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A conceptual paper on the impact of technological innovations on halal SMEs supply chain performance: a mediating role of sustainability practices

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Abstract

In recent times, business environments have witnessed a surge in the usage and adoption of technological innovations to boost sustainability and resilience. This has shaped Malaysian government policies targeted at enhancing strategic or high impact industries where halal SMEs feature prominently. Also, technology and sustainable practice-related challenges hindering the Supply Chain Performance (SCP) of halal SMEs have been identified. However, available studies on halal SMEs do not cover the role of Technological Innovation (TI) on the SMEs' SCP and the significance of Sustainability Practices (SP) in this relationship. Also, relatively few studies analyse technological innovation in halal SMEs. The objectives of this conceptual paper are: to explore the impact of technological innovation on halal SMEs' supply chain performance and the mediating role of sustainability practice in the practice; and propose a conceptual framework whereby the effects of technological innovations on halal SMEs' supply chain performances are mediated by sustainability practices. Relevant extant studies in academic journal articles housed in various popular databases, such as Scopus, Emerald, Elsevier, etc., were comprehensively reviewed and incorporated into this study. The proposed model has potential to provide empirical data on the subject areas. The study suggests a tentative research agenda for future studies to achieve halal SMEs' efficient, flexible, competitive, and sustainable supply chain performance through effective interactions of technological innovations and sustainability practices.

1. Introduction

Since the COVID-19 pandemic, technological innovations have revolutionised all industries. There has been a surge in the usage and adoption of technological innovations to boost sustainability and resilience in the uncertain environment, with immense impacts on the supply chain (Ali *et al.*, 2021; Alraja *et al.*, 2022; De *et al.*, 2020; Hajar & Hadi, 2021; Kazancoglu *et al.*, 2023; LaBerge *et al.*, 2020). The significance of technological innovation within the supply chain cannot be overemphasised, as it promises to boost diversification and resilience during global supply chain disruptions (Rampersad *et al.*, 2020). Also, traction towards globalisation, pressure for more environmentally sustainable operations, and the need for improved general supply chain performance have intensified technological innovation drives (Talib *et al.*, 2022). These have driven scholars and practitioners to establish viable supply chain services to rejuvenate the industry, leading to technological innovation in halal logistics and supply chain management (Ahmad *et al.*, 2023; Talib *et al.*, 2022).

Meanwhile, halal SMEs represent 80% of the total SMEs in Malaysia, according to JAKIM. The halal industry (where halal SMEs play critical roles) has been positioned to play vital roles in actualising the economic goals of the Twelfth Malaysian National Development Plan. Malaysia ranked the world's top halal industry country (Dinar Standard, 2021), has realised the enormous economic potential that still exists in the halal industry and has developed the Halal Industry Master Plan 2030 (HIMP 2030). This plan 'was developed to catalyse Malaysia's strengths towards the development of its halal industry holistically' and identifies an estimated 80% gap between demand and production of global halal products. Also, among the five key target outcomes that will drive HIMP 2030 is 'having a robust and diversified domestic halal industry' (Industry *et al.*, n.d.), where the role of halal SMEs is indispensable. Malaysian halal SMEs can leverage this gap and opportunities by improving their supply chain performance with quality technological innovation and sustainability practices.

As Malaysia still trails in innovation and technology adoption behind top Asian countries such as Japan, South Korea, Singapore, and other high-income countries, its halal industry must be strengthened with entrepreneurial technological innovations (Razak *et al.*, 2018; Salaheldeen & Battour, 2024). Hence, the dominance of halal SMEs in Malaysia's SME sector indicates that halal SMEs are not free from technological innovation delinquencies and related challenges identified with general SMEs in Malaysia. Consequentially, despite halal SMEs' strategic importance and contributions to the Malaysian economy, these challenges may threaten their supply chain performance, especially amid the quest for sustainable business practices. In the literature some of the constraints to

technological innovation have been identified in general SMEs and halal SMEs in particular may not be immune to them as well. Amongst these are poor government support, quality of human resources, funding of technological innovation, etc. (Ali *et al.*, 2021; Indrawati *et al.*, 2020; Khusna Mustafa *et al.*, 2018).

