INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN ACCOUNTING, FINANCE AND MANAGEMENT SCIENCES

OPEN ACCESS JOURNAL

Vol 14, Issue 4, (2024) E-ISSN: 2225-8329

The Moderating Role of Technical Capability on the Relationship between Toe's Model Factors toward Advanced it Adoption and Competitive Advantage in Malaysia Telecommunication Industry

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To Link this Article: http://dx.doi.org/10.6007/IJARAFMS/v14-i4/23130 DOI:10.6007/IJARAFMS/v14-i4/23130

Published Online: 24 November 2024

Abstract

The contribution of the Malaysian telecommunication sector is lower than ASEAN countries, the volume of telecommunications and media has reduced between 2020-2023, and the contribution of the telecommunication sector to the nation's GDP is less than other countries in Asia. which raises an important question of how to improve it. This study aimed to develop an integrated model of TOE and DOI factors advanced technology adoption and technical capability as drivers of competitive advantage in the telecommunication industry in Malaysia. A survey-based method was used to collect the data and 348 usable responses were obtained and analysed using the appropriate statistical methods. Non-probability sampling through using convenience sampling technique was used. The data was analysed using variance-based SEM, known as the SmartPLS. This study revealed that relative advantage, complexity, compatibility, financial resources, competitive pressure, and government regulation were found to have a significant positive relationship with advanced IT adoption. Advanced IT adoption was found to have a significant positive relationship with competitive advantage. Advanced IT adoption mediates the relationship between relative advantage, complexity, compatibility, financial resources, competitive pressure and competitive advantage. It was found that technical capability significantly and positively moderates the relationship between advanced IT adoption and competitive advantage.

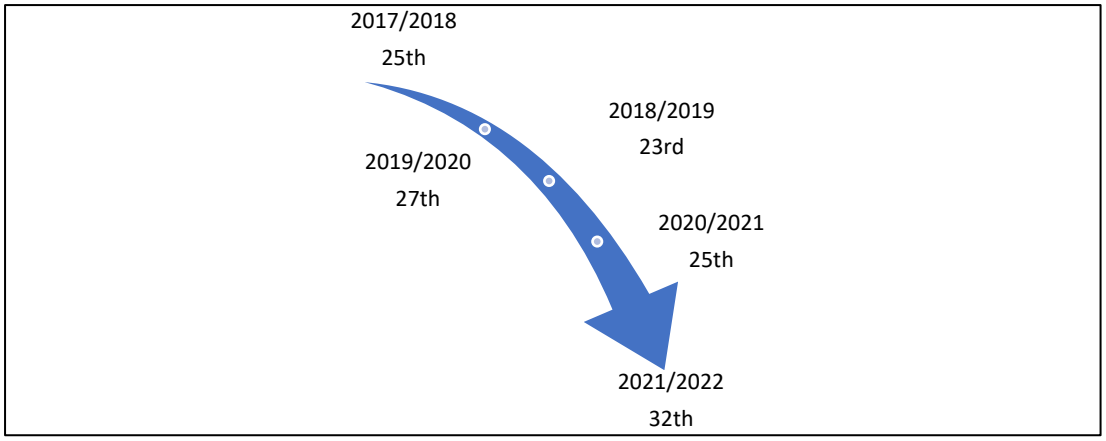
Keywords: Technical Capability, Advanced it Adoption, Competitive Advantage, Toe Model, Telecommunication Firms

Introduction

The use of advanced information technology (IT) to achieve competitive advantage has become an essential strategic issue amongst firms in the current changing globalization environment (Leong *et al.*, 2023). In fact, the term "IT" is used to describe a wide range of digital technologies that enable data to be accessed, transmitted, stored, and modified through networks (Ezzaouia & Bulchand-Gidumal, 2020; Sharma *et al.*, 2021). For example, advanced technologies, such as the 5th generation of the mobile network, provide telecommunications firms with advanced data analysis capabilities and greatly facilitate firms' success (Chen, 2019; Waqar & Paracha, 2023). Therefore, firms adopt advanced technologies to improve their decision-making and customer services (Maroufkhani, Tseng, *et al.*, 2020), enhance their competitive advantage, and improve organizational performance (Kalaitzi & Tsolakis, 2022). Porter (1985), argued that the firm's ability to achieve sustainable competitive advantage is the only reliable way to achieve superior performance. Porter (1985, p. 3) also stated that "competitive advantage grows fundamentally out of the value a firm is able to create for its buyers that exceeds the firm's cost of creating". Competitive advantage is defined as "an organisational capability to perform in one or many ways that competitors find difficult to imitate now and in the future" (Gautam Dhruba & Bhandari Ghimire, 2017, p. 468). In this context, The competitive advantage achieved over a period of time may change over time. Thus, to explain competitive advantage, the evolution of a firm's resources, capabilities and factors that affect competitive advantage over time must be incorporated (Kalaitzi & Tsolakis, 2022; Leong *et al.*, 2023).

In a modern country like Malaysia, Malaysia Telecom Market has witnessed strong growth in recent years and is expected to have continued growth over the forecast period to 2025. The telecommunications market in Malaysia is expected to grow from USD 8.19 billion in 2023 to USD 8.92 billion by 2028, at a CAGR of 1.72% during the forecast period (2023-2027) (Malaysia Telecoms Industry Report, 2022). According to Malaysia Telecommunication Market Report, 2020-2025, the growth of the telecommunications sector is being driven by the increasing adoption of smartphones and data-intensive applications, such as video streaming and online gaming (Global Monitor, 2023). The Malaysian government is also playing a role in the growth of the telecommunications sector by investing in infrastructure development and providing incentives for businesses to adopt new technologies (Mordor Intelligence, 2023). The government has published definitive wireline voice and broadband subscription data for 2017; It is expected that hundreds of millions of fixed broadband connections by 2025, versus tens of millions of wireline voice connections, ensuring that mobile will be the principal form of connection (Global Monitor, 2023).

According to the Global Competitiveness Report issued by the World Economic Forum, Malaysia also slipped four notches to 27th placing in the 2019-2020 World Competitiveness Ranking from 23rd place in 2018-2019. Malaysia also slipped five notches to 32nd in the 2021-2022 World Competitiveness Ranking from 25th in 2020-2021 among economies in the world ranked as most competitive (Figure 1) (World Economic Forum, 2023). The drop by five places from the 25th in 2020/2021 was due to a decline in scores in nine indicators in the 12 pillars to measure both macro- and micro-economic aspects of competitiveness.



Sources: The Global Competitiveness Report: World Economic Forum
Figure 1. Malaysia's Global Competitiveness Index (The Global Competitiveness Report: World Economic Forum, 2022)

In the context of the Malaysian telecommunication sector, the report "The Malaysian Economy in Figures (MEIF) 2022" by the Ministry of Economy showed that the Investment in Telecommunication as a percent in GDP in Malaysia is 0.45, which is lower than ASEAN countries such as Indonesia, Philippines, and Thailand, which account for 0.66, 0.64, and 0.66 respectively (refer Table 1) (MEIF, 2023).

