outlines the key research objectives for the study on the adoption and digitisation of 5G technologies to understand the current state of 5G deployment in specific countries and provide practical recommendations for adopting 5G technologies in the Malaysian context.

To establish the relationship between 5G adoption and digitisation within smart cities (smart government) and smart agriculture.

To provide international benchmarking of countries using the TOE framework on opportunities, challenges and the approaches adopted.

To provide recommendations on a generic technology adoption framework contextualised to the Malaysian context.

Literature Review

5G Technology and Smart Verticals: City, Government and Agriculture

5G technology represents a transformative leap in mobile communications, setting new standards in connectivity and bandwidth, surpassing those of the previous 4G networks. According to Forge and Vu (2020), enhanced Mobile Broadband (eMBB) enables 5G to provide unprecedented data speeds, reaching up to 20 Gbps, reaching up to 20 Gbps, which is about 20 times faster than 4G. This enhancement is crucial for supporting high-bandwidth applications like streaming high-definition video and facilitating more immersive digital experiences. Ultra-Reliable Low Latency Communications (uRLLC) offer significantly reduced latency compared to earlier networks, enabling real-time communication and responsiveness. Massive Machine-Type Communications (mMTC), the third pillar, allows 5G networks to handle a vastly greater number of devices simultaneously. This aspect is essential for the expanding IoT ecosystem, where countless devices, from home appliances to industrial sensors, require reliable and simultaneous connectivity.

Overall, 5G is more than just a step up in speed and efficiency; it enables new business models and technological possibilities across various industry verticals (Deloitte China & China Unicom Smart City Research Institute, 2020). Unlike traditional cellular networks designed for public use, 5G private networks offer dedicated, reliable wireless connectivity tailored to organisations managed by them or a third-party provider (Salam & Dieter, 2022). These networks are particularly suited for smart vertical applications and emphasise machine-to-machine connectivity (Forge & Vu, 2020a; Damsgaard et al., 2022). Lastly, 5G private networks utilise edge computing, which processes data closer to the user or device reduces latency and improves

system performance, rather than relying on cloud computing (Deloitte China & China Unicom Smart City Research Institute, 2020; Hong et al., 2021; Salam & Dieter, 2022; Mangra et al., 2023).

TOE framework

The Technology, Organization, and Environment (TOE) framework developed by Tornatzky & Fleischner (1990) was chosen to frame the literature findings as the best framework for this research, compared to Diffusion of Innovations Theory, Technology Acceptance Model (TAM), The Unified Theory of Acceptance and Use of Technology (UTAUT). It addresses the comprehensive aspects of 5G benchmarking from three (3) main pillars: technology enabler, internal organisational factors and external support, especially from the government policy and industry ecosystem. The TOE model by (Tornatzky et al., 1990) was used in agriculture (Li & Cheng, 2021), healthcare (Karippur & Balaramachandran, 2022; Yang et al., 2022), government & city (Iftikhar et al., 2021; Ullah et al., 2021; Ng et al., 2022; Gupta, 2023), and industry & business (Miao & Zhao, 2023; Morawiec & Sołtysik-Piorunkiewicz, 2023; Raj & Jeyaraj, 2023).

Methodology

Research Design and Instrument

This research mainly uses a systematic literature review by collecting data from available resources online, mainly from secondary research sources, i.e., reports, case studies, and industry publications. The project alignment was done in the first month of the project. The critical papers in this research are collated using the Systematic Literature Review (SLR) methodology, where articles are filtered and screened. The data collected are analysed to identify the industry's best practices, challenges, and opportunities related to technology adoption. Atlas. ti software is used to identify patterns and relationships within the data, mainly using statistical techniques and literature analysis. Recommendations tailored to Malaysia's specific needs and goals should be supported by benchmarking data. To give a grounding recommendation, we contacted the industry players to gain specific insights on the 5G deployment challenges. A semi-structured interview has been implemented from the middle of September until November 2023 to gather qualitative data.

Data Collection

Based on Figure 1, this section highlights the process of obtaining the most relevant articles, including the search strategy and criteria for inclusion and exclusion.

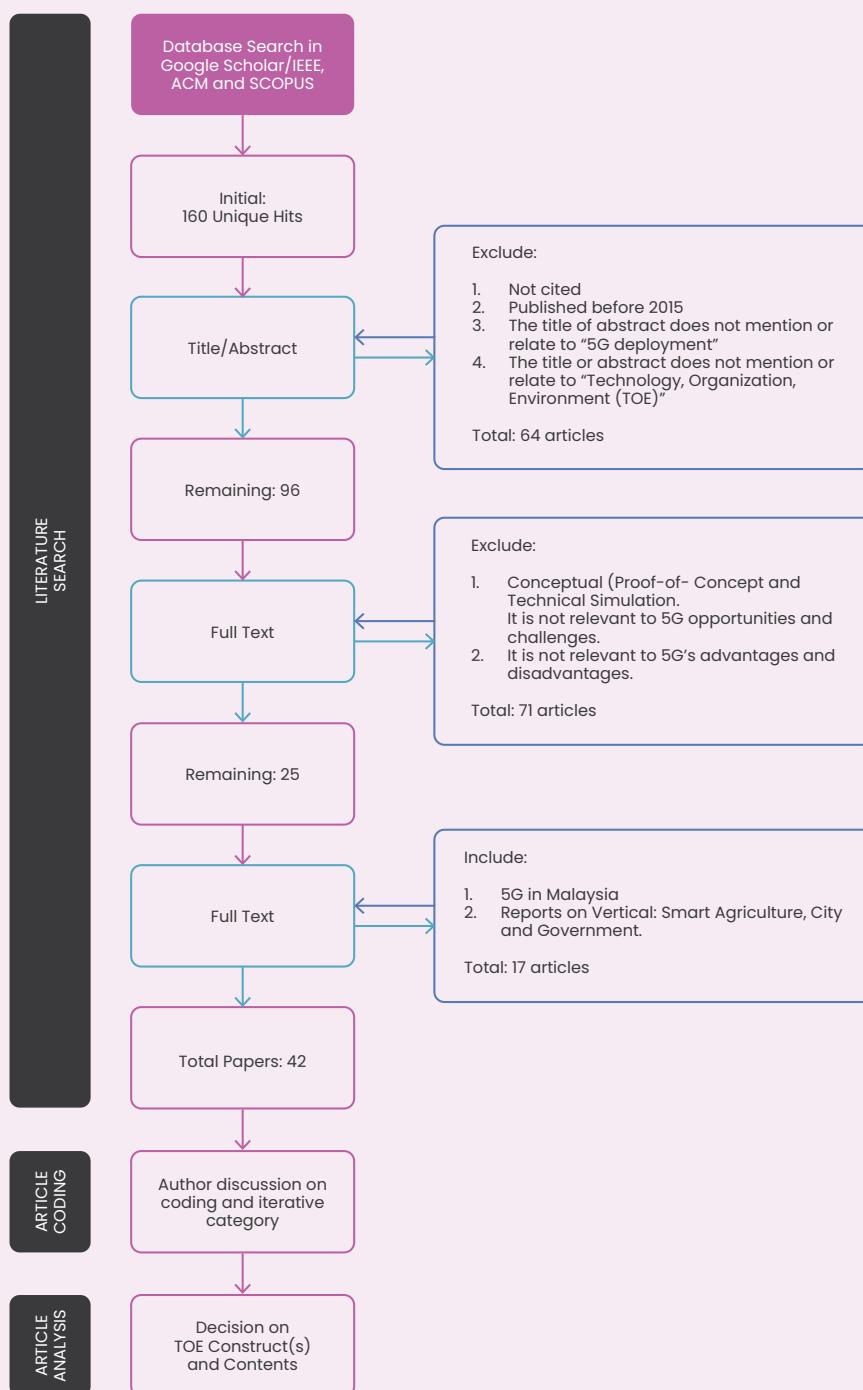


Figure 1: Literature Search Flowchart

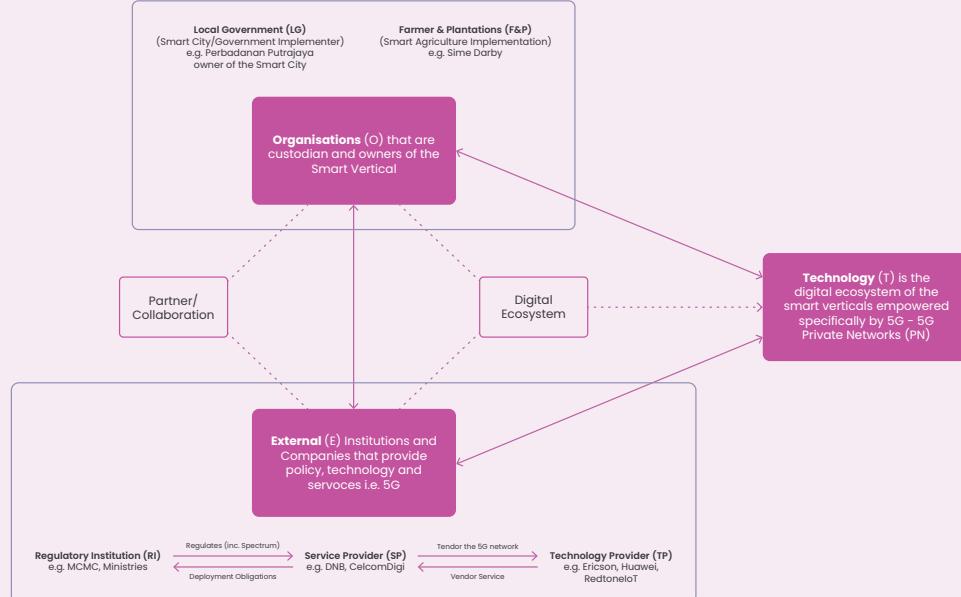
Data Analysis

TOE CONSTRUCT

Figure 2 depicts the Technology, Organization, and Environment (TOE) framework and its respective ecosystem. The technological construct focuses on Hardware/Device Ease of Use and Perceived Usefulness. These elements encompass the tangible aspects of technology that impact its adoption, including the user-friendliness of hardware devices and the perceived benefits of using 5G technologies.

The organisational construct assesses Financial Capacity, Skilled Workforce, and Awareness of 5G Technology. These aspects examine the organisation's or country's readiness to adopt and integrate 5G technologies. Financial capacity reflects the economic resources available for investing in 5G technologies. The skilled workforce evaluates the competence and expertise of the human resources within the organisation or country. 5G technology awareness encapsulates how organisations disseminate knowledge and create awareness about 5G technologies among their stakeholders.

The external environmental construct explores the Regulatory Environment and 5G service providers. The regulatory environment assesses the existing norms, laws, and regulations that can influence the adoption of 5G technologies. The 5G service providers represent the three (3) evolving roles: infrastructure providers, vertical solutions providers, and platform service providers.



TOE Framework

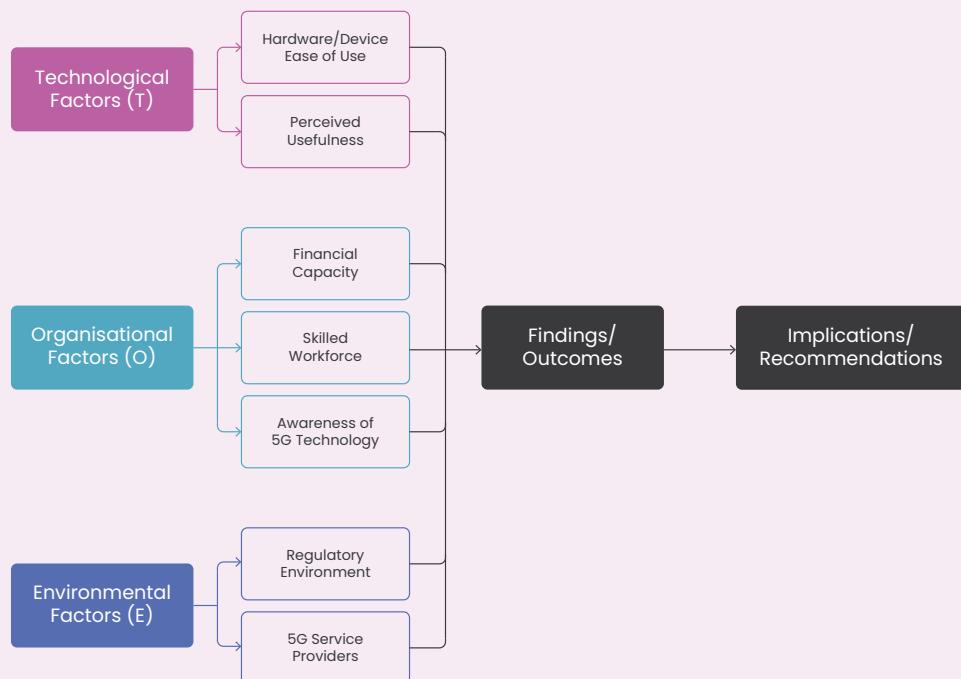


Figure 2: TOE Construct and Ecosystem

Findings and Analysis

This section comprehensively discusses and illuminates the results of our in-depth comparative analysis, centring around the adoption and integration of 5G technology across various sectors from various countries worldwide. A thorough exploration and insightful commentary on the experiences of multiple countries, with their unique socio-political and economic landscape, offers a distinct approach to implementing 5G technology.

Smart Verticals: Agriculture, City and Government

Integrating 5G technology brings about transformative implications for various sectors such as agriculture, urban development, and government services. In agriculture, 5G promises enhanced productivity and efficiency through precision farming and Information and Communications Technology (ICT) focused practices despite challenges in regions with limited 4G accessibility. For smart cities, tackling population growth and resource management challenges by leveraging 5G for robust connectivity and fostering a transition from manual to intelligent services via IoT and Big Data

integration is the focus of 5G digitalisation. In the realm of smart government, 5G is set to revolutionise sectors like security, health, transport, and energy services by improving connectivity and efficiency. It is noted that addressing challenges such as inadequate ICT infrastructure, public mistrust, and digital divides necessitates a paradigm shift towards improved service delivery and business process changes to leverage 5G technology.

However, the practical implementation of 5G in smart agriculture, particularly in developing countries, requires further development and refinement (Wu, 2022; Kota & Giambene, 2019; Arrubla-Hoyos et al., 2022; Meng & Cheng, 2019). Despite the broad application range of 5G, from unmanned aerial vehicles and real-time monitoring to Artificial intelligence (AI) powered robots and data analytics, challenges remain, particularly in regions with limited 4G accessibility, including rural areas in developed countries like the United Kingdom (Tang et al., 2021). In addition, the entire practical implementation of 5G in agriculture still necessitates extensive exploration and development (Meng & Cheng, 2019).

Furthermore, the journey towards fully realising the potential of e-government is fraught with challenges spanning organisational, political, social, and infrastructural dimensions (Zeebaree et al., 2023; Dumont et al., 2017; Wamoto, 2015). Critical issues such as inadequate ICT infrastructure, flawed project management, design shortcomings, and a digital divide hinder the effective implementation of e-government services (Alzahrani et al., 2017). Moreover, public mistrust, fuelled by security, privacy, and a lack of awareness concerns, further complicates the situation (Denford et al., 2019; Zeebaree et al., 2023). Addressing these challenges necessitates a paradigm shift towards improved service delivery and changes in business logic, underpinned by the capabilities offered by 5G technology (Sadiq & Governatori, 2015; Chiarini, 2016; Siddiquee, 2016).

Digital Ecosystem

The article by Mangra et al., 2023, emphasises the critical role of agriculture in global food supply, rural development, and climate resiliency, highlighting its extensive reach across urban and non-urban industries worldwide. It proposes a transdisciplinary framework integrating ecosystems, networks, and governance to manage the agriculture ecosystem

sustainably, facilitating collaboration among diverse stakeholders. The integration of 5G technology extends the ecosystem's reach and effectiveness, especially in food distribution, which often involves transportation over large distances due to factors like producer location, urban demand, and environmental conditions. In addition, a transdisciplinary framework for the agriculture ecosystem was elaborated in (IEEE, 2022), emphasising the integration of various network components to enhance the food supply chain, rural development, and climate resiliency. In summary, the transdisciplinary approach using 5G and future networks is central to aligning and enhancing various stages of the agriculture ecosystem, thereby addressing key areas such as the food supply chain, rural development, and climate resilience.

The 5G smart city ecosystem is integral to modernising urban areas, acting as the foundation for the IoT. This ecosystem is driven by 5G technology, enabling extensive data collection and transmission essential for efficient city operations (Huseien & Shah, 2022). Within the smart city framework, a triple-helix model highlights the integration between municipal administration, research organisations, and information and ICT providers, with ICTs being crucial for connecting innovative solutions and enabling sustainable,

smart administration (Charalabidis et al., 2019). Globally, examples like Singapore's Smart Nation initiative and China's smart city development stages showcase the diverse applications of 5G in smart cities (Deloitte China & China Unicom Smart City Research Institute, 2020; Huseien & Shah, 2022). Smart city operators, as integrators and creators of operational ecosystems, utilise a "capital + technology" model, leveraging big data, cloud computing, and 5G networks (Deloitte China & China Unicom Smart City Research Institute, 2020). This approach creates efficient IoT platforms and supports the diverse requirements of smart cities.

In Malaysia, Putrajaya, Smart City planning is outlined in its Smart City Blueprint (Putrajaya, 2023). The Putrajaya Smart City framework focuses on enhancing quality of life and sustainability through the integration of the IoT and other ICT innovations, structured around seven (7) key domains: Smart Transportation and mobility, Smart Home & Environment, Smart Government Services, Smart Infrastructure & Utilities, Smart Safety & Security, Smart Economy, and Smart Community.

Hardware/Device Availability

In the early stages of the 5G rollout in South

Korea, KT, led by Lee Jong-sik, faced several challenges. These included the struggle to commercialise anticipated innovative services like AR, VR, and autonomous driving. The initial 5G specs were rushed, leading to vendor implementation difficulties and performance that was not significantly better than LTE (Waring, 2023). Establishing a robust ecosystem was challenging, especially with immature device technologies or technology readiness (AlRaeesi AlBalooshi & Habibur Rahman, 2019; Albaloooshia et al., 2021; Tang et al., 2021; Damsgaard et al., 2022; Naqvi et al., 2022; Shim et al., 2022; Waring, 2023). A local industry representative also noted the availability of 5G-enabled hardware that is still nascent, where the hardware cost has not met the economics of scale for mass adoption for enterprise applications. This contributed to the slow adoption of 5G private networks.

Selected Advanced 5G Countries

This research evaluates the adoption of 5G technology in countries with unique approaches and sectors of focus. It is noted that China, a global leader in 5G deployment, integrates this technology into its ambitious smart city initiatives. Post 2010, the exploration phase saw the publication of development plans and

the introduction of pilot cities for smart city experimentation, addressing the initial challenges of information silos and homogeneity. The 13th Five (5) Year Plan in 2016 marked a pivotal point, emphasising the need for a new type of smart city and the transition from conceptualisation to practical implementation, supported by the establishment of smart city evaluation models and national standards.

Singapore is actively investing and embracing 5G technology to enhance its standing as a leading smart city through various strategic initiatives across critical sectors such as healthcare, manufacturing, and maritime. According to Huseien & Shah (2022), the government has allocated SG\$ 40 million to develop the required infrastructure and ecosystem, supporting multi-year research programmes and collaborations between educational and technological institutions like the National University of Singapore (NUS) and Singapore Technologies (ST). These initiatives aim to create a “people-oriented smart Singapore,” leveraging 5G’s low latency and high bandwidth capabilities to drive innovation in AI, robotics, VR property viewing, and advanced educational tools (Deloitte China & China Unicom Smart City Research Institute, 2020; Huseien & Shah, 2022).

Germany is proactively establishing itself

as a leader in the 5G domain, emphasising innovative applications notably, in the field of automobile manufacturing. A significant partnership has been formed between Ericsson, Telefónica Germany, and Mercedes-Benz to establish a private 5G network at the Sindelfingen plant, to enhance production efficiency and precision (Pätzold, 2019). The partnership faced market challenges over the past decade, with many 4G LTE-enabled applications failing to capture significant global market share. Nevertheless, the country has shown resilience and progress in 5G deployment. Lastly, South Korea, despite facing market challenges, shows resilience and progress in 5G deployment, with a focus on its telecommunications infrastructure. For instance, Korea Telecom pioneered a trial 5G network to support the 2018 Winter Olympics in Seoul, demonstrating the network’s capability across multiple cities. Additionally, they introduced a cloud-supported Augmented Reality (AR) / Virtual Reality (VR) gaming platform, leveraging the enhanced capabilities of 5G technology.

TOE Framework

This section dissects the critical aspects of 5G technology adoption in various industry verticals across different countries. The analysis is segmented into

TOE Environmental factors, each presenting unique elements that influence the adoption and implementation of 5G technology.

TOE Framework – Technological Aspect

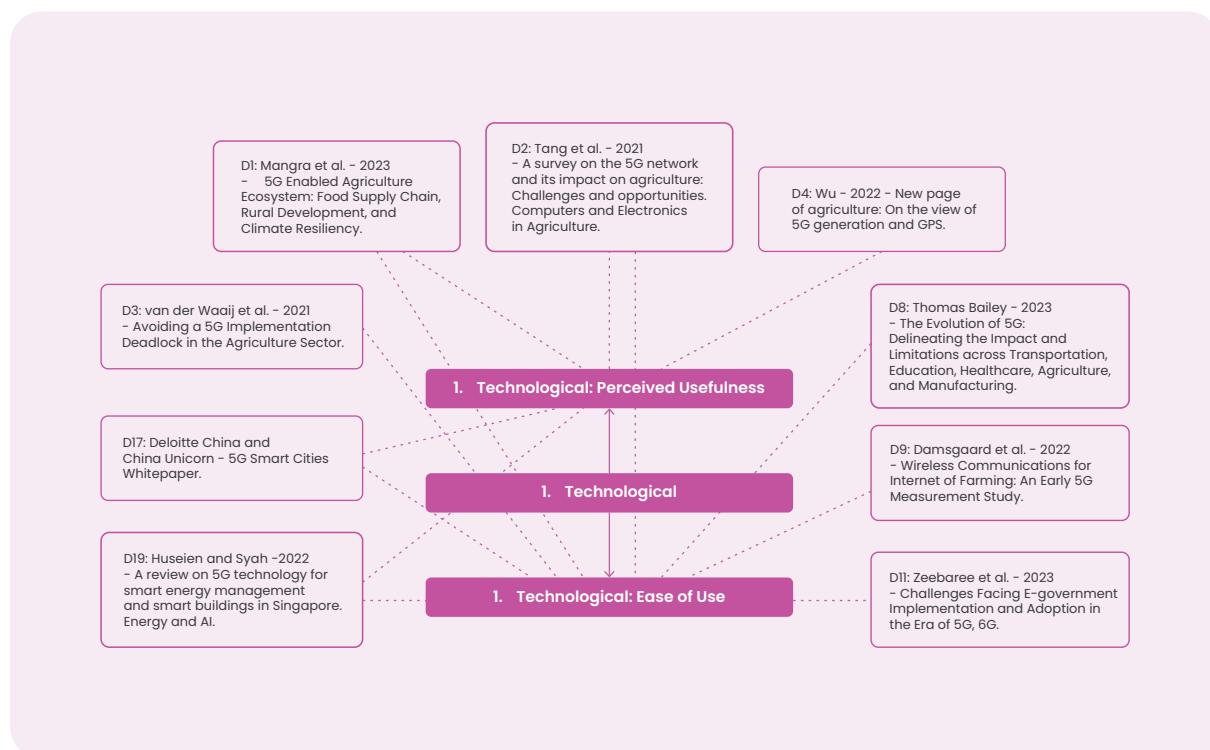


Figure 3: Literature Map of Technological Aspect

The adoption of 5G technology across various sectors, including smart cities, smart agriculture, and smart government, heavily depends on technological aspects like hardware ease of use and perceived usefulness and is elaborated in the list of literature in Figure 3. Devices employed in these sectors should be user-friendly, intuitive, and supportive of all users. Furthermore, the perceived usefulness of 5G technology is significant as it has the potential to revolutionise these sectors by enabling high-speed, reliable data connectivity, supporting digital transformation, and fostering innovation. However, achieving these benefits requires investing in robust network infrastructure, promoting collaborative research, and developing a user-friendly real-time platform to process and disseminate data.

Hardware/Device Ease of Use Construct

The hardware and devices utilised in 5G innovative applications must be user-friendly to ensure they are accessible and efficient for all users, regardless of their technical proficiency. Leveraging 5G technology in smart city or agriculture applications must aim to enhance user experience and accessibility. It is crucial to focus on intuitive design and user support. Devices should feature simple, intuitive user interfaces and ergonomic designs to facilitate ease of use, reduce strain during prolonged usage, and ensure comfort for all users.

5G-enabled technologies will introduce a safer, more innovative, and more efficient era in transportation (Bailey, 2023). The main application of 5G in the personal automobile sector is simple; cars that drive themselves. While this idea is undoubtedly exciting, there are also efficient implications. This can grant mobility to populations unable to drive, e.g., the youth and elderly (Bailey, 2023). Going forward, 5G will combine with single-vehicle intelligence and C-V2X to enable application scenarios, such as vehicle-road collaboration, collision within or beyond the line of sight, precise parking and smart routing strategy, to achieve full autonomy in driving and significantly improve the travel experience of people (Deloitte China & China Unicom Smart City Research Institute, 2020).

5G technology, with its faster speeds and response times, enhances ease of use. It offers a versatile and convenient single communication technology for indoor and outdoor applications, benefiting sectors like precision agriculture (van der Waaij et al., 2021). Digitalisation and robotisation may aid sensor placement to retrieve data on yield, soil, and fertilisation (Mangra et al., 2023). The integration of 5G technology in smart agriculture, with aerial inspection systems, empowers advisory services and Farm Management and Information Systems (FMIS) with richer sensor data, enabling data-driven suggestions based on previous crop cycles for increased yields, reduced inputs, and lower environmental footprint over time (Shi et al., 2019, 2021; Damsgaard et al., 2022).

Perceived Usefulness Construct

The perceived usefulness of 5G technology spans across various sectors, such as smart agriculture, smart cities, and smart governance. It enables precision agriculture, improving farm-to-market efficiency, reducing waste, and fostering innovation (Mangra et al., 2023). In smart cities, it supports an integrated security system, enhances healthcare networks, and facilitates smart transportation, enhancing safety, efficiency, and sustainability. In

smart governance, 5G aids in developing an integrated smart urban platform for real-time data collection, processing, and dissemination, facilitating more responsive, efficient, and transparent governance.

5G technology and its upcoming advancements, including 5G-Advanced and 6G, are poised to enhance smart agriculture and rural development (Mangra et al., 2023). Precision agriculture will be revolutionised with high-speed and voluminous data connectivity, optimising farming operations, reducing waste, and fostering innovation from farm to market. In rural areas, 5G promises to extend and deepen the reach of services, improving access to markets, services, and essential healthcare through telehealth, thus catalysing rural development (Hecht, 2022; Mangra et al., 2023). Moreover, sharing crop health and environmental data within farming communities can enhance relationships and trust, leading to better product pricing and local economic growth.

A patrolling robot or robot hospital with advanced cameras and thermal imaging can cover roads up to 800–1,000 meters long, operating continuously for seven (7) to eight (8) hours. The high bandwidth and low latency of 5G enable public security authorities to assess the environment, issue commands, and remotely control the robot, improving city safety and substantial cost savings in patrolling manpower. Furthermore, city roads equipped with cameras, weather sensors, and smart traffic devices, interconnected through 5G's network slicing technology, feed data into a comprehensive system that manages traffic flow efficiently, provides real-time updates on road conditions, and enhances safety by facilitating communication between vehicles and pedestrians. This holistic approach to smart traffic management optimises various aspects of urban transportation (Deloitte China & China Unicom Smart City Research Institute, 2020).

TOE Framework - Organisational Aspect

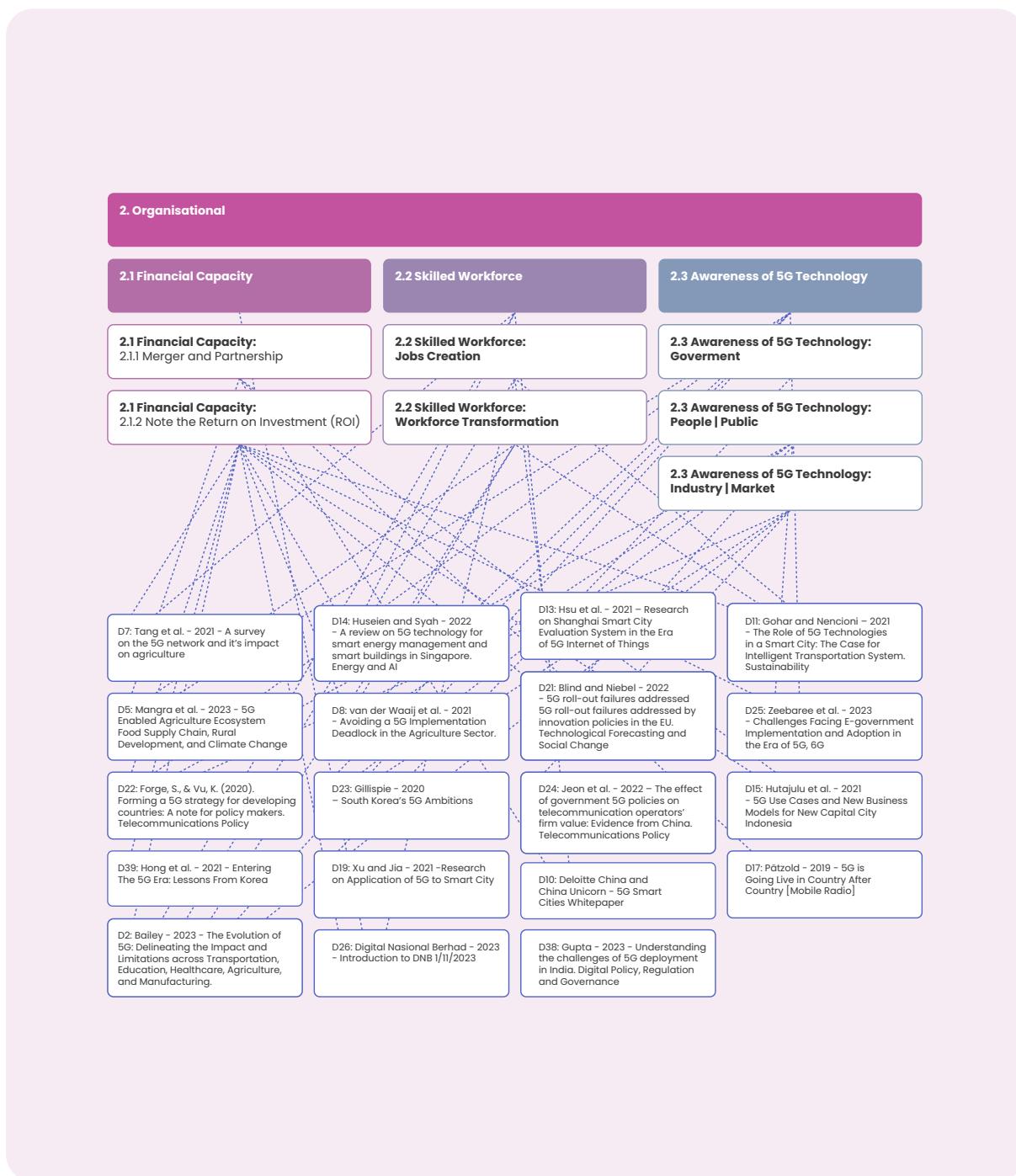


Figure 4: Literature Map of Organisational Aspect

The integration of 5G promises numerous benefits, including potential cost reductions, substantial savings, and GDP contribution. The adoption of 5G technology necessitates significant financial investments which can be seen in countries like Singapore and China. However, this adoption varies significantly between high-income and low-to-middle-income countries, considering potential risks to network service providers' market financing capacities and firm values. The expansion of 5G technology is also expected to initiate a substantial shift in the labour force, driving automation across sectors and creating numerous job opportunities. Even though 5G technology enables the transformation of various industry sectors by efficiently enhancing mobile connectivity, the industry's perception of 5G adoption may shift from enthusiastic to lukewarm. Such perception depends on numerous factors, including technology rollout, implementation effectiveness, and digitalisation maturity of different sectors. Internal organisation, public awareness, and understanding of 5G technology still require improvement to counter its adoption and acceptance challenges. This is elaborated in the list of literature in Figure 4.

Financial Capacity Construct

Betancourt (2021) analysed eight (8) obstacles that interfere with the 5G deployment: cost, return on investment (ROI), business model, the average return per user (ARPU), regulatory policies, spectrum, transport, and security. This is mainly because 5G systems are costly (Forge & Vu, 2020b) compared to previous 4G deployments due to the higher number of sites and power consumption, contributing to higher capital and operating expenditures. The 5G also competes with licence-exempt spectrum-based technologies, such as Wi-Fi and ZigBee, for broadband services and high-speed industrial automation. These alternatives are cheaper with devices and machines that are already ubiquitous, with these communication chipsets having proven track records.

Singapore has identified several critical verticals for 5G adoption, including healthcare, manufacturing, and maritime. It has set aside SG \$40 million to develop the necessary supporting infrastructure and ecosystem. The engineering teams at the National University of Singapore (NUS) and Singapore Technologies (ST) have signed a \$6.6 million multi-year research programme deal to create a "people-oriented smart Singapore" soon (Huseien & Shah, 2022). In China, there were around 180,000 buses and trams in Shanghai by the end of 2018. A 60 per cent fleet modification and development of a new management system would push the total investment to nearly 10 billion RMB (Deloitte China & China Unicom Smart City Research Institute, 2020).

As for smart farming technologies, which require high investment costs, better rural coverage and connectivity, and the possibility of higher bandwidth to handle the vast data among many sensors and devices deployed remotely (Tang et al., 2021), such systems are usually beyond the reach of small and medium scale farmers and plantation holders. ADLINK's MicroRAN 5G private network addresses this issue by offering small and medium enterprises a compact, secure, and efficient solution for modernising manufacturing processes, integrating Edge computing, 5G, Wi-Fi, and Ethernet technologies.

It is an easy-to-deploy architecture, capable of handling up to 25 5G end nodes and unlimited Wi-Fi/wired users, simplifies infrastructure and enhances operational efficiency in smart manufacturing (OpenSystems Media, 2023). The interview with one (1) Malaysian agriculture manufacturer informs that there are real financial barriers to procuring basic smart sensor systems for small producers. The usage of smart agriculture has been pioneered by listed plantation companies such as Sime Darby and companies that have collaborated on technology, as listed by Malaysia Digital Economy Corporation (MDEC) Malaysia.

Mergers and partnerships

As 5G infrastructure and service setup are generally expensive compared to other wireless connectivity due to the protected spectrum and higher quality of services guaranteed, mergers and partnerships are one of the approaches to reduce the expenditures incurred. In the US, Sprint launched True Mobile 5G in metropolitan areas of nine (9) US markets. The company continues to advocate for a merger with T-Mobile to accelerate the deployment of a ubiquitous, nationwide 5G network that includes coverage in rural locations. The combined company has the resources and technology to build a 5G network that fuels innovation across every industry, dramatically increasing competition and allowing new economic growth (Pätzold, 2019). This benefits the rural areas with single providers because of the high investment costs and potential market revenues (Mangra et al., 2023).

In the Netherlands, a country with a long-standing tradition of agricultural cooperatives that share risks and revenues, the 5G connectivity infrastructure can be owned or guaranteed by a cooperative of, say, on-farm equipment suppliers. Cooperatives like CEMA and the European Agricultural Machinery Association could generate the equity necessary for investments and/or arrange for a supplier to provide connectivity as a service (van der Waaij et al., 2021). ZTE has cooperated with more than 60 operators worldwide in 5G and accumulated ample experience in providing products and services for the commercial deployment of 5G networks across the globe.

The study by TNO elaborated on the deadlock between 5G rural deployment by network service providers and global agriculture manufacturers that produce 5G-supported equipment. This chicken-and-egg dilemma, where both manufacturers that require connectivity in rural areas and telecom providers that do not have enough customers in most rural areas hinder 5G innovations for global applications in agriculture. The study recommends that telecom operators, larger farm equipment manufacturers and industry associations partner to solve the solutions deadlock (van der Waaij et al., 2021).

Note the Return on Investment (ROI)

The ROI obtained from deploying 5G technology is a critical factor that necessitates significant initial financial investments across numerous industries. The Global System for Mobile Communications Association (GSMA) predicts that 5G's impact on the world's GDP will become evident within five (5) years of its 2019 launch, amounting to \$2.2 trillion by 2034 and culminating in a mature ecosystem with profound global economic implications. The process and pattern of deployment of 5G networks for low-income and medium-income countries is likely to be somewhat different for high-income countries. Moreover, most low-income and middle-income nations realise that, like the higher-income nations, there is a strategic importance in embracing the digital economy for their growth and competitiveness, so the attitude towards change through "high-tech" is quite positive (Forge & Vu, 2020b). Moreover, existing technologies in this market offer high quality of service (QoS) at a much lower cost, so the use of 5G uRLLC may compete only if it is cost-effective, which is dependent on mass production, requiring a major ecosystem in which competing technologies have already been built.

Effective infrastructure and network sharing could result in a substantial 40 per cent reduction in overall management costs (BEREC, 2011). However, operators still grapple with the economic challenges of expanding and deploying this new infrastructure, which involves dealing with millions or even billions of small cells. To tackle this issue, operators must carefully assess user coverage and revenue potential per cell site to determine the most cost-efficient deployment approach (Guevara & Auat Cheein, 2020). Moreover, since 4G LTE and 5G networks may use the same frequency spectrum via dynamic spectrum sharing, 5G technology can lower data costs than the current 4G costs.

From the perspective of the initial stage of corporate product innovation and strategic transformation, due to the high uncertainty surrounding 5G technology, the related investment

by and research and development (R&D) activities of telecommunication operators are likely to affect their firm value negatively (Jeon et al., 2022). One (1) example is that top high-tech firms from South Korea have experienced several market setbacks (with a few exceptions) for 4G LTE-enabled device applications. They have failed to corner any notable global market share (Gillispie, 2023), even though South Korea regularly ranks as one (1) of the world's most innovative economies over the past decade. Another possible hidden cost is related to cybersecurity issues, where purchasing equipment from the cheapest vendors, most notably Huawei, will involve high monitoring costs down the line due to cyber espionage and cyberattack concerns (Panza et al., 2020). In addition to rising energy costs around the globe, service providers and businesses have started to consider power consumption regarding 5G deployment decisions.

Skilled Workforce Transformation Construct

The expansion of 5G technology is significantly reshaping the global workforce, creating a demand for skilled professionals adept in this advanced technology. By 2035, 5G is projected to generate over 22 million jobs worldwide, with a ripple effect in job creation across various sectors. In Malaysia, 5G deployment could create up to 737,000 jobs and reskill over 544,000 jobs in the next decade. This technological shift requires a workforce skilled in managing and integrating 5G with AI and machine learning (ML), leading to a transformation from traditional roles to more complex, technology-driven positions. Consequently, extensive retraining is necessary, with millions in China and the U.S. needing to adapt to these new roles. The integration of 5G is vital not only in enhancing labour productivity and efficiency but also in facilitating the transition to digital culture environments, underscoring the need for a workforce that is both skilled and adaptable to technological advancements. The workforce is undergoing a significant transformation due to the evolution of industries, shifting away from traditional roles towards managing devices and systems (Bailey, 2023; Mangra et al., 2023). Additionally, the advancement of 5G technology is driving a shift in skill requirements, with workers transitioning from repetitive tasks to more complex roles that involve overseeing technology-driven operations, including the integration of AI and ML for more efficient management activities (Mangra et al., 2023). Consequently, many workers, including an estimated 50 million in China and 11.5 million in the US, require retraining to adapt to these new roles (Kelly, 2020).

In August 2019, Huawei released its "Global Industry Vision" (GIV) report, which predicted that in the industrial sector, there would be 103 robots for every 10,000 employees (Huawei, 2019;

Pätzold, 2019). Regarding Malaysia's job impact of adopting 5G technology, specific sectors will see a certain number of jobs lost or avoided. 225,000 jobs are classified as lost or avoided within the Retail and Entertainment sector. In Manufacturing, this figure is 77,000; in the Public Sector and Government, the number is 7,000. Finally, the total number of jobs lost or avoided across various sectors due to the adoption of 5G technology is estimated to be 544,000 (DNB, 2021). In the context of e-government, 5G can improve communication networks and infrastructure, essential for the success of these initiatives. However, these projects are costly and risky, requiring a highly skilled workforce and substantial infrastructure development. Training and capability building is crucial, as many employees lack the necessary skills and experience for these advanced electronic systems (Zeebaree et al., 2023).

Awareness of 5G Technology Construct

Many studies on e-government have identified several factors impeding the implementation and adoption of the system. Among them are lack of awareness, resistance to change, and lack of government plan and strategy (Zeebaree et al., 2023). To address the lack of awareness in China, the Smart City – Top Level Design Guide published in 2018 unifies the requirements of top-level design, with the design concepts and realisation process clearly explained. With digitalised government operations and streamlined processes, dealing with the government is easier for the people (Deloitte China & China Unicom Smart City Research Institute, 2020).

The demand for 5G technology adoption within organisations is contingent on various factors, including the extent of the 5G rollout and its effective implementation (Blind & Niebel, 2022). However, it is not straightforward, as alternative technologies might be better suited for certain applications, and there may not be a clear consumer demand for 5G-related products (Blackman & Forge, 2016). For instance, in Industrial IoT, alternative technologies can provide long-range, low-cost solutions without requiring significant data capacity, potentially rendering 5G unnecessary. Similarly, alternative technologies like LoRaWAN might fulfil smart agriculture and precision farming requirements without needing 5G. Therefore, organisational awareness and consideration of the specific technological needs play a pivotal role in determining the adoption of 5G (Bieser et al., 2020).

In the interview with the Indonesian smart agriculture solution provider, it is found that successful adoption is possible in green-house-based agriculture systems after careful study of the returns through improved yield, reduction of input cost and controlling (monitoring)

the environmental variables as being done in smart farming. The farmers also need to move from the paradigm of production-focused farming to market-focused farming, where the production of high-value produce gives better returns. There is also a significant issue of the ageing workforce, where most farmers in Indonesia are above 40 years old, and smart agriculture can only be introduced to millennial farmers through interventions and re-education. To expect a significant shift and adoption of digital farming will require a systemic assessment of the whole local ecosystem focusing on the internal dynamics of smart vertical organisation that owns and manages digital technology.

TOE Framework – Environmental Aspect

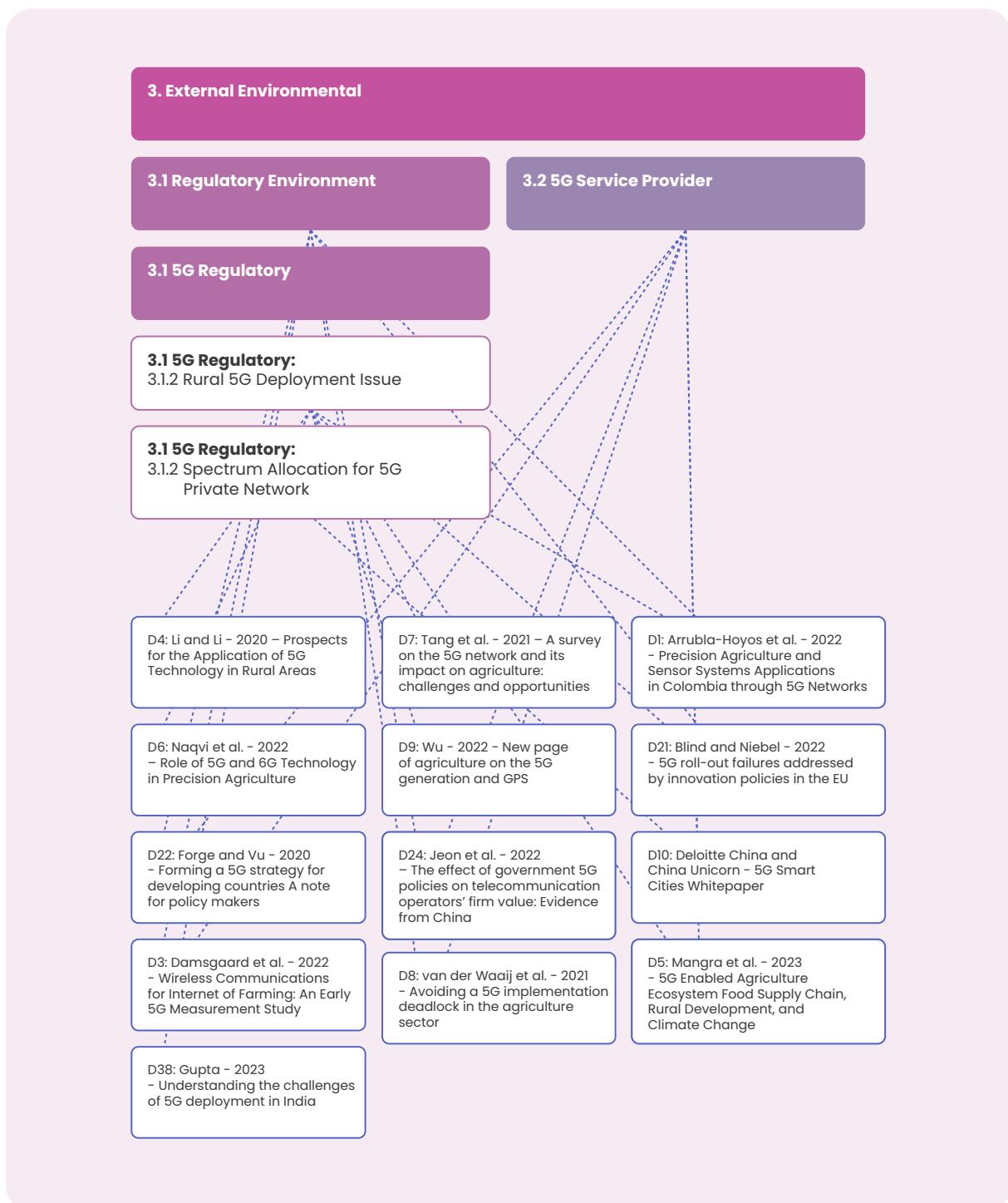


Figure 5: Literature Map of Environmental Aspect

Challenges such as high capital expenditures, technical complexities, and uncertain business cases in developing countries and agricultural sectors necessitate strategic policymaking are elaborated in the list of literature in Figure 5. Moreover, the global disparity in 5G coverage, particularly in rural areas, creates economic disincentives for investment, leading to 5G underdevelopment. Government institutions, especially telecommunications regulators, play an important role in championing and nurturing 5G digital technology within the environmental construct. The regulatory environment for 5G private networks needs to be clear due to uncertainty in the implementation framework and policies. We also note that smart, collaborative platforms considering multiple stakeholders are critical for efficient policy operationalisation.

Regulatory Environment Construct: Spectrum Allocation for 5G Private Network

The spectrum allocation for 5G private networks is critical in developing and deploying these networks across various sectors. Several countries have designated specific frequency bands for private 5G use. For instance, the Netherlands has made the 3.5 GHz band available for private network licensing. At the same time, the United States has approved using the Citizens Broadband Radio Service (CBRS) spectrum in the 3.5GHz to 3.7GHz frequency range. Similarly, Japan and Germany have allocated specific bands in the 3.7GHz to 3.8GHz range for private 5G networks (Reeb, 2021).

The flexibility of 5G technology allows it to utilise licensed, unlicensed, and shared spectrum, catering to different industry needs. This adaptability is particularly significant for private networks in specific agriculture, manufacturing, and healthcare industries. For example, Ericsson and Telefónica Germany have collaborated to enable 5G car production for Mercedes-Benz via a private 5G network in Germany (Pätzold, 2019). The spectrum-sharing concept is also gaining traction, with schemes like License Spectrum Sharing and Licensed Shared Access emerging. These allow MNOs to share spectrum with incumbents such as satellite services, broadband wireless access, or military services. Countries like Indonesia have updated regulations to facilitate such sharing (Hutajulu et al., 2021).

However, there are challenges, such as the high cost of deploying private networks due to the need for dedicated infrastructure and spectrum leasing from national regulators (Damsgaard et al., 2022). Additionally, the disparity in global 5G coverage, particularly in rural areas, poses economic challenges for network service providers and hinders the development of 5G-based products in sectors like agriculture (van der Waaij et al., 2021).

Hence, allocating and managing spectrum for 5G private networks are vital in fostering competition, encouraging private sector investment and innovation, and ensuring efficient use of scarce spectrum resources.

Rural 5G Deployment Issue

The deployment of 5G in rural areas, particularly to enhance agricultural productivity and rural development, faces several challenges and opportunities. Agriculture is crucial for the livelihoods of a significant portion of the world's poor, who predominantly reside in rural areas (Mangra et al., 2023). While 5G technology promises to revolutionise rural connectivity by offering seamless communication capabilities, its implementation in these areas is complicated by various factors.

Firstly, existing communication infrastructure in rural and remote areas is often limited, with many areas lacking even basic 3G coverage (van der Waaij et al., 2021). The high initial infrastructure cost of 5G means its deployment is initially focused on densely populated urban areas. Extending 5G coverage to rural regions depends on national strategies, regional development plans, and public policies to increase connectivity (Arrubla-Hoyos et al., 2022). In countries like the Netherlands, government incentives and regulations are being used to ensure almost complete coverage, thereby facilitating the rollout of 5G in rural areas (van der Waaij et al., 2021).

However, the economic viability of 5G in rural areas is a concern (van der Waaij et al., 2021). The potential market in these regions is not large enough for multinational agricultural manufacturers to invest heavily in 5G development. This creates a dilemma, as enhanced connectivity through 5G is essential for the widespread adoption of advanced agricultural technologies, such as precision agriculture. Some solutions include establishing private 5G networks using specific frequency bands, like the 3.5 GHz band in the Netherlands, which can be particularly useful for farms outside the reach of public networks (van der Waaij et al., 2021).

5G Service Providers Construct: Evolving Roles

Network service providers are integral to the 5G revolution, fulfilling roles as infrastructure providers, vertical solutions providers, and platform service providers, ensuring seamless integration and functionality within the smart cities' ecosystem (Deloitte China & China Unicom Smart City Research Institute, 2020). For telecommunication service providers,

their primary responsibilities as infrastructure builders involve setting up network facilities, expanding network coverage, increasing bandwidth and speed, and ensuring stable operations of smart city applications (Deloitte China & China Unicom Smart City Research Institute, 2020).

Additionally, the expansion of 5G networks is vital for meeting the connectivity needs of public utilities and residents and maintaining smart city functionality. This includes implementing long-distance fibre cabling, as seen in the Putrajaya Smart City Blueprint. Telecommunication operators also benefit from their natural advantages in network resources, operation, and management, especially in deploying edge computing facilities alongside base stations for cost-effective and efficient edge cloud deployment. This positioning gives them a competitive edge in data collection and processing, addressing bandwidth wastage and latency issues.

With 5G networks, service providers are now required to up their game by offering comprehensive services, combining communication networks with advanced technologies for tailored solutions in urban development, as vertical solution providers (Deloitte China & China Unicom Smart City Research Institute, 2020). This involves connectivity and enhances the application of smart technologies, which is crucial to developing smart city solutions. For instance, in collaboration with Ericsson, Qingdao Port, and ZPMC, China Unicom achieved a breakthrough by remotely controlling a 5G-connected quayside container crane at Qingdao Port, a world-first in a real production environment. Additionally, in Guizhou, China Unicom's tourism incubation base is advancing the "tourism + IT" concept, focusing on three (3) key areas: tourism big data, IT system integration, and tourism industry operation with a core product named Tourism Big Data Platform, rolled out nationwide.

Finally, 5G service providers should become the "platform service operators" in smart city ecosystems (Deloitte China & China Unicom Smart City Research Institute, 2020). They facilitate the integration and connectivity of third-party applications with smart city platforms by opening API interfaces. This connectivity, enabled by the 5G network, allows sharing of network resources, data, and operational services. A notable example is smart transportation, where telematics applications are integrated with the platform, accessing real-time public transport data as seen in initiatives like Singapore's digital government platform.

Collaborative Ecosystem

As noted earlier in the financial construct above, the collaborative ecosystem is required to solve the deadlock that hinders development and investment. In recent years, telecommunication operators have actively encouraged transformation and upgrades in agriculture, leading to the establishment of their Internet subsidiaries and the execution of Internet-related projects across the country. Take China Unicom as an example. In Jiangxi province, China Unicom is advancing the “Internet + farming” concept by developing and integrating agricultural IT products at its agricultural incubation base. This involves deep engagement in the government’s strategic planning for smart agriculture as China Unicom develops, operates, and supports innovative IT solutions, thereby facilitating the transformation and upgrading of agriculture in the region (Deloitte China & China Unicom Smart City Research Institute, 2020).

It is also observed that a similar setup by Telkom Indonesia established a specific agriculture technology subsidiary to develop solutions for digital transformation in agriculture practices, namely “AGREE Smart Farming”. The subsidiary manages the research and development in smart farming innovations through a partnership with Indonesian start-ups, universities, and research institutions. The expert from AGREE Smart Farming noted that the 5G wireless technology, due to the complexity of the setup in rural areas, “will be the last technology” adopted for connectivity. As observed, most smart farming technology is now connected using more cost-effective wireless technology such as Wi-Fi, Bluetooth, and 3G connectivity.

Recommendations

Implications for government and regulatory bodies.