Meanwhile, numerous halal SMEs and industry supply chains have peculiar challenges and issues that can be overcome with technological innovations. These include complex management of warehousing and terminals; the lack of trust and knowledge (integrity); perceived risk; difficulty in obtaining *Shari'ah*-compliant funding; multiple regional and global halal standards; and others that are directly related to the halal matters- non-segregation, concerns and possible regulation of rapidly developing genetically engineered or edited/synthetic genomes (man-made designer microorganisms and plants); food traceability issues and cross-contamination of halal-*haram* goods in supply chain processes etc. (Ahmad *et al.*, 2023; Dashti *et al.*, 2024; Elasrag, 2016; Mahidin *et al.*, 2017). Hence, to overcome these challenges and issues, halal SMEs, like other SMEs, are expected to capitalise on constant technological innovations to be more resilient and competitive and improve their supply chain performances (Alraja *et al.*, 2022; Dashti *et al.*, 2024; Indrawati *et al.*, 2020). However, technological innovations are not without their impacts or risks on the sustainability practises of enterprises (Ahmad *et al.*, 2023; Zaynullina, 2021). As part of their social responsibility, organisations must adopt environmentally friendly and technologically advanced approaches that result in sustainable performance (Alraja *et al.*, 2022).

Furthermore, there is an uptick in research on entrepreneurship and sustainable innovation. Still, there is a dearth of research on increasing sustainable innovation in the Malaysian and global halal industry (Salaheldeen & Battour, 2024). Also, relatively few studies have analysed technological innovation in SMEs. Most research on innovation was focused on large companies, leaving exploration of the impacts of innovation on SMEs, especially in developing countries, at a very low level (Bigliardi & Galati, 2016; Osman & Abbas, 2016; Radicic & Petković, 2023). These are indications that available studies on halal SMEs do not cover the influence of technological innovation on sustainability practices and their effect on SMEs' supply chain performance (Alraja *et al.*, 2022). Hence, the model proposed by this paper has the potential to provide an analytical focus on the significance and impacts of technological innovation on individual elements of SMEs' operational supply chain performance.

Given the significance and potential of technological innovation in providing a remedy to challenges, limitations, and other matters that are peculiar to halal SMEs, this conceptual paper is intended to explore the impact of technological innovation on halal SMEs' supply chain performance while identifying the mediating role of sustainability practice; and propose a conceptual framework whereby the effects of Technological Innovations (TI) on halal SMEs' Supply Chain Performances (SCP) is mediated by Sustainability Practices (SP). Hence, an explorative literature review was conducted, and a conceptual framework was proposed. For future research, the paper designed and suggested a model where the impacts of technological innovation on halal SME supply chain performance are mediated by sustainability practice.

The originality of this conceptual paper lies in proposing a model that attempts to examine how sustainability practices will mediate the impacts of technological innovations on the supply chain performance of halal SMEs. Hence, this study has engendered an effort to fill the gap of exclusion of the mediating and moderating effects of key variables in entrepreneurship, sustainable innovation, and supply chain identified in the body of literature (Ismail, 2022; Salaheldeen & Battour, 2024).

2. Literature review

2.1 The context of the study –Malaysia halal industry

In Malaysia, SMEs have always been identified as central to the country's national development (Tahir *et al.*, 2016). SMEs account for 97.4% of the country's overall establishments, contributing to 47.8% of total employment and 37.4% of GDP (DOSM, 2022). the Twelfth Malaysian National Development Plan (2021-2025) 'focuses on restoring the growth momentum of key economic sectors, and propelling strategic and high impact industries as well as micro, small and medium enterprises (MSMEs) to realign growth in a sustainable trajectory as well as strengthening Malaysia's position in the global supply chain'. Also, the national development plan has been designed to boost the halal industry among eight strategic and high-impact sectors identified by the Malaysian government (Economic Planning Unit, Prime Minister's Department, 2021). According to the government, the industry's development will be accelerated through the Halal Industry Master Plan (HIMP) 2030). This plan outlines seven strategic thrusts to produce high-quality products and services along the halal supply chain (Marketing-Interactive.com, 2021).

Significantly, 'accelerating technology adoption and innovation' features among the four catalytic policy enablers of the Twelfth Malaysian National Development. According to the Malaysian government, this is essential because the COVID-19 pandemic has significantly altered business operations, changed how people interact and accelerated digital technology adoption (Economic Planning Unit, Prime Minister's Department, 2021). Hence, according to the plan, advanced technologies, digitalisation, and niche capabilities will be leveraged to enhance the contribution of strategic and high-impact industries and activities to the economy.

In addition, advancing sustainability forms the third theme of the Twelfth Malaysia National Plan. This focuses on advancing green growth, enhancing energy sustainability, and transforming the water sector to ensure the nationwide shift to more sustainable economic practices and lifestyles that value natural endowments and environmental health. This addresses climate change, unsustainable consumption and production practices, and biodiversity loss (Economic Planning Unit, Prime Minister's Department, 2021).