Table 1
Investment in Telecommunication in ASEAN (MEIF, 2023)

Country	**Investment in Telecommunication (% of GDP)**
Indonesia	0.66
Malaysia	0.45
Philippines	0.64
Thailand	0.66

The MEIF report (Table 2) also shows the volume and value of telecommunications and media in Bursa Malaysia. The report indicates that the volume of telecommunications and media has reduced between 2020, 2021, and 2022. The volume decreased from 106.54 to 63.47 to 36.00 billion, respectively. Similarly, The value has reduced from 38.90 to 36.00 to 20.89, respectively (MEIF, 2023).

Table 2
Volume and value of telecommunication & Media in Bursa Malaysia (MEIF, 2023)

Bursa Malaysia	2020		2021		2022	
	Volume (Billion unit)	Value (RM billion)	Volume (Billion unit)	Value (RM billion)	Volume (Billion unit)	Value (RM billion)
Telecommunication & Media	106.54	38.90	63.47	36.00	36.00	20.89

The MEIF report also show that the contribution of the telecommunication sector to the nation's GDP is less than other countries in Asia such as China, Japan, South Korea, Singapore, India, Indonesia, and Thailand as depicted in Table 3 (MEIF, 2023).

Table 3
Comparing telecommunication to GDP (2022) (MEIF, 2023)

Country	**Telecommunications contribution to GDP (2022)**
China	7.20%
Japan	3.80%
South Korea	4.50%
Singapore	4.10%
India	3.30%
Indonesia	3.00%
Thailand	3.00%
Malaysia	3.20%
Vietnam	2.60%
Philippines	2.50%

The 'Developments in the Malaysian Economy Report', issued by Bank Negara 2023, shows that the performance of Malaysia's information and communication sector has decreased from 10.0 in 2014 to 8.4 in 2018 (Bank Negara, 2023).

The above indicators show that the Malaysian telecommunication sector has been having problems contributing to the country's economic growth over the last three years, from 2019-2022. Such issues may hinder the overall performance and competitiveness in the market (Hameed et al., 2018). The question in such a situation is, what are the reasons that have led to a decrease in the competitiveness of the Malaysian telecommunication sector? The Malaysian telecommunication sector is under increasing pressure to reduce operational costs and develop consumer relationships. The Bank Negara Report (2023) shows some causes for the competitiveness problem of the Malaysian telecommunication sector. For example, (i) increasing competition from over-the-top (OTT) players such as Netflix and Spotify, which provide services that compete with traditional telecommunications services, such as video streaming and music streaming. This puts more pressure on telecommunications companies to differentiate their offerings and provide more value-added services; (ii) Rising cost of spectrum: The cost of range is rising as more and more players enter the telecommunications market. This is making it difficult for smaller players to compete; and (iii) Declining average revenue per user (ARPU): The average revenue per user (ARPU) in the telecommunications sector is declining as customers are becoming more price-sensitive. This makes it difficult for telecommunications companies to generate revenue (Bank Negara, 2023). Moreover, the Malaysian Telecoms Industry Report 2022-2027 shows that the Malaysian government has several regulations that govern the telecommunications sector. These regulations can make it difficult for telecommunications companies to innovate and compete. In addition, the telecommunications sector is constantly changing as new technologies emerge. This can

make it difficult for telecommunications companies to keep up with the latest trends and maintain their competitive advantage (Telecoms Industry Report, 2023).

As explained by Porter (1996), competitive advantages are not fixed and long-lasting but temporary due to competition, Porter mentioned that IT innovation adoption can change industry structure, alter the rules of competition, leverage new ways to outperform rivals and change the competition environment. Chang et al. (2019) asserted that "advanced IT adoption can play an important role in telecommunications firms to secure competitive advantage", When a firm owns advanced IT technology this indicates that it has the ability to build the organizational capabilities for operation, thus, influence positively on a firm's competitive advantage. It's argued that the adoption of advanced technology can increase the operational performance of firms to stay competitive because technology adoption enhances the financial and market performance of firms (Maroufkhani et al., 2023). Thus, the adoption of advanced information and technology allows firms to be more competitive (Molinillo & Japutra, 2017; Waqar & Paracha, 2023).

Evidence suggests that the advanced IT adoption process is affected by contextual factors that shape a firm's technology adoption decision-making, which can be grouped into technological, organizational and environmental contexts (Zhang & Jedin, 2022). Technological context considers the technology in the firms and those outside the firm; organizational context examines factors associated with the size of the firm, managers' support and financial readiness; and environmental context considers how environmental variables like competition pressures, business practice, and government interventions shape the firms (Kalaitzi & Tsolakis, 2022; Maroufkhani, Wan Ismail, et al., 2020; Waqar & Paracha, 2023). Thus, the Technology-organization-environment (TOE) framework (Tornatzky et al., 1990) is the most employed theory in technology adoption studies at the organizational level, this is because these three contexts represent "both constraints and opportunities for technological innovation" (Hmoud et al., 2023; Hong et al., 2021; Kulkarni & Patil, 2020).

Literature Review

Related Literature

The current literature argues that TOE factors (known as IT driver forces) for advanced technological innovations adoption allow firms to be more competitive (Chang et al., 2019; Maroufkhani et al., 2023). TOE factors have been considered in the literature as essential drivers of advanced IT adoption (Ahmed et al., 2022; Hmoud et al., 2023; Maroufkhani et al., 2023); meanwhile, current literature still lacks empirical validation to validate a unified model of TOE factors that influence advanced IT adoption (Kalaitzi & Tsolakis, 2022; Leong et al., 2023). Scholars conceptualise TOE factors differently (Hashem & Aboelmaged, 2023; Mukherjee et al., 2023). In this context, scholars have provided different sets of TOE in a technology adoption context, making it difficult to determine the relationship between TOE factors and advanced IT adoption (Waqar & Paracha, 2023). Put differently, although TOE factors have been considered critical drivers of IT adoption, there is no agreement about what constitutes TOE factors. Specifically, what dimensions include technological, organizational and environmental factors in the TOE framework? (Hashem & Aboelmaged, 2023). Such a situation caused scholars to claim that TOE theory dimensions need to be further developed, elaborated and investigated (Kalaitzi & Tsolakis, 2022; Leong et al., 2023) and need further

empirical validation (Hmoud et al., 2023; Hong et al., 2021; Maroufkhani, Wan Ismail, et al., 2020).