The integration of 5G technology has significant implications for governments worldwide. Governments are pivotal in crafting regulatory frameworks and fostering stakeholder collaborations to harness these benefits effectively. Meanwhile, regulatory bodies play a pivotal role in managing resources like spectrum allocation (including private networks) and ensuring equitable infrastructure development, with a special emphasis on digital inclusion in rural areas. Here are some key implications:

1. Regulatory Policy, Framework, and Consortiums: Governments play a crucial role in establishing regulatory frameworks and standards for deploying and using 5G technology with stakeholders from various ministries. They should ensure data privacy and security, promote fair competition among service providers, and facilitate stakeholder collaboration (Mangra et al., 2023). The government should also facilitate the development of a framework for each smart vertical important to Malaysia, by setting up a consortium of experts to collaborate in research and development efforts.
2. Investing in Smart Verticals Hubs: Governments can leverage 5G technology to enhance the delivery of public services. For example, implementing 5G-powered virtual labs in smart cities educational institutions can provide high-quality education to a broader audience and break geographical barriers (van der Waaij et al., 2021). Additionally, establishing user-friendly agricultural hubs powered by 5G technology can enable farmers to access real-time data and expert guidance, leading to increased yields and sustainable farming practices (Mangra et al., 2023). These hubs should be supported by financial grants and monitored closely to ensure the sustainability and success of the smart digital ecosystem.
3. Spectrum Allocation for 5G Private Networks: Regulatory bodies are crucial in allocating and managing spectrum resources for 5G networks. It is essential for regulatory bodies to ensure sufficient spectrum availability and allocation mechanisms that

promote competition and investment in 5G infrastructure. The allocation of private network spectrum and specific allocations for rural coverage can pave the way for more private network deployments in the future.

Implications for 5G Service Provider

Implications for network service providers can be summarised as follows:

1. Enhanced Service Offerings and Service Evolution: Telecom service providers should invest in developing comprehensive and scalable 5G infrastructure to support the growing demand for smart city applications, smart agriculture, and smart government initiatives. By providing robust and secure network architecture, service providers can ensure seamless connectivity and efficient data flow, enabling the full potential of 5G technology in enhancing safety, efficiency, and sustainability in urban environments (Mangra et al., 2023; Deloitte China & China Unicom Smart City Research Institute, 2020).
2. Collaboration initiatives for 5G Innovation and Research: Telecom

service providers should prioritise collaboration with government agencies, research institutions, and industry verticals to invest in research and development projects jointly focused on integrating 5G technology into various sectors. This collaboration allows for tailored solutions that address specific needs and pain points within each industry, leading to more efficient and sustainable practices (Mangra et al., 2023).

Implications for smart agriculture and city providers

Implications for smart agriculture providers are summarised as follows:

1. Establish User-Friendly 5G-Enhanced Agricultural and City Hubs: Providers should prioritise the creation of user-friendly agricultural hubs powered by 5G technology in smart agriculture. These hubs can serve as central points for data collection, analysis, and consultation services, supporting sustainable and efficient farming practices. Smart city providers should focus on creating a user-friendly mobility app that caters to a broad demographic of users, including the

youth, the elderly, and those with limited mobility.

2. Increased Accessibility for All Users within the Agriculture Players: The user-friendly nature of 5G-enhanced smart agriculture solutions ensures accessibility for a wide range of users, regardless of their technological proficiency. By prioritising ease of use and compatibility with various assistive technologies, providers can ensure that advanced smart agriculture solutions are accessible to all users, promoting inclusivity and equitable access to agricultural technologies (Mangra et al., 2023).
3. Develop a smart city digital blueprint framework: Cities should assess their existing infrastructure, identify key domains for improvement, and develop a comprehensive plan integrating technology, data, and communication. Prioritising projects based on feasibility, impact, and sustainability goals can create connected and sustainable urban environments, leveraging smart technologies for long-term advancement and public welfare.

Conclusion

5G revolutionary technology has extensive implications for governments worldwide and regulatory bodies, network service providers, and providers of smart city and smart agriculture solutions, fostering innovation, improving service delivery, and addressing societal challenges. The successful integration of 5G in countries such as China and Singapore provide valuable insights into the strategic measures undertaken to overcome challenges in its deployment and adoption. It serves as a roadmap for other countries and industries to address challenges in 5G adoption. However, the successful integration and adoption of 5G technology necessitates concerted efforts from all stakeholders. This includes embracing collaboration, investing in the necessary infrastructure, supporting the digital transformation of industry verticals, and adhering to regulatory requirements. By undertaking these measures, the full potential of 5G can be harnessed, bringing about a digital revolution that promises to reshape the landscape of various sectors and society at large.

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TOPIC 02

A Study on Malaysian Digital Signature Market Demand and Feasibility of Certification Authority Interoperability

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Abstract

The adoption of digital signatures is becoming increasingly important due to its many advantages, including increased security, convenience, and cost savings. Despite these benefits, a significant challenge lies in the lack of cross-Certification Authority (CA) interoperability, hindering the seamless use of digital signatures across diverse platforms and services. This study aims to explore the CAs' views on interoperability across their platforms, the value and implications of such practice, and to establish the potential relationship between interoperability and increased digital signature efficiency and market demand. Interviews with 15 participants, including managers and technical experts from three (3) CAs, gathered insights on the potential relationship between interoperability and increased efficiency and market demand for digital signatures. Subsequently, a systematic literature review (SLR) analysed 57 articles to understand interoperability issues and challenges in various countries. The findings revealed that Malaysian CAs are currently well-equipped to handle the existing demand for digital certificates, actively preparing for anticipated medium-term growth

through scalability, automation, and infrastructure enhancements. The study shows a synergistic relationship between increased digital signature efficiency, interoperability, and potential market demand, emphasising the transformative impact of digital signature on productivity. Thus, achieving interoperability among CAs in Malaysia is crucial for advancing Malaysia's digital economy. It requires collaboration among CAs, the Malaysian Communications and Multimedia Commission (MCMC) as a regulatory body and other stakeholders to address technical, business, and governance challenges. While the National Root CA is a subject of discussion, alternative solutions, such as trust stores, are viable options. With the right infrastructure and policies in place, Malaysia can become a leader in the use of digital signatures and the promotion of cross-CA interoperability, which would benefit both individuals and businesses alike.

Introduction

The Digital Signature Act 1997 (DSA 1997) and Digital Signature Regulations 1998 (DSR 1998) provide the licensing framework for providing digital signatures in Malaysia, including the type of services, the qualification requirements, applications, and the respective fees. According to Government of Malaysia (1997) and Kadir (2012), the DSA 1997 defines a digital signature as an electronic method of authentication that uses a mathematical algorithm to validate the authenticity and integrity of a digital document or message. The act also provides for the recognition of digital signatures as legally binding and enforceable in electronic transactions. On the other hand, the DSR 1998 further provides detailed requirements for the creation, verification, and storage of digital signatures. The regulations specify the technical standards that must be used to create and verify digital signatures, including the use of public key cryptography and the X.509 certificate format (Chong, 1998). The acts also provide for the accreditation and regulation of Certification Authority (CA) that issues digital certificates and provide other services related to digital signatures. CAs are required to comply with strict security and operational standards and are subject to regular audits and inspections.

At present, there are four (4) CAs that issue digital certificates in Malaysia licenced by Malaysian Communications and Multimedia Commission (MCMC), namely Pos Digicert Sdn. Bhd.; MSC Trustgate Sdn. Bhd.; Telekom Applied Business Sdn. Bhd.; and Raffcomm Technologies Sdn. Bhd. These CAs provided digital signature services to various clients and organisations in Malaysia including government agencies, financial institutions, healthcare providers, and businesses of various sizes and industries. Currently, a user who has been issued a digital certificate from one (1) CA would not be able to use the same digital certificate on another CA's platform. This is because each CA has its own unique digital certificate, which is based on its own digital signature and public key (Afshar, 2015). When a user obtains a digital certificate from a CA, the certificate is signed by the CA's private key and includes the CA's public key. If the user tries to use their digital certificate on another CA platform, the platform will not be able to verify the certificate's digital signature, and the certificate will be considered invalid. However, there are efforts underway to promote interoperability among different CAs in Malaysia. This would allow digital certificates issued by one (1) CA to be used on another CA's platform, as long

as both CAs have agreed to the same interoperability standard. This would make it easier for users to use their digital certificates across multiple platforms, and it could help to promote wider adoption of digital signatures.

Problem Statement

The legislative landscape for digital signatures in Malaysia is defined by the DSA 1997 and DSR 1998. This legal framework governs various aspects, including the types of services provided, qualification prerequisites, application processes, and associated fees (Government of Malaysia, 1997). For a digital signature to be recognised as valid, enforceable, and effective in Malaysia, it must undergo certification and validation by licensed CAs. The principal role of a CA is to issue a subscriber's certificate, confirming the identity to be embedded in the certificate as per the provisions outlined in the DSA 1997.

Despite the presence of multiple CAs in Malaysia, the lack of interoperability among them creates challenges for users who need to use digital signatures across different platforms. Currently, a user who obtains a digital certificate from one (1) CA cannot use the same certificate on another CA's platform. This limits the flexibility and ease of use of digital signatures, which

can be a barrier to wider adoption and usage of digital signatures in Malaysia (Kamaruzaman et. al., 2010). Therefore, there is a need to explore the feasibility of establishing interoperability among different CAs in Malaysia and identify potential strategies and approaches for achieving this goal. The research will focus on understanding the current state of interoperability among CAs in Malaysia, identifying the technical and regulatory barriers to interoperability, and evaluating best practices and policies adopted in other countries to promote interoperability. The research will also investigate the potential benefits of interoperability, including increased efficiency, enhanced security, and improved user experience. Ultimately, the goal of the research is to provide recommendations for promoting interoperability among different CAs in Malaysia to drive better adoption and usage of digital signatures.

Research Objectives

The objectives for this research are as follows:

To identify the capacity of the existing four (4) Certification Authorities (CAs) to meet current and forecasted medium-term demand;

To establish the relationship between increased digital signature efficiency and interoperability against potentially higher market demand and adoption of digital signatures;

To explore through literature review the best practices on how interoperability has been promoted for Digital Signatures in other countries for potential adoption for Malaysian CAs in promoting digital signatures;

To gather input and feedback from CAs on the interoperability among the CAs; and

To provide recommendations on the best practices, standards adoption, and/or policy or legislative approaches for increasing digital signature efficiency, interoperability, and market demand.

Literature Review

Public Key Infrastructure

A Public Key Infrastructure (PKI) is a system that provides a secure method for exchanging digital information. It is a set of policies, procedures, hardware, software, and roles that are used to create, manage, distribute, use, store, and revoke digital certificates. PKI is used to facilitate the secure electronic transfer of information for a range of network activities such as e-commerce, internet banking, and confidential email (Albargi et. al., 2015).

Utilising asymmetric cryptography forms the basis for the functionality of the PKI. In this system, each user has a pair of keys known as the public key and private key. The public key is used to encrypt data, while the private key is used to decrypt it. The private key is kept secret by the user, while the public key is made available to anyone (Stallings, 2017).

In modern-day digital communication, the PKI stands as a crucial element. It provides a secure and reliable way to exchange information over the Internet. PKI is used in a wide range of applications, including secure email, online banking, e-commerce, and digital signatures. The use of PKI ensures that the information being

exchanged is authentic, confidential, and tamper-proof (Singh, 2018). A comparison of PKI definitions among ASEAN countries is shown in Appendix 1.

It is shown that Indonesia (Republic of Indonesia, 2008), Laos (Government of Lao People's Democratic Republic, 2012), Myanmar (The Union of Myanmar, 2004), and Thailand (Kingdom of Thailand, 2001) do not define PKI, Public Key, and Private Key in their law and act. There are several reasons why these countries do not provide these definitions. Firstly, lack of awareness or understanding of the benefits and challenges of PKI for enhancing the security and trust of electronic transactions and communications. Additionally, the absence of technical expertise or resources hinders the implementation and maintenance of a national PKI system (Singh, 2018). Moreover, insufficient political will or commitment impedes the harmonisation of national laws and regulations with regional or international standards and best practices on PKI. Furthermore, inadequate cooperation or coordination among relevant stakeholders hampers the development and promotion of PKI adoption and development (Albargi et. al., 2015). Lastly, limited demand or incentive from users or customers of PKI services,

such as individuals, businesses, and organisations, to utilise digital certificates for their electronic transactions and communications.

Adoption of Digital Signatures

Malaysia has made significant progress in the adoption of digital signatures. The Electronic Commerce Act was implemented in 2006 with the purpose of granting legal acknowledgement to electronic signatures (Government of Malaysia, 2006). The introduction of the DSA 1997 has provided a legal framework for the utilisation of digital signatures in Malaysia, hence further reinforcing this notion (Government of Malaysia, 1997).

The digital signature process involves the actions of signing and verifying. Signing means the sender employs a mathematical method to create a unique digital signature for the message or document using a private key. Signatures are created by combining message content with the sender's private key (Saripan & Hamin, 2011). On the other hand, verification indicates that the recipient can verify the digital signature using the sender's public key. The recipient uses the sender's public key to process the message and digital signature. If the computed signature matches the digital

signature, the message is legitimate and hasn't changed since signing.

MCMC performed a survey in 2019 (MCMC, 2021), which revealed an upward trend in the use of digital signatures among users in Malaysia. According to the survey findings, a significant proportion of firms in Malaysia, specifically 63 per cent, employ digital signatures as a means of conducting their transactions. Similarly, a substantial majority of government organisations, precisely 87 per cent, utilise digital signatures for their internal procedures. The demand for digital certificates has grown significantly, with 19,203,000 digital certificates issued in 2023 as compared to 13,800,000 issued in 2019 (MCMC, 2023). Nevertheless, despite the considerable rate of acceptance, there are certain difficulties that require attention and resolution. A significant obstacle that arises is the absence of interoperability between different CAs.

CA Interoperability

Cross-CA interoperability refers to the ability of different CAs to recognise and accept each other's digital certificates (Brands, 2000) (Prasad & Kaushik, 2019). This is essential for the seamless use of digital signatures across different platforms and systems (Wazan et. al., 2013). In Malaysia, cross-CA interoperability is still a

challenge. Currently, there are four (4) CAs in Malaysia that issue digital certificates. However, they do not recognise each other's certificates which makes it difficult for users to use their digital certificates across different platforms and systems.

CA interoperability challenges are the difficulties or barriers that arise when different CAs try to exchange or validate digital certificates across different domains, jurisdictions, or standards. Interoperability challenges can affect the security, trust, and efficiency of digital transactions that rely on digital signatures and certificates (Prima & Sucahyo, 2011) (Stegemann & Gersch, 2019). There are three (3) common interoperability challenges identified in this study.

The first challenge is the lack of common standards or frameworks for digital certificates and signatures. Different CAs may use different formats, algorithms, or protocols for issuing and verifying digital certificates and signatures. This can create compatibility issues and increase the complexity and cost of interoperability. Next is the lack of mutual recognition or accreditation among CAs. Different CAs may have different policies, procedures, or criteria for issuing and validating digital certificates and signatures. This can create trust issues and legal uncertainties among CAs and their users.

Lastly, lack of cross-border or cross-domain cooperation among CAs. Different CAs may operate in different geographical or functional domains, such as countries, regions, sectors, or industries. This can create regulatory or technical challenges for interoperability.

Methodology

This research was systematically divided into two (2) distinct phases, each tailored to the specific aims of the study. This dichotomy allowed for a comprehensive approach to our investigation and ensured a thorough exploration and analysis of the subject matter. The first phase focused on qualitative analysis through open-ended interviews that directly addressed objectives 1 and 2. The second phase involved a systematic literature review, targeting objectives 3 to 5.

PHASE 1: Open-ended Interviews

In the first phase of the study, a qualitative approach was utilised, specifically through open-ended interviews. This method, widely recognised in qualitative research, facilitates a deep and comprehensive understanding of specific topics (Moser & Korstjens, 2018). The focus was on gathering data from four (4) existing CAs, with an emphasis on selecting representatives actively involved in the CA's operations. These representatives were chosen from both managerial and operational levels, ensuring a varied and insightful perspective on the issues at hand.

Research Design

The objective of this approach is to collect data from CAs by carefully selecting individuals who are directly involved in their operations. The selection of the representative will encompass individuals holding managerial and operational positions, thus facilitating the acquisition of diverse perspectives on the issues at hand. In order to validate the semi-structured interview's content, the assessment made by various experts from MCMC on different aspects of the interview was considered. Next, the interview data is transcribed and analysed utilising the software tool Atlas.ti. Atlas.ti facilitates the analysis of interview material by organising it thematically and generating summaries of the findings (Ronzani et. al., 2020).

Research Instrument

The interview sessions with three (3) CAs have been conducted via online and face-to-face interview sessions to gather the "collective wisdom" and explore the similarities and divergences across different CAs. There are 29 with 4 sections in the semi-structure interview questions. Section A is the background questions, where the experience of the participants on the topic is mapped, as well as the general impressions about CA's operation.

In this section, the participants are also asked to explain the process that they have gone through in dealing with the digital signatures to bring the topic into their minds before going deeper into the questions. Section B consists of questions regarding CA's capacity to handle higher market demand for digital signatures and then Section C consists of questions about the relationship between increased digital signatures efficiency and interoperability against potentially higher market demand. The last section which is Section D consists of questions about CA's interoperability issues and challenges to answer RO4. The questions are focused on CAs' opinions or suggestions on how to achieve interoperability including technical challenges, possible solutions, and proposed time frame for a full interoperability of the CA.

The participants were provided with questionnaires in advance of the interview session to facilitate their preparation for accurate responses. The questions asked during the interviews reflected the specific objectives of the study. An interview guide was used to ensure that relevant questions were asked but not used rigidly. Where appropriate, additional questions were asked that were relevant to participants' situations, especially when new issues emerged during the interviews.

Sampling

Although there are four (4) CAs, only three (3) CAs participated in the interview conducted. Table 1 shows a total of 15 participants from three (3) CAs was considered an appropriate sample size to obtain diverse insights while remaining manageable for detailed analysis. Participants were carefully selected from management and operational positions within CAs to ensure a diverse and representative sample. The selection criteria included experience, decision-making capacity, and direct involvement in CA operations to ensure a comprehensive understanding of the subject matter.

NO	NAME	CERTIFICATE AUTHORITY
1	Senior Manager 1	CA1
2	Senior Manager 2	CA1
3	Manager 3	CA1
4	Technical 4	CA1
5	Technical 5	CA1
6	Senior Manager 6	CA2
7	Senior Manager 7	CA2
8	Senior Manager 8	CA2
9	Technical 9	CA2
10	Technical 10	CA2
11	Senior Manager 11	CA3
12	Manager 12	CA3
13	Manager 13	CA3
14	Technical 14	CA3
15	Technical 15	CA3

Table 1: List of 15 Participants Involved in the Study

Data Collection

The interviews were conducted using two (2) methods: face-to-face and online. To ensure a consistent approach across both methods, specific strategies were employed. Verbal consent for participation and audio-record the interview was obtained during the interviews. The researchers emphasised maintaining the anonymity of the participants and the confidentiality of the study findings. Following the interviews, the data collected underwent rigorous thematic analysis. This step was essential for identifying and confirming the key themes relevant to the study's objectives.

Data Analysis

The interview transcripts, each with an average length of 60 minutes, were meticulously transcribed word-for-word, adhering to strict guidelines to ensure thorough accuracy. This detailed transcription process included capturing non-verbal cues and significant pauses, essential for maintaining the integrity of the conversations. The analysis of this interview data was conducted using the Atlas.ti software, which was particularly effective for its thematic coding and organisational capabilities. This software played a crucial role in dissecting the intricate narratives, enabling the extraction

of key themes that closely aligned with the central research questions. Triangulation methods were also employed, using multiple data sources and methods to validate and corroborate the findings, enhancing the study's credibility.

PHASE 2: Systematic Literature Review

In the second phase of the study, a systematic literature review was conducted in order to answer our Research Objective 3, which included a comprehensive search of multiple databases (journal articles, international standards, guidelines, policies, and frameworks) using targeted keywords with a focus on digital signatures and CA interoperability. Strict inclusion and exclusion criteria were applied to select only the most relevant and high-quality sources. The aim was to uncover and examine best practices for improving the interoperability of digital signatures in different countries in order to assess their applicability and potential adoption in Malaysia.

Literature resources in this report were collected from multiple digital databases being actively used by researchers including Google Scholar and Google search engine. Initially, 339 articles that focused on digital signatures were

retrieved from the search engine. The articles were reduced to 57 articles that fall under the category of CA interoperability.

The technique used in the systematic literature review adopts the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (Moher et. al., 2009). The review methodology for this work involves four (4) steps that consist of identification, screening, eligibility, and inclusion as depicted in Figure 1.

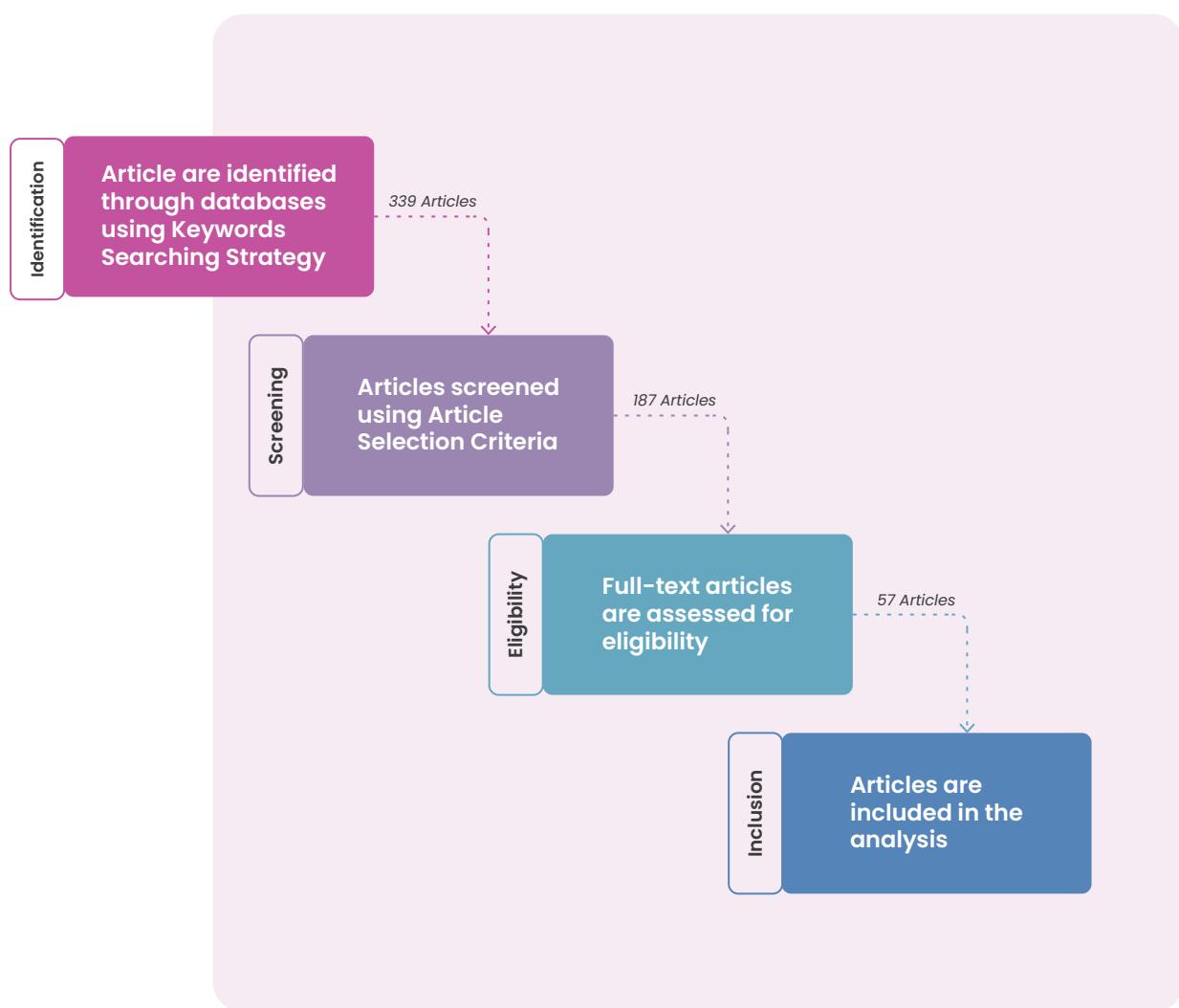


Figure 1: Systematic Literature Review Analysis Flow Diagram

The basis of the identification process makes use of the keywords searching strategy as shown in Table 2 to retrieve articles from the database. Keyword searching strategy guides researchers in searching for the main information used to describe the research topic. Without the right keywords, it might be difficult to find appropriate articles needed for the literature. Using the keywords searching strategy, 339 articles were retrieved.

KEYWORDS

"Digital Signature" OR "CA interoperability"

Table 2: Keywords Searching Strategy

Next, the screening process identifies the suitability of literature resources to be included in the survey based on the article selection criteria listed in Table 3. With hundreds of articles found in the database, it is crucial to select significant resources that are useful to the researchers. The type of article, language, and the domain of the article are important criteria in selecting the articles. The criteria specify the research requirements so that researchers will not deviate from their research scope. These criteria will guide researchers in structuring the output of the research from the input obtained from the articles. During the screening process, 187 articles were filtered from the resources.

The eligibility process retrieves the full-text articles that have been identified in the previous step. From the 187 identified resources, 57 articles were successfully assessed and downloaded that are used in the next stage of the systematic literature review methodology.

Lastly, the inclusion process gathers all of the assessed articles to be included in the study. The systematic literature review methodology would help researchers to conduct their research by finding accurate resources. Without using this methodology, researchers may have to read and review thousands of articles with no clear direction.

CRITERIA	INCLUSION	EXCLUSION
Type of Article	Journal, conference proceeding, act, and law.	Other sources (e.g., PowerPoint slides, thesis, and patent).
Language	English	Non-English (e.g., Thai, Bahasa Indonesia, and Lao languages).
Domain	Public Key Infrastructure (PKI)	Other than PKI (e.g., Blockchain and Machine Learning).

Table 3: Article Inclusion and Exclusion Criteria

Finding and Analysis

To identify the capacity of the existing four (4) Certification Authorities (CAs) to meet current and forecasted medium-term demand.

Based on analysis using Atlas.ti, the capacity of the CA to meet current demand is shown in Figure 2. The overall results show that the Certificate Authority (CA) to are currently equipped to handle the current demand for digital certificates.

Infrastructure which is the foundational element of the CA's technological backbone plays a crucial role in CA interoperability. A robust and scalable infrastructure is vital for accommodating the increasing demand for digital certificates efficiently. Adequate hardware, network resources, and scalability ensure that the CA can handle the evolving landscape of digital transactions securely.

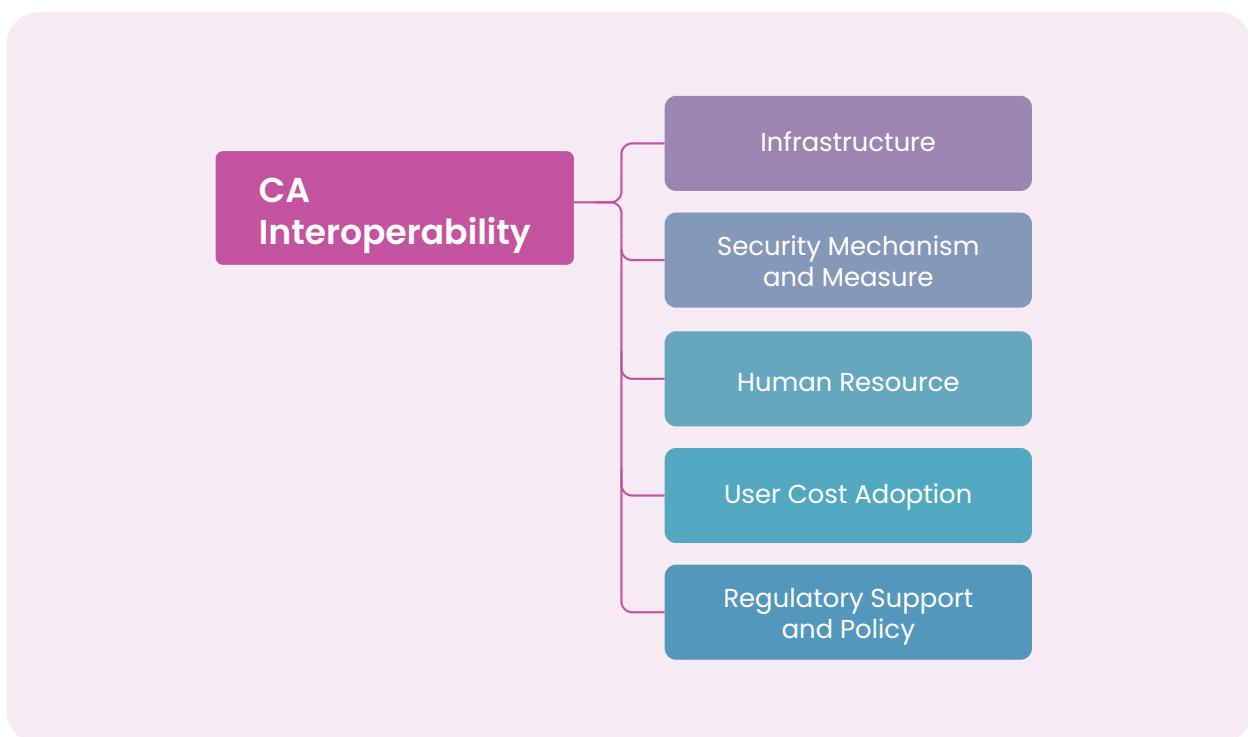


Figure 2: The Capacity of the CA to Meet Current Demand

From the analysis, the security measures and mechanisms significantly enhance the CA's capacity by prioritising the integrity and reliability of its operations. A well-implemented PKI not only bolsters the overall security posture but also directly influences the CA's capacity by streamlining digital certificate issuance and management processes. Concurrently, security mechanisms like firewalls, intrusion detection systems, and endpoint security reinforce the CA's resilience, indirectly impacting its capacity by mitigating potential disruptions from security threats. This integrated approach ensures that the CA operates with heightened security and efficiency, aligning its capacity with the dynamic demands of the digital landscape.

On the other hand, human resources play a pivotal role in determining the CA's capacity. Skilled personnel are indispensable for overseeing, monitoring, and administering the CA's operations effectively. The role of human resources extends beyond operational support to encompass capacity planning, ensuring that the CA is adequately staffed to meet increasing demands while maintaining a high level of security. This comprehensive strategy involves ongoing training and development to keep the workforce abreast of evolving technologies and security best practices, reinforcing the human element as a critical factor in the CA's capacity.

User adoption cost and regulatory support and policy form additional considerations in the holistic approach to the CA's capacity. By streamlining user adoption processes, making them cost-effective, and ensuring regulatory compliance, the CA can collectively enhance its ability to meet current demand. An efficient user adoption process can stimulate widespread acceptance of digital certificates, potentially leading to increased demand. Meanwhile, clear regulatory frameworks provide a stable environment within which the CA operates, ensuring that its capacity aligns with legal requirements and industry standards. As CAs take this comprehensive approach, integrating infrastructure, security, human resources, user adoption strategies, and regulatory compliance, they navigate and effectively address the multifaceted challenges of meeting current demand.

While CAs exhibit varying levels of scalability and automation, the majority are taking proactive measures to prepare for the forecasted medium-term increase in demand. Adopting a holistic approach that integrates infrastructure enhancement, process optimisation, training, and collaboration, these CAs aim to ensure the

continued issuance of secure and reliable digital certificates to meet the evolving needs of the digital landscape. This strategic alignment positions CAs to effectively address the multifaceted challenges associated with meeting current demand.

To establish the relationship between increased digital signature efficiency and interoperability against potentially higher market demand and adoption of digital signatures.

From the analysis, it is expected that the increased in digital efficiency and interoperability lead to higher market demand. The relationship between increased digital signature efficiency, interoperability, and potential market demand and adoption of digital signature is synergistic as shown in Figure 3.

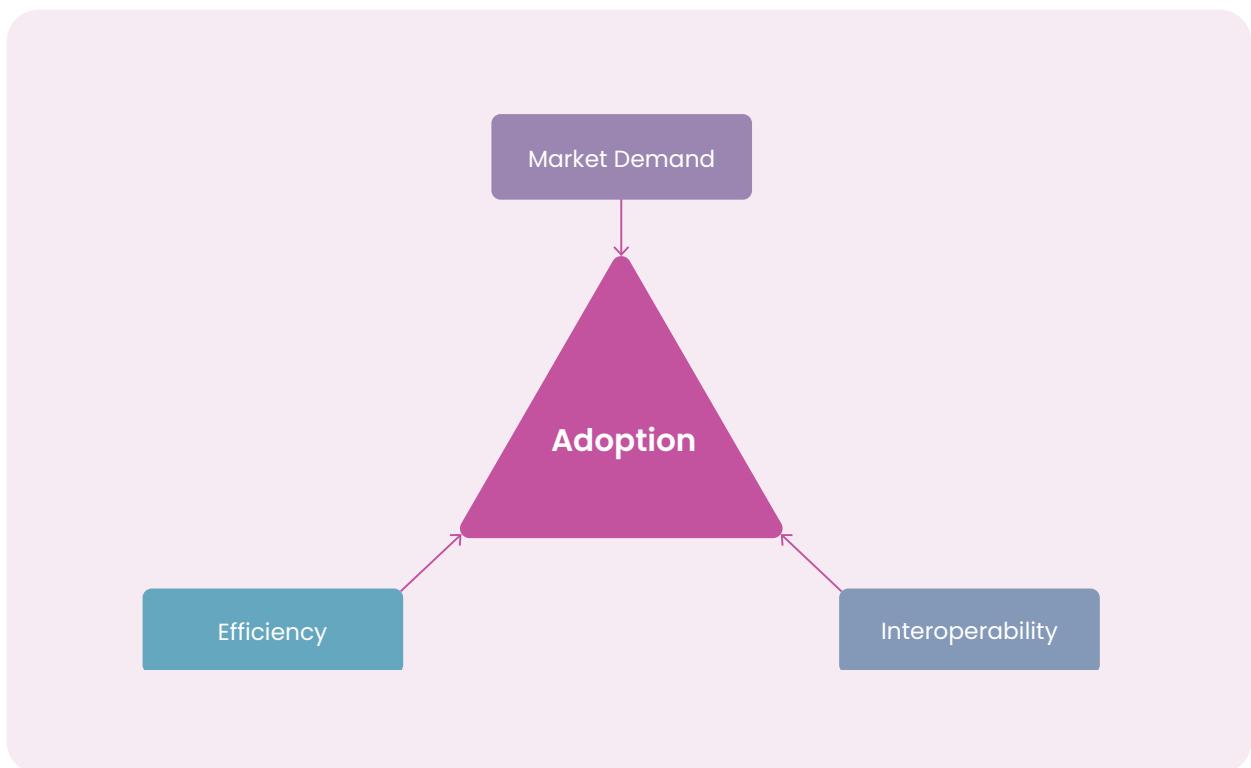


Figure 3: The Relationship Between Increased Digital Signature Efficiency and Interoperability Against Potentially Higher Market Demand and Adoption of Digital Signature

It is also proven true that there is a consensus that digital signatures significantly improve efficiency and productivity in various tasks and workflows. They eliminate the need for physical signing, printing, and scanning of documents, enabling users to sign and approve documents from anywhere with an internet connection (Earl & Kimport, 2011) (Gupta et. al., 2004). Digital signatures also facilitate the enforcement of standard operating procedures (SOPs) by allowing for predefined signing sequences and timestamps, ensuring compliance with regulations.

The analysis also shows there are efforts to promote the adoption of digital signature technology, such as workshops, roadshows, and awareness campaigns. There is a focus on approaching targeted organisations and individuals to demonstrate the benefits and use cases of digital signatures. Trust in digital signature technology is crucial for its adoption. The interviews mention various efforts to inform users about the benefits and limitations of digital signatures. These efforts include social media promotion, workshops, direct pitches to organisations, and proof of concept demonstrations. Compliance with international standards, such as WebTrust certification, is highlighted as a way to ensure trust in digital signature technology (Patton & Jøsang, 2004). Digital signatures are perceived as highly useful and productive, leading to increased efficiency in various tasks, which can drive market demand and adoption. When the market demand for digital transactions rises, efficient and interoperable digital signatures become essential for meeting user expectations, regulatory requirements, and seamless integration with digital workflows.

Thus, the relationship between increased digital signature efficiency and interoperability is crucial for driving higher market demand and adoption of digital signatures. Efficient digital signature processes, coupled with interoperability between different providers and platforms, can enhance user experiences and productivity, ultimately leading to greater trust and adoption of this technology. Efforts to promote digital signatures and build trust among users play a pivotal role in driving adoption within both government and private sectors.

To explore through literature review the best practices on how interoperability has been promoted for Digital Signatures in other countries for potential adoption for Malaysian CAs in promoting digital signatures.

Efforts to enhance CA interoperability are crucial for building a secure and connected digital ecosystem. This becomes particularly relevant as organisations and individuals increasingly rely on digital signatures, secure email communication, and other PKI-based services in their daily operations (Paulus et. al., 2004). Standards organisations and industry collaborations play a significant role in driving interoperability initiatives within the PKI space.

This study analyses CA interoperability models to identify the best model to be proposed to the government of Malaysia. The risk analysis was done based on the CAs interoperability models as shown in Table 4.

RISK CRITERIA / MODEL	ROOT CA / HIERARCHY	CROSS CERTIFICATION (MESH)	CROSS RECOGNITION	BRIDGE CA	CERTIFICATE TRUST LIST
Technical Operability	MEDIUM It can disrupt the entire hierarchy, causing widespread operational challenges.	HIGH Maintaining connectivity and synchronisation across all pairs may pose operational difficulties, especially in large-scale implementations.	MEDIUM Risks related to coordinating and enforcing rules across multiple entities.	MEDIUM TO HIGH If technical issues or resource constraints affect the bridge CA, it can result in operational bottlenecks and impact the overall interoperability.	MEDIUM TO HIGH Lies in the potential lag between a security breach and the update of the trust list.
Cost	LOW Simple, easy system.	HIGH Each pair of CAs must go through expensive process to cross-certify.	LOW TO MEDIUM Coordinating body must enforce rules and audit participants.	MEDIUM Bridge CA has significant workload.	LOW but varies with modes of use.
Scalability	MEDIUM Short and certain certification paths back to trusted root.	LOW Full mesh has n^2 pairs, certification paths may be long.	MEDIUM No technical barriers, but challenging administrative coordination.	MEDIUM TO HIGH Limiting factor is bridge workload.	HIGH Simple, direct trust.
Security risks	HIGH Single breach of root brings down network, subordinate CAs must be re-certified.	LOW Single breach may have no effect on others, or may fragment network.	LOW Depending on level of technical integration, probably no effect on network.	MEDIUM Breach of bridge brings down network, but participants can still operate on their own.	MEDIUM Depending on implementation, may be lag between security breach and list update.

Table 4: Risk Analysis on CA Interoperability Models

From the risk analysis in Table 4, the best model can be suggested for Malaysian CA interoperability is the Bridge model. Choosing the Bridge CA model for CA interoperability in Malaysia has several justifiable reasons. Firstly, this model involves moderate costs, offering a balance between affordability and the structured interoperability framework it provides. The medium to high scalability of the Bridge CA model is beneficial for accommodating a potentially large and growing ecosystem, which is particularly important for a national CA infrastructure (Wazan et. al., 2013). In terms of security, the Bridge CA model carries moderate risks compared to a single root CA. In the event of a breach, participants in the network can still operate independently, minimising potential impacts (World Bank, 2007) (Danquah & Kwabena-Adade, 2020). The structured trust model of the Bridge CA simplifies the establishment of trust relationships, contributing to predictability and reliability within the interoperability framework.

Administratively, the Bridge CA model is more manageable than a full mesh model, making it easier to coordinate and enforce rules (Kakei et. al. 2020). The direct trust relationships inherent in this model enhance simplicity and clarity in the interoperability framework. Additionally, the Bridge CA model offers flexibility in implementation, allowing Malaysia to customise its interoperability framework based on specific technical and regulatory requirements while maintaining a centralised point of trust (Arseni et. al., 2021).

There is a clear trend in the current CA interoperability discussions to move towards the Bridge CA model as depicted in Appendix 2. The Bridge CA may be sitting above the Root CA/Hierarchy, Cross-Certification (Mesh), Cross Recognition, Certificate Trust List models, or even a combination of all of these. It would appear that the main advantage of Bridge CA is the provision of a stable third party to coordinate and promote CA interoperability by whatever means necessary.

In the absence of a Bridge CA, interoperability may fall between the cracks. Individual governments, accreditation agencies and CAs do not have sufficient motivation, skills, or resources to deliver and maintain interoperability (Yang et. al., 2019). In addition, the creation of a bridge allows interoperability to be

achieved through staged testing and upgrades since perfect interoperability does not need to be achieved at once (Ford et. al., 2007).

The potential adoption of the Bridge CA model emerges as a strategic necessity for the government of Malaysia in bolstering its CA interoperability framework. The identified advantages, such as providing stable third-party coordination, promotion of interoperability through various means, and the facilitation of staged testing and upgrades, position the Bridge CA as a pivotal component in ensuring the seamless integration of PKI-based services (Hardin et. al, 2015). The evolving landscape of digital transactions and communications necessitates a robust and adaptive approach, and the Bridge CA model aligns with the current trends in CA interoperability discussions. By embracing this model, Malaysia can not only address the potential pitfalls of interoperability lapses but also promote a standardised and secure digital ecosystem that aligns with global best practices.

To gather input and feedback from CAs on the interoperability among the CAs.

Based on the findings of the interview with the CA, achieving interoperability among CAs in Malaysia is seen as a complex but possible goal. The CAs highlighted four (4) issues and challenges they faced to achieve interoperability. Below are details of the discussion for each identified challenges and issues related to interoperability.

a. Lack of Standardisation in Software

Despite the existence of a standard format like X.509, subtle deviations in implementation can impede seamless communication between different digital signature systems. Standardising certificate formats becomes imperative to ensure a consistent and universally accepted structure, facilitating smoother interoperability. The absence of standardised software implementations across different vendors contributes to interoperability challenges (Jardim-Goncalves et. al., 2006). As CAs employ their own proprietary software for digital signatures, disparities in implementation

may arise, leading to compatibility issues. Addressing this challenge involves advocating for standardised software practices within the industry to enhance the coherence of digital signature systems. The result in this study highlights the importance of standardising software to alleviate interoperability issues.

b. Security Issues

Security and privacy issues arise when different systems interoperate, increasing potential risks. Companies may implement varying security measures based on their specific needs and requirements. This can result in inconsistencies across the organisation, making maintaining a uniform level of protection challenging. In addition, integrating the systems or applications for interoperability purposes can be complex when they have different security protocols (Kouroubali & Katehakis, 2019). Incompatibility between security measures may create vulnerabilities or points of weakness that attackers can exploit. The variations in authentication techniques might influence the overall usability and accessibility of the system.

c. Business Considerations

Interoperability may face resistance from CAs if perceived as conflicting with their business interests. The interviews underscore the importance of assessing the business implications of interoperability. CAs may question the benefits and alignment with their overarching business strategies, emphasising the need for a delicate balance between technological advancements and business considerations. Business considerations affecting interoperability has intersection between technology and business strategy (Agostinho et. al, 2016). It is suggested that a nuanced evaluation of the benefits and alignment with overarching business strategies is crucial for CAs facing interoperability decisions. Therefore, this study proposes that evaluating the perceived benefits and alignment with business strategies is crucial.

d. Business Operation

The issue of the integrity and security of business operations is of paramount importance. The continuity of business operations will be disrupted because

of technological obstacles associated with interoperability (Nepelski, 2019). These challenges mostly pertain to the compatibility concerns arising from digital signature formats and certificate management, particularly in modifying signed documents. This issue is also interconnected with Business Considerations. The possible impact on the company encompasses various variables, including the loss of control and heightened competition.

To provide recommendations on the best practices, standards adoption, and/or policy or legislative approaches for increasing digital signature efficiency, interoperability, and market demand.

The Malaysia acts that specify electronic and digital signatures are highlighted in three (3) documents. Firstly, the DSA 1997 that focuses on the legal recognition of digital signatures and their use in electronic transactions (Kadir, 2012). The act also provides legal recognition to digital signatures and digital certificates. In addition, it establishes the regulatory framework for CAs.

Secondly, the DSR 1998 which is a set of rules made under the DSA 1997. The regulations cover various aspects of licensing, certification, and auditing of digital signature authorities and repositories in Malaysia (Government of Malaysia, 1998). The regulations also specify the approved digital signature schemes and the requirements for key management and storage.

The Electronic Commerce Act 2006 on the other hand addresses various aspects of electronic commerce, including electronic contracts and the liability of network service providers (Government of Malaysia, 2006). The act recognises electronic messages and electronic contracts, as well as addresses the liability of network service providers for third-party content.

This study analyses the governing legislation of ASEAN countries to observe

Malaysian acts against other international best practices and standards. In order to maintain the relevance and effectiveness of the above acts, it is crucial to recommend improvement. There are eight (8) recommendations for improvement as shown in Table 5.

NO	RECOMMENDATION	ACTIVITY
1	Review and Update	Periodically review and update the legislation to keep it in line with technological advancements and changing business practices.
2	Harmonisation with International Standards	Align the legislation with international best practices and standards to facilitate cross-border transactions and enhance interoperability.
3	Enhanced Cybersecurity Measures	Strengthen provisions related to the security of digital signatures and electronic transactions to address evolving cybersecurity threats.
4	Clarity and Simplicity	Ensure that legal language is clear and easily understandable, facilitating broader comprehension and compliance.
5	Incorporate Privacy Protections	Integrate provisions for protecting personal data and privacy in line with contemporary data protection standards.
6	Accessibility and Inclusivity	Consider measures to enhance digital accessibility and inclusivity to accommodate a broader range of users, including those with disabilities.
7	Promote Innovation	Create an environment that encourages innovation in electronic transactions, ensuring that the legal framework does not inadvertently stifle technological advancements.
8	Dispute Resolution Mechanisms	Strengthen mechanisms for dispute resolution in electronic transactions to provide efficient and effective remedies for parties involved.

Table 4: Risk Analysis on CA Interoperability Models

The DSA 1997, DSR 1998, and the Electronic Commerce Act 2006 have played pivotal roles in shaping Malaysia's approach to electronic transactions. However, recognising the constant evolution of technology, it becomes imperative to proactively recommend enhancements to these acts. The eight

(8) identified recommendations, ranging from bolstering cybersecurity measures to fostering innovation, collectively form a roadmap for the necessary modernisation of these long-standing legislations. By embracing these improvements, Malaysia not only aligns itself with international standards but also ensures the continued trust and efficiency of electronic transactions within its borders.

Recommendations

Based on the findings of this study, a Certification Authority Interoperability Framework in Figure 4 is recommended to MCMC to bolster CA interoperability in Malaysia and ensure a robust and secure digital infrastructure to be adopted at the national level. This CA interoperability framework design is critical to enhance the seamless functioning of digital security infrastructures.

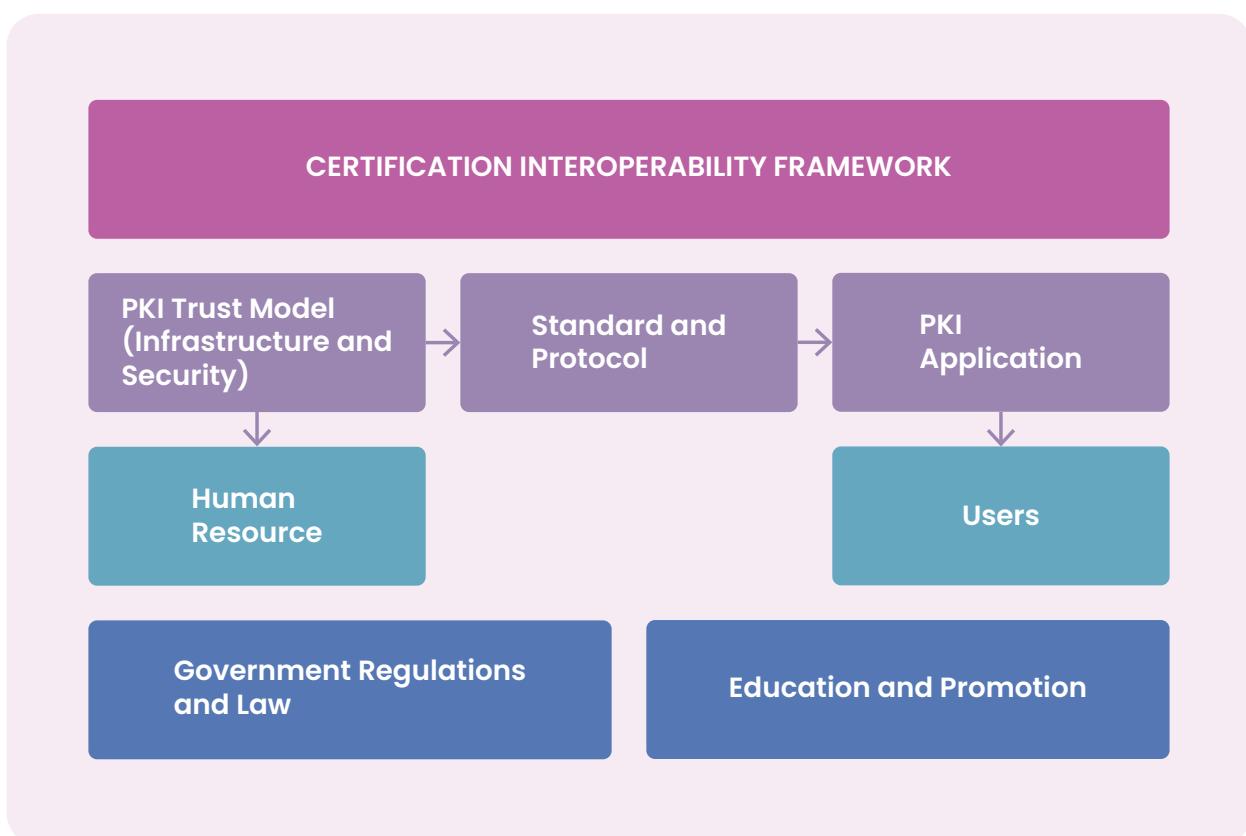


Figure 4: A Proposed Certification Authority Interoperability Framework

The proposed Certification Authority Interoperability Framework presents a comprehensive structure with key components that are instrumental in fostering effective CA interoperability. To fortify this framework, it is recommended to prioritise the PKI Trust Model across all components. This alignment with industry standards ensures a consistent and secure foundation for interoperability, fostering trust in the digital environment. A key focus should be on establishing a robust infrastructure and security measures as foundational elements. Encouraging CA to adopt state-of-the-art security measures is essential to facilitate seamless interoperability without compromising data integrity and confidentiality (Lampathaki, 2011). Additionally, standardising protocols within the framework is crucial, ensuring that PKI applications adhere to common technical standards. This standardisation simplifies communication and data exchange between different CAs and PKI applications, promoting a cohesive and interoperable digital landscape.

In the next layer of framework, lies human resources, which play a pivotal role in the success of interoperable CA systems. To address this, it is recommended to invest in capacity-building initiatives for personnel involved in PKI management. Equipping them with the necessary skills ensures efficient implementation and maintenance

of interoperable systems. Furthermore, a user-centric approach in the design of PKI applications is paramount, prioritising user experience and accessibility to encourage widespread adoption and utilisation by individuals and organisations (Perlman & Kaufman, 2008).

In conjunction, aligning the framework with government regulations and laws is vital as the pillar underpinning the other components. Collaboration with regulatory bodies ensures that policies governing PKI and CA operations are updated to accommodate interoperability requirements, fostering a regulatory environment conducive to secure and standardised digital transactions (Basu, 2004) (Tai & Ou, 2003). Simultaneously, education and promotion initiatives are recommended to raise awareness about the benefits of interoperable CAs and PKI systems. Engaging stakeholders through campaigns and training programmes contributes to building understanding and trust in the security and reliability of interoperable digital signatures.

Collectively, these recommendations fortify the proposed Certification Authority Interoperability Framework, positioning it to meet the dynamic demands of a secure and interoperable digital ecosystem in the ever-evolving landscape of cybersecurity and technological advancements.

Conclusion

In conclusion, this study has provided valuable insights into the dynamic landscape of digital signatures in Malaysia. The findings underscore the growing importance of digital signatures in various sectors, driven by the increasing reliance on digital transactions and the need for secure and efficient authentication processes. The Malaysian digital signature market exhibits promising potential for growth, as businesses and individuals recognise the benefits of enhanced security, reduced paperwork, and streamlined processes.

Furthermore, the examination of the feasibility of CA interoperability has revealed crucial considerations for establishing a more connected and interoperable digital signature infrastructure. The interoperability of CAs is essential for fostering a seamless and trustworthy digital environment, promoting cross-platform compatibility, and ensuring the widespread acceptance of digital signatures.

As the digital landscape continues to evolve, the study highlights the importance of collaboration among stakeholders, including government bodies, businesses, and technology providers, to establish standardised practices and promote interoperability. The implementation of interoperable CAs can contribute significantly to the growth and maturity of the Malaysian digital signature market, fostering trust and confidence among users.

The insights gained from this study provide a foundation for future initiatives aimed at promoting the widespread adoption of digital signatures in Malaysia. By addressing the identified challenges and leveraging the opportunities presented, stakeholders can collectively contribute to the development of a robust and interoperable digital signature ecosystem, ultimately shaping a more secure and efficient digital future for Malaysia.