2.2 Technological innovations in the supply chain domain

Due to innovation's multifaceted nature, there are many definitions of the concept, but the inextricable relationship between innovation and entrepreneurship is very instructive. Joseph Schumpeter's (1934) equating of entrepreneurship to innovation is more significant and appropriate today than ever (Śledzik, 2013). SME technological innovation refers to both revolutionary initiative (creation of new technology) and modification - making significant improvements on existing technologies (Indrawati *et al.*, 2020; Salaheldeen & Battour, 2024). The former and the latter include discovering and

applying new processes or methods, introducing new products or services, exploiting new opportunities, opening new markets, creating new industry structures, improving existing products and services, modifying existing processes and products, increasing economies of scale, etc. (Indrawati *et al.*, 2020; Śledzik, 2013). Irrespective of the way and manners of its definition, technological innovation revolves around input, process, and output as they relate to product and organisation.

Technological innovations have attracted tremendous attention due to their vast benefits and significance. These include lowering production costs, improving the quality of goods, improving firm competitiveness, impacting the complex and constantly changing business environment, and catering to organisations' need for flexibility and responsiveness (Hajar & Hadi, 2021; Hussain *et al.*, 2022; Ifenthaler *et al.*, 2021). It is believed that technologies have the potential to affect every aspect of businesses or organisations, produce significant improvements, and be a panacea to challenges in supply chain and logistics management (Ali *et al.*, 2021; Hajar & Hadi, 2021). It revolutionises the operational process for small-scale industries by aiding process integration, digitisation, automation, and efficient resource use. This leads to substantial performance improvements across supply chain processes—procurement, production, inventory management, and retailing (Hajar & Hadi, 2021; Hussain *et al.*, 2022). Technological developments also cause changes in organisational experiences, such as the capability to produce new goods and services while enabling people to learn new things, communicate with others, and create and share innovations (Celtekligil & Adiguzel, 2019). Hence, halal SMEs cannot afford to be indifferent to the global technological revolution if they want to improve their supply chain performance and be more competitive, resilient, and sustainable.

The spate and rate of new types and models of technologies over the past few decades is high, hence the rapidly changing faces of the business world and the redefining of ways supply chain operations are conducted. The first three industrial revolutions heralded by advances in mechanisation, electricity, and IT were quickly followed by innovative technologies in the manufacturing environment, which brought about the fourth industrial revolution – Industry 4.0. This refers to a new era of business process decentralisation aided by technological advances where information about actual products is linked to web-based applications and integrated into the production process (Ali *et al.*, 2021; Hajar & Hadi, 2021). Machine to Machine (M2M) communications, Internet of Things (IoT), Cyber-Physical Systems (CPSs), artificial intelligence, and Big Data Analytics (BDA) have created a business environment where employees, machinery, devices, and enterprise systems are connected through CPSs and the Internet (Hajar & Hadi, 2021). Various cutting-edge or disruptive technological innovations have transformed the supply chain field. These include containerisation, Electronic Data Interchange (EDI), Radio Frequency Identification (RFID), Quick Response (QR) codes, Smart packaging, GPR tracking, robotic and drone technologies, and more recent applications of big data, blockchain technology, and electric vehicles (Ali *et al.*, 2021; Hajar & Hadi, 2021; Talib *et al.*, 2022). Today, companies are embracing advanced technological innovations associated with the fourth industrial revolution by heavily investing in automation and robotics. These innovations bring significant benefits to manufacturing and enable extensive process integration (Hajar & Hadi, 2021).

The application of e-business technologies has assisted many companies in streamlining their business processes and improving operational performance through process integration (Hajar & Hadi, 2021; Hussain *et al.*, 2022). The steady increase in business systems automation leading to efficiency, productivity gains, and improved quality encourages organisations to extend technological innovations in operational arenas to other organisational areas, such as supply chain management (Hajar & Hadi, 2021). Technological innovations have enabled innovative process management, provided new paradigms for industrial management, and significantly improved the nature and quality of products and services provided by organisations (Ali *et al.*, 2021; Hajar & Hadi, 2021; Hussain *et al.*, 2022).