Moreover, there is agreement about the importance of TOE factors for advanced IT adoption (e.g., Leong et al., 2023; Mukherjee et al., 2023; Waqar & Paracha, 2023); however, the role and contribution of advanced IT adoption in the firm's competitive advantage have narrowly been theorized and tested. In this context, most of the current studies are concerned about first-time of IT adoption (e.g., Eze, Olatunji, Chinedu-Eze, & Bello, 2019; Ezzaouia & Bulchand-Gidumal, 2020; Kulkarni & Patil, 2020), but addressing the post-adoption of technological innovation has little attention in the current literature (Kalaitzi & Tsolakis, 2022; Leong et al., 2023). It's argued that current literature ignores the empirical validation of the relationship between innovation adoption and firms' competitive advantage (Abdullahi et al., 2022; Hong et al., 2021). Specifically, most of the current literature has focused on determinants of IT adoption; however, the outcomes and impact of IT adoption had limited attention till now little studies have tried to study the post-adoption of technological innovation (Hashem & Aboelmaged, 2023; Hmoud et al., 2023; Hong et al., 2021).

In the same vein, technical capability can moderate the relationship between IT adoption and the resulting competitive advantage (Dadhich & Hiran, 2022; Shehata & Montash, 2020; Zhang & Jedin, 2022). For example, it's argued that the impacts of IT adoption on competitive advantage can be moderated by several organizational-level factors, such as technical capability (Dadhich & Hiran, 2022); however, current literature overlooked the moderating role of technical capabilities on firms' competitive advantage (Gao et al., 2020; Zhang & Jedin, 2022). It's argued that understanding the role of TOE factors and technical capability in influencing IT adoption is essential to enhance the determinants of competitive advantage (Mukherjee et al., 2023). Some studies (e.g., Lai et al., 2018; Oliveira et al., 2019) empirically confirmed that environmental context moderates the relationship between TOE factors and IT adoption. Further, the study of Chiu and Yang (2019) empirically confirmed that environmental context moderates the relationship between advanced IT adoption and competitive advantage, while little is known about the moderating role of organizational-level factors such as technical capability in the relationship between IT adoption and competitive advantage (Chen, 2019; Dadhich & Hiran, 2022). Future studies need to examine the moderating role of technical capabilities in in the context of technology adoption (Maroufkhani et al., 2023). In this context, it's essential to examine the moderating effects of organizational variables, such as technical capability, on the relationship between IT adoption and competitive advantage (Chen, 2019; Maroufkhani et al., 2023).

TOE Model

According to Eze et al. (2019), the TOE framework demonstrates the features of factors that stimulate technology adoption; this framework presents a broad range of factors that can help identify managers' behaviour for advanced technology adoption. The TOE framework comprises three contextual factors that shape a firm's technology adoption decision-making: (i) Technological context, (ii) organizational context, and (iii) environmental context. Technological context represents the factors related to technology that influence advanced IT adoption in Malaysian telecommunication firms, which comprises in this study three variables related to the DOI theory: relative advantage, complexity and compatibility

(e.g., Hmoud et al. 2023; Hashem and Aboelmaged, 2023; Ahmed et al., 2022; Leong et al., 2023). Organizational context represents the organizational factors that influence advanced IT adoption in Malaysian telecommunication firms, which comprises in this study two variables: financial resources and top management support (e.g., Hashem and Aboelmaged, 2023; Ahmed et al., 2022 Waqar and Paracha, 2023). Environmental context represents the external factors that prompt Malaysian telecommunication firms to adopt advanced new technology, which comprises in this study variables that are competitive pressure and government regulations (e.g., Leong et al., 2023; Opasvitayarux et al., 2022; Chen, 2019).

Hypothesis Development

Direct Relationship between TOE Variables and Advanced IT Adoption

Relative advantage in this study is regarded as "the degree to which an innovation is perceived as being better than the approach it supersedes" (Chen, 2019, p. 52). The relative advantage "called perceived benefit" of technological innovation affects a firm's intention to adopt advanced technology (Rogers, 2003). Thus, new advanced technologies that have outstanding advantages in creating strategic and operational competitiveness are more likely to be adopted (Chen, 2019). Put differently, the higher the relative advantage of advanced technology is, the faster this technology will be adopted (Hashem and Aboelmaged, 2023). Priyadarshinee et al. (2017) suggested that relative advantage is a crucial element in encouraging or discouraging the adoption of technology. Thus, if a telecommunication firm encourages its employees to be aware of how advanced technologies can create effective operations and reduce costs, employees can complete an understanding of the advantages that advanced IT can offer (Waqar and Paracha, 2023). Once the level of awareness is raised, employees may accept and actively participate in the positive adoption of advanced technology (Ahmed et al. , 2022).

H1: There is a significant positive relationship between relative advantage and advanced IT adoption.

Complexity is "the extent to which the innovation is perceived as relatively difficult to understand and use" (Chen, 2019, p. 53). Firms tend to assess new advanced characteristics, Complexity is one of those characteristics that affect on form of a firm's intention either favourable or unfavourable toward the new technology, and the subsequent decision to buy and adopt. Thus, firms' intention to adopt an advanced technology is influenced by the degree of innovation's complexity (Liu, Ben and Zhang, 2019; Waqar and Paracha; 2023). Accordingly, the easier it is to integrate advanced technology into firms' operations, the greater the chance of adopting this technology (Chen, 2019). This is because, complex innovation requires more technical skills of individuals and needs greater implementation and operational efforts to increase its possibility of adoption (Maroufkhani, Wan Ismail & Ghobakhloo, 2020). New technology must be simple to use in order to increase the likelihood of adoption (Rogers, 2003). The more easily technology can be incorporated into business processes, the more likely it is that it will be adopted (Leong et al., 2023). Therefore, the literature shows that complexity has a negative correlation with technology adoption.

H2: There is a significant negative relationship between complexity and advanced IT adoption.

Compatibility is "the extent to which an innovation is consistent with the existing norms, past experiences and the values of potential adopters" (Rogers, 2003, p. 240). The compatibility of technology with a firm's experiences and requirements is positively related

to innovation adoption (Rogers, 2003). Ali et al. (2021) asserted that compatibility has an impact on the adoption of any new technology. Maroufkhani, Wan Ismail & Ghobakhloo (2020) state that compatibility is one of the most important determinants in the adoption phases of technology diffusion. According to one argument, companies typically look for compatibility data when deciding whether to adopt advanced technologies. This is done to determine how well the new technology can integrate with the company's existing technology (Eze et al. , 2019). In order for new technology to be adopted by businesses, it must be compatible with existing software, hardware, and value systems without necessitating significant additional expenditures for employee training or changing the technology that is already in use (Opasvitayarux, 2022). Business compatibility will therefore be a significant factor in determining whether a company will adopt the new advanced technology (Kalaitzi, 2022).

H3: There is a significant positive relationship between compatibility and advanced IT adoption.