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APPENDIX 1: Public Key Infrastructure of ASEAN Countries

COUNTRY	PUBLIC KEY INFRASTRUCTURE	CERTIFICATE AUTHORITY (CA)	DIGITAL CERTIFICATES	PUBLIC KEY	PRIVATE KEY
1. Brunei	Asymmetric cryptosystem means a system capable of generating a secure key pair, consisting of a private key for creating a digital signature, and a public key to verify the digital signature.	A person who or an organisation that issues a certificate.	A certificate that a Certificate Authority has issued and which the subscriber listed in it has accepted.	A key listed in the certificate used to verify a digital signature.	A key used to create a digital signature.
2. Cambodia	Public Key Infrastructure refers to an infrastructure which is equipped with technical mechanisms and equipment, staff, policies, and procedures to safeguard the security and safety for management and utilisation of a digital signature.	A legal entity which certifies a digital signature.	Records in a computer system issued by the Certificate Authority to identify the owner of digital signature certificate who is the owner of digital signature verifying key/public key.	Codes in the computer system used for authenticating a digital signature.	Codes in the computer system used for creating a digital signature.
3. Indonesia	N/A	A legal entity that functions as a trustworthy party, which issue and audit Electronic Certificates.	Electronic Certificates: Certificates which are electronic in nature and contain Electronic Signatures and identifies indicating the legal subject statuses/of parties to electronic transactions, as issued by Certification Authorities.	N/A	N/A
4. Laos	N/A	Certification Service Provider: A legal entity or organisation authorised by the Science and Technology Sector to issue secure digital signature certificates and provide related services.	A certificate issued by a legal entity or authorised organisation that provide a secure digital signature certificate.	N/A	N/A
5. Malaysia	Asymmetric cryptosystem means an algorithm or series of algorithms which provide a secure key pair.	A person who issues a certificate to a subscriber upon application and satisfaction of the requirements and upon payment of the prescribed fees and charges.	A certificate that identifies the certification authority issuing it, names or identifies its subscriber, contains the subscriber's public key, and is digitally signed by the certification authority.	The key used to verify a digital signature listed in that certificate.	The key used to create a digital signature.

APPENDIX 1: Public Key Infrastructure of ASEAN Countries

COUNTRY	PUBLIC KEY INFRASTRUCTURE	CERTIFICATE AUTHORITY (CA)	DIGITAL CERTIFICATES	PUBLIC KEY	PRIVATE KEY
6. Myanmar	N/A	A person or an organisation that has been granted a license by the Control Board under this law for services in respect of the electronic signature to issue the certificate to the subscriber.	A certificate issued to a subscriber by the certification authority as an electronic data message or other record identifying the relation between the signer of an electronic signature and the electronic data message.	N/A	N/A
7. Philippines	Asymmetric or public cryptosystem means a system capable of generating a secure key pair, consisting of a private key for creating a digital signature, and a public key for verifying the digital signature.	The authority who issues a digital certificate.	An electronic document issued to support a digital signature which purports to confirm the identity or other significant characteristics of the person who holds a particular key pair.	A key used to verify a digital signature.	A key used to create a digital signature.
8. Singapore	Asymmetric cryptosystem means a system capable of generating a secure key pair, consisting of a private key for creating a digital signature, and a public key to verify the digital signature.	A person who issues a certificate to the subscriber.	A record issued for the purpose of supporting digital signatures which purport to confirm the identity or other significant characteristics of the person who holds a particular key pair.	A key used to verify a digital signature.	A key used to create a digital signature.
9. Thailand	N/A	Certification Service Provider: An organisation who issues digital certificates to subscriber.	A data message or other record confirming the link between a signatory and signature creation data.	N/A	N/A
10. Vietnam	Asymmetric cryptography means any cryptographic system which is capable of creating pairs of keys: private key and public key.	An organisation providing certification service of electronic signature to provide digital signatures certification service.	A form of electronic certificate granted by a certification authority to provide identity for the public key of an entity to certify that such entity is the signer of digital signature by using the corresponding private key.	A key in the key pair of the asymmetric cryptography, used to verify digital signatures.	A key in the key pair of the asymmetric cryptography, used to create a digital signature.

APPENDIX 2: Adopted CA Interoperability Models

NO	COUNTRY	INTEROPERABILITY MODEL	JUSTIFICATION
1	Bosnia and Herzegovina	Root CA/ Hierarchy Model	PKI should have a hierarchical structure. The basis of this hierarchy is the root certification body which should be implemented on the server under the control of the Bosnia and Herzegovina state institution.
2	Canada	Bridge CA Model	Canada would seem to suggest that while a bridge system between CAs is eventually needed, governments start by using a single certificate authority within the government as a shared service provider (as opposed to different institutions having different CAs and trying to connect them together).
3	China	Bridge CA Model	Since there are distributive PKIs throughout different domains, such as government, finance and local systems, Bridger CA is regarded as a proper solution for China PKI interoperability.
4	Germany	Bridge CA Model	In Germany, the bridge CA trust model first appeared to be the best interoperability solution for large networks of PKIs.
5	Japan	Bridge CA Model	In Japan, to keep each local authority as a trust point, and to implement that there is no legally superior body, the Bridge Model is adopted.
6	Romania	Bridge CA Model	By building a CA for each major governmental agency or ministry, Romania can construct a nationwide public key infrastructure which will not have a single point of failure because each of these authorities will be a root CA, and trust will be established by cross-certifying each with the national Bridge CA.
7	Serbia	Bridge CA Model	The model of the interoperability of PKIs in Serbia is based on the bridge model that enables interoperability between the existing and new PKI domains of different architectures as well as their connection with international PKI domains.
8	Singapore	Cross Recognition Model	An individual CA or an entire PKI domain agrees to recognise another CA or domain rather than building from a lower-lever technical solution in Singapore.
9	South Korea	Cross-Certification (Mesh) Model	Cross-certification is relatively simple and made with the procedure of issuing certificates in one (1) way or another between CAs that are only to establish trust points in South Korea.
10	Sudan	Root CA/Hierarchy Model	In Sudan, the Hierarchy model has many advantages such as (1) application support, (2) the root CA is used very infrequently; its job is mainly to certify and to revoke the subordinated CAs, (3) half of the path validated, and (4) no need for path construction.

APPENDIX 2: Adopted CA Interoperability Models

NO	COUNTRY	INTEROPERABILITY MODEL	JUSTIFICATION
11	Taiwan	Bridge CA Model	Since there are distributed PKIs throughout different domains, such as government, finance and healthcare systems, BCA is regarded as a proper solution for Taiwan.
12	United Arab Emirates	Root CA/Hierarchy Model	The Government Root Certification Authority is intended to be the highest Certification Authority in the hierarchical structure of the Government Public Key Infrastructure in the UAE. The high-level UAE PKI architecture will encompass a root and multiple certified subordinate CAs' to support their own PKI policy and function.
13	United States	Bridge CA Model	In the US, Bridge CA leverage the emerging federal agency PKIs to create a unified federal PKI, to limit the workload on agency CA staff, to support agencies' use of any FIPS-approved cryptographic algorithm and a broad range of commercial CA products, and to propagate policy information to certificate users in different federal agencies.

TOPIC 03

Digital Healthcare Adoption by Malaysian Senior Citizens: Its Challenges, Needs, and Future Action

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Abstract

Malaysia is already experiencing population ageing, with 7.4 per cent of the population aged 65 years and over in 2023. As Malaysia heads towards an aged society, policies are needed to better prepare seniors for healthy ageing. Digitalisation promises to improve seniors' well-being and promote ageing in place. Through digital healthcare services, seniors can easily access health-related information, telemedicine services, fitness applications, etc., that enable them to manage their health actively. However, the digital divide among seniors may result in slower adoption of digital services. This research project aims to study the state of digital healthcare services adoption rate among seniors in Malaysia, to understand the challenge of digital healthcare adoption, to identify the current and future needs of digital healthcare services, and to provide general recommendations on addressing the digital healthcare gaps. A mixed mode approach, which comprises both survey and interview, was adopted in this research. A total of 404 responses were collected through the survey, and 22 interviews were conducted. Based on the data collected, it is found that most seniors are open to adopting these technologies, provided that training or technical support is available. Furthermore, six (6) building blocks that support the adoption of digital healthcare services among senior citizens in Malaysia were proposed: digital infrastructure, digital literacy, health literacy, awareness, needs, and the senior's perception. Finally, general recommendations were proposed to relevant stakeholders to spur the adoption of digital healthcare, including healthcare professionals, digital healthcare service entrepreneurs/developers, payers' organisations and authorities, community organisations, telecommunication companies, and policymakers.

Introduction

In Malaysia, the percentage of the population aged 65 years and over has increased from 7.2 per cent to 7.4 per cent from 2022 to 2023 (Department of Statistics Malaysia, 2023). This indicates that Malaysia is already experiencing an ageing society. The World Bank further estimated that the rate of ageing would increase in the coming years, and the share of the population aged 65 and above is projected to double to 14 per cent by 2044 and reach 20 per cent by 2056 (Schmillen, 2020).

As the population ages, the demand for primary and specialist healthcare resources increases. Seniors, as the most significant users of healthcare services, could greatly benefit from the digitalisation of healthcare services. Digital healthcare refers to a field of knowledge and practice using digital technologies for health preferences (Borle et al., 2021). It has paved the way for new types of innovative services and is expected to deepen the development of the Internet setting with novel electronic devices. For instance, the advancements in digital technologies, including the Internet of Services (IoT), virtual care, remote monitoring, Artificial intelligence (AI), big data analytics, blockchain, and smart wearables, have

shown immense potential in enhancing healthcare delivery. Healthcare professionals can interact with patients remotely through computers, tablets, and smartphones, breaking geographical barriers and enabling faster medical attention (Haleem et al., 2021).

Nevertheless, digital healthcare is a double-edged sword: it has the potential to reduce health inequalities by increasing access to healthcare, but it also holds the capacity to exacerbate inequality in access to healthcare (Barnett, Mishuris, et al., 2022). Seniors equipped with the necessary infrastructure and digital skills are likely to reap the benefits of digital healthcare. However, those not tech-ready may be left out, putting them at an even greater risk of unmet healthcare needs. In other words, ensuring the digital inclusion of seniors is the key to delivering equitable healthcare and promoting healthy ageing among seniors.

Seniors' adoption of digital technologies is lower than that of younger adults due to multiple reasons (Abouzahra & Ghasemaghaei, 2022). According to the Malaysian Communications and Multimedia Commission (MCMC) Internet Users Survey 2020, over half of adults aged

60 and above (51.8 per cent) do not use the Internet (MCMC, 2020), highlighting the digital divide between different age groups. To bridge the digital divide, assessing senior citizens' challenges and the need to adopt digital healthcare is crucial (Zainal et al., 2023). Through a better understanding, policymakers can formulate a proper intervention promoting equal healthcare access among seniors.

The following are the four (4) research objectives (RO) in this research:

RO 1 To study the state of the adoption rate of digital healthcare services among seniors in Malaysia.

RO 2 To understand the challenges of digital healthcare adoption among senior citizens in Malaysia.

RO 3 To identify the current and future needs of digital healthcare services that will benefit and improve the daily lifestyle of senior citizens in Malaysia.

RO 4 To provide general recommendations on addressing digital healthcare gaps as inputs to MCMC and critical stakeholders to spur the adoption of digital healthcare among Malaysia's senior citizens.

Literature Review

Digital healthcare has enormous potential to facilitate independent living and enhanced access to health and assisted living services. Digital health services encompass a wide range of services, such as telemedicine, e-pharmacies, health management services, and digital health insurance (Sit, 2021). Some of these platforms in ASEAN countries include Halodoc (Indonesia), MyDoc (Singapore and Vietnam), Doctoroncall (Malaysia), Medgate (the Philippines), and Raksa (Thailand).

One of the critical barriers to the use of technology is the impact of poverty and the financial implications of relying on technology that may be expensive to purchase, maintain, or keep connected (Moody, 2022). This is relevant because seniors typically have limited or no fixed income as they are retired.

Studies have also indicated that seniors do not use digital healthcare services simply because they are unaware of the opportunities (Kaihlanen et al., 2022; Sourbati, 2009). Also, the adoption of digital healthcare relies heavily on trust to succeed (Adjekum, 2018). A lack of trust in the digital healthcare system will significantly hinder the adoption of digital healthcare.

Ageing also brings about physiological and psychological changes, such as poor eyesight, hearing loss, memory loss, difficulty acquiring new information, feelings of inadequacy, and lack of interest in learning. These have led to other barriers, such as low digital literacy and poor representation of their need in the digital platform (Liljeroos, 2023). In addition, many must rely on family members for support and guidance. Some have encountered difficulties getting the understanding and patience from family members while learning to use healthcare technology (Ocloo, et al., 2021).

To facilitate the adoption of digital healthcare among senior citizens, digital healthcare services or platforms need to consider the specific needs of the seniors. The digital healthcare services should reflect their needs through a better interface design, including content that aligns closely with their needs or a better integration into the existing health systems.

In addition, the availability of dedicated counsellors to train and educate seniors and provide continuous support could greatly impact the uptake of digital healthcare (Wilson et al., 2021). Additionally, financial support was also highlighted as an important facilitator in the update of digital health technologies. Although digital healthcare tools have the potential to be useful, senior citizens might need time to overcome their fears and adopt digital healthcare tools (Safarov, 2021).

External factors such as policy and legislation, the available incentives, and the level of public awareness were also found to significantly impact the digital healthcare uptake (Coves, 2022). Customised strategies, greater integration of technologies, and well-planned training are essential enablers to facilitate the successful implementation of digital healthcare among senior citizens (Hung, 2022; Watt, 2022).

Numerous countries have implemented initiatives to encourage the adoption of digital healthcare among the elderly. In Singapore, the “Seniors Go Digital” programme was launched to accelerate the digital adoption of seniors through large-scale direct interaction with them. Through this programme, seniors can sign up for government-subsidised smartphone and mobile plans and learn basic digital skills under the close personal guidance of the Digital Ambassadors (Perdana, 2022).

Similarly, Australia’s “Be Connected” programme adopts a community-centred approach to assist older Australians in learning the basics of digital technology. The programme offers free online learning resources and free computer classes run by community organisations across Australia. (Department of Social Services, 2022).

Instead of using a bottom-up approach to encourage public adoption of digital healthcare services, Estonia and Sweden focus on top-down strategies. These strategies aim to enhance national IT infrastructure in terms of interoperability and system integration. Elsewhere in Germany, given the population’s high digital health readiness, digital health services, especially electronic health record solutions (EHRs) and e-prescriptions are very popular (Thiel et al., 2018).

In Germany, digital health applications can apply to be in a listing of DiGA – high-quality approved digital health applications (DHAs). DiGA has been integrated into standard care by law. Under this Act, healthcare professionals can prescribe DHAs to patients with costs covered by the national health system (Wangler, 2023).

In Malaysia, there are many programmes available to teach seniors Digital technologies. These programmes are organised by different organisations/committees such as MyAgeing™, the Digital Technologies Seniors Programme (DTSP), *Pusat Aktiviti Warga Emas* (PAWE), members of Parliament, and state assembly members. Of the above, except for PAWE centres which are by the Social Welfare Department, most programmes are often self-driven initiatives and are not part of a centralised government campaign. Recently, Malaysia has also started introducing cheaper WiFi packages for seniors, such as Pakej Perpaduan (Rahmah) Fibre Broadband.

Methodology

This research adopts a mixed-methods approach that combines both qualitative and quantitative methodologies. In this study, two (2) research instruments were developed to collect the relevant data to answer the research objectives and questions, i.e., the survey questionnaire and interview questions. The survey questionnaire consists of four (4) sections: demographic information, the state of digital technology usage, the perception of digital healthcare services, and the challenges and recommendations of adopting digital healthcare services. A semi-structured interview using a qualitative approach was used to identify the challenges, needs, and potential solutions of adopting digital healthcare services. The questions are loosely structured and give interviewees more opportunities to express themselves fully.

Survey questionnaires were targeted to Malaysian seniors aged 60 and above. Malaysian seniors comprise 11.1 per cent of the total Malaysian population, equivalent to 3.6 million people (Baharudin et al., 2022). To ensure sufficient sample collection, a minimum of 384 participants are sought (Krejcie & Morgan, 1970). Both online and hardcopy surveys are distributed across all states in Malaysia.

Purposive sampling is adopted when selecting the informants for qualitative interviews. The sample locations are Selangor, Kuala Lumpur, Johor, Pulau Pinang, Perak, Kelantan, Sabah, and Sarawak. The senior respondent selection is based on three (3) primary criteria to ensure significant variation: experience in using digital healthcare services, age, and gender. The saturation point will determine the final number of participants, where further data collection would not contribute significantly to the overall understanding of the topic. (Strauss and Corbin, 1998). Besides seniors, interviews were also performed with healthcare providers, not-for-profit organisations, and caretakers so that inputs from various stakeholders were considered.

The data collected through the survey questionnaire is analysed using univariate techniques and descriptive statistics. The audio recordings collected from interviews were transcribed and translated verbatim. The researchers then looked for emerging codes and grouped them into relevant themes. The interview transcriptions were also analysed using the qualitative data analysis software NViVO.

Findings and Analysis

Demographic information

A total of 404 responses were collected from the survey. Among the survey respondents, 208 (51.6 per cent) were female and 195 (48.4 per cent) were male. 47.9 per cent of the respondents are aged 60 to 64. More than half of the respondents (54.1 per cent) only received secondary education or lower. Table 1 shows the socio-demographic characteristics of the respondents. While the researchers have made the best effort to avoid coverage error, the responses gathered from the survey do not reflect the per capita ratio of the elderly in each state and the place of residence. These results, therefore, should be interpreted with caution.

VARIABLE	CATEGORY	FREQUENCY	%
Age	60 - 64	193	47.9
	65 - 69	106	26.3
	70 - 74	53	13.2
	75 - 79	31	7.7
	80 and above	20	4.9
Gender	Female	208	51.6
	Male	195	48.4
Ethnicity	Malay	197	48.9
	Chinese	156	38.7
	Indian	42	10.4
	Others	8	2.0

VARIABLE	CATEGORY	FREQUENCY	%
Place of Residence	Federal territory of Kuala Lumpur	23	5.7
	Johor	17	4.2
	Kedah	28	6.9
	Kelantan	61	15.1
	Melaka	10	2.5
	Negeri Sembilan	14	3.5
	Pahang	26	6.5
	Penang	28	6.9
	Perak	72	17.9
	Sabah	7	1.7
Type of Residence	Sarawak	27	6.7
	Selangor	69	17.1
	Terengganu	21	5.2
	Urban	210	52.1
Education Level	Suburban	129	32.0
	Rural	57	14.1
	Remote	7	1.7
	Primary school	70	17.4
	Secondary school	141	35.0
	Diploma	61	15.1
	Bachelor's degree	79	19.6
	Master's degree/Professional qualification	34	8.4
	Doctor of Philosophy	11	2.7
	None	7	1.7

VARIABLE	CATEGORY	FREQUENCY	%
Total number of family member(s) living under the same roof	1	36	8.9
	2	75	18.6
	3	97	24.1
	4 and above	173	42.9
Health condition (self-rated)	None	22	5.5
	Very good	45	11.2
	Good	246	61.0
	Fair	95	23.6
	Poor	17	4.2

Table 1: Socio-demographic of the survey respondents (n=404)

For the qualitative study, 22 volunteers participated in the interviews, comprising 17 elderly people, two (2) digital healthcare providers (Angsana Health, doc2us), two (2) not-for-profit organisations (MyAgeingTM, DTSP), and one (1) caretaker. Table 2 summarises the demographic information of the senior interviewees.

VARIABLE	CATEGORY	FREQUENCY	%
Age	60 - 64	7	41
	65 - 69	4	24
	70 - 74	2	12
	75 - 80	4	24
Gender	Female	9	53
	Male	8	47
Ethnicity	Malay	8	50
	Chinese	6	40
	Indian	3	10
Place of Residence	Federal territory of Kuala Lumpur	3	18
	Johor	2	12
	Kelantan	3	18
	Penang	2	12
	Perak	2	12
	Sabah	2	12
	Sarawak	1	6
	Selangor	2	12
Tech Savvy	Yes	14	82
	No	3	18

Table 2: Demographic of the senior interviewees (n=17)

Among the 17 senior interviewees, three (3) (18 per cent) have no basic digital skills and do not own or operate a smartphone alone. Among the 14 senior interviewees with digital skills, four (4) (29 per cent) have experience using DHS other than MySejahtera, while 10 (53 per cent) did not use any DHS.

The state of digital healthcare services adoption

Table 3 shows the survey respondents' adoption of digital tools. Among the 404 survey respondents, 357 (93.1 per cent) own a technological device and 316 (78.4 per cent) use the Internet daily.

VARIABLE	CATEGORY	FREQUENCY	%
Own Technological Device (e.g., smartphone, PC, or laptop)	Yes	375	93.1
	No	28	6.9
Frequency of Internet Use	Daily	316	78.4
	A few times a week	41	10.2
Assistant is available when facing difficulties using digital technology (e.g., from friends, children, etc.)	About once a week	9	2.2
	Less than once a week	14	3.5
	Never	23	5.7
Assistant is available when facing difficulties using digital technology (e.g., from friends, children, etc.)	Yes	368	91.3
	No	35	8.7

Table 3: The Adoption of Digital Tools

Figure 1 shows the digital skills of the survey respondents. About 85 per cent (345) of the respondents could communicate through instant messaging applications such as WhatsApp and Messenger. This is followed by online search information (62 per cent) and uploading photos and videos (51 per cent). Less than half of the respondents can join video calls on Zoom, Microsoft Team, etc., and perform online purchases and cashless payments. Less than one-third of the respondents can install software or mobile applications in their digital tools and edit documents, photos or videos. Approximately eight per cent of the respondents do not acquire any digital skills mentioned above.

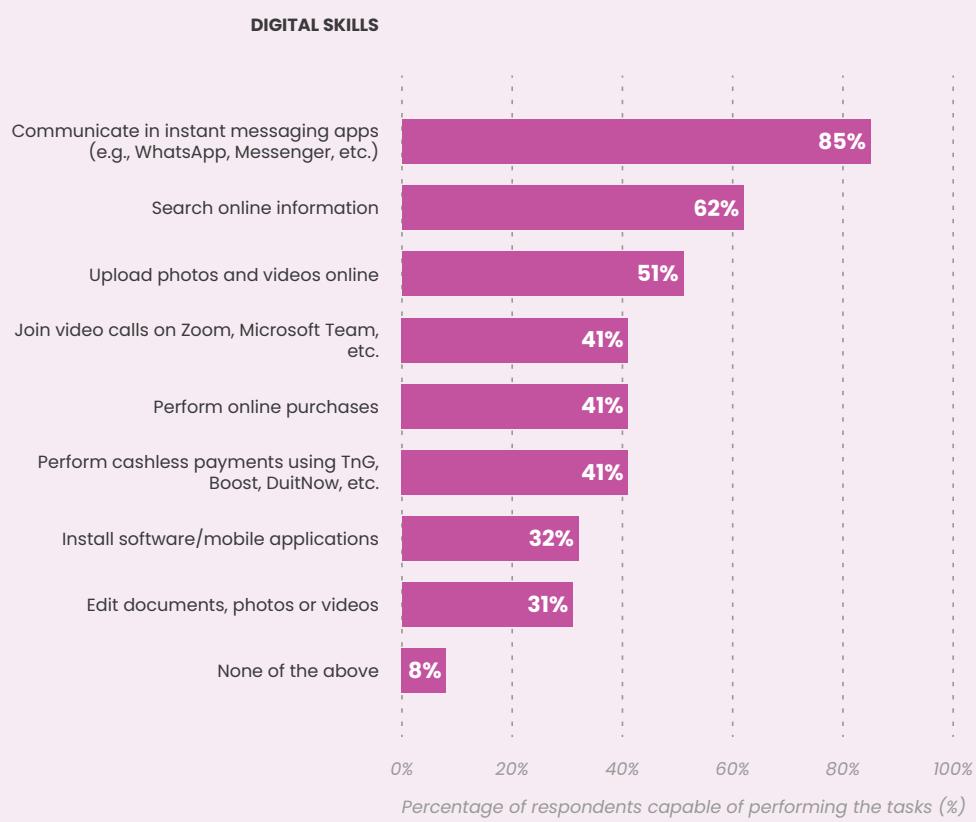


Figure 1: Digital skills of the survey respondents

The digital skills in Figure 1 were further grouped and analysed according to the respondents' demographic characteristics. Although younger seniors have higher digital skills than older seniors, the age factor alone is insufficient to explain the digital divide. A cumulative number of factors such as education level and the type of community, influence digital skills. For example, as seen in Figure 2, respondents living in urban and suburban areas have been found to have better digital skills compared to those who live in rural and remote areas. Nonetheless, the respondents from rural and remote areas only comprised 15.8 per cent of the total. Further studies focusing on rural and remote areas are needed to confirm the findings.

Among the factors, the frequency of Internet usage (Figure 3) and whether the seniors own any technological device were two (2) factors that have been found to correlate strongly with digital skills. This indicates that for seniors to be equipped with good digital skills, owning a technological device and having Internet access are the most important prerequisites.

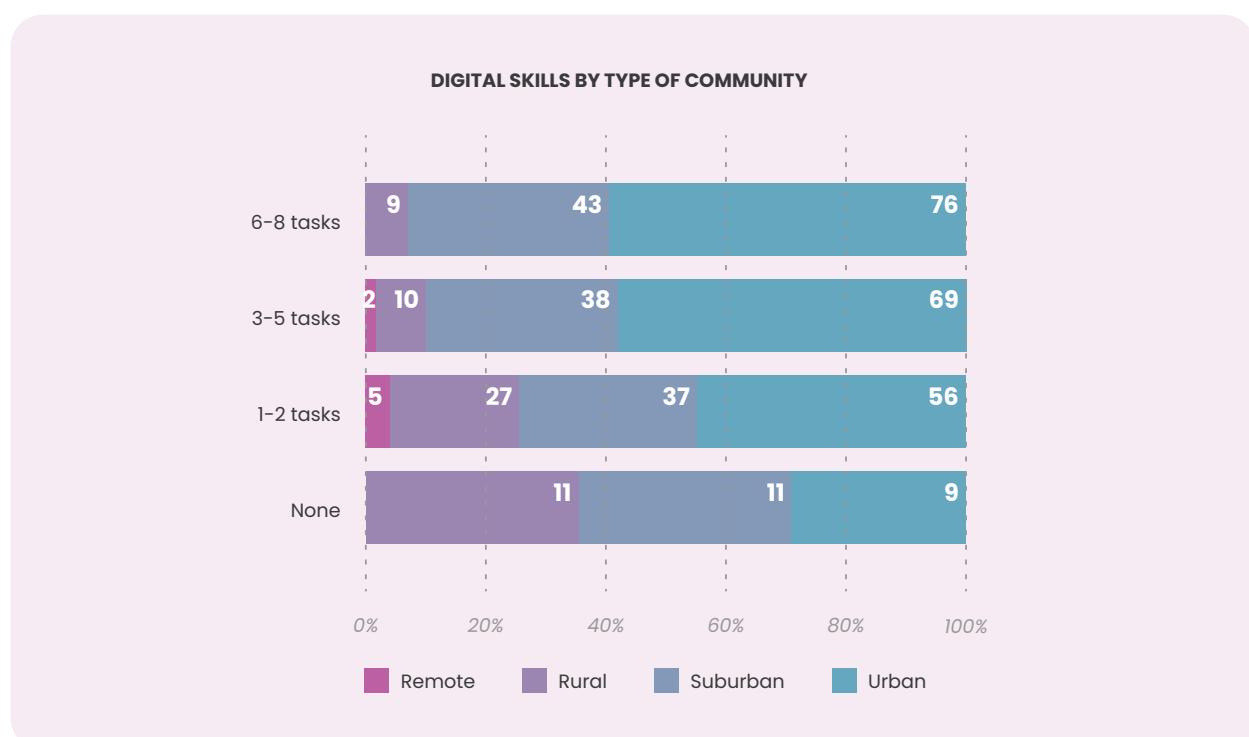


Figure 2: Number of tasks the survey respondents can perform by type of community

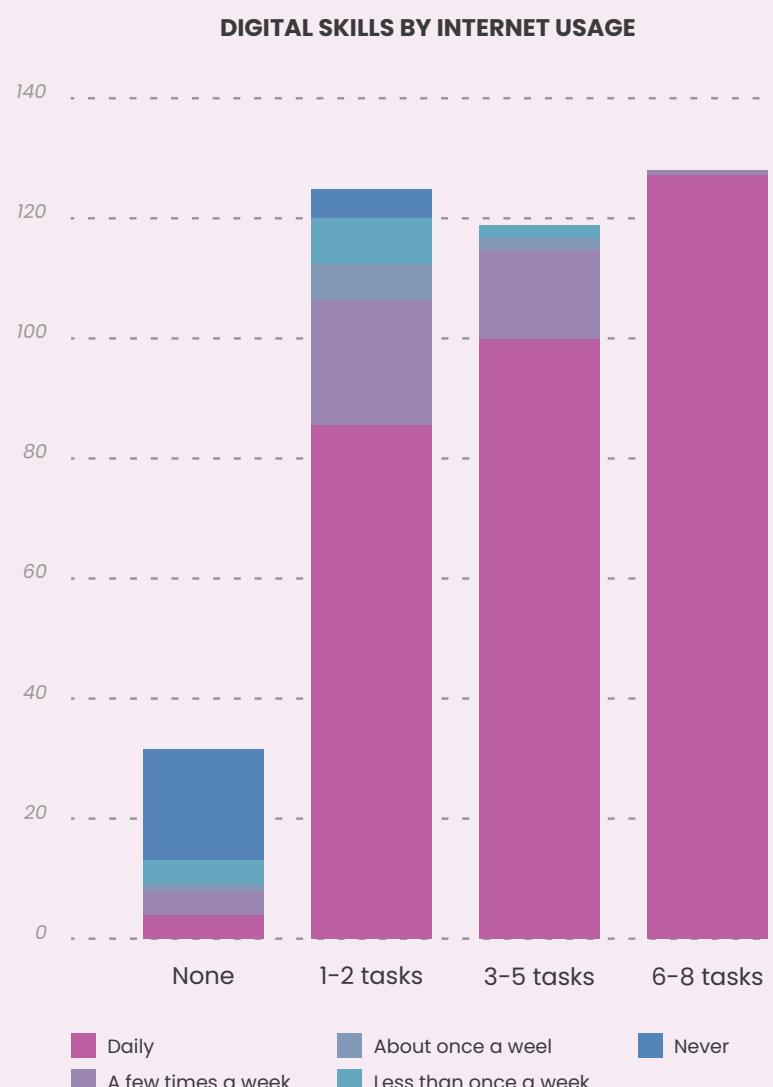


Figure 3: Number of tasks the survey respondents can perform by Internet Usage

Figure 4 shows that more than half of the respondents did not use any digital healthcare services during the survey. The most used digital healthcare services are online appointment bookings (25 per cent of the total respondents), followed by instant messaging with healthcare providers 23 per cent) and wellness monitoring applications (20 per cent). It was found that age does not influence the type of digital healthcare services they use.

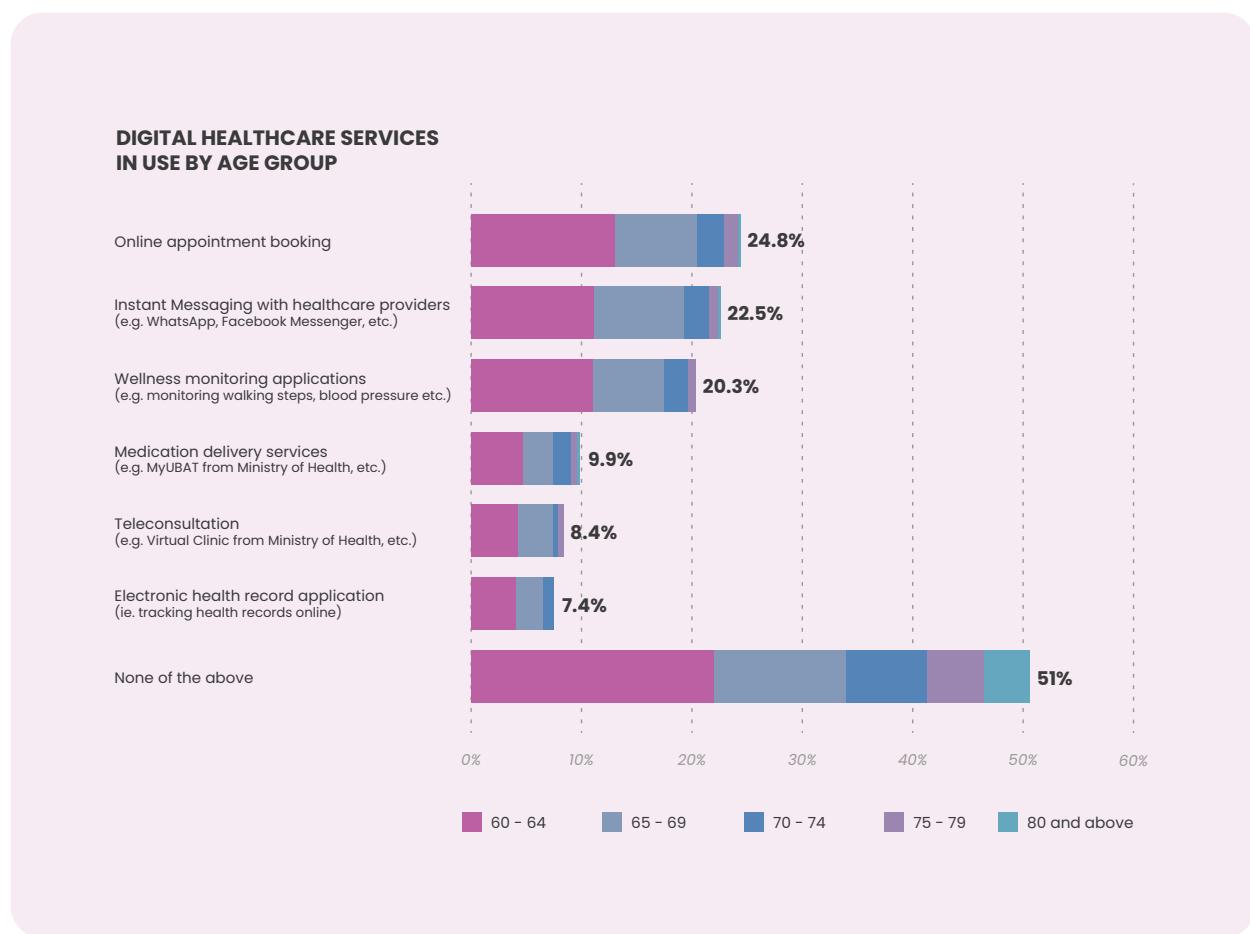


Figure 4: The digital healthcare services used by the respondents according to their age group

Figure 5 presents the survey results on why the respondents did not use digital healthcare services. 59 per cent of respondents prefer face-to-face healthcare consultation, 53 per cent are unaware of any digital healthcare services, and 44 per cent are concerned about their privacy and data security. Other than the barriers listed above, interview respondents have also expressed that physical and cognitive impairments such as poor eyesight, shaky hands, and forgetfulness are some barriers to adopting digital healthcare services.

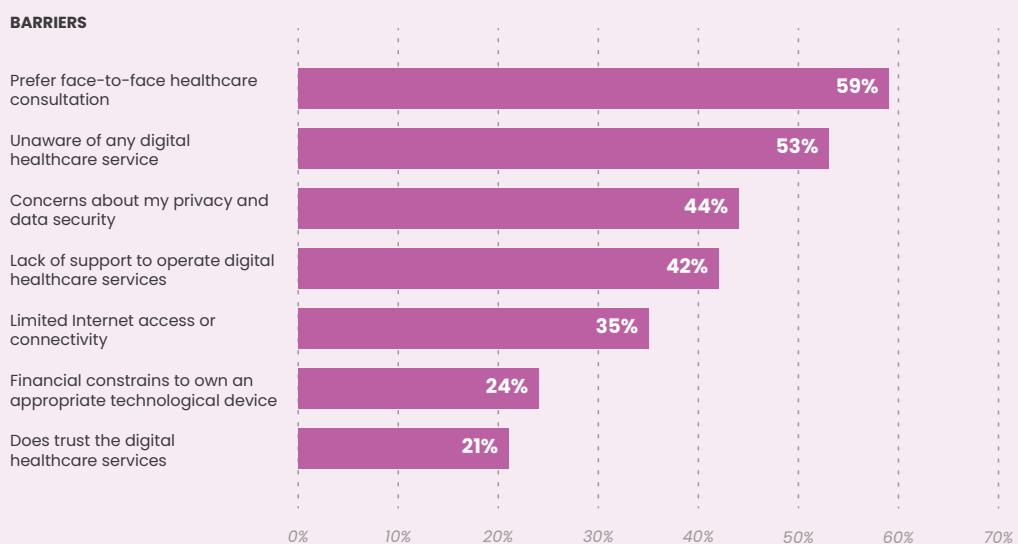


Figure 5: The reasons for not using digital healthcare services

Based on the data from Figure 6, the survey respondents are more likely to adopt digital healthcare services if they save time (64 per cent), are convenient and easy to use (63 per cent), and are recommended by healthcare professionals (51 per cent).

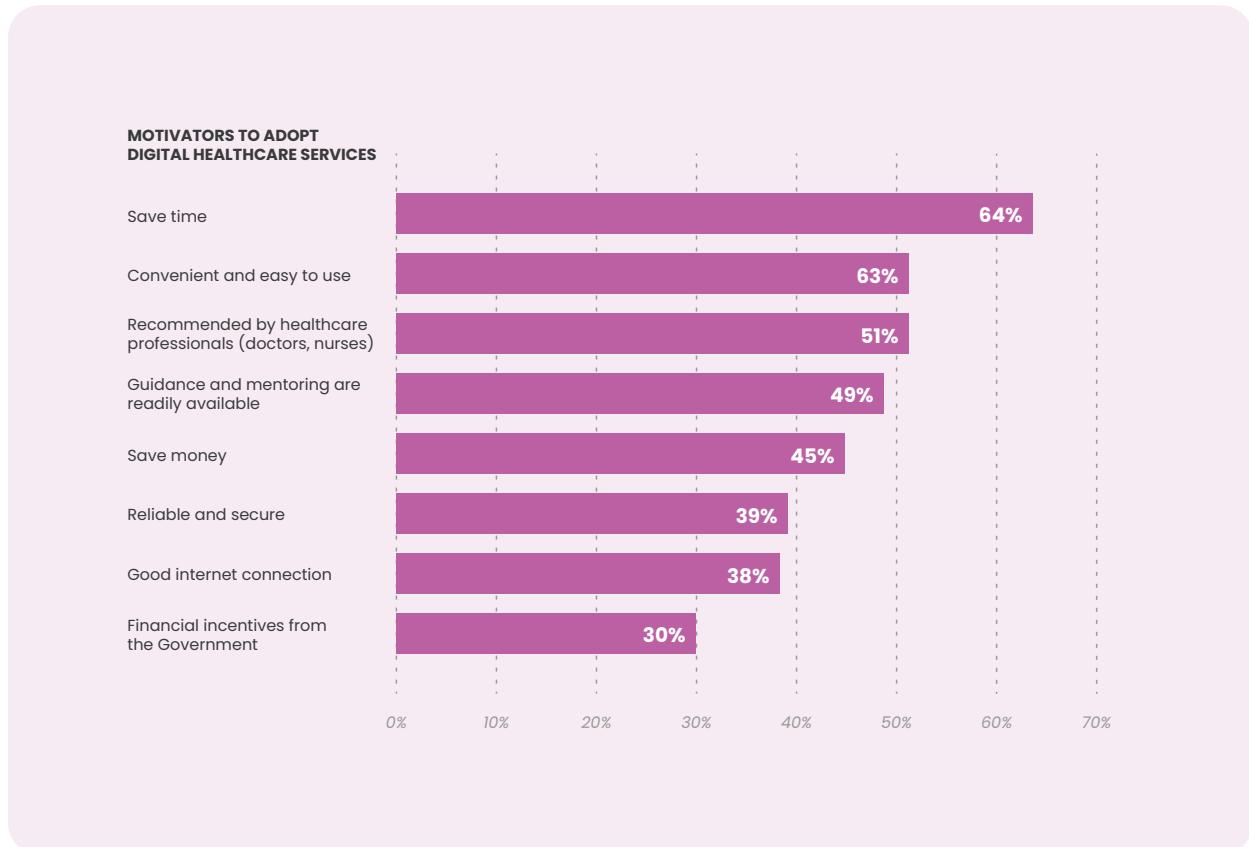


Figure 6: Reasons that will motivate the respondents to adopt digital healthcare services

Nonetheless, seniors who can adopt digital healthcare could be more if they are aware of the opportunity and perceive the digital healthcare services as useful. This is because 62 per cent of the survey respondents can perform three (3) or more digital tasks, but only less than half of the respondents use the DHS listed in Figure 4. This finding is also validated through interviews whereby many volunteers are unaware of the digital healthcare services they can use.

The interview transcriptions were analysed using thematic analysis. The text data were further categorised into subcategories. The categories are digital infrastructure, digital literacy, health literacy, user interface design and functionality, digital trust, and lack of awareness. It is also important that digital healthcare services be quality, accessible, affordable, and trustworthy.

Recommendations

Based on the findings, six (6) building blocks that support the adoption of digital healthcare services among senior citizens in Malaysia were proposed. They are digital infrastructure, digital literacy, health literacy, awareness, needs, and perception. These building blocks are illustrated in Figure 7.

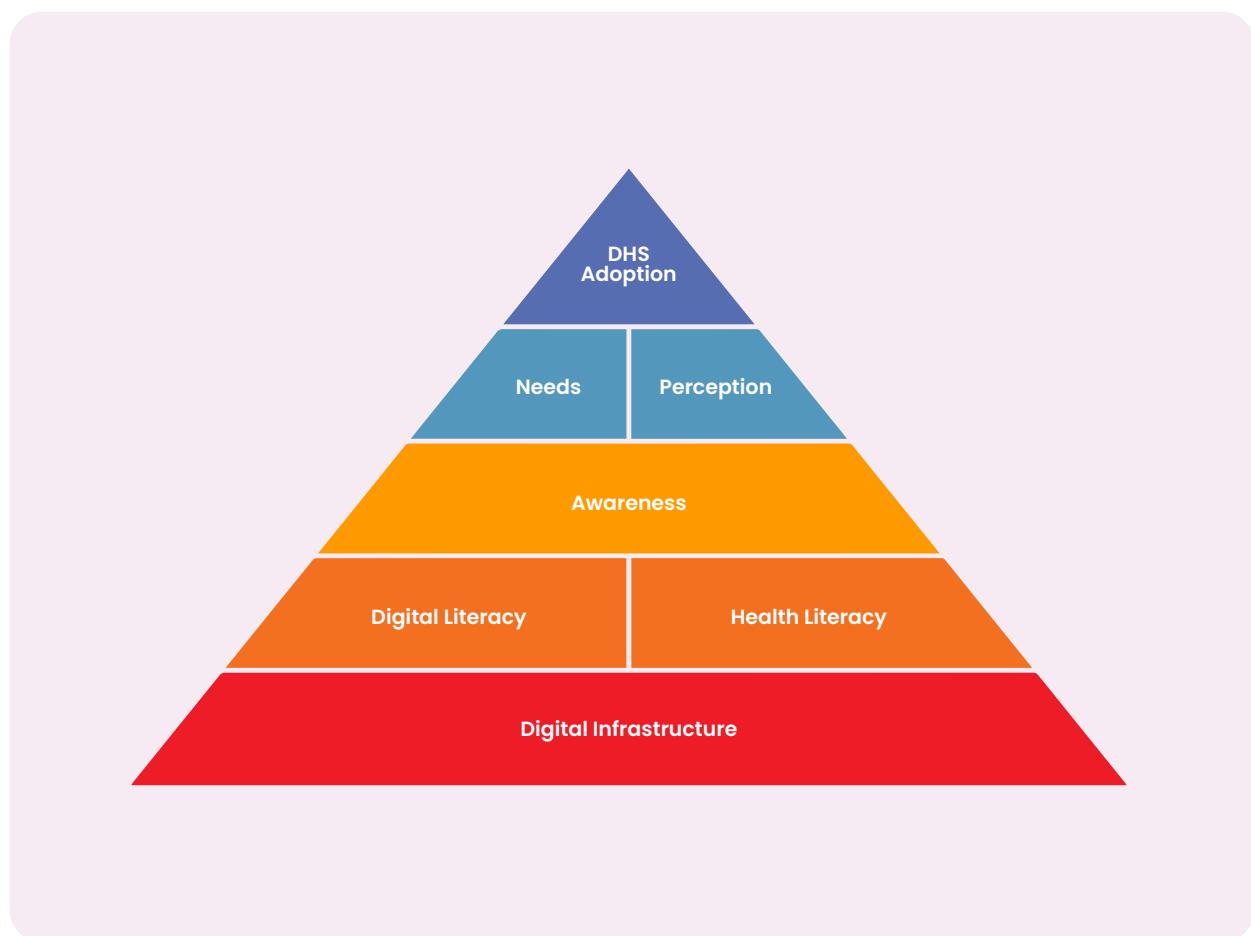


Figure 7: The building blocks towards digital healthcare services adoption among senior citizens

DIGITAL INFRASTRUCTURE

Digital infrastructure is often interpreted as the hardware, software, and organisational and institutional settings for transferring, storing, accessing, processing, and/or using digital data (Scholz et al., 2018). Physical digital infrastructure includes internet broadband, mobile telecommunication, digital communication suites, data centres and networks, etc. In addition, there is a growing perception that data, too, is an infrastructure, as a deemed 'raw' material for data-driven innovation (Ducuing, 2020).

Lack of access to digital technologies has remained one (1) of the critical contributors to the digital divide (Saeed, 2021). This occurs due to the cost of technology, insufficient broadband access, and the use of lower-performing devices (Saeed, 2021). Moreover, many digital healthcare systems, such as remote monitoring and telehealth, necessitate consistent, reliable service and speed (Shahid, 2022). Thus, it is evident that incorporating the construction of supportive digital infrastructures is necessary, which was also a key strategic focus in the MyDigital initiative.

In Malaysia, due to the effort made by the *Pelan Jalinan Digital Negara* (JENDELA), quality access to digital connectivity has been improved nationwide. However, senior citizens may not benefit from the

recent changes due to low awareness of the opportunities and support available to them. A proactive approach is needed to inform the senior citizens of the cost involved and acquisition methods to upgrade their digital tools. These include setting a task force in health clinics to answer their questions on "Can I afford it?", "How do I buy it?", and "How do I select the right product?" (Akinola, 2021). This should be accompanied by a subsidy programme to help seniors in need.

Regarding Digital Healthcare, interoperability has emerged as one (1) of the most important success criteria. Interoperability is a prerequisite for digital innovations such as artificial intelligence, big data, or mobile applications (Lehne, 2019). Uncovering the full potential of digital medicine requires an interconnected data infrastructure with fast, reliable, and secure interfaces. Medical data hidden in isolated databases, incompatible systems, and proprietary software are difficult to exchange, analyse, and interpret.

In addition, health data are classified as sensitive personal data and require high safety and security standards. Digital healthcare service providers and the users in the interoperable digital health ecosystem should undergo a reliable digital identification, authentication, and authorisation mechanism that guarantees

trust in the exchange of health data and aligns with nationally appropriate means (WHO, 2021).

In general, a standardised technology architecture for digital healthcare in Malaysia needs to be proposed. More studies are required to investigate the readiness of Malaysia's healthcare facilities in digital transformation, the opportunities for integrating disruptive technology into healthcare services, and the implementation strategy for successful digitalisation.

DIGITAL LITERACY

Digital literacy entails the ability and skills to create, assess, acquire information, and learn from online sources and digital platforms using technology. Many older individuals may lack familiarity with technology, struggle to navigate digital interfaces, understand medical applications, or engage effectively with online health resources. This lack of digital literacy can result in scepticism, fear, or reluctance toward adopting digital healthcare solutions. By enhancing their digital literacy, seniors gain the skills and confidence to utilise these services effectively.

Bridging this gap requires comprehensive education and support programmes tailored to seniors, empowering them

with the necessary skills and confidence to effectively navigate and utilise digital health tools. This can be achieved through training programmes and outreach programmes targeting different groups of seniors.

Training involves educational programmes, workshops, or activities designed specifically for senior citizens who need to enhance their skills, knowledge, and abilities in navigating digital healthcare services. For instance, the training programmes can teach seniors how to use computers, smartphones, the Internet, social media, or specific applications to help them manage their healthcare needs. The setting of the training sessions must be customised to suit the senior citizens.

For effective adoption of digital tools, structured training should also be complemented by outreach programmes. Outreach programmes are organised initiatives or activities designed to engage specific target groups or communities outside typical institutional or organisational settings. These programmes aim to connect with, educate, assist, or provide resources and services to individuals who might not otherwise have access or exposure to such opportunities. Outreach programmes are crucial so that no one is left behind.

Improving digital literacy was more effective with peer influence and community support. Therefore, it is worthwhile to invest in community organisations that aim to strengthen the social bond within the community.

HEALTH LITERACY

Health literacy refers to the ability of individuals to gain access to, understand and use information in ways that promote and maintain good health for themselves, their families, and their communities (WHO, 1998). Health-literate people are more likely to make better health decisions by following healthy lifestyles and using healthcare resources best. On the other hand, people with low health literacy are more likely to make riskier health decisions, have poorer chronic disease management, be less likely to participate in health-promoting and disease-detection activities, have poor medication adherence, and have overall poorer health outcomes.

Health literacy should be improved through better provision of information, effective communication, and structured education. Seniors should have regular access to high-quality health information through effective channels. Conducting health literacy surveillance regularly, providing funding to health literacy programmes, and better coordination

action across ministries are a few strategies the government can use to help improve the health literacy of seniors.

Media publicity is a feasible strategy for communicating health literacy to seniors. Media publicity refers to the strategic efforts made by individuals, governments, and organisations to engage with various forms of media, such as newspapers, television, radio, online platforms, and social media channels. It involves proactive communication to disseminate information, share news, promote events, or convey messages to a broader audience through media channels. Successful media outreach helps increase brand visibility, shape public perception, and disseminate information through credible media channels to target audiences. Working on media outreach requires attention to detail. For instance, if the target audience is senior citizens living in rural areas, television and radio programmes are still their primary source of information.

AWARENESS

The lack of awareness among senior citizens regarding the existence and benefits of digital healthcare services poses a significant barrier to their uptake. Many within this demographic remain uninformed about the existence and accessibility of these services, unaware

of the advantages accompanying their utilisation, even with high digital skills. Information about teleconsultations, health monitoring apps, or telemedicine options often fails to reach seniors, leaving them unaware of the potentially life-improving or life-saving healthcare resources. The absence of awareness about these digital solutions hampers their ability to make informed decisions about their health and well-being, limiting their access to convenient, efficient, and sometimes cost-effective healthcare alternatives.

Recommendations from healthcare professionals on digital healthcare services were found to be an important facilitator in encouraging seniors to adopt the service. Unfortunately, even healthcare professionals, may not be aware of the services available and may not have the time to promote them. Not all healthcare practitioners are uniformly receptive to digital healthcare services. Generational differences, lack of exposure, and complacency with traditional practices make them hesitant to change their established workflows, especially if they perceive technology as disrupting their usual practices.

For national digital healthcare services such as myUBAT and virtual clinics, it is suggested that the government allocate

additional manpower in government healthcare facilities to proactively promote digital healthcare services to seniors. For private digital healthcare services, the government should provide clear guidance on legal compliance to digital healthcare providers to market their services without breaching the existing legislative and regulatory laws, such as non-advertising laws. Setting up a platform similar to DiGA in Germany can also recognise and promote high-quality digital health applications.

NEEDS

Seniors are experiencing physiological changes such as eyesight, hearing, memory, and cognitive skills. Retirement makes them more likely to suffer from financial constraints and social isolation. Products and services not considering seniors' unique needs will most likely fail to get them to adopt the system (Briede, 2023).

However, product and service users often do not express their needs well, unless seniors are involved during the design process, designers may incorrectly anticipate the senior's needs and preferences. Hence, the creation and implementation of new solutions should actively involve different stakeholders to confirm that they meet the needs raised. Different stakeholders should be

encouraged to utilise the sandbox environment and health technology assessment to ensure that digital healthcare services are feasible and of high quality.

A sandbox environment would enable businesses to investigate and trial new and groundbreaking products, services, or ventures under the guidance and oversight of regulators. This mechanism would allow the innovators to test their ideas within a controlled setting, enabling regulators to gain deeper insights into the technology.

In Malaysia, a Health Technology Hub under the National Technology and Innovation Sandbox (NTIS) was established in 2022 to facilitate the implementation of health technology innovation testing in a safe and controlled environment. In addition, the Health Technology Assessment Section (MaHTAS) was established to produce health technology assessments, clinical practice guidelines, and other synthesised research evidence. It serves as an input for decision-making and policy-making concerning health technologies such as procurement, adoption, implementation, disengagement, reimbursement, and pricing.

The government is also advised to incentivise companies to create senior-

friendly and secure digital healthcare solutions. Many countries recognise the importance of digital healthcare solutions for seniors and have implemented initiatives that promote innovation in digital health for seniors. These include the United Kingdom's National Health Service (NHS) Digital Innovation Hub, Australia's Medical Research Future Fund (MRFF), and Singapore's Healthcare Productivity Fund.

A well-designed payment system is also needed for the widespread adoption of digital healthcare services as it addresses key factors such as accessibility, convenience, trust, innovation, data analysis, and financial sustainability for the service providers. The payment system uncovers issues surrounding digital healthcare services' payment mechanisms and reimbursement systems. In any healthcare system, there are four (4) significant payors. They are the government, employer, insurance companies, and individuals (out-of-pocket expenses).

PERCEPTION

A user's perception plays a crucial role in adopting digital healthcare services because it significantly influences their attitudes, behaviours, and decisions regarding using these services.

Perception shapes how users view a digital service's usability and overall experience. If users perceive a service as intuitive, user-friendly, safe, and efficient, they are more likely to adopt and continue using it. Users are also more likely to adopt a digital service if they perceive it as easy to use and offers significant utility or value compared to alternatives.

Positive perception enhances trust in the digital healthcare service provider. Users are more likely to adopt services they perceive as trustworthy and credible based on factors such as reputation, security measures, and user reviews. Positive perceptions driven by social influence, such as peer recommendations, encourage adoption. Concerns about data privacy, security, or potential drawbacks may hinder adoption if not adequately addressed by the service provider.

DHS ADOPTION

A recent advancement in building public trust in digital healthcare was the revision of Section 21 of the Poisons Act 1952 (Act 366). Under the revised provisions, the Poisons (Amendment) Act 2022 (Act A1666) requires the use of digital signatures on electronic prescriptions in accordance with the provisions enforced by MCMC for the issuance of digital signatures under the Digital Signature Act 1997 (Act 562). The digital signature's advantages include

helping reduce prescription errors and raise users' confidence.

Other efforts to build public trust include improving usability, addressing cybersecurity concerns, highlighting value propositions, managing brand reputation, establishing effective feedback mechanisms to handle the feedback appropriately, and leveraging positive social influence to shape positive perceptions and encourage adoption. In short, to encourage the adoption of digital healthcare services, policymakers and digital healthcare providers must understand and actively manage users' perceptions.

In summary, the relevant stakeholders involved in spurring the adoption of digital healthcare services for seniors in Malaysia are identified as the seniors/users themselves, healthcare professionals, digital healthcare service entrepreneurs/developers, payers' organisations and authorities, community organisations, telecommunication companies, and policymakers. Their involvement according to the six (6) building blocks was tabulated in Table 4.

STAKEHOLDERS	DIGITAL INFRASTRUCTURE	DIGITAL LITERACY	HEALTH LITERACY	AWARENESS	NEEDS	PERCEPTION
Seniors	✓	✓	✓	✓	✓	✓
Healthcare professionals	—	—	✓	✓	✓	—
Digital healthcare service entrepreneurs/developers	—	—	—	✓	✓	✓
Payers' organisation and authorities	—	—	—	—	✓	✓
Community organisations	—	✓	✓	—	—	—
Telco companies	✓	—	—	—	✓	✓
Policymakers	✓	✓	✓	✓	✓	✓

Table 4: The involvement of stakeholders in digital healthcare services adoption

Conclusion

The analysis is integral to the research objectives, as it crystallises the recommendations for addressing the challenges and fulfilling the needs of senior citizens and the digital healthcare industry. These recommendations are geared towards enhancing digital infrastructure, digital literacy, health literacy, creating awareness, tackling seniors' needs, and building their trust in digital healthcare services. Additionally, they emphasise the importance of government, industries, and community collaboration to drive digital healthcare adoption among senior citizens in Malaysia. Hence, the findings serve as a strategic framework for offering comprehensive recommendations to promote digital healthcare adoption among senior citizens and improve the digital healthcare industry's capacity to cater to the needs of seniors.

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TOPIC 04

Free-to-Air Channel: Uses, Motivation and Gratification of Users in Sarawak

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Abstract

Free-to-Air Television (FTA TV) stands as a cornerstone of information dissemination and entertainment for the populace throughout Malaysia. The National Broadcasting Digitisation Project, led by the Malaysian government, via the brand name of myFreeview, established a paradigm transition from analogue to digital television ensuring accessibility nationwide, even in rural areas. MYTV Broadcasting Sdn. Bhd. introduced a digital-quality FTA service, enabling high-quality programmes. Given the high penetration rate of smartphones in Malaysia, reaching nearly 94 per cent of the population, users have access to an extensive selection of possibilities that satisfy their unique content preferences. This wide range of options provides viewers the flexibility to customise their content consumption to suit their own personal preferences. This study investigated the uses, motivation and gratification factors that drive consumers to use FTA channels via MYTV reception in Sarawak

employing the quantitative method. High mean ratings for uses, motivation, and gratification indicated positive reception of MYTV, with positive significant relationships observed, and technological acceptance mediated this relationship between these factors. Policymakers should improve technology literacy, identify barriers, and customise content to boost user motivation by creating culturally sensitive content that resonates with the diverse population of the region. This also guides content providers in tailoring products for increased user motivation. While recognising its limitations, the study calls for future research to expand its scope and adopt a longitudinal approach for insights into evolving dynamics of MYTV to understand shifts in the media landscape and technological advancements over time. Overall, this work enhances our understanding of user dynamics in the Sarawakian context and lays the groundwork for broader investigations in the field.

Introduction

Malaysia has transitioned from analogue to digital television (TV) due to technological advancements in the transmission sector. The evolving media landscape, with 98 per cent of viewers engaging with content across both traditional TV and online platforms, highlights the transformative impact of technology and the pervasive reach of the internet. The Uses and Gratification theory emphasises that media users are active participants who select media for specific needs and gratification. This is particularly relevant in the context of Free-to-Air Television (FTA TV) in Malaysia, where traditional television and online platforms coalesce.

Platforms like MYTV Mana-mana, Astro Go, Tonton, RTM Klik, Unifi TV, Awesome TV, and AlHijrah Plus have emerged as conduits for delivering FTA TV content. The Malaysian Government's transition from analogue to digital TV, catalysed by the National Broadcasting Digitisation Project and epitomised by MyFreeview, has revolutionised the accessibility of high-quality free TV content across the nation. However, there is a discrepancy in awareness levels among viewers of FTA TV options available, especially those provided by the MYTV platform.

Examining the possible unauthorised use of TVRO in the context of these criminal activities conforms to the study's objective and provides insights into the factors influencing user behaviour in Sarawak's digital television market.

The Malaysian Communications and Multimedia Commission (MCMC) has instituted policies to regulate and control illicit activities within the Communication and Multimedia Industry (CMI). It is imperative to explore the usage, motivation, and gratification of FTA channels, particularly in Sarawak, to better understand the complex interplay between technological advancements, media consumption patterns, and sociocultural dynamics in Sarawak.

Problem Statement

The FTA channel environment in Sarawak faces numerous challenges, including a lack of empirical study on content preferences and consumption habits of Sarawakian FTA channel customers. This lack of understanding hinders media stakeholders from adapting their content to the complex preferences of the Sarawakian audience. The continued relevance of FTA channels in Sarawak is threatened by developments in technology and the emergence of alternative media outlets, such as streaming services replacing residential FTA channels. Understanding the unique advantages that FTA channels provide to Sarawakian audiences is crucial for formulating measures to maintain and retain FTA channel users.

Sarawak's unique sociocultural elements, such as multiple linguistic groups and cultural customs, add to the media landscape's diversity, affecting viewers' choices for specific types of content and the efficacy of FTA stations. Research on these socio-cultural aspects is lacking, making it difficult to create communication strategies and materials that appeal to Sarawak's diverse population.

High FTA TV penetration persists in Malaysia, particularly in East Malaysia. Cable and satellite subscription providers like ASTRO have encountered fewer restrictions and reaped the benefits of their extensive coverage. The convergence of technologies has facilitated the digitisation of television systems and spurred the adoption of internet access bundled with cable television services. In response to these dynamics, the Malaysian government initiated the introduction of MYTV.

Smartphone penetration in Malaysia reached a record level of 94.8 per cent in 2021, according to the MCMC. However, this trend does not necessarily indicate a complete transition from traditional local media, such as FTA TV, to online content. Local content on platforms like YouTube and over-the-top (OTT) services such as Netflix, Disney Plus, Iflix, and others have gained popularity, particularly among smartphone users. These platforms provide personalised or user-generated content that aligns with the preferences of modern viewers and caters to the "on-demand" lifestyle.

This research aims to explore and investigate the issue based on pre-identified parameters, such as research and learning, easy access to entertainment, communication and social interaction, surveillance, interpretation, linkage, socialisation, entertainment, education, information seeking, distraction, withdrawal, access to material, product information and technical support, games and sexually explicit content, and consumer transactions.

Objectives

This study identified the uses of MYTV in Sarawak based on several categories of socio-cultural backgrounds, socio-economic standards, and demographic characteristics. Employing the identified patterns as the baseline data, the study further investigated the motivation that drive consumers to use MYTV as well as understand the impact of uses and motivation on the gratification.

Specifically, this research aims to:

Identify the usage of MYTV among users in Sarawak.

Identify the motivation of MYTV users in Sarawak.

Identify the gratification of MYTV users in Sarawak.

Determine the relationship between usage, motivation, and gratification of MYTV users in Sarawak.

Examine the mediating role of technological acceptance in the relationship between usage, motivation, and gratification of MYTV users in Sarawak.

Conceptual Framework

This research adopted the "Uses and Gratification Model" as the main theoretical ground. However, to ensure the comprehensiveness of the research, motivation was added as another independent variable with technological acceptance in a mediating role. This study's conceptual framework is illustrated below:

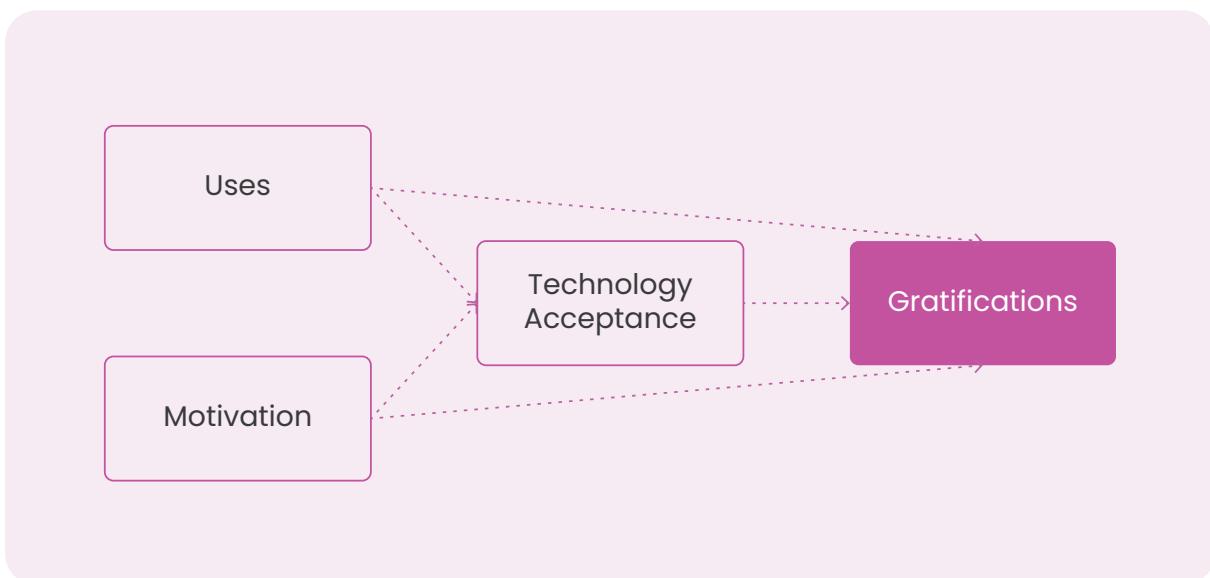


Figure 1: Conceptual Framework

Literature Review

The dynamic nature of FTA channels demands a comprehensive analysis of usage, motivation, and gratification of users. This research review explores many dimensions related to the FTA viewing experience, with a particular emphasis on the moderating effect of technology acceptance.

In recent times, several studies have been carried out to gain insights into the users' adoption and usage of digital television. Ahamad & Alimom

(2020) have conducted a qualitative study which revealed that low exposure and acceptance among the respondents to FTA viewing experience is due to the factors of unattractive programme style and concept in the main Channel such as RTM. Alan et. al (2021) studied the consumption patterns of television among community in rural areas in Sarawak on 365 respondents, among them are aged between 25 to 70 reiterated a similar finding which results show that they hardly watch FTA channels in a week.

Dias (2016) identified five (5) primary categories of motivation for social media technology usage: the desire for social interaction, the need to alleviate tension, the desire to satisfy influential or emotional needs, the desire to address cognitive needs, and the desire to accomplish self-integration. In the interim, Kimanhi (2016) identified five (5) factors that influence the decision to migrate to digital I television: entertainment, social interaction, persistent access, leisure time, and fashion/status. As stated by Mohammed Habes (2019), the fulfilment of self-actualisation needs significantly influenced the intention to continue using social networking services, whereas the satisfaction of social needs only mediated the relationship between the two (2). Additional research has identified a variety of individual reasons for utilising contemporary media, such as seeking solace from reality, time management, information acquisition, time management, entertainment, and the establishment of new social connections (Bondad-Brown et al., 2012; Guo & Chan-Olmsted, 2015; Salloum & Al-Emran, 2018; Wang, 2014).

The concept of the Uses and Gratification Theory (UGT) may be traced back to the field of communication science, as evidenced by the works of Katz et al. (1973) and Blumler and Katz (1974). Ray et al. (2019) asserted that UGT offers a suitable theoretical framework for comprehending the motivation and mechanisms behind individuals' deliberate engagement with media platforms to satisfy specific demands.

Previous scholars mainly used UGT on traditional media, however, numerous scholars employ U&G in various domains, including new media (Menon & Meghania, 2021), education (Menon, 2022), augmented reality (Ibáñez Sánchez, Orus & Flavia, 2019), business (Ray et.al 2019; Boudkouss & Djelassi 2019), and more. UGT has grown in relevance and usage as a theoretical framework in

research on the factors that lead to the adoption of various technologies. This in a nutshell, corroborates the idea that UGT is a valuable and tried-and-true theoretical framework for comprehending why consumers choose to consume media.

The aim of creating the Technology Acceptance Model (TAM) is to discover the characteristics that are important in the technology acceptance process (Oyman et.al 2022). In other words, the approach seeks to identify the external elements influencing users' beliefs, attitudes, and behavioural intentions. In the first iteration of the model, (Perceived Usefulness (PU) and Perceived Ease of Use (PEU) were identified as the two (2) primary elements influencing computer technology adoption and intention to use.

The TAM was developed to forecast the likelihood of an individual or organisation adopting a new technology (Alfadda & Mahdi, 2021). This model was based on the theory of reasoned action (Fishbein & Ajzen,1975) which stated that behaviour was governed by the purpose to perform the activity, attitude toward the behaviour, and social pressure to perform the behaviour.

Rogers (1995) first created the Diffusion of Innovations (DOI) theory, which emphasised the importance of technological elements associated with the assimilation and proliferation of information technology. According to Rogers (1995), there are five (5) characteristics of an innovation that have an impact on its adoption rate. These include the innovation's relative advantage over existing technologies, its compatibility with the workflows and knowledge of the organisation, its complexity to implement, its trialability, and the ability to observe the development of the innovation both within the organisation and among competitors. Individual perceptions of the following five (5) attributes can be used to forecast the rate at which innovations are adopted.

To forecast technological acceptance, the present study will integrate the UGT factors—specifically technology acceptance and motivation, and with the facilitating conditions and compatibility derived from the DOI model.

Methodology

The research design in this investigation utilised a quantitative method to collect information from the population of interest in Sarawak. A survey questionnaire was developed and sent to respondents using purposive sampling, utilising various methods such as social media platforms, regional media outlets, and internet news websites. The final phase involved physical methods, where respondents were solicited at public areas in several districts around Sarawak.

A questionnaire was developed to gather information on usage, motivation, technological acceptance, and gratification, as well as the appropriate demographic profile recommended by funders. The optimal number of respondents was 384, with 402 individuals responding after multiple rounds of recruitment. However, 18 responses had to be discarded due to missing information. The final tally of responses collected was 384, sufficient to accurately reflect the target population of Sarawak, which was reported to be 2,907,500 in 2023.

A pilot study was conducted to determine the reliability and validity of the questionnaires, with 50 participants chosen from the west coast region of Sarawak. The reliability results for all four (4) factors were found to be above 0.8, which is considered good. To shorten the time, it took for respondents to answer questions during physical data collection, enumerators read part of the questions aloud to the people they approached.

Statistical analysis was conducted using Statistical Package for the Social Sciences (SPSS), addressing each of the study objectives descriptively and inferentially. The data collected was used to measure the population percentage at 50 per cent and to understand the factors influencing the use of technology in Sarawak.

Findings and Analysis

A total of 392 responses were collected of which eight (8) were excluded from analysis because they were found to be incomplete. Hence, 384 responses were confirmed for final data analysis.

Descriptive Analysis

The demographic profile of the respondents is presented below:

PROFILE	CATEGORIES	NO	%
Gender	Female	227	59
	Male	157	41
Age	20 - 25	96	25
	25 - 30	46	12
Ethnicity	31 - 40	77	20
	41 - 50	94	24
	> 50	71	18
	Malay	114	29.69
	Melanau	86	22.40
	Chinese	74	19.27
	Iban	54	14.06
	Bidayuh	30	7.81
	Indian	5	1.30
	Kayan	5	1.30
	Jawa	3	0.78
	Bisaya	2	0.52
	Kadazan	2	0.52
	Bajau	2	0.52
	Kedayan	2	0.52
	Kelabit	2	0.52
	Kenyah	1	0.26
	Lun Bawang	1	0.26
	Bugis	1	0.26

PROFILE	CATEGORIES	NO	%
Educational Qualification	High School (SPM / Certificate)	103	27
	Diploma / STPM	73	19
	Undergraduate Degree	118	31
	Post Graduate Degree	48	13
	None of the Above	42	11
Region / District / Zone of Residence	Mukah	66	17
	Kuching	60	16
	Kota Samarahan	59	15
	Miri	39	10
	Sibu	38	10
	Bintulu	36	9
	Serian	25	7
	Asajaya	20	5
	Limbang	8	2
	Sri Aman	8	2
	Betong	7	2
	Bau	6	2
	Sarikei	4	1
	Lundu	3	1
	Kanowit	3	1
Residential Type	Kapit	1	0
	Baram	1	0
	Residential Residence	164	43
	Landed	147	38
	High-rise	38	10
Marital Status	Village house	20	5
	Longhouse	9	2
	Industrial area	6	2
Employment Status	Married	209	54
	Single	175	46
Employment Status	Full-time	179	47
	Unemployed	120	31
	Self-employed	66	17
	Part-time	19	5

PROFILE	CATEGORIES	NO	%
Monthly Income	< RM 1,000	140	36
	RM 1,001– RM3,000	116	30
	RM3,001 – RM5,000	61	16
	RM5,001 – RM7,000	44	11
	RM7,001 – RM10,000	16	4
	> RM10,000	7	2
Number of Television Sets	1 unit	284	74
	2 units	85	22
	3 units	14	4
	4 units	1	0.3

Table 1: Demographic Profile of Respondents

The majority of respondents are female (59 per cent), aged between 20–25 years, with the age range being 40 to 45 years. There are 16 ethnicities, with the majority from the Malay ethnicity (29.69 per cent). The second and third highest ethnicities are Melanau and Chinese (22.40 per cent), Iban (14.06 per cent), Bidayuh and Indian (1.3 per cent), and Jawa (less than 1 per cent). The remaining ethnicities include Bajau, Bisaya, Kadazan, Kedayan, Kelabit, Bugis, Kenyah, and Lun Bawang.

Education qualifications among respondents are mainly undergraduate (31 per cent), followed by high school (SPM/ Certificate) (27 per cent), postgraduate degree (13 per cent), diploma or STPM (19 per cent), and without any qualification (11 per cent). Most respondents come from Mukah (17 per cent), Kuching (16 per cent), Kota Samarahan (15 per cent), Miri (10 per cent), Sibu (10 per cent), Bintulu (36 per cent), Serian (20 per cent), Asajaya (20.5 per cent), Betong (7.2 per cent), Sri Aman and Limbang (8 per cent), Betong (7.2 per cent), Sarikei (6 per cent), Lundu and Kanowit (3 per cent), Baram and Kapit (2 per cent). Residential residence is the most common type of housing, with 43 per cent living in residential residences, 38 per cent in landed housing, and 10 per cent in high-rise buildings. Village houses are the least common, with only 5 per cent in longhouses and 2 per cent in industrial areas.

Married status makes 54 per cent for the majority of respondents, while employment status is ranked as full-time (47 per cent), unemployed (31 per cent), self-employed (17 per cent), and part-time (5 per cent). Monthly income is categorised into three (3) categories: RM1000 (36 per cent), RM1,001 to RM3,000 (30 per cent), RM3,001 to RM5,000 (16 per cent), RM5,001 to RM7,000 (11 per cent), RM7,001 to RM10,000 (4 per cent), and above RM10,000 (2 per cent).

Usage Pattern

POPULAR PLATFORM FOR FTA	NUMBER	%
Astro	169	44.0
NJOI	78	20.3
Unifi TV	64	16.7
MYTV	38	9.9
None	25	6.5
YouTube	6	1.6
Facebook	4	1.0

Table 2: Popular Platforms

The study reveals a diverse range of preferred platforms for FTA television content. Astro is the most popular, with 44 per cent of respondents opting for it. NJOI has a smaller viewership, while Unifi TV has a larger audience. MYTV is the next popular platform, with 9.9 per cent accessing content specifically. YouTube is the least popular, with 1.6 per cent accessing it. Facebook is the most used. However, 6.5 per cent of respondents have no affiliation with any of the mentioned platforms, indicating alternative or non-digital preferences. This highlights the varied choices and preferences among audiences in selecting platforms for FTA content.

STREAMING SERVICES	NUMBER	%
Netflix	110	28.6
MYTV Mana-mana	102	26.6
Astro Go	77	20.1
Tonton	73	19.0
RTM Klik	56	14.6
Unifi TV	46	12.0
Awesome TV	31	8.1
None	31	8.1
Disney Channel	24	6.3
Viu	18	4.7
Apple TV	11	2.9
AlHijrah Plus	7	1.8
Sooka	6	1.6
Amazon Prime Video	3	0.8
Android Box	2	0.5
IQIYI	2	0.5
HBO Go	1	0.3

Table 3: Streaming Services

The study reveals a diverse range of streaming services among respondents. MYTV Mana-mana is the most popular, with 26.6 per cent of respondents subscribing to it. Astro Go is preferred by 20.1 per cent, while Netflix is the next popular, with 28.6 per cent of respondents subscribed. Tonton is used by 19 per cent of respondents, while RTM Klik and Viu are used by 14.6 per cent and 4.7 per cent of respondents, respectively. 8.1 per cent of respondents did not subscribe to any streaming service, suggesting a preference for traditional media consumption or an untapped market segment that might require different content or pricing strategies. This diverse range of subscriptions reflects the varied choices and platform preferences among consumers in accessing streaming content.

TIME SPENT (DAILY)	NUMBER	%
1 hour	71	18.5
2 hours	93	24.2
3 hours	78	20.3
4 hours	39	10.2
5 hours	31	8.1
6 hours	14	3.6
7 hours	1	0.3
8 hours and above	5	1.3
Not watching	52	13.5

Table 4: Time Spent Watching Free-to-Air Channels in a Day

The study reveals that 24.2 per cent of respondents dedicate two (2) hours per day to watching FTA channels, indicating a moderate level of content consumption. 20.3 per cent spend three (3) hours daily, while 18.5 per cent allocate one (1) hour, a smaller segment with shorter viewing durations. 10.2 per cent spend four (4) hours, a smaller segment with extended viewing habits. 13.5 per cent do not watch FTA channels, suggesting alternative media consumption habits or untapped market segments. This data demonstrates the diverse range of viewing durations among individuals, indicating varying levels of engagement with FTA content daily.

CATEGORIES	NUMBER	%
World and Local News	284	74.0
Lifestyle, Health, and Well-Being	187	48.7
Economy	124	32.3
Food, Culinary, and Arts	123	32.0
Sports & Adventures	109	28.4
Politics and Public Affairs	107	27.9
Technical and Technological Information	83	21.6
Educational Programmes	71	18.5
Fashion, Beauty, and Trends	66	17.2

Table 5: Staying Up-to-date with Current Issues Categories

The study reveals that 74 per cent of MYTV viewers rely on staying updated on world and local news current issues as their primary reason for watching. Additionally, 48.7 per cent of respondents seek content related to lifestyle, health, and well-being. 32 per cent and 28.4 per cent engage with MYTV for content focused on food, culinary, arts, and sports, respectively. Politics/public affairs and technical/technological information are also popular. Fashion, beauty, and trends are the least popular, with 17.2 per cent of respondents expressing interest in this category. This diverse range of viewership motivation highlights the varied interests and preferences among MYTV viewers.

SCALE	RA	%	SC	%	EA	%	PA	%	CP	%
Strongly Disagree	38	9.9	7	1.8	6	1.6	7	1.8	9	2.3
Disagree	32	8.3	17	4.4	18	4.7	21	5.5	11	2.9
Slightly Disagree	27	7.0	19	4.9	17	4.4	21	5.5	18	4.7
Slightly Agree	77	20.1	73	19.0	85	22.1	75	19.5	59	15.4
Agree	153	39.8	180	46.9	170	44.3	182	47.4	193	50.3
Strongly Agree	57	14.8	88	22.9	88	22.9	78	20.3	94	24.5

NOTE RA = Religious Activities; SC = Social Contents; EA = Economic Activities; PA = Political Activities; CP = Cultural Programmes

Table 6: Current Issues and Interest in Watching MYTV

The study reveals that MYTV is primarily watched by respondents for religious activities, social content, economic activities, political activities, and cultural programmes. The reasons for watching MYTV vary across these categories, with 39.8 per cent of respondents tuning in for religious content, 46.9 per cent for social content, 44 per cent for economic activities, 47.4 per cent for political activities, and 50.3 per cent for cultural programmes. The data reveals a diverse range of interests and engagement levels across these categories. Cultural programmes are the most popular, with 24.5 per cent strongly agreeing and 15.4 per cent slightly agreeing, followed by social content, with 22.9 per cent strongly agreeing and 19 per cent slightly agreeing, and economic activities with 22.9 per cent strongly agreeing and 19.5 per cent slightly agreeing. Political activities come next with 20.3 per cent strongly agreeing and 19.5 per cent slightly agreeing, and finally religious content is the next popular. This data demonstrates the diverse engagement of MYTV viewers across various themes, showcasing its appeal in meeting diverse viewer preferences.

TITLE	NUMBER	%
TV3	164	42.71
TVS	159	41.41
Berita RTM	109	28.39
8TV	102	26.56
Awesome TV	85	22.14
TV1	77	20.05
SUKAN RTM	70	18.23
TV2	65	16.93
OKEY	64	16.67
NTV7	57	14.84
Bernama	46	11.98
TV ALHijrah	42	10.94
TV9	35	9.11
SUKETV	30	7.81
TV5	22	5.73
Wowshop	17	4.43
TV6	8	2.08
TOTAL	1152	100

Table 7: Favourite MYTV Channels

A study on MYTV revealed that the top three (3) channels among respondents were TV3, TVS, and Awesome TV. TV3 was the most popular, with 164 respondents choosing it, indicating substantial viewership. TVS was preferred by 159 respondents, indicating strong audience engagement with its content. Awesome TV had a median level of interest, with 85 respondents choosing it, indicating moderate viewership. TV1 was moderately preferred by 77 respondents, while Wowshop and TV6 were the least preferred channels. The data shows a clear hierarchy in channel preferences among MYTV viewers, with TV3 and TVS leading in popularity, while Awesome TV and TV1 maintain moderate interest levels.

TITLE	NUMBER	%
News	293	76.30
Drama Series	219	57.03
Movies/	211	54.95
Reality Shows	167	43.49
Documentaries	158	41.15
Talk Shows	104	27.08

Table 8: Preferred MYTV Shows

A survey of 293 MYTV viewers revealed a distinct hierarchy in viewer preferences. The majority, 293 individuals, preferred news programming and drama series, indicating a strong reliance on the platform for staying informed. Drama series, with 219 respondents, reflected a significant interest in fictional narratives and storytelling. Talk shows, with only 104 individuals selecting this category, were the least preferred. This data highlights the importance of informative content and engaging narratives in shaping MYTV audiences' content preferences and potentially guiding content creation and curation strategies.

TITLE	NUMBER
Education	120
Sports	115
Health	113
Entertainment	112
Politics	99
Religious	98
Cooking	94
Crime	90
Mysterious	83
Animation	72
Comedy/Sitcom	45
Games or quiz shows	31
Travelogue	29
Business	25
Children Programmes	18
Home shopping	8

Table 9: Preferred themes/genre of TV shows

The study reveals that the top three (3) preferred genres of MYTV shows among viewers are education, sports, health content, and entertainment. Education is the most popular genre, followed by sports and health content. Entertainment is also popular, with 112 respondents expressing strong interest in these categories. Crime, cooking, and mysterious content are moderately popular, with 90 and 94 respondents respectively. However, business, children's programmes, and home shopping are the lowest preferred genres, with only 25 respondents selecting it. This indicates a clear disparity in audience preferences, with strong engagement in educational, sports, health, and entertainment genres, moderate interest in crime, cooking, and mysterious content, and lower appeal in business, children's programmes, and home shopping.

Inferential Analysis

DESCRIPTIVE STATISTICS					
	N	MINIMUM	MAXIMUM	MEAN	STD. DEV.
Usage	384	1.00	6.00	4.6759	.91778
Motivation	384	1.00	6.00	4.5278	.97999
Technological Acceptance	384	1.00	6.00	4.5293	.85470
Gratification	384	1.00	6.00	4.7104	.86857
Valid N (listwise)	384				

Table 10: Mean Scores of Variables

VARIABLE / EFFECT	β	SE	t	p	95% CONFIDENCE INTERVAL	
					LLCI	ULCI
Usage(U) à TA (path 'a')	0.2500	0.356	7.0216	.0000	.1800	.3201
TA à Gratification (path 'b')	0.6548	.0382	17.1286	.0000	.5796	.7299
EFFECTS						
Direct (path 'c')	.2500	.0356	7.0216	.0000	.1800	.3201
Indirect*	0.4246	.0532			.3155	.5248
TOTAL	0.6747	0.340	19.8647	.0000	.6079	.7415

Table 11: Mediation Analysis 1

The study analysed the relationship between usage and technology acceptance (TA) on gratification. The results showed that usage is positively related to TA, while TA is positively related to gratification. The direct effect for path 'c' was also significant, indicating usage is related to gratification. The indirect effect for mediation was found to be mediated by TA. The study also found a relationship between user satisfaction (gratification) and the usage of the MYTV service. The adoption of technology was positively correlated with user satisfaction. Thus, the study suggests that technological acceptance plays a mediating role in the degree of service usage and user satisfaction. Regular users of the MYTV service tend to be content partly due to the technology itself (TA).

VARIABLE / EFFECT	β	SE	t	p	95% CONFIDENCE INTERVAL	
					LLCI	ULCI
Usage(U) à TA (path 'a')	.1957	.0410	4.7748	.0000	.1151	.2763
TA à Gratification (path 'b')	.6628	.0470	14.1101	.0000	.5704	.7551
EFFECTS						
Direct (path 'c')	.1957	.0410	4.7748	.0000	.1151	.2763
Indirect*	0.4613	.0557			.3567	.5731
TOTAL	0.6570	0.305	21.5693	.0000	.5971	.7169

Table 12: Mediation Analysis 2

The study analysed the relationship between motivation and technological acceptance (TA) on gratification. The results showed that motivation is positively related to TA, while TA is positively related to gratification. The direct effect for path 'c' was also significant, with a p-value less than 0.001. The indirect effect for mediation was found to be mediated by TA, with a 95 per cent confidence interval of (0.5971, 0.7169). The study also found a relationship between users' satisfaction (gratification) and motivation of the MYTV service. This suggests that an individual's likelihood of accepting the technology associated with a service or platform increases with their level of motivation. Therefore, users' acceptance and familiarity with the technology contribute to their satisfaction and drive them towards using the MYTV service.

Discussion

The study explores the positive reception of MYTV among Sarawakian consumers, focusing on usage, motivation, and gratification. It highlights the significant relationships between these variables and the mediating role of technological acceptance in determining users' levels of gratification. The research aligns with existing literature, demonstrating that unappealing programme varieties contribute to low exposure and acceptance of) channels.

The theoretical framework of the study is supported by studies on the Technology Acceptance Model (TAM) and Rogers (1995) theory of the diffusion of innovations. The incorporation of Uses and Gratification Theory (UGT) components reinforces the theoretical framework. The study also connects with the wider debate on media consumption patterns while examining the dynamics of MYTV adoption.

The research gap acknowledges the lack of empirical studies on content preferences and consumption patterns of Sarawakian FTA channel subscribers. The high mean scores for usage, motivation, and gratification indicate a positive reception of MYTV. However, the study acknowledges that alternative media sources pose a threat to the continued relevance of FTA channels, highlighting the need for further research.

The study acknowledges the socio-cultural heterogeneity of Sarawak and emphasises the importance of customised communication strategies. It connects with the intricacies brought forth by various linguistic groups and cultural norms. The study's objectives, focusing on uses, motivation, and gratification factors, align with the broader need for empirical research.

Recommendations

This study highlights the complex relationship between usage, motivation, and technology adoption in digital television. It recommends policymakers to address technology literacy issues and remove barriers to digital television access to enhance technology acceptance and engagement. Future researchers should focus on comparative analysis of user preferences in border communities, exploring Free-to-Air channels from neighbouring countries. This will provide a more comprehensive understanding of the platform's impact and effectiveness, offering insights for strategic improvements. Cross-platform media consumption patterns should also be analysed to capture the dynamic nature of user behaviour.

Service providers should consider customisation strategies to align their products with user motivation, enhancing overall engagement. This can lead to increased user satisfaction and loyalty. In Sarawak's diverse sociocultural landscape, culturally sensitive content should be created to resonate with the population. Understanding the impact of cultural practices and linguistic diversity on media consumption is essential for tailoring content that resonates with the diverse population.

SMEs can explore advertising opportunities and partnerships with content producers to reach a larger audience. Matching marketing efforts with Sarawakian consumers' preferences and motivations is crucial, and partnering with regional content producers can improve the relevance of advertisements. Utilising digital channels and tailoring content to Sarawak's unique sociocultural features can also improve consumer perceptions and advertising effectiveness.

Conclusion

It is imperative to recognise the limits of this research, such as its exclusive focus on Sarawak, which may not be entirely indicative of the wider Malaysian landscape. Subsequent investigations may broaden the geographic range and integrate a variety of demographic variables. Furthermore, longitudinal research could shed light on how the dynamics of MYTV would shift media landscape and technological improvements over time. Although the research employs quantitative methodologies, a qualitative investigation may yield more profound knowledge of the subtleties of user motivation and gratification. Integrating the two (2) methods would provide a deeper knowledge of the subject.

In summary, this research adds to our knowledge of consumer behaviour in the context of digital television by illuminating the complex interactions that exist between usage, motivation, gratification, and acceptance of new technology among Sarawakian MYTV subscribers.

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TOPIC 05

An Analysis of the Impact of Internal Data Sharing on Employee Productivity, Decision Making and Transforming Data into Business Value

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Abstract

The research aims to understand how data-sharing affects employee productivity and decision-making using a qualitative Malaysian Administrative Modernisation and Management Planning Unit (MAMPU) case study. The finding shows that MAMPU developed two (2) data-sharing portals; one (1) is for open data-sharing, and the other is for internal and restricted data or Malaysian Government Central Data Exchange (MyGDX) that links data-sharing from various agencies in the public sector. The research found that data-sharing could potentially influence employee productivity and performance as data are valuable resources that could help employees effectively perform their jobs. This research also found that the absence of data-sharing can restrict the efficiency and effectiveness of the employees in acting fast and taking action to improve and enhance their operations and responsibilities. The finding also shows that data-sharing, especially internal data-sharing, consists of much critical and impactful data that

are not mostly and openly shared. Thus, relying only on open data without internal data will affect the effectiveness and completeness of decision-making. Quality data is highly critical as low-quality data will cause ineffective decision-making quality. Therefore, more quality decision-making requires open and essential data from internal data-sharing as it may have more valuable data critical for sound decision-making. In addition, the result found that employee skills and analytical capabilities are more important than just having sophisticated and/or automated tools, as without human capabilities and skills, the effectiveness of data-sharing and the quality of the data shared may be affected. However, both sophisticated and/or automated tools are very useful for affecting decision-making quality and work effectiveness. The research also highlights the importance of data-sharing practices in driving innovations, as many data-driven opportunities can be made possible with data sharing.

Introduction

Today's business environment is characterised by fierce competition, technological advancement, and the big data revolution; organisations need to act fast and utilise the resources efficiently and effectively to capitalise on the opportunity and make effective decisions fundamental for the organisation's survival and sustainable performance (Klus & Müller, 2021). In the era of big data eruption, digital and information technology have become the nexus of the industrial revolution; thus, organisations need to invest, adapt, and respond to this quickly and accurately to capture market share (Ghobakhloo & Fathi, 2019). Big data explosion creates voluminous data-sharing, which is pivotal for an organisation's success. Unsurprisingly, data-sharing has become the building block of the big data revolution. Studies have found that data-sharing has caused a significant impact on the operation and quality of the business in terms of improved services, enhanced organisation performance, increased innovation, and quality of decision-making (e.g., Santoro et al., 2019; Chatterjee et al., 2021), it also advances research and benefits society (Darch & Knox, 2017). The lack of data-sharing and big data analytics capabilities can hinder the significant

effect of accurate predictive values (Dubey et al., 2019), thus hampering the decision-making quality and directly reducing the organisations' performance and competitive advantage, innovation as well as employee productivity.

Although data-sharing is fundamental for organisational success and crucial for advancing the big data industry (Janssen et al., 2017), not many organisations are willing to share data openly (Welch et al., 2016; Santoro et al., 2019). Some share only certain data and only for internal use (Ghasemaghaei, 2019). Researchers pointed out that organisations are reluctant primarily due to various reasons, such as lack of trust due to no sophisticated tools to deal with privacy data management, property rights, and intelligence data, as well as lack of big data analytics capability, causing organisations to be careful with open data-sharing (Wimmer et al., 2016). While most organisations (public and private) understand the crucial role of data-sharing in improving their predictive values of decision-making accuracy, which is important for performance effectiveness, many are still prudent and insecure but just satisfied with sharing data internally between departments within the organisations. Some may share

data with direct collaborators and important partners to improve their business operations but are restricted to the area directly dealing with the collaboration work. This creates a loop about whether internal data-sharing has the same effects as open data-sharing regarding the predictive value of decision-making on organisation and employee effectiveness. Studies on open data-sharing have exhibited the positive impacts of data-sharing on decision-making quality, innovation, performance, and competitive advantage (Bedini et al., 2014); however, there was a lack of studies on the effect of internal data-sharing on similar outcomes.

Therefore, the research objectives (ROs) of the study are:

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- RO 1** To identify how data-sharing practices (e.g., internal data-sharing) positively impact employee performance/productivity.
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- RO 2** To explain how data-sharing (e.g., internal data-sharing) positively enhances employees' decision-making quality.
-
- RO 3** To understand how data-sharing quality (e.g., data automated tool), sophisticated tools (e.g., data classification), and big data analytics capability contribute to the positive effects of internal data-sharing on employee decision-making quality
-
- RO 4** To provide recommendations on transforming data into business value (by identifying ways organisations can effectively use data to drive business value and improve performance, identifying best practices for data management and analysis, and identifying opportunities for data-driven innovation).

Literature Review

THE IMPORTANCE OF PERFORMANCE

Among the leading impacts of data-sharing is its effectiveness in bringing positive outcomes and profit to organisations (Mohamed Ali, 2021), leading to increased performance. Thus, organisations cannot ignore the significant role of performance in its survival and effectiveness as to date, with the highly competitive business environment and digitalised economy, there is a growing pressure that compels organisations to utilise big data analytics to achieve competitive advantage and gain the market share (Wang, 2018). With the current phenomenon, organisations cannot just rely on traditional performance achievement but need to increase innovation and possess analytical capability aligned with the recent technological development of big data and a digitalised economy to achieve better and more sustainable performance.

DECISION-MAKING QUALITY AND OVERALL PERFORMANCE

Undoubtedly that the quality of the decision-making determines the success of the organisation's overall performance (Ghasemaghaei et al., 2018). Big data through data-sharing helps organisations, managers, and employees create values that contribute to quality decision-making. Many organisations have started to believe they would incur a loss if they do not use big data analytics to get accurate data for business decisions and capture this vast market share (Chatterjee et al., 2021). Using big data analytics could improve real-time decision-making and contribute to overall employee and organisational performance (Loukis et al., 2019). In the public sector, for example, data also plays an important role in making better-informed decisions across public sectors, contributing to sound policymaking (Mohamed Ali, 2021).

DATA-SHARING

Data-sharing refers to the disposition or preservation of data for public access with the purpose of providing access for reuse (Chawinga & Zinn, 2019). It is also called open data or a deliberate effort to make raw data

fully available for public access (Dong & Li, 2017; Chawinga & Zinn, 2019). Data-sharing facilitates research and transferring into values through data reuse, making data interoperable (Logan, 2021). Data-sharing differs slightly from knowledge-sharing or information-sharing as both typically refer to the exchange or sharing of knowledge or information among employees in the organisations they acquired or created (Gibbert & Krause, 2002; Rutten et al., 2016). Hogel, Partboteeah, and Munson (2003) define knowledge sharing as the exchange of experience, information, skills, tacit information, and explicit information among employees. Other studies, such as Wiewiora, Trigunasyah, Murphy and Coffey (2013), define knowledge sharing as expert insights, while Wagner (2008) defines it as the act of making knowledge available to others (either within the firms or outside the firms). Similarly, as defined by Xiao, Zhang and Basadur (2016), information sharing refers to members (employees) delivering information to each other. Therefore, what makes data-sharing different from information-sharing or knowledge-sharing is that data-sharing is more comprehensive and includes raw data, primary or secondary data, facts, knowledge, evidence, and experience. It goes beyond the academic world (Hulsen, 2020). Therefore, it can be understood that knowledge sharing, and information sharing are part of data sharing.

In Malaysia, most private sector organisations focus on internal data-sharing to improve their systems, enabling data-sharing between departments before sharing the data with other organisations (Malaysian National Data-sharing Policy, 2019). Although open data-sharing has a huge potential, many are concerned about the protection of the market share, the cost and benefit of data-sharing, the ambiguity of data-sharing that could violate personal rights and the development of a sustainable data-sharing model. Some prefer internal data-sharing for following ISO/IEC 27000 (international organisation for standardisation in terms of data security) which ensures the security of customers' and partners' personal data. It is very important for organisations to also classify their data-sharing into open data and/or confidential/private to ensure data security. Following ISO/IEC 27000 will protect the data and thus make it safe to be shared openly (Mohamed Ali, 2021).

DATA CLASSIFICATION IN DATA-SHARING

Data classification allows the storage and processing of the data into categories (Saravanan & Sujatha, 2018). This will increase the organisation's data security/data protection. Data classification can also help the organisation conform to their internal data protection in accordance with ISO/IEC 27000 of data security. Studies (e.g., Tankard, 2015; Kitsios et al., 2023) have indicated that data classification could enhance data-sharing security, thus improving the organisations' data-sharing policy.

AUTOMATED TOOLS IN DATA-SHARING

Data automation refers to creating data entities and data objects that can be used to automate data operations and data modelling, enabling businesses to confidently handle data more efficiently and consistently (Duan et al., 2015), thus improving quality data critical for effective decision-making. With data automation, employees can develop processes quickly while still ensuring accuracy and compliance with regulations. This helps organisations make the most of their data and make data-driven decisions faster and easier than ever before. Data automation can process large data sets accurately and efficiently (Wu et al., 2013) involving internal data such as internal communications, job posting management, or open data such as external company reviews. Thus, to ensure an organisation becomes more effective and increases its predictive decision-making analytics, automated data tools are required to provide timely data updates and more accurate data using actual user data.

Methodology

This study undertakes a qualitative approach involving a case study method to understand further data-sharing practices in enhancing decision-making and transforming data into business values for achieving employee and organisational productivity, innovation, and competitive advantage. The case study provides an opportunity to examine the context-specific and direct occurrence of the issues under study. The unit of analysis is the organisation (i.e. Malaysian Administrative Modernisation and Management Planning Unit (MAMPU)). The data analysis involves reviews of the organisation's written reports (internal/external) and expert interviews with data experts and policymakers involved in data-sharing policies and decision-making.

This study focuses on MAMPU as the research subject. After reviewing the background of MAMPU, it is noted that MAMPU is involved in data-sharing. MAMPU acts as the central agency or enabler that provides a platform that links the data from the participating agencies and shares them openly on data.gov.my and/or through the Malaysian Government Central Data Exchange (MyGDX) for internal data-sharing and/or restricted data-sharing. In this study, a purposive sampling method was employed in the selection of the experts/interviewees. The sampling method chooses the sample according to the needs of the study. This study has conducted four (4) interviews. Two (2) interviews were with data experts (i.e. one (1) from big data and one (1) from MyGDX/data-sharing). Another two (2) interviews with the policymakers (i.e. one (1) from the data architecture and one (1) from the open data section). Through this method, the study has collected relevant and useful information for answering the research objectives of the study.

DATA COLLECTION AND ANALYSIS

This study uses two (2) methods/instruments to collect the data (i.e., written report reviews and analysis and expert interviews). First, this

study reviews and analyses the written report published by MAMPU regarding its data-sharing. This is followed by four (4) expert interviews with the data experts and policymakers to gather more and deeper information regarding data-sharing practices at MAMPU. The written reports were analysed using NVivo automated text software version 12.0. For the expert interviews, each of the interviews was audio-taped or voice-recorded to ease the data transcription into a Word document as it allowed us to record accurately what was said compared to notes taking. The interview questions were based on the research objectives. Thus, the findings from each of the four (4) interviews were summarised according to the research objectives.

Findings and Analysis

General Findings

The NVivo automated text analysis results based on the written reports shows that MAMPU is involved in government open data-sharing, where MAMPU links data from government agencies to an open data platform called data.gov.my. MAMPU is also involved in internal data-sharing through MyGDX portal for a more restricted/internal data-sharing, which is shared through the Application Programming Interface (API) upon request from the data users and must be approved by the data owners. In general, the result indicates the importance of open and internal data-sharing in the government agenda. Figure 1 displays the word cloud result from NVivo analysis.



Figure 1: Word Cloud of MAMPU’s Data-sharing

Specific Findings

OBJECTIVE 1

How do data-sharing practices (e.g., internal data-sharing) positively impact employee performance/productivity?

The results from NVivo automated text analysis support that data-sharing affects employees' performance and productivity. Based on the word cloud generated from the analysis indicates that the words "impact, performance, effectiveness, effectively, efficient, quality, improving" are linked to internal and open data-sharing.



Figure 2: The result of Word Cloud – Research Objective 1

The results of the interview with MAMPU's data experts and policymakers about the effectiveness of data-sharing practices on employee performance/productivity show a mixed outcome. This is mainly because MAMPU, as a central agency, acts to link data from agencies into an open data-sharing portal (i.e. data.gov) and for internally restricted data on MyGDX. MAMPU does not collect data directly from the data owners/sources. Therefore, MAMPU does not have the actual statistics to confirm that data-sharing has a significant positive impact on employee work outcomes (i.e. performance/productivity). For instance, the data expert states that:

"If we talk about the impact of data-sharing, I don't see it. It's not that I don't see it. I think that MyGDX is less relevant because we provide a platform for them. The person who is using the data-sharing from MyGDX or the person who obtains the data is someone else. For example, at MAMPU, this is another part that, like us, has a system that we have created. In making that decision, they use the MyGDX platform. But the impact of the data-sharing whether it is good or bad, must be evaluated by the agencies or data users. But if I must respond about the impact, it is only based on what we are expected, not on what we have experienced. The impact of data usage after that, that's what we don't know".

However, according to other experts, sharing data among employees can positively impact on their performance and productivity. Data-sharing can make their jobs easier by increasing work effectiveness. The data helps employees solve problems, reduce errors, and enhance the quality of their work, leading to high-value outcomes.

In this case, the expert indicates the importance of internal data-sharing regarding the database by referring to the case involving

Bantuan Rakyat 1 Malaysian (BRIM), Bantuan Perihatin or e-kasih under the Lembaga Hasil Dalam Negeri Malaysia (LHDN). For example, all data regarding the receivers of BRIM, Bantuan Perihatin and e-kasih in the system in LHDN are collected internally and not directly from the public. For example, LHDN collects the data from the Jabatan Pendaftaran Negara (JPN) and other agencies and decides the receivers' suitability before LHDN channels the funds to them. Some verifications, validations, and data updates from the data owners/sources were performed later and from time to time to improve the service. This example shows that internal data-sharing could affect performance/productivity positively. In addition, the data-sharing portal developed by MAMPU links data from various agencies on one (1) platform as in open data ([data.gov](#)) and restricted/internal as in MyGDX, which provide data that are accurate, reliable, and highly operability thus help the agencies or employees, including the policymakers to perform their tasks and responsibilities more accurately, with minimum errors, thus helping employees to achieve better performance and increase productivity.

OBJECTIVE 2

How does data-sharing (e.g., internal data-sharing) positively enhance employees' decision-making quality?

The results from the NVivo software indicate that data-sharing, in general, is vital for decision-making. To understand the findings better, the interview content was analysed more thoroughly.



Figure 3: Word Cloud of the Result of Research Objective 2

The results indicate that the quality of policy development, especially for policymakers, relies heavily on the accuracy and quality of data collected. The decision-making process and policy outcomes will suffer if the data is inaccurate or of low quality. To mitigate this, policymakers take the initiative to gather accurate information by visiting relevant agencies to better understand of the issue and learn from past experiences. Seeking advice and guidance from the Chief Government Security Officer (CGSO) or legal advisers also helps policymakers gain comprehensive knowledge before developing policies. According to one (1) of the policymakers:

"Data-sharing will make the decision more informed, more accurate, more real-time. It doesn't matter if the data is internal or open".

Version 2.0 of the government's open data-sharing developed by MAMPU added a data dashboard and data catalogue which is considered useful for decision-makers as a reference prior to in-depth investigation. Thorough checking of data-sharing from MyGDX can also further enhance decision-making quality.

The policymaker in this study also believes that accurate and real-time data-sharing between government agencies could improve the efficiency and effectiveness of many important decisions. For example, the recent increase in prices of commodities like fish, chicken, and local rice could have been avoided if the Kementerian Perdagangan Dalam Negeri, Koperasi dan Kepenggunaan (KPDNKK) had shared and monitored their data to predict the sudden price rise caused by shortages. With the help of reliable data-sharing, the Minister or top management could make fast and accurate decisions to direct agencies under the Kementerian Pertanian dan Keterjaminan Makanan Malaysia (KPKMM), such as the Department of Veterinary Services (DVS), to issue more licences for chicken breeding and farming, request the Federal Agricultural Marketing Authority (FAMA) to monitor rice production, and

the Lembaga Perikanan Malaysia (LKM) to supply more fish. By sharing data between all agencies, the Kementerian Perdagangan Dalam Negeri (KPDN) could predict and forecast shortages and surpluses of essential food supplies, and order relevant agencies to increase and monitor the supply, thus preventing shortages and stabilising prices. This could also help avoid conflicting statements from different agencies regarding shortages, surpluses, and the prices of supplies.

OBJECTIVE 3

How do data-sharing quality (e.g., data automated tool), sophisticated tools (e.g., data classification) and big data analytics capability contribute to the positive effects of internal data-sharing on employee decision-making quality?

The result from the NVivo software shows some findings regarding the relationship between quality, and sophisticated and automated tools in data-sharing (see Figure 4). However, it is not clearly outlined whether data quality is as important as or better than sophisticated and automated tools' usage in affecting decision-making quality. Thus, to answer this research objective clearly, it is important to look at the three (3) main factors:

- i) data quality
- ii) sophisticated tools, and
- iii) big data analytic capability/skills.



Figure 4: Word Cloud of the Result of Research Objective 3

i. Data quality

All the experts interviewed acknowledge the critical importance of having comprehensive and voluminous data-sharing to determine the quality of the data collected. The policymakers believed that data quality could be determined based on comprehensive/voluminous data-sharing. Without voluminous data-sharing, policymakers may find it difficult to determine the quality of the data gathered from the data-sharing. According to one (1) of the experts, both voluminous and high-quality data are very important as they will have a high impact. This kind of data could cover a variety of aspects, and the analysis will also show accurate and comprehensive coverage that is useful to many people and organisations. The data expert states that:

"The volume of data and the data quality will indeed have a high effect. Because many data are usually related to high coverage. We can cover or even our analysis can cover as many individuals as possible".

However, the expert also warned that highly voluminous data may include irrelevant data which can create noise in the decision-making. This noise will distract the policymakers and/or decision-makers from focusing on the real cause of the main issue to solve, this may affect the decision/policymaking efficiency and effectiveness.

The MAMPU has developed two (2) data-sharing portals, namely data.gov.my and MyGDX, that enable data-sharing from various agencies on a single platform for open data and for restricted data. However, it is the complete responsibility of the data suppliers/providers (i.e. agencies) to ensure the quality of the data they provide. As the agencies collect data from sources (or data owners), they must ensure the accuracy and the integrity of the data. The agencies conduct several verifications before data warehousing and data-sharing. Especially for restricted data-sharing in MyGDX, the data is encrypted as it is confidential and

restricted. Thus, only the data users who receive approval from the data owners or the data suppliers will be given an API to access that data. Even for open data, it is highly important to have high data quality, especially in an open data portal (data.gov.my). The portal provides the data dashboards/data visualisation and data catalogue, which need high-quality data to provide accurate and useful dashboards. The open data-sharing portal version 2.0 provides high frequency, high granularity and high impact data, resulting daily views of more than 20, 000. Thus, it is highly essential to have high-quality data.

ii. Automated/sophisticated tools

Based on the interview outputs, data-sharing involves many automated tools to improve its quality. Most of the agencies, especially those that share data via MyGDX, use tools for their data-sharing. Even without specific tools, the agencies share data using API technology, and use the Secure File Transfer Protocol (SFTP), which is a network protocol for securely accessing, transferring and managing large files and sensitive data. As the data expert states that:

"Through SFTP, the agencies transfer files in CSV or an Excel form from one (1) server to another or manually. There are those who upgrade it to make server scheduling for data transfer."