Financial resources are "the financial resources available at the organization for adopting and implementing the information system" (Daradkeh, 2019, p. 675). Financial resources are particularly associated with the technology adoption decision, financial resources readiness was identified to be the main determinant influencing advanced technology adoption (Hashem and Aboelmaged, 2023). This is because, when adopting a new advanced technology that has not been widely utilized, an organization must have adequate resources available for not only the implementation process but also an exit strategy should the endeavour fail (Daradkeh, 2019). Thus, the lack of capital/financial resources can prevent the firms from fully exploiting a new technological adoption (Maroufkhani, Wan Ismail & Ghobakhloo, 2020). The other thing is that, when adopting a new technology privacy, security, and governance considerations must be addressed proactively through all phases of research, development, and deployment, These factors have financial requirements that must be planned for before adopting a new advanced technology (Chen, 2019; Leong et al. , 2023). When a firm lacks adequate financial resources, IT equipment and professional employees for new technology cannot be affordable by firms. (Ahmed et al. , 2022; Lai, Sun and Ren, 2018). According to Chen (2019), telecom operators must preserve the stability of their financial resources, particularly in light of the rising rate of mobile phone use, which raises the likelihood of technical improvements and necessitates the improvement of large-scale operations on an annual basis. Businesses are well-positioned to adopt cutting-edge IT technology when they can dedicate enough financial resources (Wagar, 2023).

H4: There is a significant positive relationship between financial resources and advanced IT adoption.

Top management support in this study is regarded as "the degree to which managers comprehend and embrace the technological capabilities of a new technology system (Maroufkhani, Wan Ismail & Ghobakhloo, 2020, p.7). According to the TOE, when top managers feel optimistic about the results of technology adoption in the firms, they will be more likely to support the decision to adopt new technology (Hmoud et al., 2023; Mukherjee et al., 2023). This argument has been supported by Chen (2019) who found that managerial support is required to be consistent and constant during technology adoption and implementation, otherwise, the technology adoption could fail. This is because managers at the higher levels can designate key personnel to supervise the adoption project and allocate

adequate financial resources to the adoption process, otherwise, the lack of top management support could negatively impact the IT adoption (Waqar and Paracha, 2023). Top management support means managers being willing to accept the risks associated with adopting new advanced technology (Ali et al., 2021), allocating adequate resources to encourage the adoption of new technology (Kyriakou & Loukis, 2019), encouraging staff to learn about the new technology, rewarding staff for meeting goals (Hashem, 2023), and empowering staff to address issues relating to the new technology (Toufaily et al., 2021). Thus, top management support plays a significant role in organizations' adoption of advanced technology (Verma and Bhattacharyya, 2017).
H5: There is a significant positive relationship between top management support and advanced IT adoption.

Competitive pressure is "the influences from the competitive external environment that prompt the organization to use advanced technology" (Maroufkhani, Wan Ismail & Ghobakhloo, 2020, p. 8). According to TOE, adopting new technologies is often a necessary strategy for firms to compete in the marketplace (Chen, 2019). Businesses are under intense pressure to compete to achieve their strategic goals as a result of market dynamics and globalization (Ahmed et al., 2022). A climate of fierce rivalry forces businesses operating in the same industry to adopt new technologies to seize market opportunities and outperform their rivals (Aboelmaged and Hashem, 2018). As a result, it is possible to see competitive pressure as a catalyst for technological innovation (Chen, 2019; Hmoud et al., 2023). Because of market competitiveness, IT breakthroughs spread quickly (Cruz-Jesus, Pinheiro, & Oliveira, 2019). Businesses feel pressure to embrace new technology as soon as their rivals do in order to remain competitive (Hashem and Aboelmaged, 2023; Eze et al., 2019). To put it another way, businesses that are under pressure to improve their performance and stay competitive may be more inclined to use cutting-edge IT to gather information and make data-driven decisions (Ahmed, 2022). Thus, competitive pressure is an important determinant of advanced technology adoption (Khayer et al., 2019).
H6: There is a significant positive relationship between competitive pressure and advanced IT adoption.

Government regulations in this study are regarded as "the necessary support provided by a government to facilitate the diffusion of IT innovation among firms" (Khayer et al. 2021, p. 8). According to the TOE, government regulations play an important role in stimulating advanced IT adoption (Eze et al., 2019), by setting or removing barriers to introducing new advanced technology (Chen, 2019). According to earlier studies, regulations are necessary to foster confidence and remove governmental or legal obstacles that may prevent technology adoption (Kalaitzi & Tsolakis, 2022). For instance, by controlling taxation and other policies that boost or decrease rewards or by changing the environment in which innovation is welcomed (Kulkarni and Patil, 2020). According to Eze et al. (2019), several supportive laws and government initiatives encourage the adoption of new technologies. Government rules can be in terms of encouraging or restricting technologies, which may cause businesses to search for technology substitutes (Maroufkhani, Wan Ismail, and Ghobakhloo (2020). According to Wagar (2023), these restrictions may encourage businesses to adopt a certain sort of new technology while discouraging them from embracing advancements in other areas. For instance, according to Ahmed et al. (2022), the government may establish a national standard for the adoption of technology. Data processing regulations can vary since

various nations have distinct data protection laws; for example, sending personal information across borders might cause a number of issues (Kalaitzi and N. Tsolakis, 2022). Thus, support from the government can provide a favourable environment for advanced technology adoption and can promote the diffusion of technologies (Opasvitayarux et al., 2022).

H7: There is a significant positive relationship between government regulations and advanced IT adoption.

Relationship between Advanced IT Adoption and Competitive Advantage

As explained by Porter (1990), competitive advantages are not fixed and long-lasting, but temporary due to competition, Porter mentioned that IT innovation can change industry structure, alter the rules of competition, leverage new ways to outperform rivals and change the competition environment. It's argued that the adoption of advanced technology can increase the operational performance of firms to stay competitive because technology adoption enhances the financial and market performance of firms (Maroufkhani, Wan Ismail & Ghobakhloo, 2020). Adopting advanced IT involves creating a timely plan for the technical implementation and application migration of advanced technologies, devising an adoption strategy, and getting management approval for the plan (Kulkarni & Patil, 2020). Similarly, Chen (2019) claims that adopting advanced IT innovation entails approving the financial budget and a migration schedule, determining whether customers highly accept new products and services using such innovations, and improving the competitive position after adopting such innovations. Cost-savings and efficiency are typically the results of technological innovation in the form of new or enhanced processes, achieving an organization's competitive advantage over rivals in terms of cost leadership (Leong et al. , 2023). Similarly, the concept of "product differentiation" contends that businesses seeking to gain a competitive edge must distinguish themselves via originality and innovation (Leong et al. , 2023). Thus, the adoption of advanced information and technology allows firms to be more competitive (Molinillo & Japutra, 2017). For example, process innovation can also be achieved by accessing timely and meaningful data (Shamout, 2019), resilience is another implication of IT adoption (Tsolakis et al., 2021). In addition, advanced IT adoption enables sustainability by capturing and offering the correct information for decision-making on sustainability issues and freeing up resources to enable employee-focused social practices' implementation (Shafiq et al. , 2020).