Raw data or data from original sources often contain mixed categories of information that may be useful, but also confidential and private. Due to the Personal Data Protection Act (PDPA) and the requirements of the CGSO, agencies are not allowed to share data without first classifying it according to the relevant categories. Data classification is essential for sharing data and for data visualisation or analytics. The classification process should be done by the agencies themselves as they have a better understanding of their data and can ensure that the classification is done accurately. According to the data expert:

"Once the data is confidential, it cannot be shared, that is one thing. At MAMPU, for example, the data shared through MyGDX are usually data other than open data. When there is other than open data, such as limited, confidential, secret, or top secret. These four (4) classifications of data are limited and confidential, and there is another one (1) in terms of MyGDX, which is personal data. This personal data should always fall under CONFIDENTIAL. Following the data governance, the agencies will look at every point, every variable that can or cannot be given to the data users".

iii. Employees' analytical capability/skills

According to the experts interviewed, analytical skills are crucial for employees as tools alone cannot compensate for human skills. Employees with strong analytical skills not only perform their jobs effectively but also help organisations save costs, as they can replace the need for expensive tools. The data expert interviewed emphasised the importance of analytical skills for employees, as they are essential for maximising the use of sophisticated tools. The expert also agrees that sophisticated/automated tools are useful for policymaking, if the development of that policy requires voluminous or comprehensive data; thus, the ability or analytical skills to use the software and analyse the data are crucial to own. However, the data quality does not depend on the ability/analytical skills of the employees. The quality of the data must be guaranteed and verified from the start of data creation. Thus, this policymaker asserts that high-quality data are the data that are correct, valid, and unquestionable. Thus, data-sharing should be based on the principle of "single source of truth," which means that data-sharing from various agencies should be consistent with data from the original source. For example, all data about individual identities must be similar to the data that are kept or shared at the JPN, especially regarding

names, identity cards, addresses etc. JPN is the single source of truth if the agencies require confirmation about the data related to individual identity. The expert in the interview states that:

"Data quality is fundamentally independent of analytical abilities/skills. Quality data needs to be guaranteed from the beginning, which is the moment the data is created. Quality data, in my view, refers to correct, authentic and unquestionable data. In relation to that, the principle of "single source of truth" is important in government services where certain data can only be provided by certain agencies and shared with other agencies that need it."

OBJECTIVE 4

What are the recommendations on transforming data into business value (by identifying ways that organisations can effectively use data to drive business value and improve performance, identifying best practices for data management and analysis, and identifying opportunities for data-driven innovation)?

The analysis using the NVivo software shows an overall influence of data-sharing on innovation, thus answering research objective four (4). However, the word cloud below does not indicate the specific recommendations for data-driven innovation in improving performance. Thus, this research resorts to the content analysis method to derive more insights to answer this research objective.



Figure 5: Word Cloud of the Result for Research Objective 4

The findings are summarised into three (3) parts:

1. Identifying ways that organisations can effectively use data to drive business value and improve performance

For the data to be valuable or have business value, it needs to be shared. Through data-sharing, the data creates values that are beneficial for employees, businesses, and society. There are many ways organisations can use data to improve performance. First, through data-sharing, organisations can have data on their employees' productivity, whether they need training and what kind of training. Employees can also monitor and forecast their own performance if organisations practice data-sharing related to HR practices. For organisations, data-sharing through predictive analytics and foresight could help them take precautionary steps and develop strategies to prepare for future challenges and be ready to face the problem when it comes. Data-sharing also helps decision-makers, policymakers, leaders, and managers to make accurate and informed decisions for problem-solving. Second, through data-sharing, the organisation can increase its business values, for example, by creating applications. Without data, applications may not be useful to the business. However, with data-sharing, many applications can be developed to benefit the business, create value, and help the people and society. Organisations can not only sell their products or services and reach more customers, but earn additional income by displaying advertisements and links and by charging fees from other vendors and individuals. Data-sharing also provides real-time data, which is required by many people, including businesses and society in general. This not only helps organisations but also boosts other businesses and generates more opportunities for data-sharing.

2. Identifying best practices for data management and analysis

The expert recommended that data management should primarily follow the Government Wide Reference Architecture (GWRA) for effective data-sharing practices. The GWRA ensures that the standard of data usage in the delivery of government services is uniform. It can be used as a foundation for providing digital services to society. In-depth knowledge of GWRA Data is essential to determine the value of data in government service data-driven smart initiatives, data-sharing and data analytics. GWRA provides a framework for categorising of Government Data based on the service owner/service provider and the legislation that allows data to be stored by the government. It also ensures data security in inter-agency data-sharing such as government open data-sharing and MyGDX. Therefore, GWRA should lay out the data architecture or structure before data-sharing for effective data-sharing practices.

The government's MAMPU agency conducted extensive research on data management practices in various countries before developing an open data-sharing portal and MyGDX. These portals are widely regarded as best practices and are often used as a reference by other countries, particularly in the ASEAN region. The World Bank has also recognised their effectiveness. Despite this, MAMPU continues to seek out even better practices, as stated by the expert:

"From the technology point of view, we are trying again and again, we are still doing study after study, comparison after comparison based on the findings that we engaged with the various agencies to make a comparison between what others (other countries) refer to when it comes to data sharing and what MyGDX has. So, we make countermeasures from a technology point of view. From the process point of view, we need

to receive a word from one (1) source of power (so that we have a clear direction, instead of having more than one (1) source of power). So, we make the policy, guidelines, and impose technology solutions in our digital governance”.

Version 2.0 of the open data-sharing portal is more user-friendly, complete with a dashboard and data catalogue to help people make analytical interpretations and make informed decisions. Most countries such as Denmark, Singapore, South Korea, Australia, the US, and the UK are still using portals similar to Malaysia’s public sector open data’s old portal version 1.0. Thus, it can be an opportunity for ASEAN Member States to learn from Malaysia’s public sector data-sharing.

Another best practice is change management. According to the experts, change management should be regarded as an important aspect, as without change management, employees and organisations or governmental agencies would not be aware of the latest data management practices. They would not be motivated to improve and update the knowledge and technologies in line with time. Change management increases employees’ willingness to learn and study new ways of doing things and helps in enhancing data management and analysis. Exploring and driving the public sector’s data-sharing to become the best practice also needs highly competent employees and strong adherence to the standard set, including ensuring data creation is bias-free. Thus, the best practice is to have a trusted central agency that monitors and improvises the data-sharing technology and services to ensure the smooth performance of data-sharing practices. Having MAMPU as the central agency that provides ICT services to the agencies, safeguarding their trust and confidentiality of the data shared, and acting to mediate data-sharing from various federal agencies in Malaysia can be considered as the best practice to follow.

3. Identifying opportunities for data-driven innovation.

There are a lot of potential opportunities for data-driven innovation. For example, MAMPU has conducted a competition programme called CHiPTA or Challenge on Innovation and Problem-Solving through Technology Advancement. CHiPTA is a combination of an Open Data Hackathon and a Mobile App Hackathon aimed at developing talent community creativity in developing innovative solutions and creativity by using the latest technology-based application development. From this CHiPTA, a variety of innovations were created, and a lot of potential innovation can be derived if more data-sharing were available. The only thing that restricted the innovation was the insufficient data-sharing. Regarding CHiPTA, the expert states that:

"Yes, I see it is indeed towards that (i.e. data-driven innovation). Based on CHiPTA, I see a lot of innovation created. I mean, there are many innovative solutions. I see that this time, a lot of innovations in terms of solutions to the real case of the problem. Many applications were created in terms of innovative solutions to the problem that is actually happening in solving real case problems. Only, it has limited solutions because of the data (unavailable data). For example, there was a "Rahmah application" created to find stores or restaurants selling Rahmah menus. So, what data do we want? Store location data. However, the data about the location of Rahmah stores are not openly available". In creating this app, one of the participants has to go to each store, tag and text himself and then key in those data in the system. If he has the data (if the data is openly available, or even if they are not openly available, people still can subscribe to those data), from the point of view of solution

development, maybe he can go further, there are many more issues he can cover, thus will open opportunities, space and compulsion to share data".

According to the expert, many organisations possess data, but do not share it openly. Public sector agencies, for instance, have access to a variety of data but are usually kept private. This leads to a lack of innovation. Data-sharing is essential for fostering innovation, as it encourages people to think about possible ways to improve the situation. In the context of the Fourth Industrial Revolution (4IR), which includes technologies such as robotics, artificial intelligence, machine learning, and big data analytics, data is crucial.

The expert also suggests that sharing data can accelerate innovation, particularly when it comes to confidential data that was previously restricted. MyGDX allows for more data-sharing, which in turn can drive data-based innovation, resulting in the creation of new business operations and applications. However, for data-driven innovation to thrive, it needs to be backed by leaders and legislation. Currently, many individuals and organisations are unwilling to share their data without legal protection. MAMPU has developed two (2) data portals that employ technologies to safeguard data security and improve data-sharing practices. MAMPU is also addressing the confidentiality issue, which has led to people refusing to share data, by developing the MyGDX portal. The MyGDX portal requires data classification from agencies and uses technologies such as API and SFTP to maintain data confidentiality, thus increasing data security and confidence among people and organisations to share their data. Opportunities for data-driven innovation are significant when people start sharing data. Data-sharing can drive innovation in various areas like agriculture, education, and business operations, aligned with the 4IR.

Recommendations

There are several recommendations to help enhance and improve data-sharing in Malaysia:

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- i Frequent promotions are needed to highlight the importance and benefits of data-sharing to both the public and organisations. These promotions should emphasise the crucial role data plays in creating business value in terms of performance, efficiency, and effectiveness. Additionally, they should highlight the advantages of data-sharing for the public, including improving the standard of living, community health and safety, and the efficiency of services provided by both public and private sector organisations.
 - ii It is important to address the resistance of data owners, such as agencies, people, and organisations, to share their data. This resistance may stem from fear of the unknown, lack of trust, and lack of control over the use of their data. To overcome these issues, there needs to be more promotion and awareness through social media, television, etc. The government must also take swift and serious action when data breaches occur to build trust with data owners. Data owners need to be informed about what data users are doing with their data and given the freedom to control and withdraw their consent whenever they see fit.
 - iii Promoting data-sharing should always come with a clear explanation of how shared data is protected against misuse. This includes the processes and technologies used to ensure data security and prevent data leakage and other suspicious activities such as hacking and stealing. To prevent data misuse for the benefit of others without giving anything in return to data owners, there should be insurance covering the security of data-sharing. Insuring data-sharing not only increases trust among data owners but also increases the tendency to voluntarily share data while being entitled to receive benefits if their consent is misused.
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- iv Another mechanism to improve security is to introduce terms such as "secure sharing by informed concept" embedded in the data-sharing practice. Several cybersecurity fundamentals and technologies, such as data encryption algorithms and data authenticity services like digital signatures can be adopted here. The usage of digital certificates among data owners and governments would also provide secure data-sharing and proof against loss of data confidentiality, integrity, and authenticity.
 - v Another cutting-edge service is adopting blockchain technology, which can clearly identify conditions and constraints before sharing data. This empowers data owners to have more control over their shared data. The use of blockchain technology enforces data integrity and offers tamper-resistant services.
 - vi The government should prioritise educating and promoting awareness about data-sharing at an early stage, including in secondary schools, to different levels of society. It is essential to impart knowledge about data-sharing to reduce resistance to data-sharing practices and encourage acceptance of data-sharing.
 - vii It is crucial for government employees to receive effective training in data analytics as it enhances their analytical skills and decision-making abilities. This training not only provides technical proficiency in data analysis tools but also encourages innovation, improves service delivery, and ultimately benefits the public interest.
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Conclusion

The amount of data produced on a daily basis is immense. However, data-sharing is not common practice, especially in the private sector where companies are cautious and less interested in open data-sharing. Despite realising the benefits of data-sharing, organisations tend to restrict access to their data. This approach limits the potential of the collected data to be fully utilised. In today's digital economy, where big data is prevalent, organisations should embrace data-sharing. Studies have shown that data-sharing improves decision-making and is fundamental to staying relevant in the highly competitive business world. It is important to note that only high-quality data would produce the desired effect. Quality data is crucial and increases the effectiveness of data-sharing, analytical capabilities, human resources skills, and the sophistication and automation of other tools.

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TOPIC 06

Exploring the Level of Environmental, Social and Governance Adoption for the Communication and Multimedia Industry Players

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Abstract

This study aims:

- 1) to provide a comparative benchmark of Environmental, Social and Governance (ESG) specifically on environment adoption practice within the telecommunications, broadcasting, postal and courier sectors;

- 2) to identify challenges, opportunities, and potential impacts of implementing ESG specifically on environment aspects among listed and non-listed licensees under MCMC;

- 3) to analyse the adoption of ESG initiatives in the environmental aspects of the telecommunications, broadcasting, postal, and courier sectors; and

- 4) to provide targeted sector-specific recommendations to promote Environment, Social and [corporate] Governance (ESG) adoption specifically in the environmental aspects amongst Malaysian Communications and Multimedia Commission (MCMC) licensees.

The emphasis on the environmental aspects in these three (3) sectors (telecommunication, broadcasting, and postal and courier) is due to the potential of these sectors to mitigate climate change, conserve resources, manage electronic waste, meet stakeholder expectations, and comply with the regulatory framework. The fundamental framework of the study is built from the Theory of Planned Behaviour. A qualitative method was employed to accomplish the study's objectives. An interview was conducted to investigate the level of compliance and implementation of ESG focusing on the environment among the communications and

multimedia industry players covering challenges, success factors, opportunities as well as ESG influence in business activities among the top management of the telecommunication and multimedia industry (listed and non-listed companies) registered under the MCMC (MCMC Licensees). The findings will provide information and indicators of ESG adoption specifically on the environment within the companies. Thus, it will be useful for policymakers to design more effective and targeted initiatives to enhance the capacity of ESG adoption among communication and multimedia industry players to leverage the path toward achieving the targeted Sustainability Development Goals (SDGs) agenda. It is also a great opportunity for industry players to build greater trust with employees, shareholders, and communities for their sustainable operations.

Introduction

Problem Statement

According to Jasni et al. (2020), a company should meet the requirements of ESG scores even though the ESG mandate is quite challenging for many industries and companies to embrace. Therefore, interested companies need to have a strategic plan for their future consideration, because, without such ESG strategic approaches, the commitments will initially gain zero (0) value. Jasni et al. (2020), Malaysia is in high expectations to realise a mission to become a digital economy by 2050; hence, it is interesting to explore the voluntary ESG commitments of telecommunications companies in providing a sustainable marketplace for the stakeholders. Jasni et al. (2020) also mentioned that a company needs to have a strategic way, to be consistent in ESG commitments, to gain an advantage from sustainable investment. The strategy will allocate available resources by identifying the primary stakeholders and addressing their needs. Consequently, it is a challenging task to address the complexity of deserving multiple stakeholders' reliance that will provide better quality sustainability practices, thus eventually reflected in the disclosures.

Zhang et al. (2020), indicate that despite the rapid growth of the telecommunications sector, players and firms encountered several challenges. For instance, a rising employment turnover in the telecommunications sector. The major forces that contributed to the employee turnover among telecommunications companies in Malaysia were due to the underpaid wages and employment benefits issues, along with the increasing competitors among telecommunications firms. Besides, there were growing customer complaints over the major telecommunications service providers including the slowdown of broadband internet speeds, and limited 4G LTE coverage for most of the places, which have caused the level of customer satisfaction of the mobile services provided in Malaysia such as Digi, Maxis, Celcom, and U-Mobile to decline (Zhang et al. 2020). Faced with such a backdrop, local mobile service providers seek strategies to increase their market shares and revenues. Hence, investment in CSR initiatives could be one (1) of the strategic tools because it is perceived to be able to enhance corporate image and reputation.

According to Sarangapani et al. (2021), the Malaysian telecommunications industry is currently going through a difficult period, with fierce rivalry. For telecommunications providers, this is indeed an issue. As a result, the telecommunications industry's uncertainty as a result of rivalry necessitates an understanding of brand loyalty and the forces that influence it to compete in the increasingly competitive telecommunications industry. Ishak & Asmawi (2022) discovered that the current state of knowledge is insufficient to elucidate the effective incorporation of the ESG framework into corporate strategic planning for technology hub developers, especially when the company is not publicly listed. This highlights that the company's status can indeed impact ESG reporting compliance in various ways.

From the perspective of Pranugrahaning et al. (2020), it is worth noting that the Information Communication Technology (ICT) sector has been identified as a sector that has sought to proactively respond to the international call for business mobilisation to address the SDGs. Reports on the adoption of sustainable development within the private sector have also highlighted the ICT industry as one (1) of the leading industries committed to the United Nations SDGs. Despite this, very little sustainability research has been undertaken on the broader sector, or sub-

sector, including within the developing country context.

Research Objectives

This study aims to: -

To provide a comparative benchmark of ESG specifically on environment adoption practice within the telecommunications, broadcasting, postal and courier sectors.

To identify challenges, opportunities and potential impacts of implementing ESG specifically on environmental aspects among telecommunications, broadcasting, postal and courier services licensees.

To analyse the adoption of ESG initiatives in the environmental aspects of the telecommunications, broadcasting, postal, and courier sectors.

To provide targeted sector-specific recommendations to promote ESG adoption specifically on environmental aspects among telecommunications, broadcasting, postal and courier services licensees.

Literature Review

Communications and Multimedia Industry

As digital technologies become more prevalent, the digital economy will become the foundation of the modern economy. Accelerating the digital economy is no longer optional but crucial for Malaysia (Malaysia Digital Economy Blueprint). The telecom industry has been highly reliant on innovation as a key source of sustainable growth and rapid expansion. The introduction of a variety of highly innovative products and services allowed telecommunications companies to enhance their performance and profitable growth. Hajar et al. (2020), telecommunications companies are trying to escape market growth saturation by offering a large variety of innovative services. The new focus of these companies is increasing customer value to maintain existing customer loyalty through innovative products and services, instead of seeking new customers. Therefore, telecommunications companies need to move ahead with the value innovation logic of breaking out the competition through making leaps at buyers' value, thereby opening new market space, and forming the need for demand and more chances for profitable advancement (Hajar et al. 2020).

Environmental, Social and Governance

The elements of ESG have started to be documented around the globe, particularly in Asia, and are considered the major drivers in determining potential risks, firm value, and being opted by the companies in response to the obligatory requirements defined by the regulatory bodies. Nowadays investment managers often include ESG principles amid the assets allocation process by following a more inclusive approach together with potential other emerging investment tools that attract investors who have particular investment agendas ESG in the telecommunications industry (Khalil et al. 2022). Hiyari et al. (2022) find that firms with stronger ESG performance have a higher investment efficiency (IE). Interestingly, the study finds that board cultural diversity negatively moderates the impact of ESG performance on IE for firms operating in settings prone to overinvestment. While Amosh et al. (2022) in their studies indicated that ESG collective performance maximises financial performance, while governance performance influences return on assets only. The matter is that recent studies

show that companies that meet the ESG requirements have better management, take more care of the environment and sustainable development, have lower income volatility, and have access to cheaper cash funds (Alexander & Arseniy 2021).

Environmental, Social and Governance in Communications and Multimedia Industry

Jasni et al. (2018) report that the synergies of business strategy within the telecommunications industry towards sustainable development have exhibited significant contributions in various contexts; direct and indirect impacts, marketing communication tools, and customer value perception. Prior practices held onto terms like corporate social responsibility (CSR), while the present era discusses views from one (1) common stance called ESG which is composed of all the mentioned three (3) factors, which also happens to be a widely used term for discussions related to investments. Several ESG issues can be linked with the telecommunications industry; for instance, in environmental scope, on how companies address waste and carbon footprint in their environmental system. As for the social scope, the issues are related to engagement with stakeholders, for instance, health and safety at the workplace and protection of customers' data. Meanwhile, in the scope of governance, the emphasis is on how companies strengthen the roles of the Board of Directors and enhance audit monitoring to minimize fraud in business dealings. Consequently, integrating corporate commitments and ethical decision-making has been considered a good move for sustainability development.

Research on corporate governance from an empirical perspective provides useful insights into the benefits and achievements of ESG. According to Khan et al. (2013), corporate governance characteristics have historically been acknowledged as vital in ensuring organisational legitimacy through CSR disclosure. For example, board diversity has a beneficial impact on business performance and the level of CSR disclosure (Khatib & Nour, 2021; A. Nour et al., 2020). Similarly, Fayyaz et al. (2023) discovered a favourable correlation between dividend per share, board size, gender engagement, and corporate governance.

Methodology

Research Design

This study employs a qualitative research design to gain a comprehensive comprehension of the research objectives. This study is of an exploratory nature, with the objective of investigating the degree of adherence and execution of ESG principles among MCMC Licensees operating in the telecommunications, broadcasting, postal, and courier services industry.

Research Instrument

In this qualitative research study, a semi-structured interview protocol was developed, consisting of an introductory section addressing participant information and informed consent, followed by open-ended and probing questions exploring key themes such as the level of ESG compliance, challenges, opportunities, and success factors, particularly focusing on environmental aspects within the telecommunications, broadcasting, and postal and courier services sector. The protocol also delved into specific environmental practices and their influence on daily business activities. The interview duration, logistics, and contact information were clearly communicated, and a pilot interview was conducted to refine the effectiveness of the questions.

Sampling

Purposive sampling was used where key informants were selected based on their expertise on a particular issue. In this case, the study involves top management individuals from listed and non-listed companies in the telecommunications, broadcasting, and postal and courier services sector holding MCMC Licensees. They are leaders for sustainability; risk management; and governance in the organisations. The list of licensees includes Applications Service Providers (ASP), Network Facilities Providers (NFP), Network Service Providers (NSP), Content Application Service Providers (CASP), and licensees under the Postal Services Act 2012. Due to time and technical constraints, the study involves nine (9) companies as key informants. Samples for qualitative study are generally much smaller than those used in quantitative studies (Mason, 2010).

Data Collection

A face-to-face or virtual interview was conducted with top management individuals from the selected companies. For the interview setup process, the researcher first contacts the identified companies. Companies agreeing to

participate in this study will designate a key informant, preferably an individual with expertise in sustainability or someone leading the ESG agenda within the company. Thus, all inputs gained from the key informants have been processed and extracted as findings. The interviews aimed to explore and gather information on the compliance and implementation of ESG, challenges faced, success factors, opportunities, and the impact of ESG on business activities. The observational notes were taken during a physical interview session. The interview session was recorded with permission from the key informant to facilitate the note-taking and narrative transcribing purpose.

Data Analysis

The narratives gathered from interviews were transcribed, coded, and themed using Atlas.ti software. The inductive thematic analysis was used to identify the environmental aspects adoption among the regulators and telecommunications, broadcasting, postal and courier services licensees.

Finding and Analysis

COMPANY	SECTOR	ESG MATURITY SCALE	KEY INFORMANTS' EXPERTISE	COMPANY STATUS	TYPE OF COMPANY
T1	Telecommunication	Level 3	Sustainability	Non listed	Local
T2	Telecommunication	Level 3	Sustainability	Non listed	Local
T3	Telecommunication	Level 3	Risk management	Non	Multinational
B1	Broadcasting	Level 1	Operational management	Non listed	Local
B2	Broadcasting	Level 1	Risk management	Non listed	Local
P1	Postal & courier services	Level 3	Operational management	Listed	Multinational
P2	Postal & courier services	Level 3	Sustainability	Listed	Local
P3	Postal & courier services	Level 1	Policy and governance	Non listed	Local
P4	Postal & courier services	Level 0	Operational management	Listed	Local

Note: Level 0=Minimalist; Level 1=Pragmatist; Level 2=Strategist; 3=Trailblazer (Adopted from PwC, 2018).

Table 1: List of interviewed key informants from telecommunications, broadcasting, and postal and courier services companies.

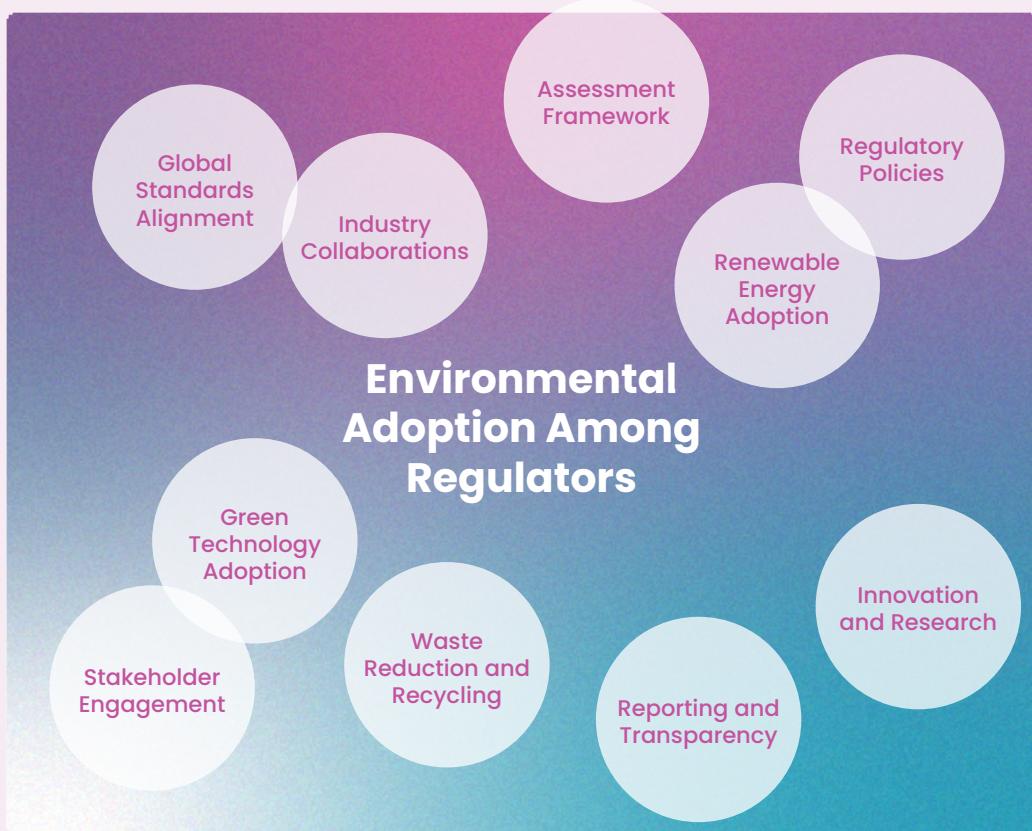


Figure 1: Themes for comparative benchmark of ESG specifically on environmental aspects adoption approaches implemented by telecommunications, broadcasting, postal and courier sector.

	TELECOMMUNICATIONS	BROADCASTING	POSTAL & COURIER SERVICES
CHALLENGES	<ul style="list-style-type: none"> • Infrastructure Upgrades • Energy Consumption • Supply Chain Complexity • Regulatory Compliance • E-Waste Management 	<ul style="list-style-type: none"> • Energy Consumption in Broadcasting Facilities • Legacy Equipment and Infrastructure • Supply Chain Sustainability • Waste from Obsolete Technologies • Community Engagement and Environmental Awareness 	<ul style="list-style-type: none"> • Carbon Emissions From Transportation • Waste from Packaging Materials • Supply Chain Sustainability • Waste Management • Community Engagement and Awareness
OPPORTUNITIES	<ul style="list-style-type: none"> • Energy Efficiency Technologies • Renewable Energy Integration • Innovation in Green Technologies • Community Engagement • Global ESG Investments 	<ul style="list-style-type: none"> • Energy Efficiency Technologies in Broadcasting • Renewable Energy Integration in Broadcasting Facilities • Innovation in Green Broadcasting Technologies • Community Engagement and CSR Programmes • Global ESG Investments 	<ul style="list-style-type: none"> • Energy-Efficient Transportation • Renewable Energy Integration in Facilities • Innovation in Sustainable Packaging • Community Engagement and CSR Programmes • Global ESG Investments
POTENTIAL IMPACT	<ul style="list-style-type: none"> • Market Leadership and Differentiation • Operational Efficiency Gains • Regulatory Relations • Employee Satisfaction • Positive Public Perception 	<ul style="list-style-type: none"> • Market Leadership and Differentiation • Operational Efficiency Gains • Regulatory Relations • Employee Satisfaction • Positive Public Perception 	<ul style="list-style-type: none"> • Market Leadership and Differentiation • Operational Efficiency Gains • Regulatory Relations • Employee Satisfaction • Positive Public Perception

Table 2: Challenges, opportunities, and potential impacts of implementing ESG specifically on environmental aspects among telecommunications, broadcasting, postal and courier services licensees.

ENVIRONMENTAL ASPECTS ADOPTION	TELECOMMUNICATIONS			BROADCASTING		POSTAL & COURIER SERVICES			
	T1	T2	T3	B1	B2	P1	P2	P3	P4
Energy efficiency & renewable energy	/	/	/	x	/	/	/	/	x
Green infrastructure	/	/	/	/	x	/	/	/	x
Waste management	/	/	/	x	/	/	/	x	x
Paperless operations	/	/	/	x	/	/	/	/	x
Transportation efficiency	/	/	/	x	x	/	/	/	x
Environmental certification	/	/	/	x	x	/	/	x	x
Sustainability reporting	/	/	/	x	x	/	/	x	x
Awareness and Education	/	/	/	/	/	/	/	x	x
Regulatory compliance	/	/	/	x	x	/	/	/	x
Research and Development	/	x	/	x	x	/	/	x	x
Collaboration and Partnerships	/	/	/	x	/	/	/	/	x

Note: / = Present; The details were presented in Appendix A.

Table 3: Environmental aspects adoption approaches implemented by telecommunications, broadcasting, postal and courier services licensees.

ENVIRONMENTAL ASPECTS	TELECOMMUNICATIONS	BROADCASTING	POSTAL & COURIER SERVICES
Regulatory Compliance and Reporting	Ensure compliance with local environmental regulations and reporting requirements. Regularly update and submit comprehensive reports on environmental performance.	Ensure compliance with local environmental regulations applicable to broadcasting operations. Regularly report on environmental performance and initiatives according to regulatory requirements.	Ensure compliance with local environmental regulations applicable to postal and courier operations. Regularly report on environmental performance and initiatives in accordance with regulatory requirements.
ESG Training and Capacity Building	Provide training programmes for employees on environmental sustainability, focusing on best practices, energy efficiency, and waste reduction. Build internal capacity to drive ESG initiatives.	Provide training for broadcasting staff on ESG principles, including Environmental sustainability. Build internal capacity to integrate ESG considerations into daily operations.	Provide training for postal and courier staff on ESG principles, including environmental sustainability. Build internal capacity to integrate ESG considerations into daily operations.
Green Technology Adoption	Embrace green technologies in the telecommunications infrastructure, including energy-efficient network equipment and eco-friendly solutions. Prioritise the adoption of technologies that minimises environmental impact.	Invest in energy-efficient broadcast equipment and facilities. Explore technologies that reduce energy consumption and minimise the environmental impact of broadcasting operations.	Invest in fuel-efficient and low-emission vehicles for transportation. Explore technologies that reduce energy consumption in sorting and delivery operations.
Renewable Energy Integration	Integrate renewable energy sources, such as solar and wind, into the telecommunications infrastructure to reduce reliance on non-renewable energy and lower the carbon footprint.	Explore opportunities to integrate renewable energy sources, such as solar or wind, into broadcasting facilities. This can contribute to reducing the carbon footprint associated with energy consumption.	Explore opportunities to integrate renewable energy sources, such as solar or electric vehicles, into postal and courier facilities. This can contribute to reducing the carbon footprint associated with transportation and logistics.
Supply Chain Sustainability	Collaborate with suppliers to enhance sustainability throughout the supply chain. Encourage suppliers to adopt environmentally responsible practices and provide transparency on their ESG performance.	Collaborate with suppliers to ensure sustainability across the broadcasting supply chain. Encourage the adoption of eco-friendly practices and transparent reporting on ESG performance.	Collaborate with suppliers to ensure sustainability across the postal and courier supply chain. Encourage the adoption of eco-friendly packaging materials and transparent reporting on ESG performance.
Waste Reduction and E-Waste Management	Implement waste reduction measures within the organisation. Develop and promote e-waste management programmes to responsibly handle the disposal of electronic equipment.	Implement waste reduction measures in broadcasting facilities. Establish e-waste management programmes to responsibly handle electronic equipment disposal.	Implement waste reduction measures in sorting and delivery operations. Encourage the use of recyclable or biodegradable packaging materials and establish e-waste management programmes for electronic equipment disposal.

ENVIRONMENTAL ASPECTS	TELECOMMUNICATIONS	BROADCASTING	POSTAL & COURIER SERVICES
Community Engagement and CSR Programmes	Engage with local communities to understand environmental concerns. Implement CSR programmes focused on environmental initiatives, such as tree planting, community clean-ups, and awareness campaigns.	Engage with local communities through CSR programmes focused on environmental initiatives. Support community projects that align with sustainability goals and address environmental concerns.	Engage with local communities through CSR programmes focused on environmental initiatives. Support community projects that align with sustainability goals and address environmental concerns related to postal and courier services.
Innovation and Research Collaboration	Foster innovation in telecommunications technology that aligns with environmental sustainability goals. Collaborate with research institutions to drive green technology advancements.	Foster innovation in broadcasting technology that aligns with environmental sustainability. Collaborate with research institutions to explore and implement green broadcasting solutions.	Foster innovation in postal and courier technology that aligns with environmental sustainability. Explore collaboration with research institutions to improve efficiency and reduce the environmental impact of operations.
Water and Resource Efficiency	Implement water and resource-efficient practices within operations. Evaluate and optimise water usage and adopt technologies that enhance resource efficiency.	Implement water and resource-efficient practices in broadcasting facilities. Evaluate and optimise water usage and adopt technologies that enhance resource efficiency.	Implement water and resource-efficient practices in postal and courier facilities. Evaluate and optimise water usage and adopt technologies that enhance resource efficiency.
Stakeholder Engagement and Dialogue	Engage stakeholders, including customers, employees, and local communities, in a dialogue on environmental initiatives. Seek input and feedback to enhance the effectiveness of sustainability programmes.	Engage with stakeholders, including viewers, employees, and local communities, in a dialogue on environmental initiatives. Seek input and feedback to enhance the effectiveness of sustainability programmes.	Engage with stakeholders, including customers, employees, and local communities, in a dialogue on environmental initiatives. Seek input and feedback to enhance the effectiveness of sustainability programmes.
Financial Incentives	Explore financial incentives and rewards for implementing environmentally sustainable practices. This can include tax incentives, grants, or other financial support for green initiatives.	Explore financial incentives for environmentally sustainable broadcasting practices. This may include tax incentives or grants for implementing green initiatives.	Explore financial incentives for environmentally sustainable postal and courier practices. This may include tax incentives or grants for implementing green initiatives.
ESG Rating and Benchmarking	Participate in ESG rating and benchmarking processes to assess and communicate environmental performance. Use the results to identify areas for improvement and showcase commitment to sustainability.	Participate in ESG rating and benchmarking processes to assess and communicate environmental performance. Use the results to identify areas for improvement and demonstrate commitment to sustainability.	Participate in ESG rating and benchmarking processes to assess and communicate environmental performance. Use the results to identify areas for improvement and demonstrate commitment to sustainability.

Table 4: The targeted sector-specific recommendations to promote ESG adoption specifically on environmental aspects amongst telecommunications, broadcasting, and postal and courier services licensees.

Recommendations

Establishing Clear ESG Metrics and Targets	Develop and adopt specific, measurable, and time bound ESG metrics and targets tailored to the communication and multimedia industry. This will provide a roadmap for improvement and allow for more accurate tracking of progress over time.
Integration of ESG into Corporate Governance	Integrate ESG considerations into corporate governance structures, including board oversight and decision-making processes. This ensures that ESG factors are considered at the highest levels of the organisation.
Investment in ESG Training and Education	Invest in training programmes and educational initiatives to enhance the understanding of ESG principles and practices among employees at all levels. This can include training on sustainable business practices, ethical decision-making, and the importance of social responsibility.
Collaboration with Industry Peers and Stakeholders	Foster collaboration with industry peers, NGOs, and other stakeholders to share best practices, address shared challenges, and collectively advance ESG standards within the communication and multimedia sector.
Innovation for Sustainable Technologies	Prioritise research and development efforts towards the creation and adoption of sustainable technologies within the communication and multimedia industry. This includes the development of eco-friendly products, energy-efficient technologies, and solutions that promote digital inclusion.
Regular ESG Reporting and Communication	Implement a regular and standardised ESG reporting mechanism, providing stakeholders with consistent and transparent information on ESG performance. This can include annual sustainability reports and other forms of communication.
Adoption of Circular Economy Principles	Explore and adopt circular economy principles within the product life cycle. This involves designing products for durability, reuse, and recycling, reducing waste, and minimising environmental impact.

Conclusion

This study not only offers a comprehensive snapshot of the current ESG landscape within the communication and multimedia industry but also provides a roadmap for future initiatives. The challenges identified underscore the need for strategic, sector-specific approaches, while the opportunities and potential impacts highlight the transformative power of sustainable practices. As the industry continues to evolve, embracing ESG principles is not just a corporate responsibility but a strategic imperative. The recommendations presented in this study, when embraced, have the potential to position companies as leaders in sustainable business practices, contributing to a resilient and responsible future for the communication and multimedia industry. The journey towards comprehensive ESG adoption is ongoing, and the insights garnered from this study serve as a catalyst for continued collaboration, innovation, and progress within the communications and multimedia sector. By fostering a culture of responsibility and sustainability, industry players can not only meet regulatory requirements but also seize opportunities for differentiation and positive societal impact in the evolving landscape of the digital era.

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TOPIC 07

A Study on the Consumer Perspective and Experience in Postal Article Safety Through Last- Mile Delivery for Postal and Courier Industry

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Abstract

The growth of e-commerce is the main factor driving the postal and courier industries. The modern customer is becoming more conscious of their rights. A few years ago, consumers made purchases without considering whether the goods met their expectations. Consumers today expect postal and courier services to provide high-quality service. Therefore, a study on consumer expectations and experience in postal article safety through last-mile delivery for the postal and courier industry has been conducted. Qualitative and quantitative research with a sample of 245 respondents are used in the study. The study is also analysed statistically using gap analysis and Importance Performance Analysis (IPA). The results showed a significant gap between expectations and experiences in all five (5) dimensions of service quality. With regards to the IPA matrix, service quality attributes were in the four (4) quadrants. Furthermore, the study highlighted 10 issues and challenges in ensuring parcel safety complies with the requirement. The negative gap in all dimensions of quality shows that quality improvement is necessary in all dimensions. Using service quality measurement instruments, IPA analysis will help courier service providers plan service quality improvement and achieve long-term goals.

Introduction

In the competitive, service-oriented business environment of today, every company needs to strive to satisfy its clients by providing the best possible quality. The long-term success of a corporate organisation is mostly dependent on its customers. The postal and courier services must offer their customers valuable, high-quality services. The courier service providers are fortifying their positions and pursuing expansion by investing in e-commerce logistics, such as the use of cutting-edge logistics technologies and revitalising the supply delivery system, to match this demand and stay competitive in the difficult market as it has evolved from door-to-door to self-service using information technology and sophisticated logistical solutions. Alongside the e-commerce industry, the postal and courier market is growing rapidly, generating significant earnings for the industry. The e-commerce business is growing at an exponential rate, which presents both opportunities and challenges for online retailers and logistics companies. Due to the rising popularity of e-commerce, there has been a tremendous growth in consumer demand for express delivery services. However, the number of complaints from customers using postal and courier services has increased along with Malaysia's growing demand for online business. For instance, it rose by 70 per cent between 2018 and 2019. In 2018, there were 1,235 complaints, while in 2019, there were 2,102 (MCMC, 2019). As last-mile delivery is a critical step in getting products to their destination, which is usually the customer's doorstep, improving the quality of the services provided is therefore imperative. During this phase, a company's reputation can be made or broken by its effectiveness and customer experience. To enhance last-mile delivery, businesses are looking for creative solutions as customer demands rise. Accordingly, the study aims to investigate the consumers' experience in the last mile of a parcel delivery service that considers consumers' experiences with last-mile delivery.

Problem Statement

When the COVID-19 pandemic struck, the movement control order disrupted domestic and international supply networks. Unintentionally, this increased the need for online purchasing, pushing companies to use e-commerce to stay in business. The postal and courier sector in Malaysia has grown rapidly in recent years, mainly due to the COVID-19 pandemic, shifting consumer behaviour, and the rise of e-commerce platforms. The logistics sector serves an ever-growing number of customers, mostly in the last-mile delivery sector, because of Malaysia's e-commerce industry's explosive growth. E-commerce is predicted by the Malaysian Communications and Multimedia Commission (MCMC) to increase from 14 parcels per capita in 2020 to 30 parcels per capita by 2025, and this rise is anticipated to continue. Even though the growth trend is favourable, many courier companies are finding it difficult to capitalise on the growing demand for their services because of intense competition and industry pressure to reduce service rates (Defry et al., 2022). Due to fierce competition and a protracted price war, many courier businesses, especially small ones are finding it challenging to profit from the growing demand for their services, despite their extensive awareness in the booming e-commerce market. The rise in parcel volume and market demands for reasonably priced services have led to a decline in last-mile delivery performance in the postal industry, which has raised consumer discontent with the security and timeliness of postal deliveries (Lei, et al, 2022). Furthermore, shifting business methods have also seriously impacted the last mile concept.

Late deliveries, parcels that are delivered in unsatisfactory circumstances, and missing or misplaced parcels are the most frequent issues. Because of this, MCMC saw a sharp increase in complaints from customers who were unhappy with the security and delivery of their postal items because of the growing volume of packages and pressure from the market to provide services at competitive prices. There has been a notable increase in the number of complaints received by MCMC about postal and courier services during the last three (3) years (2016–2018). In 2018, MCMC received 1,235 complaints, which is seven (7) times higher than the 143 complaints received in 2015 (MCMC,

2019). Among the complaints received are issues such as missing items, poor service, late deliveries, poor customer support, unfair prices, refunds, and other related delivery issues.

Research Objectives

To provide a comparative benchmark of best practices for parcel safety during last-mile delivery.

To understand consumer perceptions on the practice of parcel delivery at the doorstep when not at home, expected areas of service improvement, and consumer willingness to pay additional fees to ensure parcel safety.

To understand issues and challenges in ensuring parcel safety during last-mile delivery to different demographics comprising types of customers, receiving addresses, and other contributors which could affect postal article safety and quality of delivery.

To provide recommendations for adopting best practices, guidelines, standards, or approaches to ensure industry compliance and higher consumer satisfaction with parcel safety and quality of services during last-mile delivery.

Literature Review

Postal and Courier Industry in Malaysia

The intense rivalry has arisen in the postal and courier sector due to the quickly expanding e-commerce parcel market, the inevitable collapse of the traditional core business of mail delivery as communications shift online, and other digital issues that the industry must continue to handle. Malaysia has a substantial amount of untapped potential for the advancement of the e-commerce industry, which is partially explained by its improved internet connection, high mobile penetration rate, and increased security (Halo, 2022). Businesses in the supply chain, such as courier firms that provide parcel delivery services, can benefit greatly from the expanding e-commerce sector (Siali, Wen, & Hajazi, 2018). The increasing popularity of online shopping has played a major role in the growth of courier services in recent years (Gulc, 2020). There is fierce competition among Malaysia's postal and courier service providers since the sector is headed towards becoming a competitive market. Malaysia is home to many domestic and foreign businesses, all striving to increase their market share in this sector. Concurrent with the growing popularity of online shopping and the sporadic massive e-marketplace discount days, the courier

service providers enhanced their services and handling. These developments were fuelled by digitally connected consumers who are always looking for better deals on products and delivery fees, increased convenience, and a seamless experience. According to a new analysis by Mordor Intelligence, the postal and courier market in Malaysia is predicted to rise from USD1.32 billion (RM6.18 billion) in 2023 to USD2.55 billion (RM11.94 billion) by 2028.

Service Quality Measurement Using SERVQUAL

The service sector makes the tough decision to assess service quality through the "eyes" of its customers (Arora & Arora, 2015). The service industry can grow quickly if it can offer higher-quality services. In summary, there is a distinction between a service's quality and the performance standards that its clients hold it to. Since it gives informative information about how customers perceive services, the idea of service quality continues to be an important subject of research in marketing (Joshi & Chadha, 2016). When referring to quality in the context of services, it means assessing the services holistically, considering things like performance, features, compliance, durability, serviceability, and other quality-related factors (Parasuraman, 1988). By evaluating service quality, businesses

can gain a competitive advantage and evaluate their place in the market. Berry et al. (1994) claim that SERVQUAL is a helpful tool for supporting organisations in their pursuit of quality improvement by highlighting areas that are critical to improvement. Parasuraman (1988) states that the SERVQUAL instrument's dimensions can be applied in several industries.

Tangibility

According to Mei et al. (2018), one (1) important factor influencing service quality is the tangibles dimension. The tangible aspects of the service environment can significantly impact a customer's affective response and behavioural intention. In a similar element, customers' initial impression of a service is based on its physical surroundings (Pantouvakis & Lymeropoulos, 2008). In the same opinion, Markovic et al. (2011) argued that tangibles are more crucial for services with more tangible characteristics. Some aspects set courier services apart from regular mail services. The characteristics of courier services set them apart from regular mail services. Three (3) elements related to tangibility are availability, personnel, and assets. Personnel refers to workers who produce the service and assist in the management of courier service operations, whereas assets are defined as tangible tools, operational methods outlets' locations, and websites (Roslan et al., 2015). Any tool that signals

the presence of service during the delivery process is referred to as being available.

Responsiveness

Responsiveness, or the speed and accuracy with which courier service providers handle consumer inquiries and transactions, is a crucial component of service excellence. It involves giving customers clear information and actively listening to them to fulfil their responsibilities (Hu et al., 2012). The studied literature provides valuable insights into the importance of responsiveness as a constituent of service quality, its impact on customer satisfaction, and its role in shaping customer behaviour. Research conducted across numerous countries and industries offers a comprehensive understanding of the factors influencing service quality, customer satisfaction, and channel selection intention. This knowledge may be used by businesses seeking to enhance their service offerings and customer experiences. When referring to courier services, this could refer to the reaction that a courier service provider provides to its customers. If an employee had no justification for keeping their customers waiting, they would perceive them negatively.

Assurance

The provision of safety and guarantee by courier service providers is referred to as assurance. Additional components

of assurance include capability, kindness, validity, and security. When clients receive services, the professionalism and degree of expertise of the workforce are crucial factors in providing assurance. Furthermore, employees must be able to inspire confidence and trust in customers (Izogo & Ogbag, 2015). When answering inquiries, complaints, and other correspondence from customers, staff members must be courteous. This occurred because customers chose to patronise other companies instead of returning to the former one after becoming dissatisfied and uneasy with the service rendered by an employee. The fact that consumers prefer to do business with persons or organisations they can trust serves as evidence for this. It takes this dimension to guarantee customers' happiness.

Empathy

According to Izogo and Ogbag (2015), empathy is the capacity to focus on the requirements, wants, and difficulties of the customer and to successfully address their desires, relate to the issues suitably, show concern for them, and come up with solutions. In the words of Rishi, Deepak, and Suyash (2017), empathy includes things like offering outstanding customer service, considering the customer's preferences, and accommodating business hours. A study reported by Kasiri et al. (2017), there is a relationship between empathy and customer satisfaction. Another benefit that gives customers confidence and trust

while also boosting loyalty is empathy. In every scenario, staff members ought to be deeply engaged with the clients. Consequently, this is a means by which the business should take pride in providing customers with a personalised, exceptional, and valued experience to win their loyalty through empathy and high-quality service.

Reliability

The ability of a courier service provider to honestly and consistently provide the goods and services that are agreed upon is referred to as reliability (Ngo and Nguyen, 2016). Customers will be happy when trustworthy services are provided. Reliability is the ability to reliably deliver services as promised, accurately, and on schedule. It entails having the capacity to resolve issues, manage transactions safely, and greatly affect the motivation of customers to make purchases (Chang et al., 2016). The factors influencing customers' use of express delivery services which is a crucial last-mile delivery route were the main subject of Zhong, Lomas, and Worth's (2021) analysis. The findings demonstrated that customers' behaviour and inclination to use an express delivery service are positively influenced by their performance expectations regarding delivery reliability. From the standpoint of courier services, reliability can be evaluated by the number of times a parcel is delivered to its intended location and by the length of time it takes to deliver it.

Methodology

In this study, qualitative and quantitative methods are employed. As for qualitative research design, this study employs documentary analysis to investigate contextual insights within existing textual materials related to parcel delivery services, such as journal and industry publications. By adopting documentary analysis within the specific context of parcel delivery services, the research seeks to enrich our understanding of the subject matter, providing nuanced insights to contribute to the existing body of knowledge in parcel delivery services. For the quantitative method, respondents were selected based on their experience and perception of using postal and courier services. Those who have used such services are chosen as they can provide insights into their experiences. Section A of the questionnaire covered the demographic information of the respondents, while the next section inquired about service quality, particularly on expectations and experiences using courier services. Each item was measured with the 5-point Likert Scale (1 = Strongly Disagree, 5 = Strongly Agree). Another section is asking about the issues and challenges in courier services. A total of 245 respondents were collected. The mean scores for each service quality dimension (in both expectations and experiences aspects) were calculated. The quality gap was calculated by deducting the expectation and experience scores. Additionally, Importance-performance analysis (IPA), developed by Martilla and James (1977) was used to determine which characteristics were low-performing and needed intervention to raise the quality of services provided by the courier service providers, as well as which characteristics were high-performing and demonstrated the strength of the courier service providers. The scores of the expectations and experiences were determined for each quality attribute based on consumers' perspectives.

Each quadrant of this matrix provides a strategic guide to help courier service providers perceive the consumers' concerns, as well as the necessary steps to boost customer satisfaction. The attributes assigned to Quadrant I (areas to be improved) have high expectations but low

experience indicating the failure of the courier service provider to meet the consumer's perceived performance in this area. The attributes with both high expectations and experience fall into the Quadrant II (need to be monitored) representing the core strengths of the courier service providers. The Quadrant III (low preference) belongs to the attributes with both low expectation and experience. It shows courier service providers should be a low priority because the average expectation for these attributes is the same as the average experience overall. Attributes with low experience and high performance are placed into the Quadrant IV (possible overkill) indicating the minor strengths. It suggests that courier service providers might be overkill given that the average anticipation for these attributes is lower than the average experience overall.

Findings and Analysis

Respondent Profile

ITEMS	%	FREQUENCY
Gender	Male	40.8
	Female	59.2
Age	18-29 years	43.7
	30-39 years	24.1
Age	40-49 years	20
	50-60 years	7.3
	61 years above	4.9
Race	Malay	71.4
	Chinese	14.7
	Indian	11.8
	Others	2
Education Level	SPM/ MCE/ O-Level	3.7
	Diploma/STPM/STP/HSC/A-Level	17.1
	Bachelor's degree	50.6
Occupation	Master's degree	22.4
	Doctoral Degree	6.1
	Student	29.4
Occupation	Government Sector	20
	Private Sector	27.8
	Self Employed	13.9
	Unemployed	0.8
Income	Retiree	4.9
	Housewife	3.3
	Less RM2500	44.5
	RM 2501-RM 3170	9
	RM 3171-RM 3970	6.9
	RM 3971-RM 4850	3.7
	RM 4851-RM 5880	8.6
	RM 5881-RM 7100	6.5
	RM 7101-RM 8700	5.7
	RM 8701-RM 10,970	8.2
Income	RM 10971-RM 15,040	4.1
	More than RM 15,040	2.9

Table 1: Demographic Profile of Respondents

The analysis of participant demographics reveals a diverse cross-section of respondents across various categories. The gender distribution within the sample population indicates a slightly higher representation of females (59.2 per cent) compared to males (40.8 per cent). Age-wise, the majority of respondents fall within the 18–29 years bracket, constituting 43.7 per cent of the sample, followed by descending percentages in subsequent age groups. The racial composition highlights a predominant representation of individuals from the Malay ethnic group (71.4 per cent), with notable percentages from Chinese (14.7 per cent), Indian (11.8 per cent), and "Others" (2 per cent) ethnicities. In terms of educational attainment, a significant proportion holds Bachelor's degrees (50.6 per cent), followed by Master's degrees (22.4 per cent), while smaller percentages possess Diploma/STPM/A-Level qualifications (17.1 per cent), Doctoral degrees (6.1 per cent), or SPM/MCE/O-Level certificates (3.7 per cent). Professionally, this research covers a diverse range. Of the respondents, 29.4 per cent were students, followed by people from the private sector (27.8 per cent) and people from the public sector (20 per cent). There is also a proportion of self-employed people (13.9 per cent), pensioners (4.9 per cent), housewives (3.3 per cent), and a minimal proportion of unemployed people (0.8 per cent). The income distribution shows a diverse range, with the majority earning less than RM2,500 (44.5 per cent) and the smaller percentage earning more than RM15,040 (2.9 per cent). Collectively, these results represent a diverse and multifaceted participant pool and provide comprehensive insight into the demographics of our survey respondents.

TYPE OF RESIDENTIAL	%	FREQUENCY
Public University	20.4	50
Private University	0.8	2
College University	2	5
Polytechnic	4.9	12
College Community	1.2	3
Flat / Apartment / Condominium with doorstep delivery	12.2	30
Service apartment	1.2	7
Studio apartment	1.2	3
SOHO (Small office home office)	1.2	3
Terrace house	25.3	62
Semi Detached house	3.3	8
Cluster home	2.0	5
Townhouse	2.2	5
Villa	1.2	3
Bungalow	19.0	46
Others	0.2	1

Table 2: Type of residential

The assessment of residential types conducted in the study shows a diverse distribution among the participants. According to the data, most people live in terraced houses (25.3 per cent, followed closely by those living in bungalows (19.0 per cent). Regarding institutional residential, a significant proportion of respondents (20.4 per cent) lived in public universities, suggesting a significant presence of students and people associated with these institutions. However, minimal proportions were observed at private universities (0.8 per cent), graduate universities (2 per cent), technical colleges (4.9 per cent), and community colleges (1.2 per cent), this indicates relatively low participation among people in the country. A significant proportion of those surveyed live in various types of apartments or housing complexes. This includes residents of apartments/apartments/condos with doorstep delivery (12.2 per cent), serviced apartments (1.2 per cent), studio apartments (1.2 per cent), and SOHO residents. (Small offices/home offices) (1.2 per cent), semi-detached houses (3.3 per cent), cluster houses (2.0 per cent), townhouses (2.2 per cent), villas (1.2 per cent). Additionally, a small proportion live in other housing types classified as 'other' (0.2 per cent). The distribution of residential types within the study population shows a wide range of housing preferences and housing types. The prevalence of single-family houses such as terraced houses and bungalows indicates that a significant proportion of people live in traditional housing structures. On the contrary, the existence of various types of residents, such as apartments, housing complexes, and institutional housing complexes, shows the diversity of living styles and ways of living. This diverse housing representation in survey data can potentially impact various aspects such as accessibility to amenities, community dynamics, and lifestyle preferences.