In terms of advanced IT adoption and firm performance, Mukherjee et al. (2023), found that Internet of Things (IoT) adoption positively influences organizational performance. Similarly, Hong et al. (2021), found that chain service platforms (SCSP) adoption significantly and positively influences organizational performance. Abdullahi et al. (2022), also found Facebook adoption has a significant influence on the financial performance of SMEs in Nigeria. Khayer, Bao, et al. (2020) found that Cloud computing adoption significantly and positively influences on firm performance in China. Maroufkhani, Wan Ismail, et al. (2020),found that big data analytics adoption enhances the financial and market performance of SMEs in Iran.

H8: There is a significant relationship between advanced IT adoption and competitive advantage.

Technical Capability as a Moderator

A critical issue in the current literature is to understand the moderating role of technical capability in the relationship between advanced IT adoption and competitive advantage.

Studies such as Oliveira et al (2019), and Lai, Sun & Ren (2017) empirically confirmed that environmental context moderates the relationship between TOE factors and IT adoption. Further, the study of Chiu and Yang (2019), empirically confirmed that environmental context moderates the relationship between IT adoption and competitive advantage. Chen (2019) mentioned that technical capability includes having standardized processes for IT innovation; having the ability to quickly integrate new advanced technologies into a firm's existing infrastructure; and having suitable hardware/software to protect the security and privacy of a firm's systems and networks, which together strengthen the firm's ability to integrate the new technology, and then enhance competitive advantage. Alsetoohy et al. (2019) also assert that a firm's ability to acquire new technologies and technical resources for research and development practices and processes is considered an important technical capability to integrate new advanced technology. In this context, it's argued that firms need to provide their employee with training facilities to enhance proper advanced IT adoption and increase operational and organizational competitiveness (Pappas et al. , 2021). The higher the technical capability, the higher chance the of successfully integrating and implementing the new advanced technology, and the higher the impact on competitiveness (Mukherjee et al. , 2023).

In the literature review's micro-view, a number of earlier studies revealed the important relationship between technological capability and advanced IT adoption. For example, the study of Ahmed et al (2022), developed a comprehensive Building Information Modelling (BIM) model in Malaysia. Using data from 505 Architecture, Engineering and Construction (AEC) firms found that lack of technical capability hinders BIM adoption. Similarly, Khayer et al. (2020), found that technical IT capability significantly strengthens cloud computing adoption among 300 Chinese firms which have adopted cloud computing in China. In the same vein, some studies have confirmed a positive relationship between technical capability and performance/competitiveness. For example, Mukherjee et al. (2023), examined the adoption factors of Internet of Things (IoT) adoption in SMEs to create a competitive edge in the market. The study used data from 235 SMEs in India and found technical capability strengthens IoT adoption in SMEs positively. The study by Zhang and Jedin (2022), examined the role of innovation and technical capabilities in organizations' performance among 162 Chinese manufacturer–exporter companies. Their results showed that technical capabilities can strengthen exporting organizations' performance in international markets. Similarly, Gao et al. (2020) found that technical capabilities have been found to positively and significantly strengthen organizational performance among 106 business managers from listed firms in Asia. Ali and Matsuno (2018) found that marketing capability and technical capability interact to strengthen business performance among 207 manufacturing companies in Japan. Based on these arguments, it can be deduced that the relationship between advanced IT adoption and competitive advantage is positively moderated by technical capability. Therefore, this study hypothesizes that:

H9: Technical capability moderates the relationship between advanced IT adoption and competitive advantage.

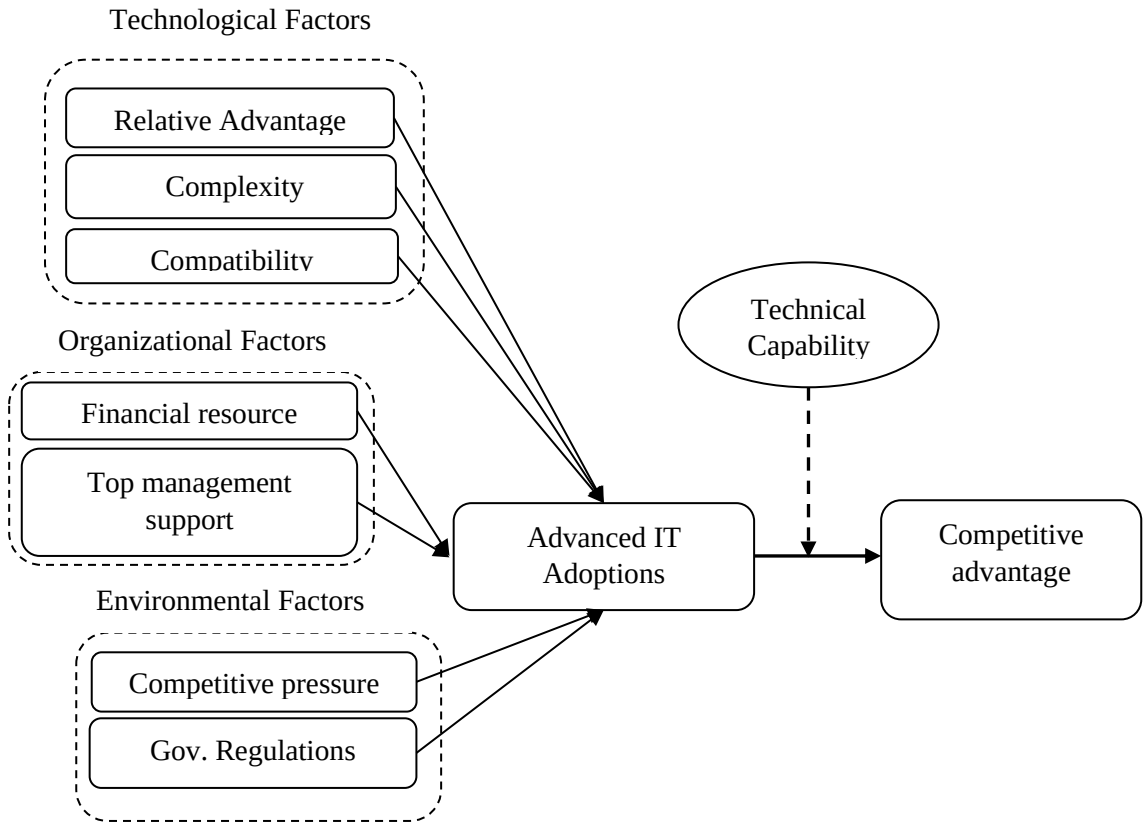


Figure 2: The conceptual Framework

Data Collection Procedures

Malaysia is chosen as the research field for this study. This research was conducted in the Malaysian service firms sector. Specifically, the telecommunication sector. The telecommunication sector in Malaysia comprises many firms are Telekom Malaysia; Celcom; Maxis Communications; Time dotcom; Axiata; U Mobile; U Telecom; DiGi; TM Touch; TM Cellular; TRI Celcom; Keretapi Tanah Melayu Berhad (KTMB); TMNet; MyRepublic.

The targeted population and key informants were drawn from the mid-level managers at Malaysia's five biggest telecommunication firms (i.e., Telekom Malaysia, Celcom, Maxis Communications, U Mobile, and DiGi). This is because these five firms provided published numbers of their employees, and agreed to distribute the questionnaire between their mid-level managers. Mid-level managers were an appropriate sample in this study because studying factors that affect advanced IT adoption necessitates focusing on mid-level managers where the adoption behaviour is clearer (Narwane et al., 2020; Okumus et al., 2017). Therefore, mid-level managers were selected because they had the position and knowledge required for this study. This approach to choosing the key informants would enhance the reliability of the data that were collected because the responses that were collected are within their domain of responsibility (Noman & Basiruddin, 2021). The unit of analysis in this study was the mid-level managers in Malaysian telecommunication firms.

Table 4
Number of mid-level managers in telecommunication firms in Malaysia

No	Firm	Number of employees	Number of mid-level managers
1	Telekom Malaysia - TM Touch - TM Cellular - TMNet	24000	2400
2	Celcom	1919	192
3	Maxis Communications	3748	375
4	U Mobile	700	70
5	DiGi	1437	144
	Total	**31804**	**3181**

To determine the accurate number of participants for this study, G*Power is used to assess the sample size. G*Power is an inferential statistics software that calculates statistical power using a range of statistical tests such as t-tests, F-tests and chi-square tests as well as one-way versus multi-way ANOVA (Field, 2009). The alpha (with a standard value of .05), power (with a standard value of .80) and effect size hypotheses are determined in this study (small, moderate or large). The sample size required for this study is 358.

Data were collected from mid-level managers at telecommunication firms in Malaysia. A questionnaire survey method was used to collect the required data that could answer the study questions and meet the study objectives to understand the hypothesized relationships from the mid-level managers' perspective at Malaysian telecommunication firms. Initially, respondents were introduced to the study's objectives, to know their willingness to participate in the study. Questionnaires were delivered to the mid-level managers that willing to participate in this study.

The Measurement items of this study are adopted or adapted from existing literature to be more appropriate to the context of this study. In this study, multiple-item scales were used to assess all constructs. Respondents were asked to evaluate the extent to which they strongly disagree (1) and strongly agree (5) on the Likert scale. Table 3.1 summarizes the variables and measurement items sources in this study.

Data Analysis and Results

Assessing the Measurement Models in PLS-SEM

The measurement model's internal consistency is used as the initial evaluation and verification criterion. By measuring and comparing items/observed variables with each other, Cronbach's Alpha has been used to evaluate the internal consistency of the entire scale. In this study, composite reliability and Cronbach's alpha were used to assess construct-level reliability by measuring how well all assigned items represented its constructs (Gotz et al., 2010), composite reliability refers to the extent to which the items consistently represent the same latent construct (Hair et al., 2010). As a result, it offers a more accurate estimate of the variance shared by the corresponding indicators (Hair et al., 2006). Whereas Cronbach's alpha assesses the internal consistency of a multi-item scale's unidimensionality (Cronbach, 1951). Table 4.10 shows that the composite reliability ranged from 0.862 to 0.921, which was higher

than the cut-off value of 0.70 (Cronbach, 1951; Hair et al., 2013), the Cronbach's α ranged from 0.786 to 0.902, which was upper than the recommended value of 0.7 (Cronbach, 1951; Hair et al., 2024).

The "Average Variance Extracted" (AVE) approach, as suggested by Hair et al., (2006) and Henseler et al. (2009) was used in this study to assess convergent validity. The average variance retrieved often from the observed items of a variable is referred to as the AVE (Hair et al., 2013). According to Table 5, each variable's AVE was higher than the suggested level of 0.5 (50%) and could, on average, account for more than half of the variation in its measuring items (Fornell & Larcker, 1981).

Table 5
Internal Consistency and Convergence Validity Results

Constructs	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Competitive Advantage	0.872	0.901	0.567
Competitive Pressure	0.869	0.897	0.522
Complexity	0.868	0.897	0.521
Compatibility	0.876	0.904	0.573
Financial Resource	0.819	0.873	0.580
Gov. Regulations	0.902	0.921	0.594
Advanced IT Adoptions	0.859	0.895	0.588
Relative Advantage	0.888	0.911	0.560
Technical Capability	0.786	0.862	0.610
Top Management Support	0.899	0.919	0.588

The criterion used in this study to validate the discriminant validity was HTMT. The heterotrait-monotrait ratio (HTMT) compares the geometric-mean correlation between indicators within the same concept versus that between indicators across constructs. Inter-construct correlation estimations are made using HTMT values (Hair et al., 2017). Henseler et al. (2015) state that the HTMT values need to be less than 0.90. The top threshold of HTMT values was less than 0.90, as shown in Table 6. As a result, the assessment of discriminant validity also confirms that the measurement model meets the HTMT requirement; thus, it was acceptable.

Table 6
Heterotrait-Monotrait Ratio (HTMT)

Constructs	A	B	C	D	E	F	G	H	I	J
Advanced IT Adoptions (A)										
Compatibility (B)	0.732									
Competitive Advantage (C)	0.647	0.694								
Competitive Pressure (D)	0.663	0.744	0.778							
Complexity (E)	0.685	0.736	0.822	0.776						
Financial Resource (F)	0.787	0.651	0.841	0.741	0.699					
Gov. Regulations (G)	0.765	0.642	0.811	0.671	0.661	0.733				
Relative Advantage (H)	0.819	0.769	0.846	0.632	0.743	0.641	0.635			
Technical Capability (I)	0.621	0.818	0.676	0.780	0.822	0.821	0.787	0.831		
Top Management Support (J)	0.749	0.637	0.823	0.750	0.696	0.650	0.685	0.665	0.812	

Assessment of the Structural Model

R square is the amount of variance in the construct in question (competitive advantage) that is explained by the model, which measures the variance in the endogenous variable(s) or constructs (s) that is(are) explained by the exogenous variable(s) or construct(s) (Henseler et al., 2016). Table 7 shows the R^2 values for endogenous variables. The R^2 values were as follows: advanced IT adoption is 0.767 and competitive advantage is 0.890, The R^2 values for the two endogenous variables were above 25%, which is at the substantial level and, thus, demonstrates a high prediction level as recommended by Cohen (1988).