Best Practices of Parcel Delivery

The best practices of parcel delivery services from the chosen nations namely Malaysia, the UK, the US, Singapore, China, and India were investigated contextually through the use of documentary analysis in this research. Each of the selected countries has its own best practices for running the postal sector.

Delivery to Local Distribution Hub

Every country place equal emphasis on localised distribution when it comes to parcel delivery to local distribution hubs that are nearest to the recipient's residence. Efficiency and convenience are prioritised in this worldwide approach for the final distribution stage. Despite their disparate geographic origins, all countries recognise the importance of being close to the recipient's location, which is crucial for optimising the last-mile delivery process. Two (2) prominent countries that have implemented centralised distribution centres are Singapore and the United Kingdom. In the UK, parcels are routed through distribution centres and delivery depots, expediting the sorting process, and preparing deliveries for dispatch. Singapore, on the other hand, adopts a coordinated approach by offering delivery to regional hubs, specified parcel collection locations, or local distribution hubs. China adopts a comprehensive strategy that includes the use of distribution centres for the final phase of delivery. This approach takes into consideration the vast geographical expanse of China and ensures efficient parcel handling at both local and federal levels. In contrast, India employs a decentralised approach, directing items to distribution centres and decentralising last-mile delivery. This strategy aligns with India's diverse topography and population concentrations. While all of these countries are committed to enhancing local delivery services, they employ different techniques for parcel preparation and sorting.

Sorting and Processing

The sorting and processing methods utilised by various postal administrations exhibit both similarities and unique strategies. In Malaysia,

items undergo meticulous categorisation in central or regional facilities based on their dimensions, weight, and intended purpose. This meticulous sorting underscores Malaysia's commitment to maintaining a well-organised supply chain. Similarly, in the UK, parcels undergo sorting at distribution centres according to their respective destinations, with real-time processing employed. This approach underscores the UK's dedication to achieving efficient and prompt package classification. In contrast, China, India, and the US all employ centralised sorting methods. The US Postal Service, for instance, prioritises a centralised and streamlined sorting process. Parcels are categorised at sorting facilities based on their size and destination, aiming to optimise transit efficiency.

The approach in Last-Mile Delivery and Consumer Authentication

For Malaysia, the UK, Singapore, and China, the importance of obtaining a signature or confirmation of delivery is emphasised. This shared practice underscores the commitment to ensuring the safe and reliable completion of the last-mile delivery process. Meanwhile, the UK is unique as it employs a hybrid approach, utilising both local courier services and postal workers for last-mile deliveries. This dual technique provides process flexibility in the distribution process by utilising the benefits of both services. As opposed to this, last-mile delivery in the US, Singapore, and India primarily relies on the dedicated work of postal workers or staff. The streamlined approach centralises accountability for the parcel service and ensures a seamless and effective delivery process. These distinctions highlight the varying strategies employed in last-mile delivery across different countries.

Notification and Tracking Technologies

Malaysia distinguishes itself by emphasising the utilisation of mobile apps for notifications and tracking, demonstrating a strong commitment to leveraging mobile technology as a convenient avenue for delivering real-time updates. On the other hand, Singapore provides comprehensive package notifications along with tracking information, showcasing a proactive approach to customer service. The inclusion of web portal alerts

in China, however, indicates a reliance on online communication channels and a preference for centralised digital channels, which may enhance the efficiency and uniformity of notification processes. These little adjustments take into account country-specific elements and accommodate a variety of customer preferences and technological surroundings.

Return and Redelivery

If the first delivery is unsuccessful, all the aforementioned countries (Malaysia, the United Kingdom, the United States of America, Singapore, China, and India) routinely offer options for redelivery or pickup from designated locations. This flexibility has been put in place to provide options for redelivery or pickup from designated locations. This flexibility is implemented to offer consumers convenient alternatives for receiving their items. In Malaysia, the parcel service takes the initiative to try and redeliver the package. If unsuccessful, arrangements are made for consumers to conveniently pick up the parcel from a nearby parcel office. This proactive approach ensures multiple opportunities for successful delivery. The UK postal service provides a number of choices for recipients in the event that a delivery is not successful. Consumers can ask for a redelivery or pick up the undelivered item from nearby offices. This flexibility allows for the varied schedules and preferences of the consumers. When parcels from the US postal service are returned undeliverable, consumers can choose to have them picked up at a nearby post office or request a redelivery. This customer-centric strategy ensures that consumers have control over the delivery process. In Singapore, parcel consumers have the choice of picking up their parcels from pre-designated locations or requesting a redelivery. This adaptability meets the various needs of the consumers by letting them select the most practical method of delivery.

Compensation Claims

Consumers in all the countries namely Malaysia, the UK, the US, Singapore, China, and India may submit online claims for compensation. This indicates a shared commitment to enhancing consumer convenience through digital media. To initiate a compensation claim, consumers must provide specific

data and related documentation in every country, ensuring a consistent process for claim validation and handling. Consumers in Malaysia and India can start the compensation claim process by going to their local distribution hub. Those who like in-person interactions and assistance may find satisfaction in this traditional approach. Consumers in the US have the option of visiting their local post office or utilising the online claims procedure. This two-pronged strategy offers options according to personal tastes and practicality. Singapore and the UK both place a strong emphasis on online submissions made through specific portals. This demonstrates a more sophisticated digital infrastructure, resulting in an accessible and effective claims procedure. Consumers in China have the option of submitting their claims online or in person at post offices. This adaptability considers the customer base's varied tastes and level of technology access. Meanwhile, the US distinguishes itself by offering a tangible claims form to its clients. For individuals who might prefer a more conventional, paper-based technique, an alternate way is available. Other nations do not specifically mention using a paper claims form; instead, they mostly rely on online submissions. The focus on online procedures is consistent with the worldwide movement towards digitalisation. This comparison and contrast show a dedication to provide a variety of choices for clients to file compensation claims by highlighting a blend of traditional and digital ways across various nations.

Transportation

The comparison reveals that every country employs a range of transport methods, indicating a comprehensive approach to meet diverse delivery needs. Postal trucks are utilised by all countries, demonstrating the critical role that specialised postal transportation resources play. On the other hand, only the US incorporates airplanes into its transportation mix, indicating a greater reliance on air travel for efficient parcel delivery. Private courier services are occasionally used by the UK, adding another layer of collaboration with outside vendors. Due to its vast size, China places emphasis on a combination of local delivery services and postal vehicles built to handle the nation's diverse landscapes.

Gap Analysis

DIMENSION	EXPECTATION	EXPERIENCE	GAP SCORE
Tangibility	4.29	3.91	-0.38
Responsiveness	4.35	3.88	-0.46
Assurance	4.42	4.04	-0.38
Empathy	4.40	4.04	-0.36
Reliability	4.40	4.00	-0.40

Table 3: Gap Score Analysis

This study examines the differences between consumers' expectations and their experiences about several service quality factors, including tangibility, responsiveness, assurance, empathy, and reliability. The mean scores for the expectation and experience quality gap have been shown in Table 3. Accordingly, the gaps between the importance and performance were negative in all the dimensions. Consumers had high standards for tangible features; they expected aesthetically pleasing physical components and high-quality infrastructure, with a mean score of 4.29 predicted. On the other hand, the average of the reported encounters was 3.91, suggesting a significant difference. This disparity indicates that to improve overall customer satisfaction and more closely match customers' expectations, the physical presentation of services may need to be refined. The findings imply that although concrete elements like the state of vehicles and facilities and responsiveness are important, they occasionally fail to live up to customer expectations.

The projected score for responsiveness to consumer needs was 4.35, which demonstrated high expectations. However, the experiences recorded an average score that was a little lower, 3.88. This shows that there is space

for improvement in terms of response times, problem-solving, and general customer service to better meet the high standards set by customers. This suggests that to guarantee that these factors continuously contribute favourably to satisfaction, more focus has to be placed on optimising them. Expected assurance in service interactions was high, with a mean score of 4.42. The mean score for the experiences was 4.04, which is marginally lower than expected and indicates a moderate level of pleasure. Enhancing features like security, dependability, and trustworthiness may increase customer satisfaction and confidence. Giving customers clear and precise information has been shown to have a beneficial effect on their level of satisfaction overall. When they obtain trustworthy information, customers appreciate the confidence and faith courier service providers engender in them. Consequently, strengthening assurance tactics can improve the customer's experience.

The service provider has to give greater attention to the empathy dimension, as evidenced by the highest mean score of 4.40 on consumer expectations. The experiences revealed a mean score of 4.04, which was somewhat lower but still in close alignment. Enhancing compassionate methods of customer service could improve the customer experience even further. Our results support the idea that sincere and real empathy can strengthen the ties between customers and courier service providers, resulting in higher levels of customer satisfaction. Therefore, it is not only supported but highly urged that the customer satisfaction sector emphasise empathy as a fundamental component. With a mean score of 4.40, it was estimated that service delivery would be highly reliable. The experiences, however, revealed a mean score that was marginally lower 4.00 than expected, indicating a moderate level of satisfaction. Improving service delivery characteristics like precision, dependability, and consistency could greatly increase total customer satisfaction. Customers' satisfaction with the postal service appears to be negatively impacted by elements like delays and uneven service quality. This shows that to achieve customer expectations, reliability in the context of safety needs to be closely examined, with a focus on ongoing improvement.

ITEMS	DESCRIPTION	GAP SCORE
RP1	Able to provide timely notification to customers on delivery updates	-0.52
RP4	Promptly response to customer request.	-0.51
RP2	Ready to help if customer faced any problem	-0.5
TA6	Courier service provider provide adequate tracking and monitoring system	-0.49
RP6	Ability in handling lost and damaged parcels.	-0.49
AS8	Courier service provider assure declaration of liability should the parcel is lost or damaged	-0.48
TA4	Adequate parcel handling safety	-0.47
EM2	Always be prepared with the necessary information if the customer wishes to know or face issues related to the safety of the parcel	-0.47
RP8	Ability to provide incident reporting.	-0.46
RL6	Able to ensure parcel delivered in good condition	-0.45

Table 4: Top 10 Highest Attributes Gap

From the analysis of the score gap, the results of the Top 10 highest gap as shown in Table 4, improving things like timely customer notifications, quick customer service, being available to assist customers with problems, and having a dependable parcel tracking system are essential for raising the general assessment or level of satisfaction with the courier service provider. The courier service provider may use these results to prioritise areas that need improvement. Taking care of these elements that have stronger negative associations may result in a more positive assessment or conclusion overall, most likely concerning client happiness, trust, or the perceived calibre of the courier service.

ITEMS	DESCRIPTION	GAP SCORE
TA5	Updated courier technology (i.e.: QR code)	-0.35
EM3	The courteousness communication from courier employees with respect to the safety of parcel delivery	-0.35
EM1	Understand the customer's need to ensure that parcel is delivered in a secure manner	-0.34
EM5	Courier service providers should take note of customer complaints regarding the safety of parcel delivery	-0.34
AS3	Provide accurate parcel information	-0.33
AS9	Courier service provider should oblige existence of safety guidelines in delivery of parcel	-0.33
AS5	Courier employees are familiar with locality	-0.31
RL2	Accuracy in retrieving customer delivery information	-0.31
EM4	The willingness to consider service delivery beyond scope to ensure the parcel is safely delivered	-0.31
TA1	Facilities and transportation tools are in order	-0.29

Table 5: Top 10 Lowest Attributes Gap

Regarding the Top 10 lowest gap results as highlighted in Table 5, enhancements in areas like updated courier technology, courteous and efficient communication about parcel safety, understanding of customer demands for safe delivery, provision of accurate parcel information, adherence to safety regulations, and local knowledge of courier staff members could greatly raise the overall assessment or satisfaction with the courier service provider. These results may help the courier service provider prioritise improvements in these areas, which could improve the overall assessment or result. This would probably increase customer satisfaction, trust, or the perception of the company's service quality.

Importance-Performance Analysis (IPA) Matrix

The next step was to perform an Importance-Performance Analysis (IPA) matrix to determine which attributes require the greatest improvement and to make sure that courier service providers are efficiently allocating their services. The IPA matrix was drawn after determining the expectation and experience scores of each quality dimension and attribute. The matrix is classified into 4 quadrants as shown in Figure 1 (Quadrant I: Areas to be improved, Quadrant II: Needs to be monitored, Quadrant III: Low preference, and Quadrant IV: Possible Overkill). Following the acquisition of the implicit experience and explicit expectation, the IPA matrix was used to plot 37 attributes, with the intersection determined by using the mean of 3.98 for experience and 4.38 for expectation.

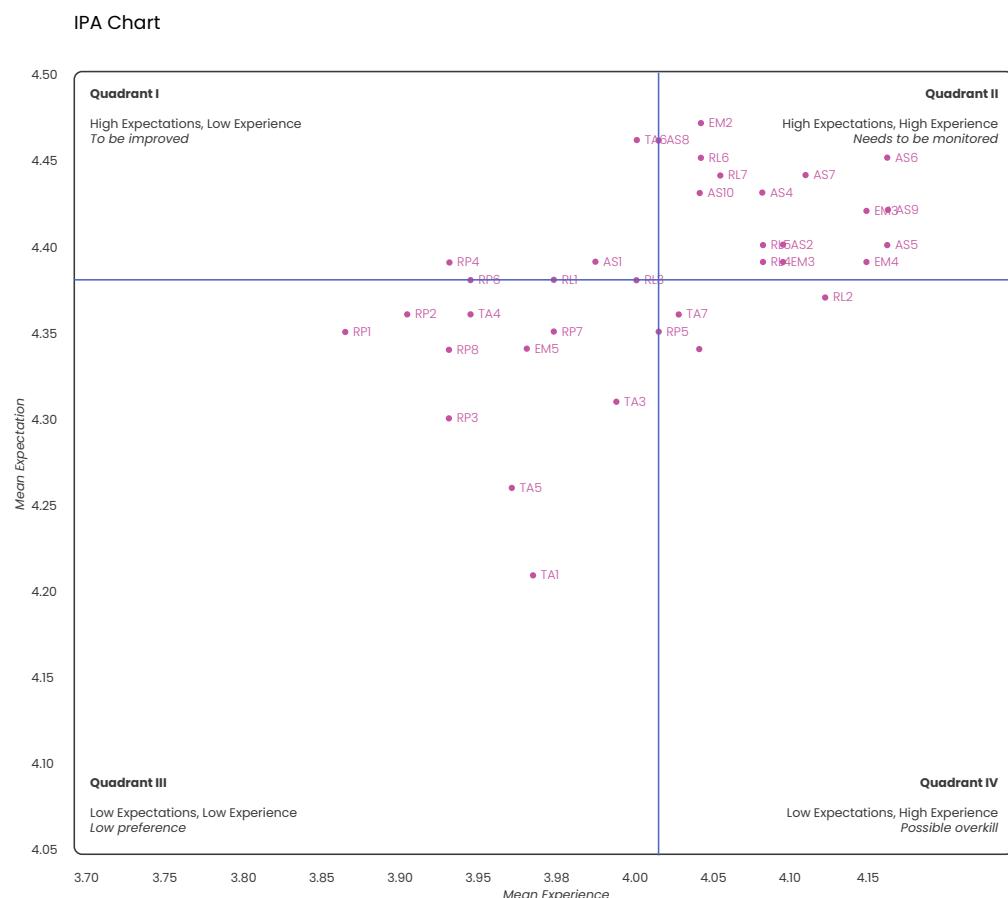


Figure 1: Importance-Performance Matrix on Consumers

TA1: Facilities and transportation tools are in order; TA2: Staff are properly presented in uniform and dress code; TA3: Adequate secure packaging services offered to customers; TA4: Adequate parcel handling safety; TA5: Updated courier technology (i.e.:QR code); TA6: Courier service provider provide adequate tracking and monitoring system; TA7: Drop off security (i.e. proof of delivery); RP1: Able to provide timely notification to customers on delivery updates; RP2: Ready to help if customer faced any problem; RP3: Capable to offer timely remedy for any issues occurred during delivery; RP4: Promptly response to customer request; RP5: Knowledgeable and skilled in handing parcel delivery; RP6: Ability in handling lost and damaged parcels; RP7: Ability in communication during parcel delivery delays; RP8: Ability to provide incident reporting; AS1: Courier service is helpful in guiding customers to ensure parcel is delivered safely; AS2: Parcel is delivered securely; AS3: Provide accurate parcel information; AS4: Integrity of courier employees when handling postal articles; AS5: Courier employees are familiar with locality; AS6: Able to ensure the protection of the personal information of the sender/ recipient when the parcel is delivered; AS7: Able to ensure that parcels are placed in a safe place for contactless delivery; AS8: Courier service provider assure declaration of liability should the parcel is lost or damaged; AS9: Courier service provider should oblige existence of safety guidelines in delivery of parcel; AS10: Courier service provider should accommodate parcel packaging guidelines; EM1: Understand the customer's need to ensure that parcel is de livered in a secure manner; EM2: Always be prepared with the necessary information if the customer wishes to know or face issues related to the safety of the parcel; EM3: The courteousness communication from courier employees with respect to the safety of parcel delivery; EM4: The willingness to consider service delivery beyond scope to ensure the parcel is safely delivered; EM5: Courier service providers should take note of customer complaints regarding the safety of parcel delivery; RL1: Consistence in meeting timeline; RL2: Accuracy in retrieving customer delivery information; RL3: Controlled damage in service delivery; RL4: Ability to notify accurate customer delivery information; RL5: Willingness in handling reversed parcel; RL6: Able to ensure parcel delivered in good condition; RL7: Courier service provider should consistent in meeting Service Level Agreement (SLA) in delivering the parcel

As depicted in Figure 1, the characteristics in Quadrant I encompassed seven (7) attributes, namely tangibility (TA6), responsiveness (RP4, RP6), assurance (AS1, AS8), and reliability (RL1, RL3). It demonstrates how these characteristics positively impact consumer expectations even when their experience is viewed as deviating from the norm. Therefore, the courier service provider should make extra efforts to improve these features and pay special attention to them to ensure that parcel safety compliances are met to effectively meet client expectations. In addition, 16 attributes associated with dimensions including assurance (AS2, AS3, AS4, AS5, AS6, AS7, AS9, AS10), empathy (EM1, EM2, EM3, EM4), and reliability (RL4, RL5, RL6, RL7) were in Quadrant II. Given that these characteristics have greater experience than the mean and positively impact consumer expectations, courier service providers must continue to provide the same or exceed the level of service by periodically assessing the efficacy of their offerings.

10 attributes, grouped into dimensions like tangibility (TA1, TA2, TA3, TA4, TA5) and responsiveness (RP1, RP2, RP3, RP7, RP8), were in the Quadrant III. It demonstrates how consumers believe these attributes don't work well enough to produce subpar results. These characteristics have less of an impact on what consumers expect, therefore accepting the service change is not as necessary. Lastly, four (4) attributes from dimensions like tangibility (TA7), responsiveness (RP5), empathy (EM5), and reliability (RL2) were incorporated in Quadrant IV. It demonstrates that, even when experience is already above average, these attributes have less of an impact on consumer expectations. As stated otherwise, these attributes exhibit phenomena of service overload; hence, to improve the user experience about parcel safety while taking resource constraints into account, service providers must shift services from these attributes to those of Quadrant I.

Issues and Challenges

The analysis of descriptive analysis shows how frequently or how important certain problems with parcel delivery services are judged to be.

ITEMS	MEAN	STD. DEVIATION
Parcel lost	6.45	2.838
Parcel damage	6.24	2.624
Long time delivery	5.99	2.498
Incorrect delivery	6.53	2.511
Dishonest personnel	6.73	2.586
Parcel Theft	6.80	2.636
Poor customer service	6.68	2.525
Limited delivery option	6.64	2.535
Difficulty in rescheduling deliveries	6.76	2.521
Impersonate delivery staff	7.01	2.812

Table 6: Descriptive Analysis of the Issues

It is clear from the mean ratings and standard deviations that consumers have varying experiences with and perspectives on these issues as shown in Table 6. For example, mean ratings in the mid-six range indicate significant levels of worry for issues including parcel loss, damage, wrong delivery, dishonest staff, parcel theft, poor customer service, restricted delivery alternatives, and trouble rescheduling deliveries. With a much higher mean rating of 7.01, the problem of delivery worker impersonation stood out and indicated a greater level of worry among respondents. The standard deviations that follow each of these concerns show how participants' experiences or perceptions of these obstacles differ in terms of agreement or divergence.

ITEMS	MEAN	STD. DEVIATION
Incompetence of Delivery Personnel	6.06	2.829
De-Regulate	6.00	2.770
Non-Standardised Courier Equipment Tools	6.19	2.614
Highly Competitive Market	5.97	2.641
Price War	5.93	2.600
Improper Parcel of Handling	6.22	2.513
Inadequate Route Planning	6.33	2.443
Unpredictable Elements	6.33	2.616
Low Efficiency Levels	6.34	2.706
Transparency	6.33	2.736

Table 7: Descriptive Analysis of the Challenges

On the other hand, the descriptive study of the challenges performed on difficulties experienced by the delivery service sector offers important insights into the perceived problems this industry faces. The standard deviations and mean scores show that respondents had differing levels of worry about certain difficulties. Interestingly, problems including low-efficiency levels, inadequate route planning, and transparency received higher mean scores, indicating that the industry views these problems as more important. In contrast, although the mean scores for difficulties such as highly competitive markets and price wars were somewhat lower, their standard deviations demonstrate a wide variety of opinions among participants. The findings highlight the complex and diverse nature of issues facing the delivery service industry, underscoring the necessity of all-encompassing approaches that tackle route planning inefficiencies, guarantee transparency, and boost productivity. To further simplify operations and raise service standards in this industry, plans should consider the market's dynamic and competitive nature in addition to handling process upgrades and tool standardisation.

Table 8 and Table 9 show the results for the t-test and One-Way ANOVA respectively. This analysis is to test the issues and challenges in ensuring parcel safety during last-mile delivery to different demographics comprising types of customers, receiving addresses, and other contributors which could affect postal article safety and quality of delivery.

VARIABLE	ISSUES	CHALLENGES	DECISION
Gender	0.240	0.283	No Different

**Table 8: Results of Independent Samples Test
for the Issues and Challenges**

From Table 8, the results show the effects of the issues and challenges to the gender. Both issues and challenges have no significant effects on gender and conclude that there is no difference in the effects of the issues and challenges on gender.

	VARIABLES	ISSUES	DECISION	CHALLENGES	DECISION
		SIGNIFICANT	SIGNIFICANT		
Type of Customers	Age	0.512	No difference	0.639	No difference
	Race	0.067	No difference	0.625	No difference
	Education Level	0.266	No difference	0.277	No difference
	Occupation	0.067	No difference	0.777	No difference
Receiving Addresses	Income	0.067	No difference	0.751	No difference
	Address	0.042	Has difference	0.207	No difference
Other Contributors	USED / M	0.000	Has difference	0.310	No difference
	USED / Y	0.015	Has difference	0.003	Has difference

Table 9: Results of One-Way ANOVA for the Issues and Challenges

Implementation Approaches on Parcel Delivery

To maintain industry competitiveness and customer satisfaction with parcel safety and service quality during last-mile delivery, service providers may implement various strategies, as highlighted by the findings of the study.

Parcels are sent to the local distribution hub nearest the consumer's home, ensuring a localised and effective last-mile delivery process on the part of the service provider. In addition to giving consumers' convenience top priority, this tactic also cuts down on transit times, which raises customer satisfaction levels. The emphasis on proximity in its operations makes it a strong contender for best practices in postal services, as it reflects the service provider's commitment to optimising the final phase of delivery and adopting a customer-centric approach. With this implementation strategy, customer satisfaction with parcel safety and service quality during last-mile delivery is guaranteed.

The careful process of classifying products at central or regional sorting facilities according to size, weight, and intended usage must be implemented by the service provider. This method shows the service provider's dedication to a well-organised and efficient sorting procedure by guaranteeing that goods are effectively guided to their designated destinations. The service provider is a solid candidate for recognition in the field of best practices because of the methodical sorting criteria, which enhance the postal network's overall efficiency.

When it comes to parcel delivery, service providers' employees go above and beyond by ensuring confirmation of delivery when required. This commitment is made possible by the comprehensive and customer-centric strategy they employ. This dedication to verification upholds the security and legitimacy of the delivery procedure, fostering client happiness and confidence. This is done to make sure that, when it comes to last-mile delivery, the safety packet complies with global requirements for a trustworthy postal service.

It might be challenging to meet consumer expectations, particularly in the areas of order tracking and delivery alerts. The service provider must prioritise integrating technology in a forward-thinking manner. Utilising mobile platforms ensures that consumers can easily track their packages and receive notifications, which is in line with the modern consumer's preference for accessibility while on the go. This approach not only improves the user experience but also shows awareness of how the digital world is changing.

The service provider stands out for its proactive approach to attempting redelivery and simplifying the parcel pickup process for customers at local courier offices. This method lessens consumers' inconvenience while also increasing the likelihood of successful deliveries. The focus on offering a variety of options helps to guarantee a satisfying consumer experience and boosts the postal system's effectiveness. When implementing return and redelivery policies, service providers' efficiency, customer happiness, and adaptability should all be taken into account.

The service provider's dedication to customer satisfaction is demonstrated by how well it handles compensation claims within its postal service. Online submissions must be in line with contemporary, customer-focused solutions, according to the service provider. Customers can easily navigate and submit information using the online approach, which speeds the claims processing. This is in line with the increasing convenience of relying on digital platforms. Recognising the diverse technical environments among their customer base, the service provider allows customers to file claims online, ensuring accessibility and flexibility in interacting with the claims procedure according to their preferences.

The parcel service provider's efficient and community-focused approach necessitates improving the transportation method. The utilisation of postal vans for localised delivery to nearby courier offices and distribution centres exemplifies a strategic approach that considers the nation's topography. This procedure reduces needless transportation and guarantees a prompt last-mile delivery to consumers in designated communities. The service provider is dedicated to streamlining its transportation processes in order to deliver parcels quickly and efficiently.

Recommendations

The results of the study shed light on the intricate ecosystem that surrounds consumer satisfaction. Many significant factors have been studied; each has a unique impact on the overall customer experience. These components are assurance, responsiveness, empathy, tangibility, and reliability. The courier service providers give careful consideration to elements that raise service quality and guarantee the safety of the delivered parcel. When aiming to deliver a satisfying and enjoyable customer experience, service providers must prioritise interpersonal relationships alongside the reliability, assurance, responsiveness, and tangible aspects of their services. By doing so, they can enhance customer satisfaction, loyalty, and trust, which are vital to the industry's long-term viability and sustainability.

A gap analysis was conducted to identify and address existing issues, enabling service providers to enhance their business operations. Determining precisely how the consumers' expectations and perceptions differ from one another is the most crucial step in the gap analysis process. The courier service provider uses these results to prioritise areas that require development. Taking care of these variables that have stronger negative associations may result in a more positive assessment or conclusion overall, most likely addressing client happiness, trust, or the perceived calibre of the service.

Based on the IPA Matrix, results showed that there were seven (7) characteristics such as courier service provider provide adequate tracking and monitoring system; prompt response to customer request; ability in handling lost and damaged parcels; courier service is helpful in guiding customers to ensure parcel is delivered safely; courier service provider assure declaration of liability should the parcel is lost or damaged; consistence in meeting timeline; and controlled damage in service delivery that requires improvement by service providers. For instance, it demonstrates how these characteristics elevate customer expectation even in situations where the actual experience resulted at the low level. Therefore, the courier service providers must successfully satisfy customer expectations by increasing additional effort to enhance these aspects and pay close attention to them to guarantee that parcel safety compliances are met.

The outcome indicates how significant several issues and challenges with parcel delivery services are thought to be. The outcome makes it evident that different consumers have different perspectives on and experiences with these issues and challenges. Therefore, it is recommended that service providers prioritise addressing and resolving the issues and challenges identified in this study, such as parcel loss, damage, wrong delivery, dishonest staff, poor customer service, restricted delivery alternatives, and trouble in rescheduling deliveries. To improve the industry's overall service standards, operational efficacy, and reliability, the courier service providers should prioritise resolving the issues and challenges related to finding. If these issues and challenges are successfully resolved, customers may be able to access a more robust and dependable service.

The effectiveness of a last-mile delivery has a big impact on a service provider's profitability. Consequently, to ensure that consumers receive the best possible service, it is imperative for the service provider to be well-versed in last-mile delivery best practices. Delivering parcels from the carrier facility to the designated address is the responsibility of the last-mile delivery phase, which is the last link in the supply chain. An efficient last-mile delivery strategy can result in things being delivered more quickly and for less money. The best practices employed by the parcel delivery companies in the selected countries were detailed in the study's findings. Therefore, the service provider should investigate various strategies that might apply inside their businesses to ensure industry competitiveness and customer satisfaction with parcel safety and high-quality services provided during last-mile delivery.

Conclusion

The study's findings indicated that the courier services quality did not completely comply with the consumers' expectations, and there is still room to improve service quality and reduce the negative gaps. Decision-makers can further use the results of the IPA matrix to effectively allocate limited resources giving special attention to the organisational weaknesses. In addition, about the issues and challenges, it is critical to address the detrimental effect on the consumer's satisfaction. The courier service providers should give priority to making improvements to the issues and challenges highlighted in the study of deliveries to all places to lessen this problem.

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TOPIC 08

Assessing the Current State of Digitalisation and Challenges in the Oil Palm Plantation Sector in Peninsular Malaysia

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Abstract

This research explores the gradual uptake of digital technologies within Malaysia's oil palm plantation sector, despite the nation's overall digital advancements. Focused on Peninsular Malaysia, the study, utilising UTAUT2 and Lokman's Emotion and Importance Quadrant (LEIQ)TM frameworks, aims to comprehend and identify the current state of digitalisation, as well as the challenges hindering the acceptance and adoption of digitalisation in the oil palm plantation sector. The focus of the study is on agro-commodity companies operating in the oil palm plantation sector to highlight the current state and the challenges of acceptance and adoption for future technological advancements in the oil palm industry. Despite the economic significance of the sector, it faces hurdles in embracing digital technologies, as this study revealed

a moderate level of digitalisation which is 72.26 per cent acceptance and adoption rate. The study identifies challenges such as habituation to technology, facilitating conditions, technological-knowledge gaps, price value, and work-life balance. Enhancing comprehension of these challenges is imperative for industry stakeholders and policymakers seeking to adeptly steer the course of digital transformation. This understanding stands to enhance productivity, efficiency, and sustainability within the domain of the oil palm plantation sector. Future research should build on these findings to formulate targeted policies and plans to address challenges and align with user expectations to promote a more technologically adaptive landscape in the oil palm sector.

Introduction

Digitalisation, characterised by the integration of digital technology into various facets of society, plays a pivotal role in enhancing efficiency, effectiveness, and overall performance across diverse sectors, including businesses and industries (Mcfadden, 2022). The potential of digital technologies in empowering decision-making processes is underscored by Jouanjean (2019), who highlights their application in the agricultural sector to bolster productivity, sustainability, and resilience. This infusion of technology not only benefits farmers but also opens avenues for efficiency and value creation within the agricultural supply chains, influencing research, innovation, and traceability (Jouanjean, 2019). In line with the global trend towards digitalisation, recent times have seen the Malaysian government's launch of the Malaysia Digital Initiative, aiming to cultivate emerging digital economy sectors and replace the Multimedia Super Corridor agenda (Chandrasekaran et al., 2022).

Despite the pervasive adoption of digital technology in Malaysia, certain industries, particularly agriculture, have lagged behind in this transition (Santiago, 2021). Agriculture, a cornerstone of Malaysia's GDP, is crucial for economic growth,

as emphasised in the National Key Economic Areas initiative. However, its hesitation to embrace digital solutions hinders its growth potential, creating an opportune moment for policymakers to harness digital technologies for fortifying policy design, implementation, and monitoring, as highlighted by Jouanjean (2019). Within Malaysia's agricultural landscape, the oil palm plantation sector commands attention due to its robust research capabilities and effective extension systems. This sector stands as a prime exponent of Malaysia's agricultural research prowess, with significant contributions to agricultural trade exports, particularly in oil palm and paddy production (International Trade Administration, 2022).

The advancements of technologies in the digital economy, particularly in agriculture, has the potential to significantly transform farming practices by improving efficiency, sustainability, and precision. Despite the potential benefits of data-driven insights for precision, efficiency, and sustainability in farming, the level and rate of digitalisation in Malaysia's oil palm plantation sector are lagging. While Sarawak and Sabah boast the largest oil palm plantations,

accounting for 28.6 per cent and 26.6 per cent of the total Malaysian oil palm planted area, respectively, our research has chosen to focus on Peninsular Malaysia, which comprises 44.8 per cent of the total planted area (MPOB, 2022). The decision to narrow our research to Peninsular Malaysia is driven by practical considerations, including the limited six-month timeframe for our study. Given the vastness of oil palm cultivation in Sarawak and Sabah, covering all respondents in these states within our time constraints would be unfeasible. Therefore, this research concentrates on Peninsular Malaysia to ensure a comprehensive and in-depth analysis within the available time frame. This research aims to analyse the current state of digitalisation in Peninsular Malaysia's oil palm plantation sectors and to identify challenges to acceptance and adoption.

The research aims to analyse the current state of digitalisation in Peninsular Malaysia's oil palm plantation sector and identify challenges to acceptance and adoption. Henceforth, the research sets its objective to measure the rate and the level of digitalisation acceptance and adoption within the oil palm plantation sector in Peninsular Malaysia using the UTAUT2 model; and to identify the issues and challenges contributing to digitalisation acceptance and adoption using LEIQ™.

Literature Review

Digital Divide and Digital Technology Adoption

The digital divide refers to discrepancies in ICT (Information and Communications Technology) access, utilisation, and outcomes. Customers or clients may be unable to use technology or AI systems because they lack access to the most recent personal technology (such as smartphones, tablets, etc.), Internet connectivity, or ICT skills (Ghandour, 2021). In contrast, according to Charness and Boot (2022), systems that use adaptive technology to mix extended reality with AR intelligence provide exciting new approaches to overcoming the digital divide imposed by an individual's age.

Education emerges as a major contributor to the digital divide, as highlighted by Lythreatis and colleagues (2022). While addressing the digital gap is crucial, particularly in the context of agricultural production, rural communities can benefit from the ongoing adoption and accessibility of digital technologies, irrespective of their direct connection to agriculture. Encouraging farmers and professionals in this sector to embrace modern technologies is crucial for enhancing the competitiveness of the agricultural sector. The integration of digital technology in agriculture holds the potential for various benefits, including cost reduction and improved product quality (Bolfe et al., 2020).

However, challenges may arise in the digitisation process due to the digital divide. Insufficient access to technology infrastructure and low levels of digital literacy in rural areas may hinder the adoption of digital technologies. While digital technologies improve production in plantation industries, they have little to no impact on the well-being and income of small-scale farmers in rural areas (Rosnan & Yusof, 2023).

Technology Applications in Agriculture

Within the dynamic landscape of modern agriculture, technology applications play an important role in transforming traditional practice and enhancing crop production. This section explores two (2) significant areas which are application of big data analytics in agriculture and the list of smart tool technologies available in the agriculture domain particularly in the oil palm plantation sector.

Application of Big Data Analytics in Agriculture

The applications of big data analytics in agriculture are quite diverse, but here are some of the most notable ones, such as precision agriculture, crop monitoring, yield prediction, disease detection, and supply chain optimisation (Coble et al., 2018).

In precision agriculture, big data analytics can be used to identify patterns and trends in soil moisture, temperature, and other environmental factors, allowing farmers to optimise their use of resources like water and fertiliser (Jatav et al., 2019, Kaur et al., 2021).

Whereas in crop monitoring, the data from sensors and other sources, farmers can be analysed to gain insights into the health and growth of their crops, allowing them to take corrective action when necessary. Concerning crop monitoring, it can drive yield prediction, disease detection and supply chain monitoring. Big data analytics can be used to model and predict crop yields based on various factors, such as weather patterns, soil quality, and historical yield data.

Other than that, by analysing data from sensors and other sources, farmers can identify signs of disease or infestation in their crops and take action before it spreads. Furthermore, by analysing data on crop yields, weather patterns, and other factors, agricultural companies can optimise their supply chains to ensure that crops are delivered to market as efficiently and cost-effectively as possible.

Overall, big data analytics has the potential to revolutionise the way we approach agriculture, by enabling farmers and agricultural companies to make more informed decisions based on data-driven insights.

Smart Tools

Smart tools in agriculture are technological devices and software applications that use data analytics, artificial intelligence, and other advanced technologies to optimise agricultural operations and increase productivity (Alreshidi, 2019; Mohamed et al., 2021; Saiz-Rubio & Rovira-Más, 2020). These tools can help farmers and agricultural businesses make better decisions about planting, harvesting, and managing crops.

Here are some examples of smart tools in agriculture (Liu et al., 2018; Saiz-Rubio & Rovira-Más, 2020; Khan et al., 2021):

1. Sensors

Sensors can be placed in the soil to monitor soil moisture, temperature, and nutrient levels. This data can be used to optimise irrigation and fertilisation practices and reduce water waste.

2. Drones

Drones have the potential to revolutionise plantation management by offering numerous benefits and applications. Equipped with advanced sensors and imaging technologies, drones provide real-time, high-resolution data on crop health, irrigation needs, pest infestations, and vegetation monitoring. To comprehensively explore the potential of drones, it is crucial to understand the industry's expectations regarding their usage and identify areas where they seek to expand drone applications, along with the associated challenges.

3. Precision farming software

Precision farming software uses data analytics and machine learning algorithms to analyse data collected from sensors and drones to create customised planting and harvesting plans. This can help farmers increase

yields, reduce waste, and save time and resources.

4. Automated machinery

Automated machinery, such as robotic harvesters, can increase efficiency and reduce labour costs. These machines can be programmed to perform specific tasks, such as picking and sorting crops.

5. Weather forecasting tools

Accurate weather forecasting can help farmers make informed decisions about when to plant, irrigate, and harvest.

6. Smart weather forecasting tools

Provide real-time data and alerts about weather patterns and potential risks.

7. Artificial Intelligence (AI)

AI technologies, including machine learning and data analytics, are increasingly being integrated into agricultural processes. AI can enable continuous data collection and analysis, allowing for automation in various aspects of farming. Machine learning algorithms can assist in crop management, disease detection, and yield prediction, ultimately enhancing decision-making and resource allocation in agriculture.

By integrating AI into these smart tools, agriculture can benefit from continuous data collection and machine learning, enabling automation and more informed decision-making. AI's ability to process vast amounts of data and identify patterns is poised to further enhance the efficiency and sustainability of agricultural practices.

Foundation of Digitalisation in Agriculture

Over the past 26 years, Australian agriculture has demonstrated a remarkable capacity for productivity growth, setting a noteworthy standard for the industry (AgFunder, 2021). As part of digital agriculture priority, towards achieving the vision of Digital Economy Australian 2030, the Australian Government has identified five (5) foundational focus areas.

The first is leadership. To lead the transformation of the agricultural sector, it is crucial to enhance connection and coordination across the industry, encouraging the pooling of resources and providing a clear plan to unify stakeholders around collective long-term goals. Secondly is the skills. There is a need to focus on delivering the necessary skills and expertise required by both the current and future workforce to modernise the sector effectively. Effective data and governance practices, such as maximizing data use, ensuring good data management, implementing common data standards, and promoting interoperability, are essential for enhancing data and governance within the agricultural domain. Fourthly, opportunities and value propositions. Efforts should be directed towards helping producers understand and realise the benefits of digitising their businesses, ensuring appropriate and agile regulation, while fostering faster commercialisation. Lastly, it is imperative to assist agricultural businesses in understanding their connectivity options and facilitating access to the infrastructure they need for seamless integration into the digital landscape (AgFunder, 2021).

Methodology

The research model employed for this study was the extended Unified Theory of Acceptance and Use of Technology (UTAUT2) model, utilised to assess the acceptance and adoption of Digitalisation Technology in the Malaysian Agriculture Sector. The original UTAUT model, developed by Venkatesh et al. (2003), aimed to explain and predict the acceptance of technology in an organisational context. It stands out as one (1) of the most comprehensive models in technology acceptance, integrating components from eight (8) prominent models in information technology research.

The UTAUT2 model, stemming from the UTAUT constructs, posits that hedonic motivation (HM), price value (PV), habit (HT), and time since the first use of the technology (comprising a total of seven (7) independent constructs or variables) collectively impact the intention to use technology. Behavioural Intention (BI) serves as the mediating variable, while Use Behaviour (USE) is the dependent variable. According to Venkatesh, Thong, and Xu (2012), the UTAUT2 model incorporates individual differences such as age, gender, and experience as moderators, influencing the effects of these constructs on BI and technology use. The UTAUT2 model is particularly applicable in the introductory phase, encompassing adoption and initial use, of the targeted technology. This study fully embraced the UTAUT2 model, with Figure 1 illustrating the UTAUT2 model.

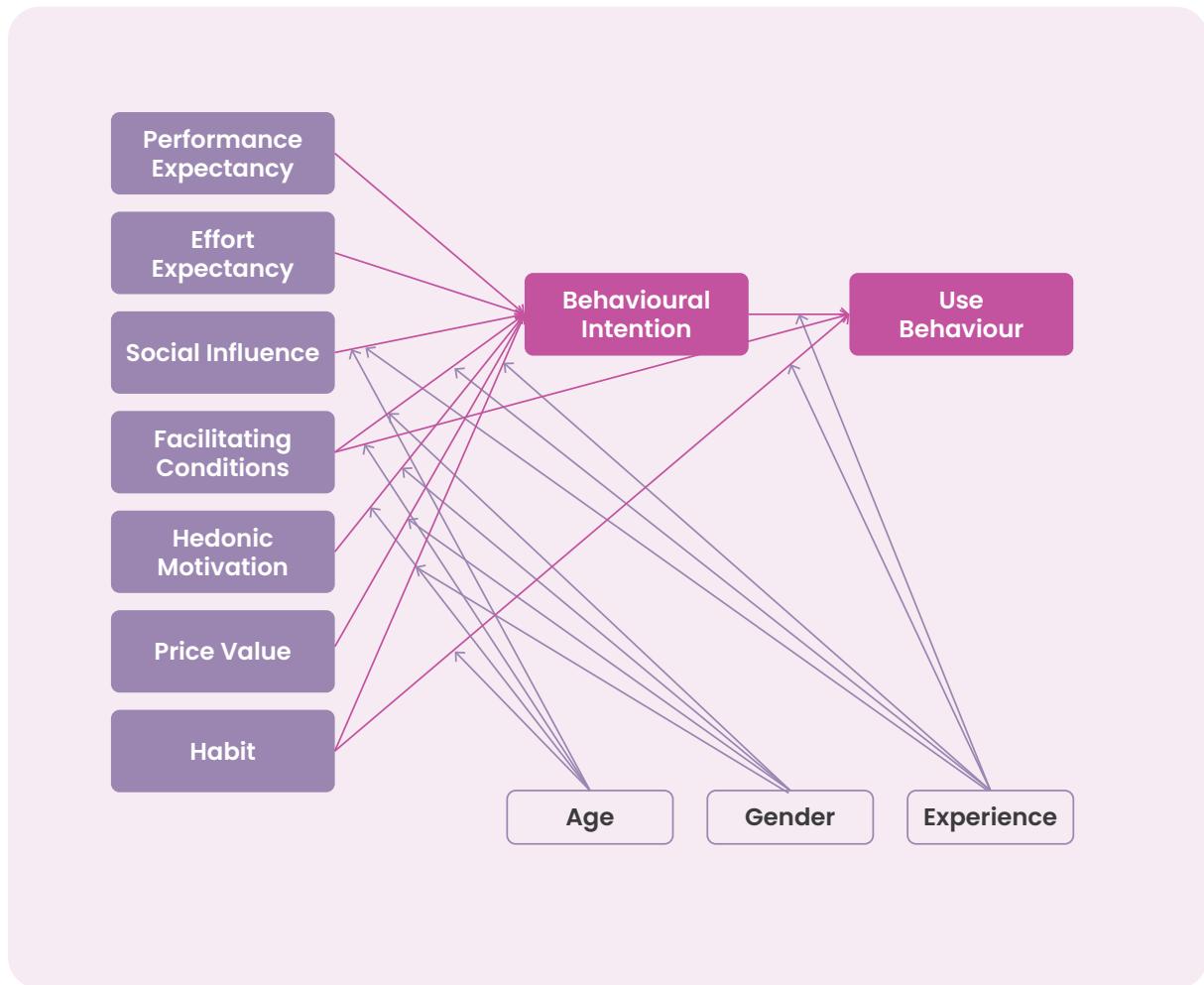


Figure 1: UTAUT2 Model (Venkatesh et al., 2012)

While delving into the issues and challenges that impacted the adoption of digitalisation, this study established the groundwork for Lokman's Emotion and Importance Quadrant (LEIQ™) model. This model, rooted in Kansei Engineering, served as a user-friendly tool for unveiling individuals' implicit experiences related to digitalisation issues. The LEIQ™ model facilitated the identification of emotions and their influence on decision-making, productivity, well-being, and overall quality of life. It offered a structured framework for categorising these experiences, the contributing factors, and their significance in people's interactions with specific stimuli.

In the context of this research, the LEIQ™ model was applied to comprehend challenges, facilitators, and future expectations directly from the primary sources—the individuals engaged in utilising technology within the sector. Utilising the emotion vs. importance axes, the model highlighted the significance of identified factors in shaping people's implicit experiences. The quadrant, illustrated in Figure 2, comprised four (4) spaces.

1. Positive experience and important quadrant
2. Positive experience and not important quadrant
3. Negative experience and important quadrant
4. Negative experience and not important quadrant

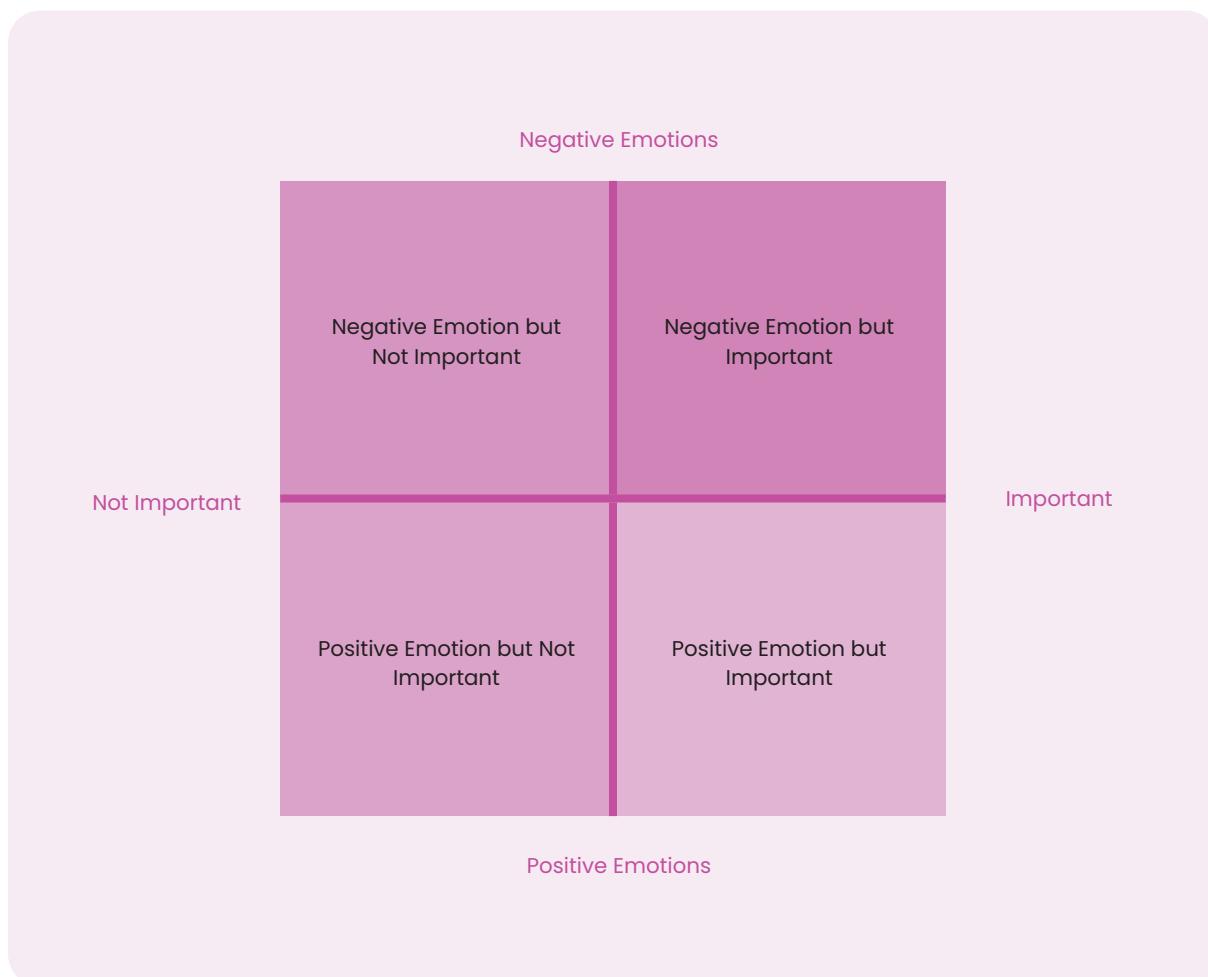


Figure 2: The LEIQ™ Model by Lokman (2018)

Finding and Analysis

Analysis and Discussion on Current Rate and Level of Digitalisation Acceptance and Adoption within Oil Palm Plantation

This section presents the results based on the analysis of the data acquired through a quantitative survey questionnaire developed based on UTAUT2 constructs. This section gives an in-depth evaluation of the acceptance and adoption of digitalisation within the oil palm plantation industries in Malaysia. The study conducted a reliability test to recheck the knowledge of the study among the first 30 respondents through the questionnaire.

CONSTRUCT	NO OF ITEMS	AVERAGE VARIANCE EXTRACTED (AVE)	COMPOSITE RELIABILITY (CR)
Performance Expectancy (PE)	0.765	30	0.421
Effort Expectancy (EE)	0.789	30	0.335
Social Influence (SI)	0.750	30	0.395
Price Value (PV)	0.719	30	0.312
Hedonic Motivation (HM)	0.846	30	0.482
Facilitating Condition (FC)	0.861	30	0.330
Habit (HT)	0.933	30	0.630
Behavioural Intention (BI)	0.952	30	0.533
Use Behaviour (UB)	0.965	30	0.386

Table 1: Pilot Test Results

To check the reliability test, the values of Cronbach's Alpha are calculated and recorded in Table 1. Based on the presented values for Cronbach's Alpha in this table, it could be claimed that the reliability of the research measurement tool is statistically acceptable. Reliability is acceptable if Cronbach's Alpha equals 0.7 or more (Tavakol & Dennick, 2011). The scales show good reliability with Cronbach's Alphas > 0.7 . The parameters were assessed how past interactions with these tools shaped their inclination to seamlessly incorporate them into their daily work routines. The structural equation modelling was executed to measure the acceptance of digitalisation/automation within the oil palm plantation sector in Peninsular Malaysia. This was because it consisted of many relationships from the parameters towards the dependent variable, which was Use Behaviour (UB). Further tests on 130 respondents were conducted, and the results are shown in Figure 3 and Table 2 below.