Table 7
R-square Result

Endogenous Variables	R Square	R Square Adjusted
Advanced IT Adoptions	0.767	0.762
Competitive Advantage	0.890	0.887

Substantial > 0.25; Moderate > 0.12, Weak > 0.02 (Cohen & Manion 1989)

The change in R^2 value when a particular predictor component is removed from the model is measured using effect size (Sarstedt et al., 2017). For determining if a certain exogenous latent construct has a significant impact on an endogenous latent construct, effect size value is useful (Cohen, 1988). This study employed Cohen's (1988) three criteria for evaluating f^2, which were 0.35, 0.15, and 0.02 for high, medium, and small impact sizes, respectively.

Table 8 shows that three relationships showed a medium effect. Compatibility has a medium effect on competitive advantage (f^2 = 0.262), followed by competitive pressure that has a medium effect on advanced IT adoption (f^2= 0.196), followed by the relative advantage that also has a medium effect on advanced IT adoption (f^2 = 0.171), followed by advanced IT adoptions hat also has a medium effect on competitive advantage. Meanwhile, complexity, financial resources, government regulations, and top management support have a small effect on both advanced IT adoption and competitive advantage.

Table 8
F-Square Result

Exogenous Variables	Advanced IT Adoptions	Competitive Advantage
Advanced IT Adoptions		0.154
Compatibility	0.140	0.262
Competitive Pressure	0.196	0.010
Complexity	0.111	0.001
Financial Resource	0.117	0.123
Gov. Regulations	0.138	0.136
Relative Advantage	0.171	0.120
Top Management Support	0.001	0.003

Large: f2 effect size > 0.34; Medium effect > 0.14; Small: 0.0 > 0.01 (Cohen, 1988)

The structural model's prediction accuracy has been evaluated using predictive relevance (Q^2 value) (Sarstedt et al., 2017). According to Stone's (1974) and Geisser's (1974) recommendations, the Q^2 value evaluation was done to examine the endogenous variable items' predictive powers (1974). The blindfolding method, which is accessible in the majority of PLS software programmes, was used to determine Q^2. The method of blindfolding omits certain points from the data matrix, imputes the items that were left out, and then calculates the model parameters (Sarstedt et al., 2017).

As a general rule, the model has predictive significance if the Q^2value is greater than zero for a certain endogenous variable, indicating that the route model's predictive accuracy is suitable for this specific construct (Sarstedt et al., 2017). Given that all of the endogenous variables' Q^2 values are greater than zero, Table 9 demonstrates that the structural model used in this study has a high predictive relevance,

Table 9
Result of Predictive Relevance

Endogenous Variables	CCR Q^2 (=1-SSE/SSO)	CCC Q^2 (=1-SSE/SSO)
Advanced IT Adoptions	0.442	0.420
Competitive Advantage	0.497	0.421

CCC=Construct Cross-validated Communality, CCR=Construct Cross-validated Redundancy

Table 10 shows the path coefficient assessment results for the proposed direct relationships in the structural model. Table 10 shows that not all direct relationships were significant. Seven direct relationship hypotheses were supported among the eight direct hypotheses, and one hypothesis was insignificant. Five supported hypotheses were significant at level p< 0.01 (exceeding the standardised value of 2.58), and two hypotheses were significant at level p< 0.05 (exceeding the standardised value of 1.96). The path coefficient value (β) for the seven hypotheses was between 0.112 to 0.238. The highest significant path (p=0.000) was found between relative advantage and advanced IT adoption (β=0.197 and t= 3.511), while the least significant relationship (p=0.036) was found between financial resources and advanced IT adoption (β=0.112 or 11% and t=2.104). The second significant

path (p=0.001) was found between complexity and advanced IT adoption (β=-0.254 or 25% and t= 3.391) in negative sign directions (means negative relationship), the third significant path (p=0.001) was between competitive pressure and advanced IT adoption (β=0.238 or 24% and t= 3.342), the fourth significant path (p=0.003) was between advanced IT adoption and competitive advantage (β=-0.164 or 16% and t= 2.982), the fifth significant path (p=0.009) was between compatibility and advanced IT adoption (β=0.152 or 15% and t= 2.619). The sixth significant path (p=0.029) was between government regulation and advanced IT adoption (β=0.135 or 14% and t= 2.197). Meanwhile, the path between top management support and advanced IT adoption was not significant.

Table 10
Path Coefficient Result (Direct effect)

Hypotheses	OS/Beta	SM	SD	LL	UL	T	P	Decision
Relative Advantage -> Advanced IT Adoptions	0.197	0.197	0.056	0.100	0.320	3.511**	0.000	Significant
Complexity -> Advanced IT Adoptions	-0.254	-0.254	0.075	-0.409	-0.114	3.391**	0.001	Significant
Compatibility -> Advanced IT Adoptions	0.152	0.149	0.058	0.062	0.295	2.619**	0.009	Significant
Financial Resource -> Advanced IT Adoptions	0.112	0.111	0.053	0.018	0.224	2.104*	0.036	Significant
Top Management Support -> Advanced IT Adoptions	-0.034	-0.031	0.059	-0.143	0.074	0.577	0.564	Not Significant
Competitive Pressure -> Advanced IT Adoptions	0.238	0.241	0.071	0.100	0.375	3.342**	0.001	Significant
Gov. Regulations -> Advanced IT Adoptions	0.135	0.132	0.062	0.025	0.258	2.197*	0.029	Significant
Advanced IT Adoptions -> Competitive Advantage	0.164	0.166	0.055	0.063	0.265	2.982**	0.003	Significant

Significant: **p < 0.01, *p < 0.05

Table 11 shows that the moderating effect of technical capability between advanced IT adoption and competitive advantage (i.e., T. Capability*A. IT Adoptions -> Competitive Advantage) was statistically significant as the t-value was 1.993 which is higher than the standardised value 1.96, the p=0.047 which is less than <0.05, and the corresponding regression weight was β=0.039 or 4%. Accordingly, the moderation effect for technical capability is significant, and hypothesis H16 was supported.

Table 11
Path coefficient result (Moderating effect)

Hypotheses	OS/Beta	SM	SD	LL	UL	T	P	Decision
T. Capability*A. IT Adoptions -> Competitive Advantage	0.039	0.037	0.019	0.004	0.080	1.993*	0.047	Significant

Significant: **p < 0.01, *p < 0.05

Discussion

First, this study sought to investigate the relationship between TOE factors and the advanced IT adoption in telecommunication firms in Malaysia. The TOE factors were identified through a literature review. The outcome of the literature review resulted in 7 influential factors of advanced IT adoption. Findings reveal that five (out of 7) TOE factors have a significant influential role in advanced technology adoption. Relative advantage, compatibility, financial resources, competitive pressure, and government regulation were found to have a significant positive relationship with advanced IT adoption. Meanwhile, complexity was found to have a significant negative relationship with advanced IT adoption. However, top management support was found not to have a significant positive relationship with advanced IT adoption. These findings support Hmoud et al. (2023) who found that relative advantages, compatibility, and top management support are significant positive drivers of business intelligence adoption in HEIs. In contrast, complexity has a significant negative influence on business intelligence adoption. the findings also support Hashem and Aboelmaged (2023), who found that relative advantage, compatibility, management commitment, financial resources, and competitive pressure significantly and positively influence agile manufacturing system adoption. In contrast, complexity has significant negative associations with adopting agile manufacturing systems. The findings are also in line with Ezzaouia & Gidumal (2020), who found that competitive pressure, customer pressure, supplier pressure, and government support have the most substantial effects on IT adoption.

Second, this study sought to investigate the relationship between advanced IT adoption and competitive advantage at telecommunication firms in Malaysia. The multivariate analysis was conducted using the SEM-PLS method. The finding showed that advanced IT adoption has a significant positive relationship with competitive advantage. The result strongly supports the findings of Leong et al. (2023) who found that blockchain adoption significantly influences SMEs' competitive advantage in Malaysia. The result is also in line with Kalaitzi and Tsolakis (2022) who found that supply chain analytics SCA adoption is crucial in improving firm performance and enhancing competitive advantage in the UK. It also supports the findings of Shehata and Montash (2020) found that ICT-driven customer relationships and environmental forces drive E-business have a significant effect on competitive advantage in Egypt. The result is parallel those of Chang et al. (2019) who found that cloud usage influences a firm's competitive advantage.

Third, this study sought to examine the moderating role of technical capability in the relationships between advanced IT adoption and competitive advantage at telecommunication firms in Malaysia. The multivariate analysis was conducted using the SEM-PLS method. The finding showed that technical capability significantly and positively moderates the relationship between advanced IT adoption and competitive advantage. Advanced IT adoption has a more significant impact on the competitive advantage when technical capability is high. Thus, in the case of high technical capability, the significance of the direct relationship between advanced IT adoption and competitive advantage would be greater. According to the competitive advantage theory, firms can achieve a competitive advantage through IT innovation adoption (Zhang and Jedin, 2022; Chiu and Yang, 2019), and the relationship between IT innovation adoption and competitiveness, according to this theory, is cyclical, and one process can be used to support the other (Porter, 1991). The results support these arguments and suggest that continued IT innovation adoption is a fundamental

way to achieve sustained competitive advantage. The respondents verified that advanced technology adoption allows them to offer higher quality than competitors, provide new services, increase employee job satisfaction, increase employee-related experience and domain knowledge, and enhance the innovative capabilities of employees; thus, increasing the competitiveness of telecommunication firms in Malaysia. This indicates that telecommunication firms in Malaysia experienced a high level of competitiveness when the technical capability was high.

Implications

In terms of theoretical contribution, the study contributed to the body of knowledge on the importance of relative advantage, complexity, compatibility, financial resources, competitive pressure, government regulations, advanced IT adoption, and technical capability, as predictors of perceived competitive advantage. Additionally, empirical evidence is provided to support the TOE theory, namely that technological, organizational and environmental factors have a horizontal link with advanced IT adoption. It was concluded that relative advantage, complexity, compatibility, financial resources, competitive pressure, and government regulations can enhance advanced IT adoption in telecommunication firms in Malaysia, but it is not the only organisational outcome; such factors were found to positively enhance firms' competitive advantage; thus, technological, organizational and environmental factors should be translated to competitive advantage, and not to only emphasise the process of technology adoption alone.

Limited studies have examined advanced IT adoption as a mediator between the TOE factors and competitive advantage. Hence, the study adds to the body of knowledge on the importance of technical capability as a mechanism that explains how relative advantage, complexity, compatibility, financial resources, and competitive pressure transfer their effect to competitive advantage. The study also provides empirical evidence to prove the theoretical arguments that TOE factors can create sustainable competitive advantage by influencing IT adoption (Leong et al., 2023). Put differently, empirical evidence was also provided to the arguments that demonstrate how the right advanced IT adoption drivers can boost sustainability performance and competitive capacities through the use of advanced technology.

This study also supports the competitive advantage theory that firms can achieve a competitive advantage through IT innovation adoption (Zhang and Jedin, 2022; Chiu and Yang, 2019); Thus, continued IT innovation adoption is a fundamental way to achieve sustained competitive advantage (Leong et al., 2023; Kalaitzi and Tsolakis, 2022). The finding confirmed that advanced IT adoption is a mechanism through which firms leverage their technological, organizational and environmental to enhance their competitive advantage. This study also added to current knowledge that confirms the relationship between TOE factors and advanced IT adoption (e.g., (Kalaitzi & Tsolakis, 2022; Leong et al., 2023), and the relationship between advanced IT adoption and competitive advantage (e.g., (Hashem & Aboelmaged, 2023; Hmoud et al., 2023; Hong et al., 2021).

Empirical evidence was also produced to indicate the moderating role of technical capability in the relationship between advanced IT adoption and competitive advantage. The extent of the impact of technical capability on advanced IT adoption and competitiveness

remained unclear before this study was conducted ((Dadhich & Hiran, 2022; Shehata & Montash, 2020; Zhang & Jedin, 2022). Hence, the current research filled the research gap on the role of technical capability as a moderator between dvanced IT adoption and competitive advantage. This study confirmed that technical capability can maximise the effect of dvanced IT adoption and competitive advantage. Future research can examine the role of technical capability on other aspects of organisational performance.

In terms of Practical contribution, the findings are useful in improving the standard of advanced IT adoption toward competitive advantage. Instead of solely looking at better technology to improve the competitive advantage of Malaysian telecommunication firms, more efforts should be dedicated to organizational and environmental factors to create a highly successful adoption of advanced technology. The results and related recommendations are useful in guiding telecommunication managers and policymakers to ensure technology, organizational, and environmental factors interact collectively to enhance advanced IT adoption and subsequently, competitive advantage. The Telecommunication firm managers; for example, should be aware of the importance of designing technological infrastructure that can absorb future improvements in telecom technologies. They should show their support and provide the required financial resources to enhance the technology adoption. Thus, technology adoption can emerge as a source of competitive advantage for the company and its continued growth. The Telecommunication firm managers in Malaysia should design systematic approaches to evaluate in-use technologies and in order to develop future plans of improvement in technology to enhance competitive advantage. This is important for telecom firms as advanced technology adoption can ensure competitiveness.

Future Research

Future research should concentrate on the relationship between advanced IT adoption and the competitive advantage of other types of service firms and other types of businesses. This will provide a clearer understanding of the effects of relative advantage, complexity, compatibility, financial resources, top management support, advanced IT adoption, and technical capability on competitive advantage in the service sector. Future studies should extend the study framework to include variables from other technology adoption theories such as the UTAUT theory to measure competitive advantage in the service sector. Other factors may also have a strong impact on competitive advantage. The top-level managers and employees' perspective should be considered in future research. Top-level managers and employees may have their own views and opinions on the impact of the TOE factors, advanced IT adoption, and technical capability on competitive advantage.

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