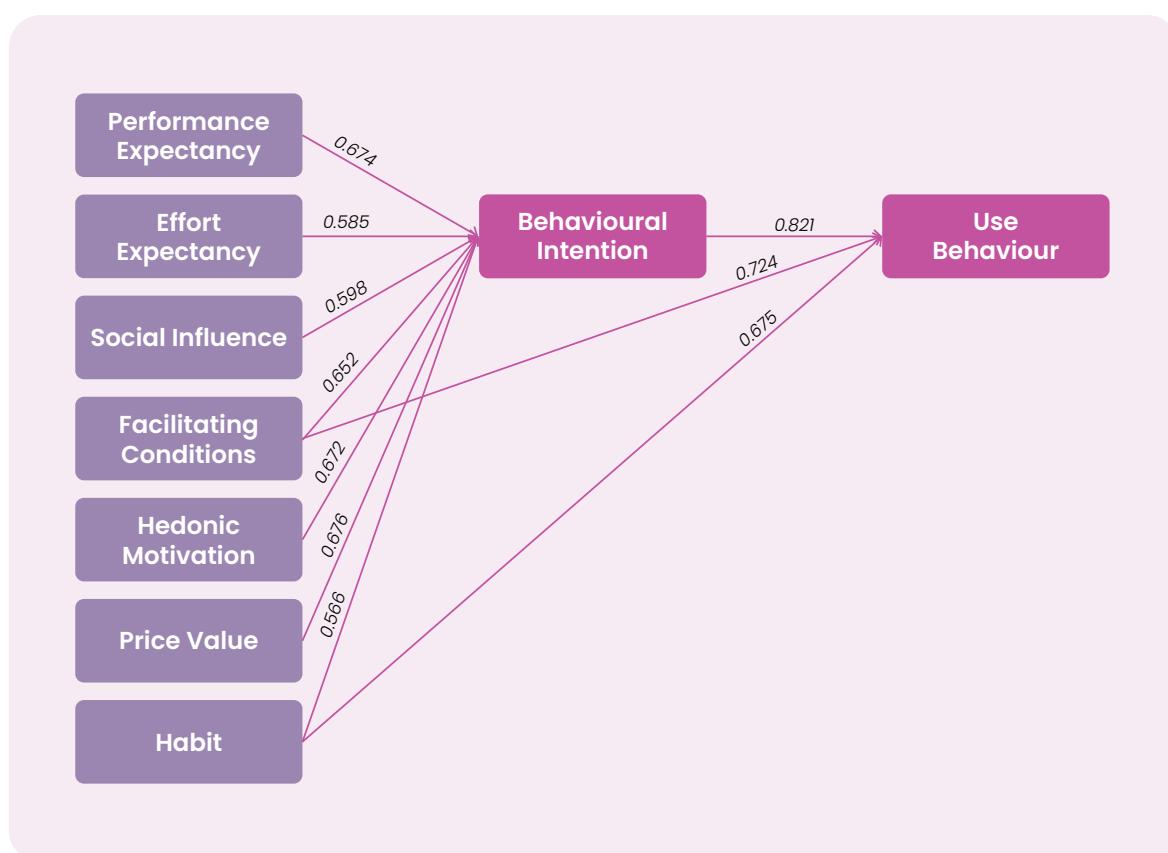


Figure 3: The UTAUT2 Model of the Digitalisation Technology Acceptance and Adoption within the Oil Palm Plantation Sector in Peninsular Malaysia

The study validates all research hypotheses as evidenced by consistently positive coefficient values, indicating a positive impact on the indicator. Specifically, H1 is strongly supported with a significant coefficient of 0.674, confirming that performance positively influences the behavioural intention to adopt and use technologies among individuals in oil palm plantations. Additionally, effort expectancy, social influence, price value, hedonic motivation, facilitating conditions, and habit also exhibit positive impacts on individuals' behavioural intentions in this context.

Furthermore, the established direct relationship affirms that behavioural intention, facilitating conditions, and habit positively influence the use behaviour of adopting and utilising technologies among individuals in oil palm plantations. Overall, the outcomes are robust with an impressive overall score of 0.59, signifying that 59 per cent of the total variation in technology adoption and use among individuals in oil palm plantations is explained by the specified independent indicators, with the remaining percentage attributed to other factors.

SCALE	N	MEAN	MODE	MEDIAN	%
PE	130	4.169	4.000	4.000	83.36
EE	130	3.787	4.000	4.000	75.74
SI	130	3.946	4.000	4.000	78.92
PV	130	3.603	3.670	3.667	72.06
HM	130	4.128	4.000	4.000	82.56
FC	130	3.715	4.000	3.667	74.30
HT	130	3.554	4.000	3.667	71.08
BI	130	3.903	4.000	4.000	78.06
UB	130	3.613	4.000	3.667	72.26

Table 2: Descriptive Analysis of Digitalisation Acceptance within the Oil Palm Plantation Sector in Peninsular Malaysia

Table 2 shows the descriptive analysis of the surveys. Performance Expectancy (PE) factor indicates the highest mean score of 4.169 out of 5.00, followed by Hedonic motivation (HE) with 4.128 out of 5.00, Social Influence (SI) with 3.946 out of 5.00, Behavioural Intention (BI) 3.903 out of 5.00, Effort Expectancy (EE) 3.787 out of 5.00, Facilitating Conditions (FC) 3.715 out of 5.00, Use Behaviour (UB) 3.613 out of 5.00, Price Value (PV) 3.603 out of 5.00, and Habit (HT) 3.554 out of 5.00. According to the results, this indicates that the level of adoption is mostly between agree and neutral in adopting and using the technologies among individuals working in oil palm plantations.

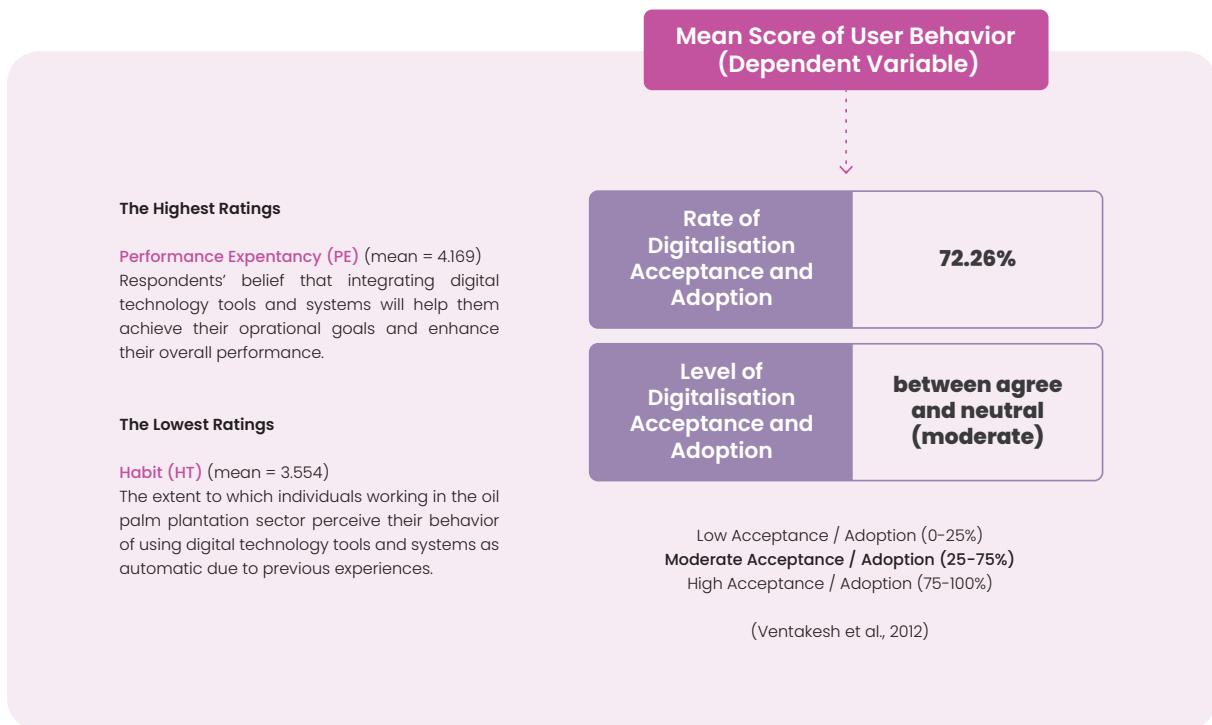


Figure 4: Rate and Level of Digitalisation within Peninsular Malaysia's Oil Palm Plantation Sector

The current rate and level of digitalisation within Peninsular Malaysia's oil palm plantations that were measured by utilising the UTAUT2 model are shown in Figure 4. Thus, the results show moderate acceptance (72.26 per cent) for digitalisation within oil palm plantations, with a level between agree and neutral.

Analysis and Discussion for Issues and Challenges using LEIQ™

This section analysed and discussed the issues and challenges associated with the implementation of digitalisation within the oil palm plantation industry. The challenges identified through focus group discussions provided valuable insights into the obstacles faced by stakeholders in adopting and integrating technology into their daily work lives. These challenges were categorised into several themes, including habit, facilitating conditions, price value, technology literacy, technology challenges, technology hazards, and work-life balance. Each theme represented unique obstacles that needed to be addressed to ensure the successful implementation of digitalisation.

Challenges in Digitalisation Implementation within the Oil Palm Plantation Sector

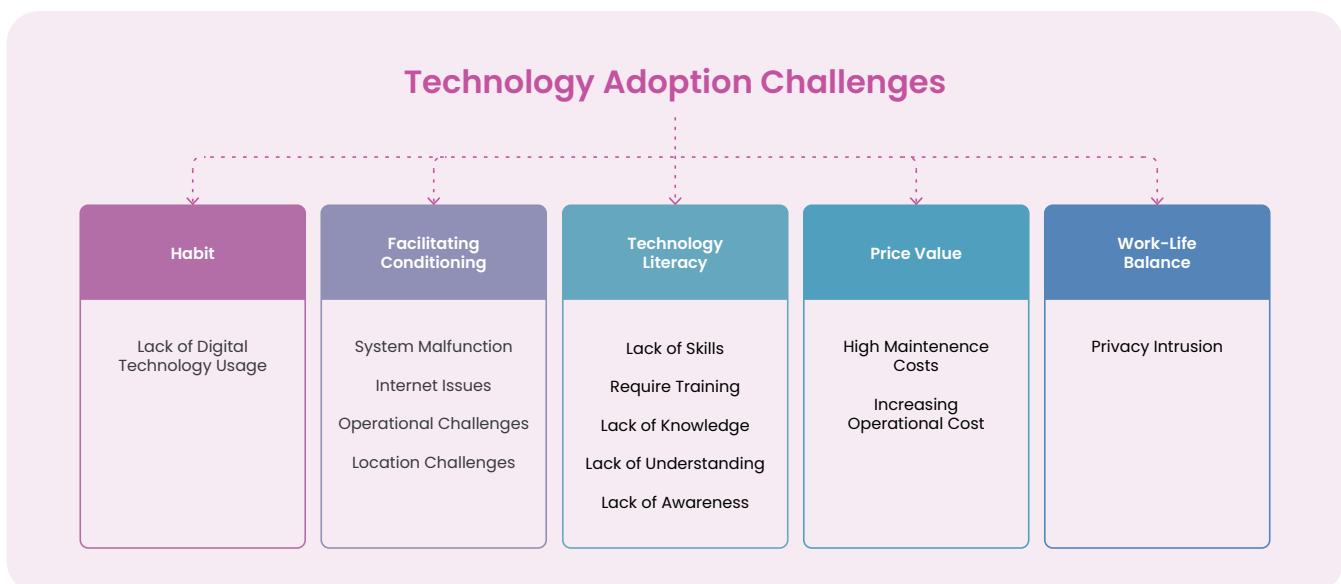


Figure 5: Significant Technology Adoption Challenges

After conducting a thorough analysis of the challenges highlighted by the participants during the FGD session, it became evident that three (3) primary themes posed significant obstacles to the successful implementation of digitalisation within the oil palm plantation sector. These themes were **habit**, **facilitating conditions**, and **price value as depicted in Figure 5 above.**

The theme of **habit** refers to the ingrained behaviours and routines that might inhibit the adoption and acceptance of digital technologies within the sector. Participants expressed concerns about resistance to change and the need to overcome existing habits to fully embrace digitalisation.

Facilitating conditions emerged as another prominent theme, underscoring the importance of having the necessary infrastructure, resources, and support systems in place to facilitate the implementation of digital technologies. Participants emphasised the need for reliable internet connectivity, adequate training, and technical support to ensure smooth and effective digitalisation processes.

Price value was identified as a significant factor influencing the adoption of digitalisation within the oil palm plantation sector. Participants expressed concerns

about the cost-effectiveness and return on investment of implementing digital technologies. They emphasised the need for clear benefits and tangible outcomes to justify the financial investment required.

In addition to these main themes, further analysis of the challenges raised by participants revealed additional themes initially categorised as 'Others'. Upon consolidation, these themes were further categorised as **Technology Literacy** and **Work-Life Balance.**

The theme of **Technology Literacy** encompassed participants' concerns regarding the level of knowledge and skills required to effectively utilise digital technologies. They emphasised the need for training and educational programmes to enhance technology literacy among stakeholders.

Lastly, **Work-life Balance** emerged as a crucial theme, reflecting participants' concerns about maintaining a healthy equilibrium between work responsibilities and personal life in the context of digitalisation. They stressed the importance of establishing clear boundaries, promoting flexibility, and addressing the potential negative impacts of digital technologies on work-life balance.

Recommendations

Considering the challenges outlined in this study, it is vital for stakeholders in the oil palm industry to consider the following key recommendations for advancing the implementation of digital transformation.

Examining the challenges hindering the implementation of digital transformation

Stakeholders in the oil palm industry can derive significant benefits from a thorough analysis of the acceptance rate obtained from the survey. By carefully scrutinising the challenges that hinder the implementation of digital transformation, the stakeholders and the policymakers can acquire valuable insights to inform their decision-making processes. They also can devise effective strategies to ensure the successful implementation of digital technology in the oil palm sector, thereby paving the way for future advancements and growth.

Include a diverse range of locations and respondent sampling for future research

Future research should explore the applicability of these findings to different industries to enhance their broader relevance. Subsequent research should involve a more extensive and diverse sample to increase the representativeness of the findings and ensure a more comprehensive understanding of technology adoption challenges. Future studies should also encompass a more diverse range of locations to examine potential cross-cultural variations in technology adoption challenges and recommendations.

Investigate the impact of technology adoption on the oil palm industry

In terms of future work, further investigation is recommended to explore the long-term impact of technology adoption on the oil palm industry.

This includes examining its effects on productivity, sustainability, and socio-economic factors. Understanding these long-term impacts will provide valuable insights for industry stakeholders and policymakers.

Identifying specific strategies and interventions

Future research should also concentrate on identifying specific strategies and interventions to address the challenges identified in the study. For example, developing training programmes to enhance technological literacy among industry professionals and promoting a culture of innovation within the industry can help overcome barriers to technology adoption.

Additionally, studies can be suggested to examine the role of government policies and regulations in facilitating technology adoption within the oil palm industry. This includes exploring the effectiveness of incentives for digitalisation and support for infrastructure development to create an enabling environment for technology adoption. Lastly, exploring the potential benefits of emerging technologies, such as the Internet of Things (IoT) and Artificial Intelligence (AI), in the oil palm industry is an important area for future research. Investigating their applications in precision farming, resource optimisation, and supply chain management can uncover new opportunities for enhancing industry practices.

Conclusion

In exploring the acceptance and adoption of digitalisation within Malaysia's oil palm plantation sector, the study revealed a significant technological gap, with an acceptance to the adoption of digital solutions rate of 72.26 per cent. This gap persists despite the transformative potential of digital solutions to enhance efficiency, sustainability, and overall performance in plantation practices. Focused on Peninsular Malaysia due to practical constraints, the analysis highlighted critical challenges, including habituation to technology, insufficient facilitating conditions, knowledge gaps in technology, financial concerns, and issues related to work-life balance. These challenges impede the seamless integration of digital solutions within the oil palm plantation sector.

By employing models such as UTAUT2 and LEIQ™, the research identified challenges positively influencing the adoption of digitalisation. These insights are crucial for stakeholders, enabling them to formulate

strategies and make informed decisions. Industry stakeholders could navigate the path to digital transformation more effectively by understanding these challenges, thereby improving productivity, efficiency, and sustainability within the oil palm plantation sector. Overall, the analysis of the challenges identified during the FGD session provided valuable insights into the multifaceted nature of digitalisation implementation within the oil palm plantation sector. By addressing these themes and developing targeted strategies, stakeholders could overcome the challenges and maximise the benefits of digital transformation.

In summary, recognising and addressing these challenges is crucial for the sector's digital transformation, impacting the level and rate of digitalisation acceptance and adoption. This research establishes a foundation for strategic enhancements in Malaysia's oil palm industry, fostering a more technologically adoptive and adaptive landscape.

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TOPIC 09

Assessing the Impact of the Jalinan Digital Negara Plan

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Abstract

The Jalinan Digital Negara (JENDELA) plan, launched in August 2020, aimed to revolutionise Malaysia's connectivity landscape, responding to challenges exposed by the COVID-19 pandemic. This research employs a qualitative approach to explore JENDELA's impact, using Social Marketing Theory as a foundational framework. The study analysed the data using NVivo, which identifies eight (8) crucial codes and four (4) themes, focusing on information, digital inclusion, customer interaction, and government plans. Drawing from diverse literature, the research provides a nuanced understanding of JENDELA's effects on economic growth, education, business innovation, and community engagement. The methodology involves a thematic analysis, yielding a theoretical framework based on Social Marketing Theory, emphasising the importance of clear information dissemination, digital inclusion, customer support, and effective government plans. The findings reveal key concerns, such as insufficient infrastructure, resistance to digital adoption, challenges

in urban connectivity, and the need for coordinated efforts. Comparative insights from neighbouring countries underscore the importance of tailored plans and partnerships. The recommendations advocate a multifaceted approach, including sentiment analysis, geographic diversity recognition, affordability assessments, and long-term impact studies. Public-private collaboration is highlighted, aligning with successful past partnerships. The research acknowledges limitations, suggesting alternative data collection methods and proposing a longitudinal research approach for comprehensive understanding. This research contributes valuable insights into JENDELA's societal impact, providing a strategic roadmap for policymakers. The proposed recommendations aim to optimise the plan's effectiveness, fostering digital inclusion and sustainable economic growth. The study emphasises the need for continuous research to address evolving challenges and opportunities, ensuring JENDELA's enduring success.

Introduction

In August 2020, Malaysia embarked on a game-changing journey with the launch of the Jalinan Digital Negara (JENDELA) plan. The objective of this plan is to improve the connectivity and quality of communication experience nationwide. The COVID-19 pandemic has created high reliance on the Internet from the Rakyat both in urban and rural areas. Hence, it has triggered an urgency for Malaysia to address the arising needs. Despite previous efforts like the National Fiberisation and Connectivity Plan (NFCP), the digital landscape demanded more. JENDELA stepped up, aiming for 100 per cent internet coverage in populated areas over five (5) years starting in 2020, catering to the evolving digital lifestyles.

JENDELA is not just about faster internet; it is a catalyst for job opportunities, flexible work arrangements, and business growth. It fuels innovation in education, supports e-commerce, and influences social dynamics, making it crucial for urban, suburban, and rural areas alike.

This research dives into three (3) critical objectives:

1. Impact Assessment: How is JENDELA affecting socio-economic

growth, education, businesses, and government?

2. Tech Solutions: What new technologies can enhance communication services for all Malaysians?
3. Benchmarking: How does JENDELA compare to other countries, and what can Malaysia learn from their successes?

JENDELA's influence on socio-economic growth, community dynamics, and social activities is pivotal. By examining these aspects, the study reveals the effectiveness of this government plan in enhancing societal well-being. Social marketers gain valuable insights to design targeted campaigns, fostering positive change through raised awareness and support. In an era of digital transformation in education, JENDELA plays a crucial role. Effective communication services are the linchpin for ensuring quality education access for all. By identifying new technologies, this research equips educational institutions with the knowledge to innovate, enhancing the overall educational experience and aligning with the global push for inclusive learning opportunities.

From a political standpoint, benchmarking JENDELA against neighbouring countries is a key analysis. This comparative study aids policymakers and government officials in identifying improvement areas and potential best practices. The data-driven insights provided by the research contribute to informed decision-making, ensuring government efforts align efficiently with societal needs and aspirations.

These research objectives are urgent in our rapidly evolving digital landscape. The implications of JENDELA's implementation go beyond connectivity; they touch the core of our society. The research is a call to action, urging us to evaluate real-world implications, enhance social marketing strategies, improve educational access and quality, and inform political decision-making.

Literature Review

The rollout of Malaysia's JENDELA plan has sparked a flurry of research, exploring its broad impacts across sectors. These studies provide a detailed look at how JENDELA affects society, touching on economic growth, education, business innovation, marketing, employment, and operational efficiency.

The World Bank (2021) emphasises JENDELA's role in enhancing Malaysia's digital infrastructure, fostering digital adoption, and driving economic development. Lynn et al. (2022) adds that digital connectivity can create jobs and improve access to education and healthcare.

Almahasees, Mohsen, & Amin (2021) note the plan's influence on online learning resources, and Carlisle, Ivanov, and Dijkmans (2023) highlight JENDELA's impact on education through gamification and virtual reality. However, challenges in equipping educators with digital skills must be addressed. Luo (2021) points out that JENDELA's improved digital connectivity benefits small businesses, enabling them to digitise operations and expand through e-commerce. Therefore, upskilling entrepreneurs for the digital era is crucial. Jiang and Stylos (2021)

explore the use of real-time data and the increasing use of online activities among the public that suggests, the importance of stability and enhanced digital connectivity which JENDELA aims for the country.

Recognising the importance of inclusivity, the research investigates how JENDELA addresses the digital divide and ensures that marginalised communities have equal access to the benefits of enhanced connectivity. JENDELA contributes to the rise of the gig economy, providing flexible work opportunities (Anwar, Schäfer, and Golušin, 2023). This transformation, however, poses challenges related to fair labour practices and job security. Luo and Zahra (2023) highlight digital connectivity's role in streamlining operations, while Raza, Woxenius, Vural, and Lind (2023) emphasise seamless communication and collaboration enabled by digital connectivity. Examining how JENDELA enhances operational efficiency is vital for sustained success. Chou, Leo and Chen (2022) note the emergence of virtual communities fostered by JENDELA, where individuals connect and collaborate. Maintaining a balance between virtual and physical interactions is crucial for holistic social well-being.

In summary, JENDELA's impact on Malaysian society is vast, covering economic growth, education, small businesses, marketing, employment, operational efficiency, and community engagement. While celebrating its successes, researchers highlight areas requiring attention and improvement. These insights contribute to a nuanced understanding, informing policy decisions for Malaysia's digital future.

Methodology

Research Design

In this study, we have chosen a qualitative approach to align with our core objective: understanding community perspectives on the JENDELA plan. This method allows us to deeply explore stakeholders' viewpoints, thoughts, and suggestions, crucial for enhancing JENDELA's progress. Qualitative research is apt for delving into complex social phenomena, like the varied experiences and perceptions of stakeholders in a national digital infrastructure plan. Its flexibility enables tailored interviews, crucial for capturing diverse perspectives effectively. While quantitative methods and surveys might oversimplify the multifaceted issues around digital connectivity, qualitative research allows for open-ended responses, ensuring a holistic understanding of JENDELA's implementation. The choice of a qualitative approach is justified by the complex subject matter, the diversity of stakeholders, and the need for in-depth exploration of their experiences. Table 1 summarises the data collection and analysis procedures.

RESEARCH OBJECTIVE	TOOLS	PROCESS
ROI	FGD / Interview	<p>Relevant stakeholders were selected to capture a wide range of insights and opinions. It was crucial to gain insights from stakeholders with various backgrounds and experiences. To ensure respondents' participation, we first shared with them the objectives of our study and why their insights and opinions were important to the research. We also informed the focus group that their participation was voluntary, and in the event, they wanted to withdraw from the focus group session, they could leave without providing any reasons. We also informed them that their identities and personal information would be kept strictly confidential, and pseudonyms would be used in the final report. Upon getting their approval, we scheduled the FGD at a convenient time and location, taking into consideration the availability and preferences of the participants. To facilitate the FGD and interview, a set of open-ended questions that addressed the impact of JENDELA implementation on each perspective was prepared. These questions subsequently provided a context for the discussion.</p> <p>The role of the interviewers was to ensure that all respondents had an equal chance to express their opinions while maintaining a productive and respectful atmosphere. As for the recording process, we sought participants' consent to record the discussion anonymously using audio equipment. This recording was used for the researchers to review and refer to for accurate analysis while keeping in mind safeguarding the anonymity of the participants. The audio recordings were then transcribed into a written format. To protect and ensure respondents' anonymity, we used pseudonyms or removed any identifying information from the transcriptions. To import and analyse the transcribed data, NVivo 14 was used.</p>

RESEARCH OBJECTIVE	TOOLS	PROCESS
	NVivo 14 – Data Analysis	<p>The first step was coding. We allocated codes to relevant sections of the transcribed data, capturing key themes and concepts related to the impact of JENDELA implementation. This coding process enabled us to identify patterns and insights within the data. Keeping in mind the respondents' anonymity, we ensured that the assigned codes did not reveal participants' identities or any personal information throughout the coding process.</p> <p>The second step involved creating nodes. In other words, it was on grouping and organising. Codes that were similar were categorised together to identify patterns and connections. This process allowed for a comprehensive analysis of the impact of JENDELA across various perspectives. The third step looked into memoing and annotation to capture respondents' thoughts and interpretations of the data, which aided in the generation of meaningful interpretations.</p> <p>Moving on to the fourth step was querying the data using the search features provided by NVivo 14. By utilising specific keywords or themes, we could delve deeper into the insights hidden within the data. This allowed us to explore and examine specific areas of interest in greater detail. The fifth step was on NVivo's visualisations, such as charts and diagrams. This assisted in illustrating relationships and trends within the data.</p> <p>Finally, the findings were reported. After analysing the coded data, we drew conclusions and reported key findings without disclosing any participant information. The focus was on providing valuable insights and contributing to the understanding of the impact of JENDELA implementation.</p>
RO2	Systematic Review – Database	<p>The first step was on literature search, whereby we conducted a comprehensive search for relevant literature from reputable databases, academic journals, and industry publications using specific keywords such as "Digital connectivity," "JENDELA," "Digital accessibility," "technology," and so on. (e.g., Business Source Ultimate @ EBSCOhost to search for literature. Mendeley was used to manage the review of the literature).</p> <p>Moving on to the second step was study selection. From the list of literature, we then screened and selected relevant studies based on criteria that we had included and excluded, including those discussing new technologies, advancements, or solutions for communication services in neighbouring countries that had successfully implemented digital connectivity.</p> <p>The third step looked into data extraction and analysis. This was done by extracting the key information from the selected studies (E.g., technologies, trends, advantages, challenges).</p> <p>The last step was data synthesis and recommendations. We summarised the findings in a clear and concise manner. Recommendations on potential technologies and solutions that could be adopted to improve communication services were discussed.</p>
RO3	Systematic Review – Database	<p>The first step was to identify and determine the neighbouring countries that had successfully implemented digital connectivity (5G) (e.g., Singapore, Thailand).</p> <p>Secondly, we moved to information gathering and collection on the digital infrastructure plans and implementation strategies of the identified neighbouring countries using reports, publications, and other credible sources. Upon data collection, the third step was to perform a comparative analysis. We strived to analyse and compare the implementation of 5G across the neighbouring countries, thereby focusing on their strengths and weaknesses, challenges, and potentials.</p> <p>The last step focused on the areas for improvement and best practices. Based on the analysis, we aimed to identify the specific areas where the JENDELA project could be improved. This was done by recommending the best practices implemented by neighbouring countries – practices that could be adopted or adapted for JENDELA as an action plan.</p>

Table 1: Data Collection and Analysis Procedures

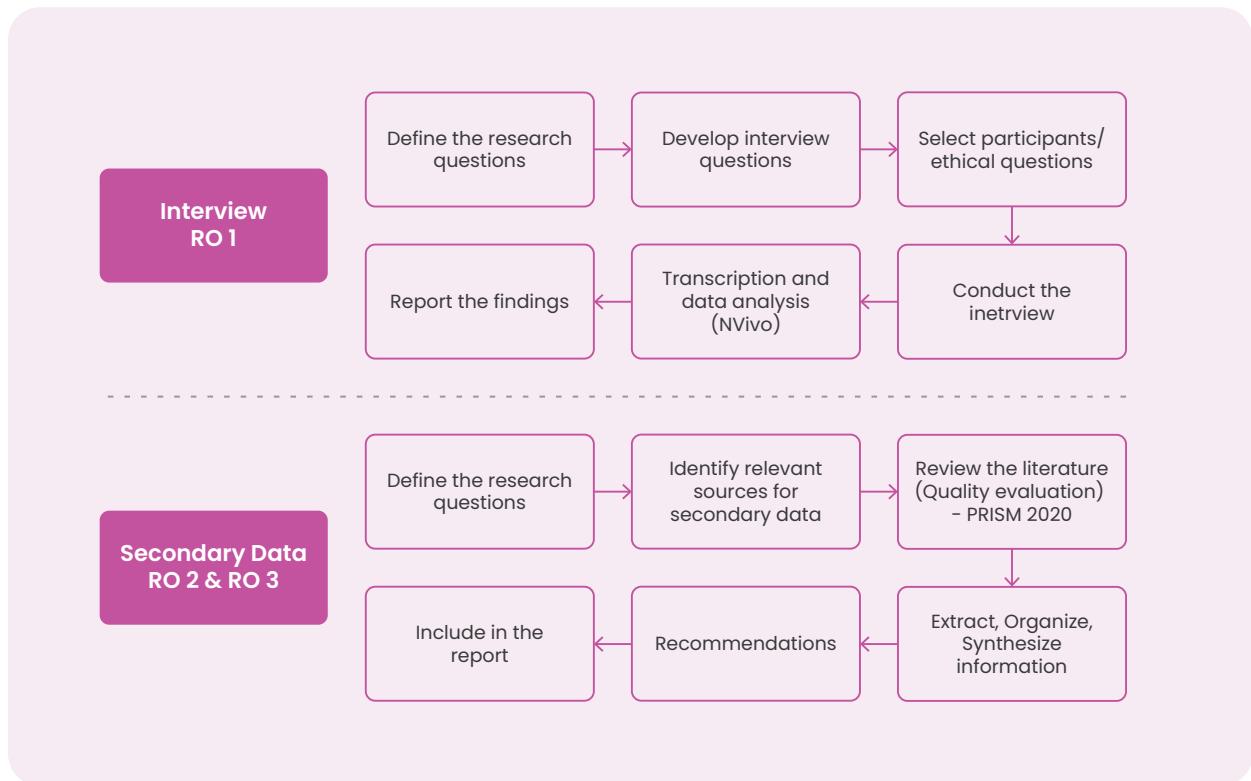


Figure 1: Research Framework

Findings and Analysis

The research design for this study adopts a qualitative approach, carefully chosen to align with the primary objective of exploring community perspectives on the JENDELA plan's implementation. The qualitative method proves suitable for gaining in-depth insights into stakeholders' viewpoints, thoughts, and recommendations, considering the complex nature of a national digital infrastructure plan. The research instruments employed are interviews

and focus group discussions, designed to address Research Objective 1 and tailored to resonate with stakeholders' perspectives. Ethical considerations, including informed consent and privacy measures, are prioritised to ensure responsible scientific investigation. As of 4 October 2023, the study involves a total of 53 respondents, representing diverse backgrounds and perspectives. The respondents are categorised as follows:

1. Telecommunication Service Providers (n = 8):

- Companies: CelcomDigi, TM, Maxis.

2. Government Officers (n = 3):

- Affiliated with Education and Health ministries, not directly involved in JENDELA plan.

3. Sabah and Sarawak (n = 8):

- Sabah: Kota Kinabalu, Ranau, Sandakan, Kota Belud.
- Sarawak: Kuching, Samarahan.

4. City (n = 5):

- Located in Klang Valley.

5. Rural (n = 6):

- Locations: Bota, Perak; Kemaman, Terengganu; Jerantut, Pahang.

6. Education Industry (n = 13):

- Includes Private, Primary, Secondary, and Higher Education.

7. Business (n = 2):

- Number of respondents from the business sector.

8. Orang Asli (n = 6):

- Location: Kampung Orang Asli Pulau Kempas, Kuala Langat.

9. State Government (n = 2):

- Officers with a direct role in JENDELA plans.

The sampling strategy is purposive, aiming to capture a broad spectrum of perspectives, and the search strategy employs a multifaceted approach through direct contacts, leveraging networks, and ensuring geographical diversity. Specific inclusion/exclusion criteria were applied for participant selection, focusing on individuals with direct involvement or experience with the JENDELA plan. Unlike a traditional literature review, this research emphasises qualitative interviews, providing a comprehensive view of JENDELA's implementation from diverse stakeholder perspectives.

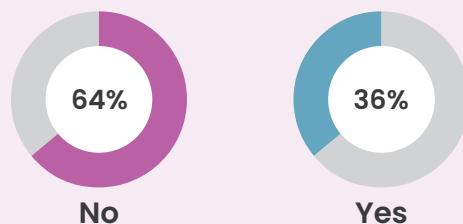
RESEARCH OBJECTIVE 1

To assess the impact of JENDELA implementation from various perspectives.

Code 1

User's awareness of the JENDELA plan

Awareness of the plan is a fundamental aspect of impact assessment.



Based on the data above, the findings indicate a significant lack of awareness about the JENDELA plan, especially within the education industry, with respondents from higher education, secondary school teachers, and primary school teachers showing little to no knowledge of the plan.

Private individuals, even within the city, were generally uninformed about JENDELA, with some expressing surprise at the scale of the government's digital awareness plan. The government officials demonstrated varying degrees of awareness, with some having a basic understanding of JENDELA's goal to enhance digitalisation and infrastructure, while others admitted limited knowledge.

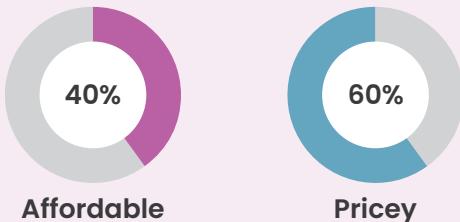
In the business sector, respondents exhibited a lack of awareness, and individuals in the rural areas were uniformly unaware of the JENDELA plan. Telecommunication service providers acknowledged their awareness but highlighted the challenge of promoting the plan to the public effectively.

Overall, the analysis reveals a substantial gap in public awareness, emphasising the need for improved communication and advocacy efforts regarding the JENDELA plan.

Code 2

User's affordability of the Internet pricing

Affordability is a critical factor in assessing the impact of JENDELA.



In lieu of the second code, the affordability of internet plans is a crucial aspect of the JENDELA plan's impact. Interviews revealed mixed perspectives on internet pricing in Malaysia. Some respondents highlighted the affordability of mobile data plans, especially when compared to neighbouring countries like Singapore. The JENDELA plan was seen as contributing to fair pricing and accessibility through surveys and collaboration with telecom operators. Standardisation of mobile data packages for various user groups was emphasised, preventing price wars and promoting high-quality services.

Concerns were raised about the high cost of routers and extenders, with some expressing dissatisfaction with the pricing and contract obligations. While respondents acknowledged their ability to afford internet plans, the focus shifted to the quality of service, suggesting a need for improvement. Comparison with other countries like India and Singapore

was made, highlighting Malaysia's competitive pricing but slower speeds. In the city, respondents expressed reluctance to upgrade due to high prices and complications, while others raised concerns about the overall cost of data plans in Malaysia, considering them among the most expensive in the ASEAN region. The impact on lower-income individuals relying on lower-tier data plans for remote work or virtual learning was acknowledged.

In Sabah and Sarawak, opinions on affordability varied, with some finding the prices reasonable and others considering them expensive, citing issues like unstable speed. In rural areas, there were mentions of high monthly fees for fixed lines, leading to the use of prepaid lines.

The government's role in addressing affordability was highlighted, with the introduction of the Rahmah package and mandatory access pricing standards. Efforts were expected to result in more

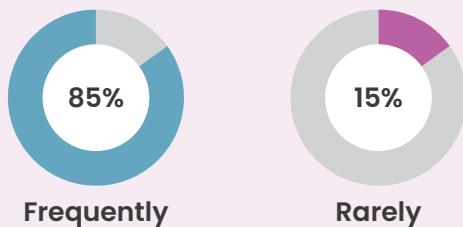
affordable internet packages nationwide, including rural areas, starting in the coming months. In summary, the analysis reveals a diverse range of perspectives on internet affordability, emphasising the need for continued efforts to ensure fair pricing, improve service quality, and address the specific needs of different demographic groups across Malaysia.

In summary, the analysis reveals a diverse range of perspectives on internet affordability, emphasising the need for continued efforts to ensure fair pricing, improve service quality, and address the specific needs of different demographic groups across Malaysia.

Code 3

User's frequent usage of the Internet

Increased internet usage by users is a positive outcome related to JENDELA's impact.



All in all, the findings of Code 3, the JENDELA plan in Malaysia has shown a significant and positive impact, particularly in urban areas. City residents heavily rely on the Internet for work, entertainment, socialising, and information access, emphasising the importance of improved connectivity for daily routines. Government officers highlight their dependence on the Internet for various work-related tasks, emphasising the transition to Wi-Fi for portability during meetings.

In the business sector, the Internet plays a pivotal role in streamlining operations, promoting businesses through social media, and boosting sales and revenue. The education sector, especially higher education, acknowledges the effectiveness of online teaching during the pandemic, underscoring the importance of nationwide internet coverage for educational accessibility.

In rural areas, individuals with businesses

recognise the benefits of optimising the Internet for promotion and marketing. Orang Asli respondents indicate diverse internet usage, including banking, payment, work, and social media. The overall analysis reflects a deep understanding of how the Internet has become integral across various sectors, aligning with the JENDELA plan's goal of encouraging broader adoption of internet services in Malaysia.

Overall, the analysis reflects a deep understanding of how the Internet has become an integral part of daily life, impacting various sectors such as education, government, business, and personal activities. The positive association between increased internet usage and the JENDELA plan's impact aligns with the goal of encouraging broader adoption of internet services in Malaysia.

Code 4

User's thoughts on the Quality of the Internet

The quality of internet services is a critical aspect of impact assessment.



The analysis of internet quality in Malaysia reveals diverse experiences across sectors and regions. Government officials, telecommunication experts, and educators discuss challenges and improvements, emphasising mandatory standards and a shift towards assessing Quality of Experience (QOE).

In the telecommunications sector, there is acknowledgment of extensive nationwide coverage but challenges in rural areas, accentuated by COVID-19 revealing connectivity gaps. Discrepancies between urban and rural internet quality highlight the existing digital divide. City residents express mixed sentiments, with some facing signal loss and dissatisfaction with 5G progress.

In education, issues with bandwidth, slow speeds, and disruptions during online learning are highlighted at both higher education and school levels. Educators emphasise stable connections for effective teaching, and government officers prioritise internet quality over coverage percentage. Challenges in obtaining 4G signals in specific areas indicate the need for comprehensive coverage.

Orang Asli's opinions vary, with some finding current coverage sufficient and others expressing the need for improvement. In Sabah and Sarawak, diverse experiences range from unstable connections to satisfactory quality, emphasising the need for targeted improvements. Rural areas face significant challenges with slow, unreliable, and difficult-to-access internet, impacting daily life and business operations.

In the business sector, informants generally report smooth experiences but acknowledge potential impacts on operations and revenue during downtime. The analysis demonstrates a comprehensive understanding of internet quality issues, highlighting the need for targeted interventions to bridge connectivity gaps and improve overall internet quality for a more inclusive digital landscape.

The depth of the situation analysis reflects a comprehensive understanding of internet quality issues in Malaysia, considering technical, geographical, and socioeconomic factors. The diverse perspectives highlight the need for targeted interventions to bridge connectivity gaps and improve overall internet quality for a more inclusive digital landscape.

Code 5

Assistance given by Private bodies

Significant role of private bodies in the implementation of JENDELA.



Based on the findings in Code 5, Private bodies have actively contributed to the implementation of JENDELA in Malaysia, indicating a collaborative effort between the government and private entities. In the telecommunication sector, companies prioritise customer service through skilled network engineers, 24/7 monitoring, and dedicated support personnel.

In education, private efforts focus on backend support during online classes to address connectivity or technical issues promptly. Training and development are emphasised for primary school teachers, with various courses and opportunities provided for continuous improvement. At higher education levels, universities support students with free drawing pads and assistance for internet connections. Online training, webinars, and dedicated support centres contribute to a positive learning environment. Businesses conduct internal training sessions to enhance employees' digital skills, particularly for

tools like Google Workspace.

Government officers highlight private sector engagement in STEM plans, with companies like Petronas actively involved in student plans and teacher training. Practical solutions, such as providing dedicated Wi-Fi lines for events, showcase private entities' commitment to addressing connectivity challenges. However, challenges are noted in Sarawak, where local policy restrictions create complexities in appointing entities from outside Sarawak for tower building and telecommunications services.

For Orang Asli communities, government agencies like JAKOA, community colleges, and GiatMara actively provide continuous training and education to empower Orang Asli entrepreneurs. The depth of the analysis reveals a multifaceted approach involving private entities in enhancing digitalisation. Private bodies contribute not only to infrastructure development

but also in providing support, training, and education, showcasing a comprehensive collaboration to ensure equal access and address digital challenges across various sectors and regions.

The depth of the analysis reveals a multifaceted approach involving private

entities in enhancing digitalisation. Private bodies contribute not only to infrastructure development but also in providing support, training, and education, showcasing a comprehensive collaboration to ensure equal access and address digital challenges across various sectors and regions.

Code 6

Awareness of users on the complaint and feedback platforms.

Significant role of private bodies in the implementation of JENDELA.



The findings regarding user awareness of complaints and feedback platforms underscore the significance of user engagement in the JENDELA plan. Users are actively providing feedback, contributing to the plan's improvement, and demonstrating its responsiveness to user concerns.

In urban areas, individuals handle connectivity issues by utilising public Wi-Fi or troubleshooting themselves before contacting their Internet Service Provider (ISP). While aware of the Malaysian Communications and Multimedia Commission (MCMC) complaint platform,

users often prefer direct contact with their ISP for faster issue resolution. Some express unawareness of JENDELA's complaint platform.

Businesses promptly contact their telecommunication providers for issue resolution, ensuring minimal service disruption. Primary school teachers follow formal channels, reporting problems to the Education District Office or higher-ranking officers. In secondary schools, consistent complaints to the education department highlight a reliance on established channels rather than direct MCMC contact.

Private users may face prolonged connectivity issues despite engaging their ISP's technicians. Higher education users, aware of alternative options, may not report disruptions to their provider. Users in Sabah, Sarawak, and rural areas often lack clarity on complaint processes, resorting to contacting service providers for poor connectivity.

Government officers highlight a structured process, involving internal IT departments and MAMPU before escalating to MCMC in government-wide cases. Concerns about limited action and attention are expressed, indicating the need for more effective

resolutions. The depth of the analysis reveals diverse user behaviours, varying awareness levels of complaint platforms, and a reliance on different channels for issue resolution.

The depth of the analysis reveals a multifaceted approach involving private entities in enhancing digitalisation. Private bodies contribute not only to infrastructure development but also in providing support, training, and education, showcasing a comprehensive collaboration to ensure equal access and address digital challenges across various sectors and regions.

Code 7

Users' perception of government plans

Users' perception of government plans can influence the success of plans like JENDELA.



The summary of findings in Code 7 exposed that the perceptions of government plans regarding digital transformation are crucial for understanding the success and challenges of plans like JENDELA. Positive perceptions indicate effective efforts, while negative ones highlight areas needing improvement.

In the telecommunication sector, coordination challenges between federal and state governments impact infrastructure approval processes, hindering the achievement of Key Performance Indicators (KPIs). However, a communication platform facilitates issue resolution by allowing telecom companies

to provide explanations for delays and seek clarification.

In rural areas, a respondent mentioned that political changes affected the availability of free 4G internet, suggesting that government transitions impact digital plans.

In the government sector, an example is shared regarding the 1BestariNet project, which aimed to enhance ICT facilities in schools. The project faced interruptions and ultimately stopped due to changes in government around April 2018. The new government sought to reduce costs,

leading to cuts in various projects, including 1BestariNet. This highlights how political decisions can impact the continuity of long-term projects, emphasising the need for stability and continuity in government plans.

The depth of the analysis reveals challenges in coordination between different levels of government in the telecommunication sector and the vulnerability of projects to political changes in the government sector. This suggests a need for improved coordination and stability to ensure the success and continuity of digital transformation plans.

Code 8

The need to increase promotional effort

Awareness or understanding of the JENDELA plan among users.



The analysis of Code 8 reveals a notable gap in awareness or understanding of the JENDELA plan among users, highlighting the need for increased promotional efforts. This lack of awareness is evident across different regions and user groups.

In urban areas, respondents express

a general lack of exposure and acknowledgment of government plans in the telecommunications industry. There is a perception that the government's role is not as prominent as that of telecommunication service providers in driving improvements. In rural areas and

Sabah/Sarawak, respondents display a lack of awareness regarding government plans and promotional efforts related to internet connectivity. This suggests a potential communication gap or lack of visibility of such plans among the public.

Telecommunication sector insights emphasise the significant role played by the MCMC in enhancing internet connectivity. MCMC utilises various platforms, including digital internet centres and the JENDELA website, for awareness campaigns and public engagement. However, the findings underscore the public's prioritisation of internet quality and connectivity over awareness of the JENDELA plan. The emphasis is on the need for increased promotional efforts to inform the public about JENDELA's digitalisation-focused objectives.

Government officers acknowledge the lack of awareness and recommend

increased promotion specifically targeting JENDELA to differentiate it from MCMC. They highlight the importance of collaboration between the private sector and the government to address capital-intensive technology needs and ensure sustainable infrastructure and services. The state government from MCMC acknowledges ongoing promotional efforts through various channels, including TV, social media, and local newspapers. However, they recognise that 100 per cent awareness is challenging to achieve, emphasising that people prioritise internet coverage and services over branding.

In-depth analysis indicates that the success of digital transformation plans like JENDELA depends on effectively bridging the awareness gap through strategic promotional efforts. This includes targeted campaigns to educate the public about the plan's objectives and benefits, fostering support and understanding among users.

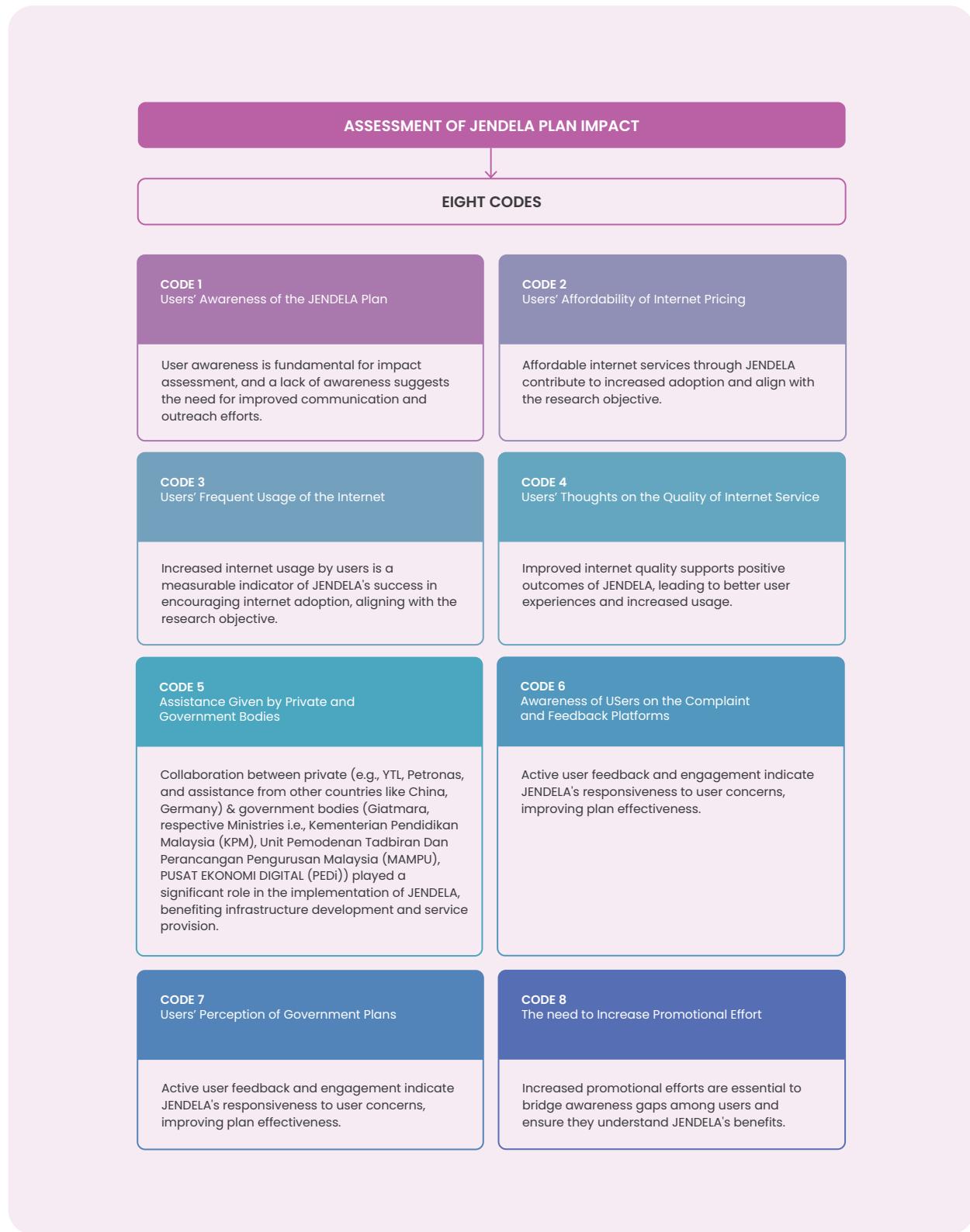


Figure 2: Assessment of JENDELA Plan Impact

Together with these eight (8) codes, we grouped the codes that are similar to each other, resulting into four (4) themes. Those four (4) themes are:

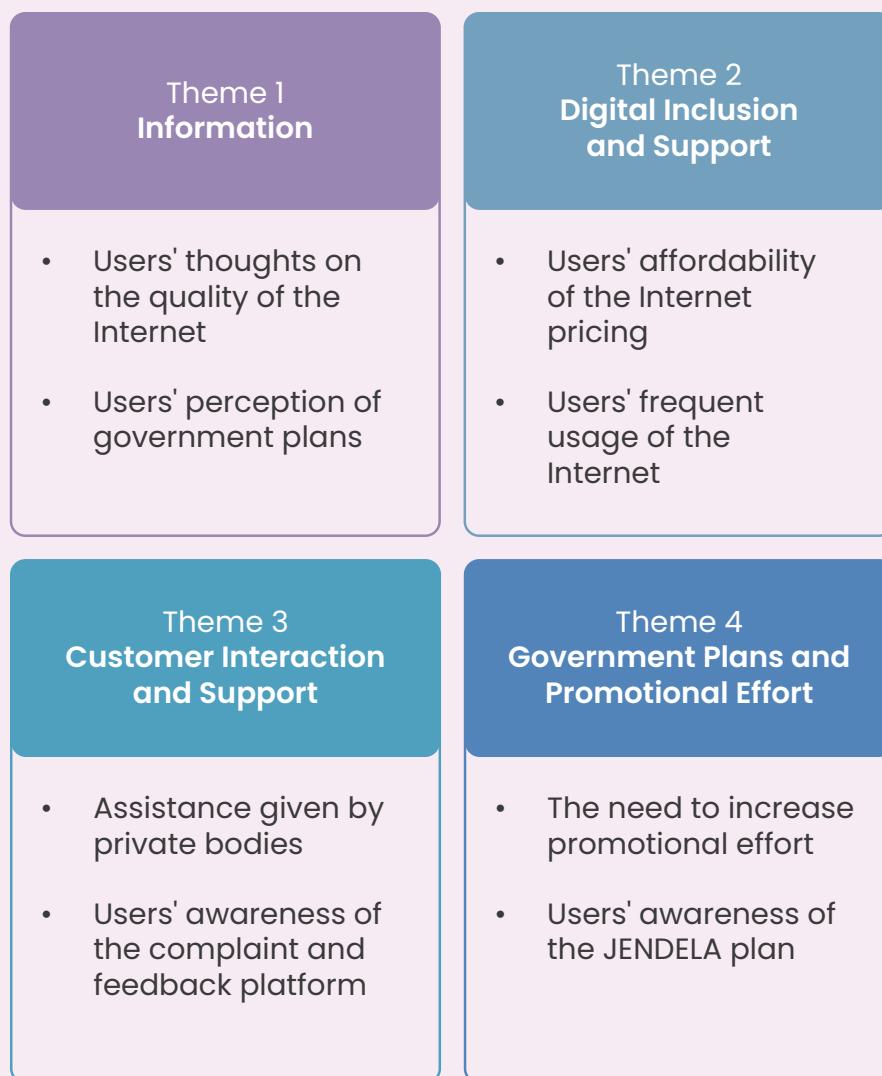


Figure 3: The Four Themes

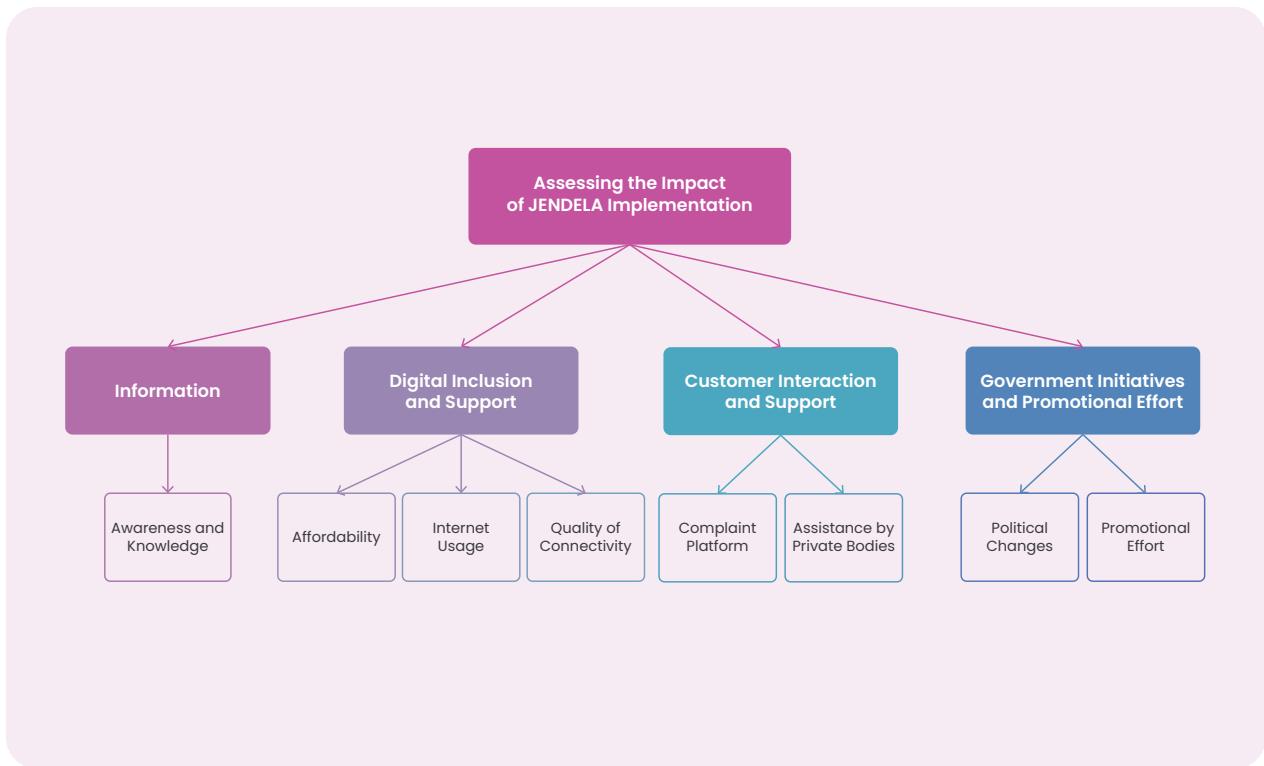


Figure 4: Themes Generated Using NVivo 14

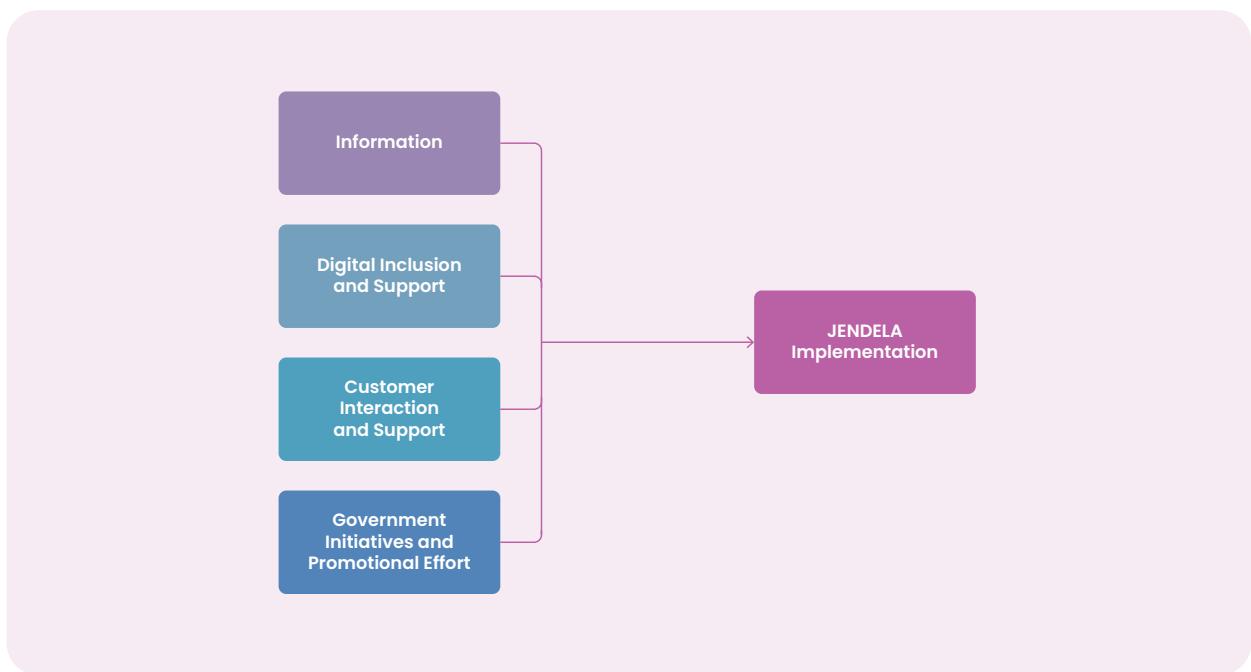


Figure 5: Theoretical Framework

RESEARCH OBJECTIVE 2

To identify potential new technologies and solutions for improvement in communication services.

The depth of the analysis reveals a multifaceted approach involving private entities in enhancing digitalisation. Private bodies contribute not only to infrastructure development but also in providing support, training, and education, showcasing a comprehensive collaboration to ensure equal access and address digital challenges across various sectors and regions.

Key Concern 1

Insufficient infrastructure causing unreliable coverage in various areas.

SOLUTIONS

1. Invest in robust and widespread infrastructure.
2. Focus on improving broadband and network coverage.

Key Concern 2

Resistance to change and digital illiteracy, lack of awareness and education, the complexity of digital applications, and the rapid pace of technological advancements, all of which hinder the effective adoption of digital tools and technologies.

SOLUTIONS

1. Implement tailored digital literacy plans to address resistance to new technologies and promote personal responsibility for digital literacy.
2. Launch multilingual campaigns to educate individuals about the advantages of digital tools like e-Wallets and clarify practical applications and benefits of technologies like 5G.
3. Prioritise user-friendly app development to make digital applications more accessible, particularly for senior citizens and less tech-savvy users.

Key Concern 3

Challenges related to connectivity in urban areas with high-rise buildings and complex road networks. (e.g., Smart Tunnel, busy streets with multiple lanes, car park).

SOLUTIONS

1. Invest in wireless infrastructure, including 4G and 5G networks.
2. Expand network coverage in densely populated urban areas.
3. Use innovative technologies like beamforming to overcome signal interference.

Key Concern 4

Overambitious digital transformation plans without proper planning.

SOLUTIONS

1. Implement infrastructure projects with a well-defined plan, starting with pilot projects before scaling up.
2. Comprehensive planning and investigation to understand signal strength and digital issues on the ground.

Key Concern 5

Lack of coordination and collaboration among stakeholders, including telco companies and government bodies.

SOLUTIONS

1. Establish efficient communication channels between state and federal government entities.
2. Foster interagency collaboration among different government departments and ministries involved in telecom projects.
3. Regularly review and update regulatory frameworks to align with technological advancements.
4. Promote Public-Private Partnerships (PPPs) to share costs and responsibilities for infrastructure development.

Figure 6: Key Concerns

RESEARCH OBJECTIVE 3

Benchmark with neighbouring countries; best practices, areas of improvements, action plan

In delving into Research Objective 3, which involves benchmarking Malaysia's JENDELA plan against the digital infrastructure efforts of its neighbouring countries, we aim to extract valuable insights from comparative analyses. This objective underscores the significance of learning from the experiences and strategies employed by neighbouring nations in their pursuit of robust digital infrastructure. By identifying best practices, areas of improvement, and formulating a strategic action plan, we aim to contribute to the enhancement and optimisation of Malaysia's JENDELA plan. This benchmarking exercise serves as a valuable tool for refining approaches, fostering innovation, and ensuring Malaysia remains at the forefront of digital connectivity, drawing inspiration from the successes and lessons of neighbouring countries.

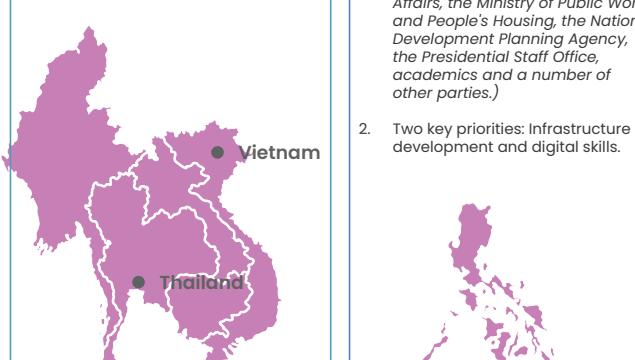
Vietnam	Thailand	Singapore	Indonesia
<ul style="list-style-type: none"> 1. National Digital Transformation Program (Perception, business strategies, and incentives for the digitalisation of firms, administration, and industrial operations). 2. e-Government services (2030 goal – top 30 for e-Gov services). 3. Smart City Development (Digital transformation to build smart cities in Vietnam - digital government, digital economy, and digital society) 	<ul style="list-style-type: none"> 1. "Village Broadband Internet" (Net Pracharat) project to reach high-speed Internet services to every village in the country and to provide free broadband Internet in rural areas. 2. Thailand's 20-year Digital Thailand Plan (2016) outlines a phased approach towards comprehensive digital transformation: Phase 1 focuses on digital infrastructure. Phases 2 and 3 prioritise digital inclusion and full digital transformation to bridge digital gaps. Aim to achieve full digital transformation by 2027 and become a global digital economy leader in Phase 4. 3. Department of Skill Development and Digital Economy Promotion Agency has collaborated with the private sector to develop online digital skills training plans. 	<ul style="list-style-type: none"> 1. Next Generation Nationwide Broadband Network (NGNBN) – fibre optics. 2. Wireless@SG (Free Wi-Fi in public spaces). 	<ul style="list-style-type: none"> 1. 100 Smart Cities Movement (<i>fibre optic infrastructures in 146 cities; several applications to support smart cities; joint idea of the Ministry of Communications and Informatics, the Ministry of Home Affairs, the Ministry of Public Works and People's Housing, the National Development Planning Agency, the Presidential Staff Office, academics and a number of other parties.</i>) 2. Two key priorities: Infrastructure development and digital skills.

Figure 7: Summary of Best Practices of Neighbouring Countries

Enhancement of Broadband Connectivity and Speed

Prioritise improving broadband connectivity and internet speeds, especially in underserved regions, by investing in fibre optic networks for equitable access and advanced capabilities.

Digital Inclusion Promotion

Promote digital inclusion through plans like providing free Wi-Fi in public spaces, enhancing digital literacy, and improving e-Government services for citizen empowerment and effective governance.

Expanding Fibre Optic Infrastructure

Consider implementing an extensive fibre optic network, similar to Indonesia's model, in a phased approach starting at the district level to bridge geographical gaps and ensure successful implementation.

Figure 8: Key Takeaways for JENDELA Plan

Recommendations

The JENDELA plan in Malaysia represents a significant stride towards achieving digital inclusion and driving economic growth. This research paper aims to furnish comprehensive recommendations for policymakers to optimise the impact of JENDELA within the context of Malaysia's unique challenges and opportunities. To ensure its success, it is imperative for

policymakers and officers to adopt a multifaceted approach that encompasses user sentiments, affordability, usage patterns, and long-term impact studies. This essay provides comprehensive recommendations for optimising the impact of JENDELA within the unique context of Malaysia's challenges and opportunities.

Conduct Comprehensive Sentiment Analysis	Undertake sentiment analysis to understand users' perceptions of internet quality. Utilise user-generated content from social media, surveys, and forums for valuable insights.
Incorporate Citizen Voices in Policy	Conduct qualitative interviews and surveys to gauge citizens' perceptions of government plans, especially JENDELA. Use this information to customise communication strategies and make necessary improvements for positive public perception.
Consider Geographic and Demographic Diversity	Recognise the diversity in challenges and opportunities across urban and rural areas. Establish partnerships with local communities and NGOs to address infrastructure challenges in rural areas.
Address Affordability and Internet Usage	Scrutinise data on household income and Internet subscription rates to understand the impact of pricing on Internet adoption. Develop targeted subsidy plans or pricing regulations to ensure affordability, especially in rural or low-income areas.
Prioritize Long-Term Impact Studies	Conduct long-term impact studies tracking key metrics such as Internet adoption rates, job creation, and economic growth. Use this data for mid-course corrections and informed long-term planning.
Promote Public-Private Collaboration	Actively encourage collaboration between the public and private sectors for the expansion of Internet infrastructure. Provide incentives or streamline regulatory processes to facilitate private sector investments. Foster innovation by supporting tech startups and smaller enterprises to contribute to the digital landscape.

Figure 9: Research Recommendations

Recommendations for Future Research Projects

Future studies can strategically focus on specific participant categories to gain a more nuanced understanding of the impact of JENDELA plans. Targeting rural populations, indigenous communities (e.g., Orang Asli), or urban poor allows for a deeper exploration of behavioural changes, technology adoption patterns, and levels of digital inclusion in these diverse groups. Moreover, delving into specific industries, such as health or education (both government and private sectors), can provide insights into the effects of JENDELA plans on industry processes and the effectiveness of government-led digitalisation.

Additionally, there is a need to address regional disparities, particularly in East Malaysia, by investigating unique challenges and grievances related to digital adoption. Exploring infrastructural challenges, cultural influences, and tailoring JENDELA plans to the context of

East Malaysia can pave the way for more region-specific strategies.

Understanding the impact on senior citizens' trust in digital tools following JENDELA awareness is another crucial avenue for future research. This involves measuring changes in perceptions, identifying factors contributing to increased trust, and evaluating the effectiveness of awareness campaigns targeting senior citizens.

Lastly, exploring changes in attitudes toward social media marketing, digital payment, e-wallets, and e-government among citizens is vital. Analysing the acceptance of digital payment methods, evaluating the impact of improved connectivity on social media engagement, and assessing changes in attitudes toward e-wallets and e-government services can provide valuable insights into evolving digital behaviours.

NO	TOPIC	AIM	OBJECTIVES
1.	Investigating the behavioural impact on a) rural populations, b) indigenous communities, or c) urban poor upon JENDELA plans.	Assess the behavioural changes in rural populations, indigenous communities, and urban poor in response to JENDELA plans	<ol style="list-style-type: none"> 1. Understand shifts in technology adoption patterns, communication and interaction behaviours. 2. Assess the level of digital inclusion and support in these communities.
2.	Focusing on specific industries, such as health or education (government and private) upon JENDELA plans, to deepen understanding and relevance.	Deepen understanding of JENDELA plans' effects on specific industries, such as health and education (both government and private sectors).	<ol style="list-style-type: none"> 1. Analyse the improvements and changes in industry processes and practices. 2. Assess the effectiveness of government plans in promoting industry-specific digitalisation.
3.	Examining the unique challenges and grievances faced by East Malaysia in the face of adopting digitalisation.	Identify and address the unique challenges faced by East Malaysia in adopting digitalisation through JENDELA.	<ol style="list-style-type: none"> 1. Explore infrastructural challenges specific to East Malaysia. 2. Understand cultural and regional factors influencing digital adoption. 3. Provide recommendations for tailoring JENDELA plans to East Malaysia's context.
4.	Investigating the increment of trust among senior citizens in adopting digitalisation tools upon the awareness of JENDELA.	Assess the increase in trust among senior citizens in adopting digital tools following awareness of JENDELA.	<ol style="list-style-type: none"> 1. Measure changes in perceptions and attitudes toward digital technologies. 2. Identify factors contributing to increased trust in digitalisation. 3. Evaluate the effectiveness of awareness campaigns targeting senior citizens.
5.	Exploring changes in attitudes toward social media marketing, digital payment, e-wallets, and e-government among the citizens.	Examine shifts in attitudes toward social media marketing, digital payment, e-wallets, and e-government among citizens.	<ol style="list-style-type: none"> 1. Analyse the acceptance of digital payment methods post-JENDELA. 2. Evaluate the impact of improved digital connectivity on social media engagement. 3. Assess changes in attitudes toward e-wallets and e-government services.

Table 2: List of Potential Research Topics, Aims and Objectives

Conclusion

The research on Malaysia's JENDELA plan offers crucial insights into its impact on the country's digital infrastructure and socio-economic progress. Conducted through comprehensive engagement with diverse stakeholders, the study aims to improve JENDELA by identifying areas of enhancement. The research employs a theoretical framework grounded in Social Marketing Theory to assess the plan's effectiveness in narrowing the digital access gap. The findings emphasise the significance of clear communication, user-focused strategies, and supportive policies for digital inclusion and economic growth. Despite encountering limitations, particularly in collaboration with government officials and telecom providers, the study provides practical recommendations tailored to Malaysia's unique challenges. Future research is suggested to explore innovative data collection methods and employ a long-term approach to understanding evolving government and industry dynamics. In conclusion, the research represents a significant stride toward optimising JENDELA, offering valuable insights for policymakers as Malaysia progresses toward digital innovation and societal well-being.

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TOPIC 10

The Uses, Motivation, and Gratification of Free-To-Air Channel Among Users In The East Coast Region Of Peninsular Malaysia

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Abstract

Malaysia has moved towards television (TV) digitalisation that has resulted in a transformation of the country's broadcasting industry to keep up with TV viewers' changing behaviour. As part of the Government's effort in bridging the digital divide among the people of urban, suburban and rural areas, National Broadcasting Digitalisation Project (NBDP) was announced by the government in 2017. Under the patronage of the Ministry of Communications and Digital (formerly known as Ministry of Communications and Multimedia Malaysia, KKMM) and monitored by the Malaysian Communications and Multimedia Commission (MCMC), the NBDP is an initiative to ensure a smooth transition from analogue to digital broadcasting on a terrestrial platform for the current Free-to-Air (FTA) government-owned and private TV stations. However, the broadcast media industry's future, particularly TV, remains uncertain as streaming services have been taking over audiences every year. In addition, since the Internet has provided more advertising opportunities, one of the main broadcasting revenues, TV is predicted to be eroded and continue to lose not only audiences but also advertisers globally and locally. For these reasons, this study was conducted to explore the FTA TV viewing in the East Coast region of Peninsular Malaysia in discovering TV viewing habit and finding advertising opportunities. The East Coast region was selected as its population was characterised by different socio-economic and cultural backgrounds. This study used a survey research method to gather responses from 403 participants from August to September 2023 using a multi-stage sampling technique. In summary, the research results were useful for broadcasters to produce FTA TV content and assist advertisers to develop targeted adverts that correspond with the tastes and characteristics of the audiences in Terengganu, Kelantan, and Pahang.

Introduction

The digital transmission of the Free-to-Air (FTA) television (TV) channels through MYTV service (formerly known as myFreeview) is one of the major ways the broadcast media business in Malaysia responds to the digital challenges, as it ensures that people receive clear signals and channel coverage. TV has been seen as a popular medium to reach wide audiences during peak hours, especially the Malay group (MCMC, 2016), despite the rise in Internet use over the last five (5) years compared to the stagnant consumption of TV and radio (MCMC, 2019). TV remains a popular medium among heavy Internet users (Karim et al., 2021). Furthermore, TV seems to be a powerful medium that influences people's opinions on a wide range of topics (Alan et al., 2021). According to Alan et al. (2021), government and private organisations should take into account the planning and execution of TV shows since they can be utilised to further the government's objective of promoting the physical and intellectual development of communities.

The way people watch TV has changed over the last few decades, suggesting a swift shift in TV viewing habits. TV can now be accessed through several platforms or applications in addition to a traditional TV set. Nowadays, consumers can use a computer, laptop, smartphone, or tablet to watch content from anywhere. The factors that influence how much TV shows are watched are numerous. For example, Modili et al. (2022) states four (4) factors of TV consumption namely due to factual and credible content, cultural aspects, personal preferences, and emotional needs. TV genre preferences have also an impact on how people watch TV, in which people felt good about what they were doing when they watched TV genres that they enjoyed. For some viewers, watching TV can be an entertaining or isolating experience, while for others, it can be a way to relax or learn new things. When watching TV, some viewers can even search for excitement (Bindah, 2019). There are plenty of different TV programmes, including newscasts, documentaries, news magazines, talk shows, variety shows, sports broadcasts, games and quizzes, children's shows, and various dramatic entertainment that audiences could choose from.

Problem Statement

However, the broadcast media industry's future, particularly TV, remains uncertain as streaming services have been taking over audiences every year. The high interactivity factor of the streaming services has negatively affected the broadcasting industry as audiences have much promising entertainment and information platforms. This also means TV viewing patterns have been altered with the presence of technology (Ponnan & Ali, 2015) and is argued to draw audiences away from FTA TV channels. Moreover, TV is predicted to lose more advertising markets globally and locally as advertising opportunities could also be obtained through the internet at a much competitive cost.

For these reasons, this study was conducted to discover the FTA TV viewing in the East Coast region of Peninsular Malaysia in exploring the advertising opportunities. Specifically, the objectives of this study were:

RO 1 To identify the demographic profile of the audiences in the East Coast region of Peninsular Malaysia

RO 2 To examine the viewing pattern of FTA TV channels among the audiences in the East Coast region of Peninsular Malaysia

RO 3 To identify the gratification level among the audiences in the East Coast region of Peninsular Malaysia

RO 4 To identify the advertising potentials from the perspectives of the FTA TV viewers in Terengganu, Kelantan, and Pahang

Literature Review

Television Viewing in Malaysia

One of the significant responses of the broadcast media industry to the digital challenges in Malaysia is the digital transmission of the FTA TV channels through MYTV service to ensure clear signals received by audiences. Despite the increase in Internet use over the last five (5) years, TV has been considered a popular medium to reach large audiences during peak hours, especially the Malay group (MCMC, 2016). Among heavy Internet users, TV is still a sought-after medium (Karim et al., 2021). TV also appears to be a significant platform that shapes how people think about many issues (Alan et al., 2021). Malaysian audiences relied on portal to access TV content. A study by Hashim and Omar (2011) observed that youth were reported to visit the portals of TV3 (65 per cent), followed by 8TV (23 per cent), NTV7 (6 per cent), TV9 (2 per cent), and RTM (1 per cent) in accessing the content. Additionally, they have also started consuming online content while also enjoy TV from any location using devices like a smartphone, laptop, tablet, or TV set (Modili et al., 2022). For example, the prime-time news programme, Berita Perdana, by Radio Televisyen Malaysia (RTM) can be viewed through MyKlik or on RTM Mobile application which was available until the year 2020. Later, in January 2021, RTM Mobile and MyKlik were integrated as RTMKlik to provide better access to RTM contents.

Factors Affecting Television Viewing

One of the popular TV contents consumed by users is news. TV news occurs concurrently with other forms of media, particularly social media. However, news reported on social media sites lacks the trustworthiness as compared to conventional TV news platforms. According to Boyman et al. (2020), young women voted televisions as a highly significant source of political information. The results demonstrated that respondents' trust in the authenticity of political information they acquired from the TV segment. They also discovered that the news channel known as Astro Awani was a popular choice with the greatest mean score, closely followed by publicly owned channels like TV1 and TV2.

In another study, National 8 of RTM appeared to have greater ways of communicating with its viewers, which stood out among other prime time news channels (Karim et al., 2021). Here, it could be inferred that TV remains to be an essential provider of reliable information, even though social media was the main source of news for the respondents during pandemics (Arandas et al., 2021). These results are consistent with a study conducted in 2011 by Buyong and Ismail, which reported that most people turn to TV for news, entertainment, and sports. The study elaborated that TV was the instrument for young Malaysians to keep up with current affairs and trends, adopt celebrity ways of life and routines as well as widely used for entertainment and social surveillance.

Methodology

A cross-sectional survey was conducted using self-constructed questions. The questionnaire was divided into five (5) sections which were represented by demographic information of FTA TV viewers, FTA TV viewing pattern, FTA TV content preference, uses and gratification of FTA TV channels, and advertising potentials in Terengganu, Kelantan, and Pahang.

Sampling

This study incorporated a multi-stage sampling procedure that combines cluster, systematic random, and stratification sampling. In the first stage, the states were divided according to region (cluster). The sampling did not further divide the districts into clusters because it will lead to too many clusters in each region that data collection will be challenging. This decision was made considering that enumerators must fulfil the sampling composition criteria such as gender, professional background, and TV viewing before

approaching anyone as a respondent. Cluster sampling is chosen because it covers the characteristics of the entire population, or when the sample has different personalisation as not having a sampling frame. The clusters were then selected using systematic random sampling. A total of 403 respondents participated in this study.

Data Collection

The survey period, including a pilot test, ran from July to September 2023 using self-administered which was closely assisted by the lead researcher and enumerators to avoid missing responses. This study hired and trained 12 enumerators in assisting the data collection process. There were 11 regions selected in this research. Each enumerator was responsible for a region respectively and required to allocate the questionnaire among the residents in the region. However, two (2) enumerators were hired in Kota Bharu as large number of surveys were needed. Figure 1 summarises the design of this research which can be divided into two (2) phases.

PHASES	RESEARCH FLOW		METHOD USED	INSTRUMENT
Phase 1	Stage 1	Literature review and instrument development	Survey (Quantitative)	1. Questionnaire 2. Consent form 3. Respondents' information form
	Stage 2	Piloting the survey questionnaire		
	Stage 3	Survey questionnaire distributed		
Phase 2	Stage 1	Data analysis	SPSS (Qualitative)	1. SPSS output 2. Recommendation template
	Stage 2	Discussion		
	Stage 3	Report writing		

Figure 1: Design of Research

Finding and Analysis

Characteristics of the FTA TV viewers in the East Coast region of Peninsular Malaysia

This section presents the summarisation of the demographic information of the FTA TV viewers in the East Coast region of Peninsular Malaysia – Table 1.

NO	ITEMS	DETAILS	FREQUENCY	%
1	Gender	Male	190	47.1
		Female	213	52.9
		Total	403	100.0
2	Age Group	20 and less	15	3.7
		21-30	132	32.8
		31-40	142	35.2
		41-50	54	13.4
		51-60	31	7.7
		61 and more	29	7.2
3	Ethnicity	Total	403	100.0
		Malay	348	86.4
		Chinese	32	7.9
		Indian	19	4.7
		Others	4	1.0
		Total	403	100.0

**Table 1: Demographic information of the FTA TV viewers
in the East Coast region of Peninsular Malaysia**

NO	ITEMS	DETAILS	FREQUENCY	%
4	Religion	Islam	349	86.6
		Kristian	14	3.5
		Hindu	17	4.2
		Buddha	21	5.2
		Others	2	0.5
5	State of Residence	Total	403	100.0
		Terengganu	156	38.7
		Kelantan	130	32.3
		Pahang	117	29.0
		Total	403	100.0
6	Region of Residence	Kuala Terengganu	54	13.4
		Pekan	15	3.7
		Kuantan	68	16.9
		Marang	28	6.9
		Dungun	38	9.4
		Kuala Nerus	36	8.9
		Pasir Mas	34	8.4
		Kuala Krai	15	3.7
		Kota Bharu	81	20.1
		Bentong	14	3.5
		Temerloh	20	5.0
		Total	403	100.0

NO	ITEMS	DETAILS	FREQUENCY	%
7	Employment Status	Employed	294	72.9
		Unemployed	5	1.2
		Student	31	7.7
		Homemaker	47	11.7
		Pensioner	26	6.5
8	Income of Husband and Wife	Total	403	100.0
		< 1000	6	1.5
		1000 – 1999	86	21.3
		2000 – 2999	108	26.8
		3000 – 3999	81	20.1
		4000 – 4999	55	13.6
		5000 – 5999	33	8.2
		6000 – 9999	26	6.5
		> 10000	8	2.0
		Total	403	100.0

**Table 1: Demographic information of the FTA TV viewers
in the East Coast region of Peninsular Malaysia**

From the survey, the respondents of this research were equally distributed in terms of gender, with females (52.9 per cent) slightly outnumbering males (47.1 per cent). Most of the respondents (81.4 per cent) were between 21 and 50 years old. Specifically, they were in the age groups of 31 to 40 (35.2 per cent), 21 to 30 (32.8 per cent), and 41 to 50 (13.4 per cent) years old. The remaining respondents were between 51 and 60 years old (7.7 per cent), 61 and above (7.2 per cent), and 20 and below (3.7 per cent) – Figure 2.

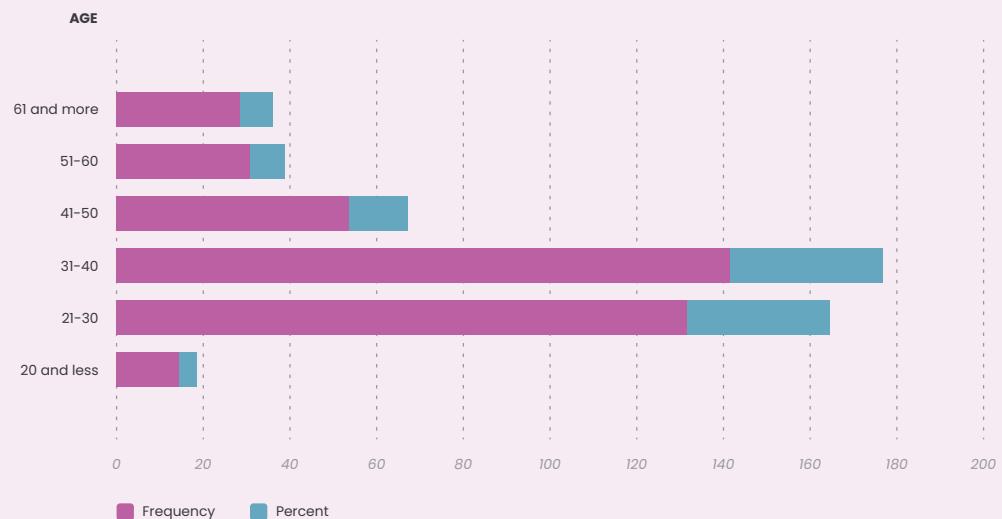


Figure 2: Age of the study's respondents

Furthermore, more than six (6) in 10 respondents (64 per cent) were from the urban areas and only 36 per cent were from rural areas. Since the East Coast of Peninsular Malaysia is a Malay majority area, Malay accounted for 86.4 per cent of the respondents, and other ethnicities accounted for the remaining respondents. Since most of the East Coast population consists of the Malays, 86.4 per cent of the respondents were Muslims and the remaining were Buddhists (5.2 per cent), Hindus (4.2 per cent), Christians (3.5 per cent), and others (0.5 per cent).

From a total of 403 respondents, more than one-third were from Terengganu (38.7 per cent), followed by Kelantan (32.3 per cent) and Pahang (29 per cent) – Figure 3.

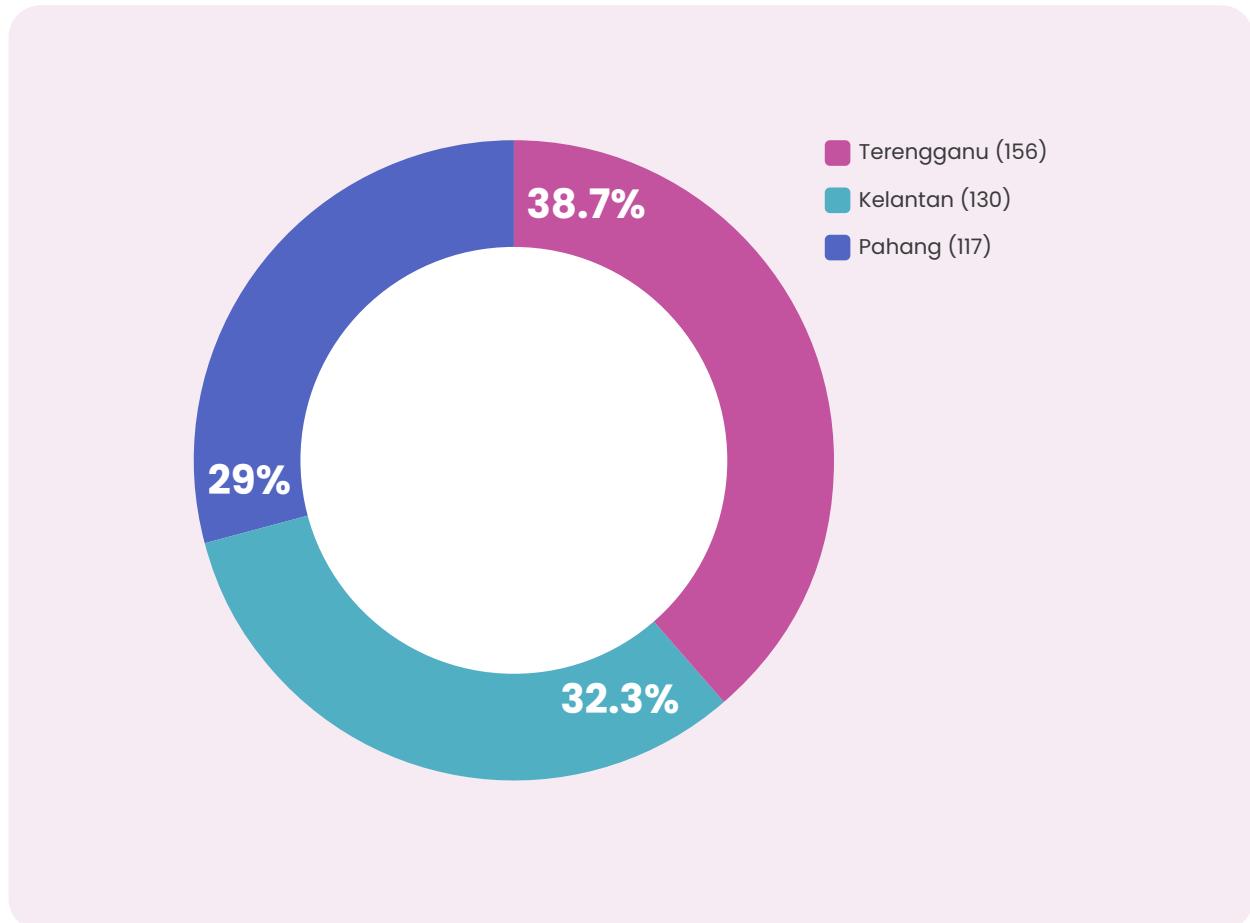


Figure 3: Respondents' State of Residence

In terms of region of residence, 20.1 per cent of the respondents came from Kota Bharu, followed by Kuantan (16.9 per cent), Kuala Terengganu (13.4 per cent), Dungun (9.4 per cent), Kuala Nerus (8.9 per cent), Pasir Mas (8.4 per cent), Marang (6.9 per cent), Temerloh (5 per cent), Kuala Krai (3.7 per cent), Pekan (3.7 per cent), and Bentong (3.5 per cent).

In terms of the employment status, more than seven (7) in 10 of the FTA TV viewers were employed (72.9 per cent). The remaining 27.1 per cent were homemaker (11.7 per cent), student (7.7 per cent), pensioner (6.5 per cent), and unemployed (1.2 per cent). The respondents' income could be aligned with the Malaysian household

income guidelines, which categorise the population into B40, M40, and T20 income groups. Households with income less than RM2,000 per month (RM1000 to RM1999) are categorised as B40. Six (6) households (1.5 per cent of the total study population) were in the B40 group. The M40 category comprises households with a monthly income between RM2,000 and RM8,000. The M40 group, with 303 households (75.2 per cent), had the highest number of FTA TV viewers surveyed. The remaining 2 per cent were T20 individuals with income exceeding RM8,000 per month – Figure 4

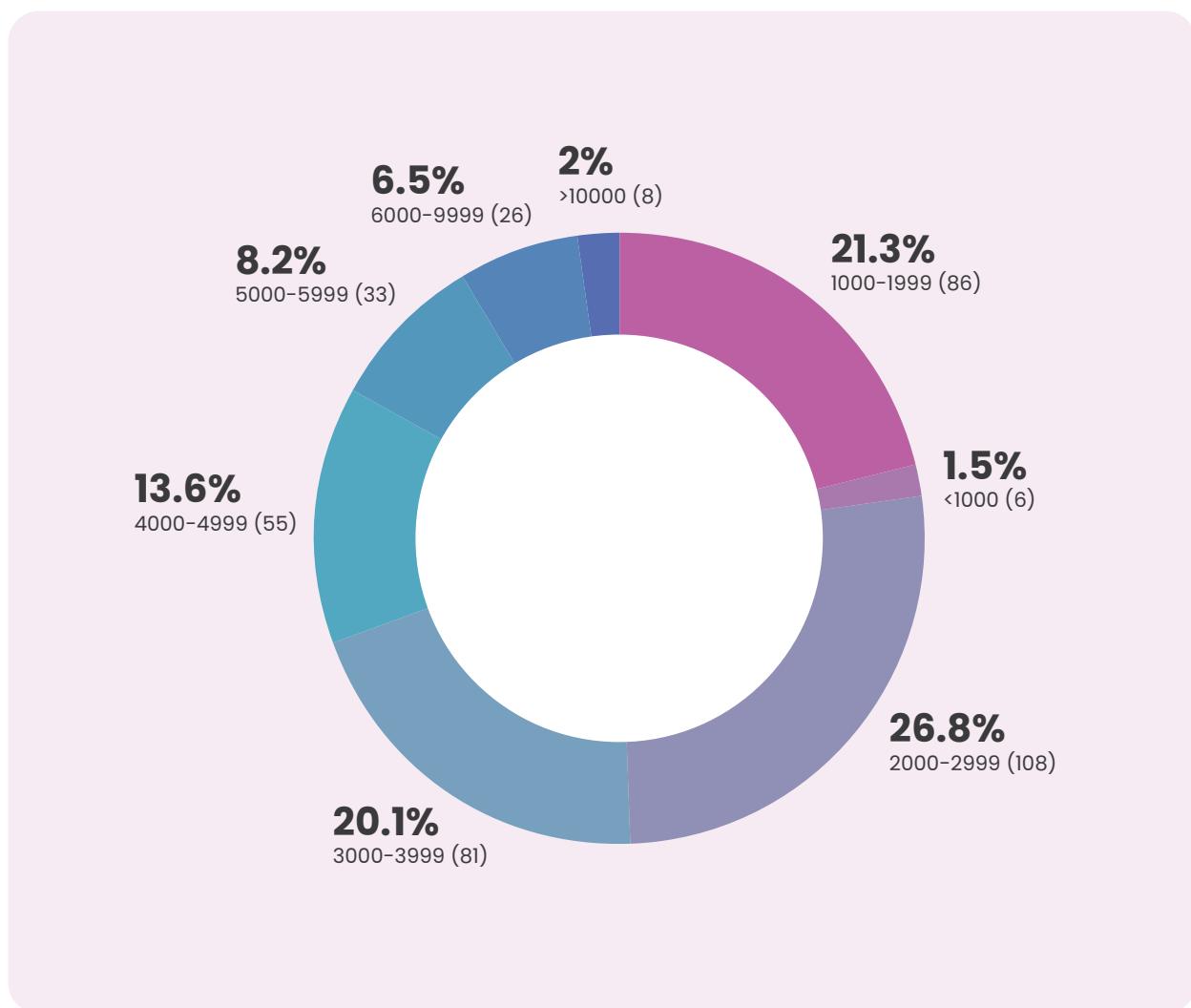


Figure 4: Household Income of Respondents

Viewing pattern of the FTA TV channels among the audiences in the East Coast region of Peninsular Malaysia

This section reports the viewing pattern of FTA TV channels among the audiences in the East Coast region of Peninsular Malaysia – Table 2. The survey reveals that slightly more than half of the respondents used MYTV service (51.3 per cent) to access FTA TV channels, followed by Astro service (48.2 per cent) and other services (0.5 per cent). FTA TV channels could be accessed through many devices. Almost all the respondents (91.3 per cent) used television to watch FTA TV channels. They also used smartphones (5.5 per cent), tablets (1.5 per cent), computers (1 per cent), and laptops (0.7 per cent). The results also show respondents' preferred locations for accessing FTA TV channels. Almost all of them (94.3 per cent) watched FTA TV channels at home. Others watched FTA TV channels at the office (3.5 per cent), public places (2 per cent), and other places (0.2 per cent).

In terms of viewing frequency, almost two (2) to five (5) of the respondents watched FTA TV channels everyday (39.7 per cent) or 2–3 times per week (32.8 per cent). Further, more than one-tenth of the respondents watched FTA TV channels once a week (15.1 per cent) or four (4) to five (5) times per week (12.4 per cent). Almost half of the respondents (48.6 per cent) stated that they watched FTA TV channels at night. Other respondents watched FTA TV channels after work (18.1 per cent), early in the morning (12.9 per cent), or at noon (11.2 per cent). Only a small percentage of the respondents watched FTA TV channels during their work break (6 per cent) or at midnight (3.2 per cent).

NO	ITEMS	DETAILS	FREQUENCY	%
1	Access to FTA TV channels	MYTV decoder service	136	33.7
		MYTV Decoder set with satellite dish	48	11.9
		Digital TV equipped with digital tuner	23	5.7
		Astro	153	38.0
		Njoi	41	10.2
		Others	2	0.5
Total		403	100.0	
2	Device used to watch FTA TV channels	Television	368	91.3
		Laptop	3	0.7
		Tablet	6	1.5
		Smartphone	22	5.5
		Computer	4	1.0
		Total	403	100.0
3	Place of viewing	House	380	94.3
		Public places	8	2.0
		Office	14	3.5
		Others	1	0.2
		Total	403	100.0
4	Frequency of viewing	Once a week	61	15.1
		2-3 times a week	132	32.8
		4-5 times a week	50	12.4
		Every day	160	39.7
		Total	403	100.0

NO	ITEMS	DETAILS	FREQUENCY	%
5	Time of the day of viewing	Early morning	52	12.9
		Noon	45	11.2
		Evening after work	73	18.1
		Break during work	24	6.0
		Night	196	48.6
		Midnight	13	3.2
		Total	403	100.0

Table 2: Viewing Pattern of FTA TV in Terengganu, Kelantan, and Pahang

In short, the respondents in the East Coast were using MYTV service despite having access to many other platforms. They also preferred night viewing at the comfort of their own home, indicating there is still a market of TV advertising in the East Coast region.

Table 3 shows the respondents' preference towards the 17 FTA TV channels offered on MYTV platforms. Almost all of the respondents chose TV3 (96.5 per cent), followed by TV1 (83.9 per cent), TV2 (83.1 per cent), TV Al Hijrah (80.9 per cent), Awesome TV (80.4 per cent), and TV9 (79.7 per cent). Meanwhile, more than seven (7) in 10 respondents chose Berita RTM (76.7 per cent), Sukan RTM (74.7 per cent), OKEY (70.7 per cent), and TV7 (69.5 per cent). In addition, more than six (6) in 10 respondents liked watching BERNAMA (67.7 per cent), 8TV (66.7 per cent), TV6 (65.8 per cent), TV5 (64 per cent), Wowshop (63.3 per cent), and SUKETV (59.8 per cent). Finally, 58.1 per cent of the respondents preferred watching TVs.

NO	CHANNELS	AGREE		DISAGREE		TOTAL	
		FREQ	%	FREQ	%	FREQ	%
1	TV3	389	96.5	14	3.5	403	100.0
2	TV1	338	83.9	65	16.1	403	100.0
3	TV2	335	83.1	68	16.9	403	100.0
4	TV Al Hijrah	326	80.9	77	19.1	403	100.0
5	Awesome TV	324	80.4	79	19.6	403	100.0
6	TV9	321	79.7	82	20.3	403	100.0
7	Berita RTM	309	76.7	94	23.3	403	100.0
8	Sukan RTM	301	74.7	102	25.3	403	100.0
9	OKEY	285	70.7	118	29.3	403	100.0
10	TV7	280	69.5	123	30.5	403	100.0
11	Bernama	273	67.7	130	32.3	403	100.0
12	8TV	269	66.7	134	33.3	403	100.0
13	TV6	265	65.8	138	34.2	403	100.0
14	TV5	258	64.0	145	36.0	403	100.0
15	Wowshop	255	63.3	148	36.7	403	100.0
16	SUKETV	241	59.8	162	40.2	403	100.0
17	TVS	234	58.1	169	41.9	403	100.0

Table 3: List of FTA TV Channels Preferred by the Audiences in Terengganu, Kelantan, and Pahang

This study further analysed genre or classification of content preferred by the FTA TV viewers in the three (3) states – Table 4.

NO	GENRE	AGREE		DISAGREE		TOTAL	
		FREQ	%	FREQ	%	FREQ	%
1	Religious	379	94.0	24	6.0	403	100.0
2	Comedy	361	89.6	42	10.4	403	100.0
3	Health	360	89.3	43	10.7	403	100.0
4	Entertainment	359	89.1	44	10.9	403	100.0
5	Crime	348	86.4	55	13.6	403	100.0
6	Education	344	85.4	59	14.6	403	100.0
7	Sports	334	82.9	69	17.1	403	100.0
8	Animation	327	81.1	76	18.9	403	100.0
9	Travelogue	326	80.9	77	19.1	403	100.0
10	Politics	304	75.4	99	24.6	403	100.0

**Table 4: List of FTA TV Genres Preferred by the Audiences
in Terengganu, Kelantan and Pahang**

Almost all the respondents preferred religious (94 per cent), comedy (89.6 per cent), health (89.3 per cent), and entertainment (89.1 per cent) genres. In addition, most of them enjoyed watching shows that carry crime (86.4 per cent), education (85.4 per cent), sports (82.9 per cent), animation (81.1 per cent), and travelogue (80.9 per cent) genres. Further, more than seven (7) in 10 respondents preferred genres pertaining politics (75.4 per cent). These results inferred that the viewing preferences of audiences in Terengganu, Kelantan, and Pahang were highly influenced by their local practices and cultures.

This research further enquired respondents' usage of streaming services, as these services are gaining popularity among Malaysians. This is aligned with the increase in internet access facilities and streaming devices that are easily available in the market. This section presents an analysis of the respondents' agreement level pertaining to their usage of streaming services – Table 5.

NO	ITEMS	AGREE		DISAGREE		TOTAL	
		FREQ	%	FREQ	%	FREQ	%
1	Netflix	326	81	77	19	403	100
2	MYTV Mana-Mana	306	76	97	24	403	100
3	Awesome TV	295	73	108	27	403	100
4	AlHijrah Plus	287	71	116	29	403	100
5	Tonton	283	70	120	30	403	100
6	Astro Go	281	70	122	30	403	100
7	RTMKlik	243	60	160	40	403	100

Table 5: Agreement Level Among the Respondents on Usage of Streaming Services

Among all the streaming services, Netflix was the most watched by the respondents (80.9 per cent). Further, more than seven (7) in ten respondents watched MYTV Mana Mana (75.9 per cent), Awesome TV (73.2 per cent), AlHijrah Plus (71.2 per cent), and Tonton (70.2 per cent). Also, more than six (6) in 10 respondents watched Astro Go (69.7 per cent) and RTM Klik (60.3 per cent). It can be deducted from this data that the respondents were still inclined towards locally owned services, despite Netflix being the most watched service.

Gratification level of FTA TV viewers in the East Coast region

In assessing the gratification level of viewers' FTA TV usage among the East Coast audiences, five (5) motives namely social, economic benefit, flexibility of use, issues, and content explored. The details of the motives are shown in Table 6.

MOTIVES (N=403)	M	%	Sd	t	Df	p
Economic Benefit	3.82	76.42	0.921	17.895	402	0.000
Flexibility of Use	3.81	76.24	0.837	19.479	402	0.000
Content	3.67	73.34	0.799	16.751	402	0.000
Issues	3.61	72.17	0.843	14.495	402	0.000
Social	3.59	71.81	0.854	13.874	402	0.000

Table 6: Motives of Watching FTA TV Channels

All the motives of watching FTA TV channels were significance. The results indicated that the viewers were watching FTA TV channels based on the motives as reported in Table 6. They mainly watched FTA TV due to economic benefit (76.42 per cent) followed by the flexibility of use (76.24 per cent). It shows that the respondents were willing to invest in installation of MYTV decoder set at home because they do not have to pay the monthly subscription fees. Furthermore, they can watch many FTA TV channels anytime that they want.

Advertising potentials in the FTA TV channels among the audiences in Terengganu, Kelantan, and Pahang

The fourth research question explored whether advertising is acceptable among the viewers in Terengganu, Kelantan, and Pahang to uncover the advertising potentials of FTA TV channels in the East Coast region. Using one (1) sample t-test, the result is presented in Table 7.

NO.	VIEWS TOWARDS COMMERCIAL BREAK (N=403)	M	SD	%	t	df	p
1	I have no problem with product placement in a TV programme	3.51	1.082	70.2	9.483	402	0.000
2	I do not change channels during commercial breaks because I do not want to miss the next scene in the show	3.27	1.129	65.3	4.720	402	0.000
3	I prefer commercial slot at the end of a show	3.26	1.167	65.2	4.441	402	0.000
4	I continue watching during commercial break	3.26	1.160	65.1	4.424	402	0.000
5	I do not change channels during commercial breaks because they provide me with information	3.23	1.091	64.5	4.155	402	0.000
6	I don't mind the repeated commercials during a show	2.82	1.185	56.5	-2.985	402	0.003
7	I bought after watching commercial stations	2.77	1.218	55.3	-3.845	402	0.000
Overall Mean		3.1019	0.873	62.0	2.343	402	0.020

*On a five-point scale where 1 = strongly disagree (1–20%), 2 = disagree (21–40%), 3 = slightly agree (41–60%), 4 = agree (61–80%), and 5 = strongly agree (81–100%).

**Test value = 3

Table 7: One sample T-test of respondents' views towards the commercials on FTA TV channels

This section presents the measurements of the respondents' views towards commercial breaks on FTA TV. This study proposes that views towards commercial breaks will influence audiences' retention level towards FTA TV shows and channels. A one-sample t-test was used to analyse each item for this variable to assess the respondents' level of agreement with each statement.

Table 7 reveals that the respondents had no problem with product placement (70.2 per cent), they did not change the channel during a commercial break because they did not want to miss the show (65.3 per cent), they preferred the commercial break shown at the end of the show (65.2 per cent), and they continued watching the commercial break (65.1 per cent) because it was informative (64.5 per cent). It can be concluded from their responses for item number 1 until item number 5 that the respondents had a positive attitude and behaviour towards the commercial breaks aired on FTA TV channels.

The respondents also did mind the repeated commercials during shows ($M = 2.82$, $p = .003$) and rarely bought the product after watching the commercial stations ($M = 2.77$, $p = .000$). Despite these issues, they still held positive views towards the commercial breaks on FTA TV. Overall, more than six (6) in 10 respondents (62 per cent) held positive views towards the commercial breaks on FTA TV channels.

Recommendations

The findings in the preceding section have provided an illustration of the current situation regarding FTA TV viewing among viewers in Peninsular Malaysia's East Coast. This part concentrates on the major issues that are significant and connected to the regions which are important to be considered by the broadcasting sector in Malaysia. therefore, this paper highlights three (3) main recommendations:

Programme scheduling should consider the viewing patterns specific to the East Coast region

The analysis of the demographic profiles allows broadcasters to gain a deeper understanding of the audiences in the East Coast. This could help them divided audiences into groups and customise their content to suit the needs and preferences of each group. Peninsular Malaysia's East Coast region, which includes the states of Pahang, Terengganu, and Kelantan, is renowned for having a vibrant populace. Every state has its own culture and tastes in television. This study suggests, FTA TV broadcasters should make investments to provide viewers with an interesting viewing experience that speaks to the diverse range of viewers in this area based on the data obtained.

As revealed through the patterns of viewing, FTA TV is a comfortable medium for audiences to watch at home. This emphasises how vital home entertainment is to their viewing habits since TVs are a necessity in the average East Coast household. In addition, despite viewers' preference towards Netflix streaming service, the respondents also used MYTV Mana-Mana to access TV contents. Therefore, the market of FTA TV channels is still appealing to the viewers in the East Coast of Peninsular Malaysia. Hence, broadcasters and content providers should take these variables into account when scheduling the shows and make sure they deliver engaging and intriguing shows every day, especially since evening viewership seems to be the trend and audiences regularly tune in to FTA TV channels. Through these considerations, broadcasters would be able to keep up with shifting viewer preferences and social trends.

Leverage on targeted advertising for local viewers in FTA TV commercials

The results of this research serve as a useful guide for media outlets looking to draw viewers in FTA TV. To optimise FTA TV's influence along the East Coast, it is imperative to customise shows, content, and advertisement in accordance with audience preferences and demands. In the end, our analysis emphasises how crucial it is to provide an interesting viewing experience that connects with the diverse range of viewers in the East Coast. Advertisers may find the information obtained through this research useful as it will enable them to better target their adverts to the appropriate audience and guarantee that their goods and services correspond with the tastes and characteristics of the target audience.

To cater to the needs of viewers in the East Coast region, broadcasters should incorporate content preferred in FTA TV commercials. Put another way, it is important to consider audience interest in relevant content into advertising prospects. According to this study, there is a strong correlation between religious content and East Coast values. According to Mokhtar (2018), Muslim consumers' behaviour is influenced by their religious identification; as a result, targeting their identity with messaging is crucial for effective advertising. Broadcasters must use the region's values to obtain advertising advantages, as these values are rooted in its local, cultural, and distinctive identity. As Mokthar (2018) concludes, sensitive handling and the incorporation of the audiences' values could result in effective commercials. Moreover, as revealed in the results, the FTA TV viewers were mostly in the M40 category. Hence, broadcasters should be initiative-taking in creating and targeting advertising messaging that highlight the value and affordability of goods and services to appeal the M40 budget-consciousness.

Employ engaging advertising formats

Our research also shows that viewers of FTA TV channels viewed the channels using MYTV decoder set, TV equipped with digital tuner, and MYTV's Mana-Mana internet platform. Therefore, to maximise the reach of the advertisements, broadcasters could combine cross-promotion with online marketing by placing social network mentions, website banners, or video clips on the websites of FTA TV channels. This strategy would reach accidental audiences who just so happen to

use online platforms (Ghazali, 2020). Rasit (2022) asserts that the emergence of new media does not render traditional media obsolete. Instead, it improves how traditional media performs. It is therefore advised that broadcasters make use of other media channels to attract more inadvertent viewers. Broadcasters might control their content and advertising tactics to fit the various media landscapes and platforms.

Using a storytelling approach in advertising is another way to emotionally engage viewers. TV visuals also facilitate the transmission of powerful narratives and emotional effect. Narrative advertising, sometimes referred to as storytelling, gives audiences a greater sense of authenticity and trust. According to Zatwarnicka-Madura and Nowacki (2018), narrative enhances memory, elicits recollections, prompts actions, and facilitates scenario visualisation.

In short, to increase audience engagement, emotionally engage and connect with advertising content, and leave a lasting impression, broadcasters must make the most of interactive advertisements and storytelling techniques.

Conclusion

This research offers an answer to the uncertainties surrounding the future of the FTA TV channels as streaming continues to overtake viewers. By exploring TV viewing habit and channel preference, this paper proposes some solutions that broadcasters, MCMC, and other relevant stakeholders could undertake and promote. Specifically, this paper outlines suggestions for a more tailored TV content and material that could be usefully targeted towards the East Coast Peninsular Malaysian households. In addition, by understanding the FTA TV viewing patterns in Terengganu, Kelantan, and Pahang, broadcasters could target advertisers there by exploring useful and suitable available advertising options.

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