2.3 Technological innovations and halal SMEs: opportunities and challenges

2.3.1 Opportunities

In addition to their crucial role as a significant source of employment and economic growth, SMEs are also regarded as a source of technology adoption and innovation (Ngah *et al.*, 2022). This may be due to SMEs' ubiquitous significant role in all areas of human needs that businesses cater to through technology. Organisations, including SMEs, have realised the significance of technological advances and considered technology a potent strategic weapon for ensuring sustainable supply chain performance (Hajar & Hadi, 2021). However, there is limited extant research regarding innovation in the halal business model, though it inherently supports innovation for competitive advantage and business sustainability (Salaheldeen & Battour, 2024). Salaheldeen & Battour (2024) is one of the few recent studies in this area. They investigate the relationships between halal entrepreneurial success, innovation capability, and sustainable innovation in the halal industry. The study posits that innovation capability mediates between halal entrepreneurial success and sustainable innovation. Hence, Battour (2024) suggests the significance of technological innovation in halal supply chain performance. Also, Ali *et al.* (2021) study proposes a sustainable blockchain framework for the halal food supply chain (SC) after conducting an exploratory study using case studies. Their findings indicated that blockchain, as a disruptive technology, can help halal food SMEs achieve SC transparency. Similarly, Rejeb *et al.* (2021) conducted systematic literature on integrating the Internet of Things (IoT) in the halal food supply chain (HFSC), with over seventy-three (73) papers analysed, using both bibliometric techniques and in-depth content analysis. The study's findings show that IoT's significant benefits include: 'traceability of products, enhancement of supply chain efficiencies, facilitation of livestock management, authentication of foods' halal status, and monitoring of halal certifications'.

However acccording to Ahmad *et al.* (2023), the study of the key factors for Green Supply Chain and Logistic Management (GSCLM) in the context of Malaysia's halal food industry indicated that technology had a negligible effect on GSCLM. The outcome of this study regarding the insignificant effect of technology on the supply chain is inconsistent with most studies relating to technological innovation and supply chain. This inconsistency may be due to the study's limitations and may not apply to halal SMEs, which were not indicated as the sampled or targeted population in the study.

Expansion of supply chains comes with more complexity, which requires advanced technology, regulations, and

certifications to ensure the quality and integrity of imported food products, for example (Dashti *et al.*, 2024). As mentioned, one of the technological innovations impacting supply chain values is blockchain technology, though its adoption and its benefits have not been fully realised, especially for SMEs (Ali *et al.*, 2021). Halal SMEs can benefit from blockchain-based halal payment services and information sharing, which is currently being practised in the halal industry through the digitisation of halal certificates (Ali *et al.*, 2021; Salaheldeen & Battour, 2024). Blockchain benefits the primary goal of the halal supply chain, which is assuring consumers of full-scale halal integrity while addressing the key aims of supply chain management, such as risk mitigation flexibility, quality, and sustainability (Ali *et al.*, 2021). Therefore, this underscores the significance of blockchain technology in halal supply chain research related to fraud, transparency, traceability, delivery, quality, safety, security, and sustainability due to their impacts on health and religious concerns for consumers (Ali *et al.*, 2021). Inadequate adoption of technological innovations such as blockchain may jeopardise the ultimate aim of the halal industry, while its successful implementation and adoption will enhance visibility, transparency, and traceability (Ali *et al.*, 2021).

Besides blockchain technology, many other innovations possess immense potential benefits to halal supply chain performance. Literature by Ali *et al.* (2021), Dashti *et al.* (2024), Hajar & Hadi (2021), Salaheldeen & Battour (2024) and Suhartanto *et al.* (2024), identifies the following:

i. Quick Response (QR) Code: This is a very affordable and effective way of traceability that can provide halal consumers with vital information like country of origin. It is different from conventional pre-packaged food labelling complexity.

ii. Radio Frequency Identification (RFID tag: contains specific information to identify leaks in the distribution network, giving the capacity to process large volumes quickly and efficiently.

iii. IoT-based business solutions enable smart retailing by tracking and tracing platforms through real-time visibility; hence, they can manage uncertainties and risks associated with the pathways of items in the halal food supply chain, including communication risks.

iv. A GPS track-and-trace system detects delays in the transportation system, which may prevent halal product counterfeiting in the logistic process while significantly impacting inventory management.

v. Smart packaging can be integrated with wireless communication and cloud service to activate real-time monitoring of halal products and services, thus providing transparency of product movement in the supply chain.

vi. Big Data Analysis (BDA) services: could be used to maximise competitive advantage through transparency while enabling supply chain innovation integration competencies and resources.

vii. 3D printing and virtual and augmented reality can also be implemented for halal ventures.

2.3.2 Challenges

However, despite technological innovation's numerous benefits and opportunities, its applications in SMEs, particularly halal SMEs, face some challenges (Ali *et al.*, 2021; Indrawati *et al.*, 2020; Rejeb *et al.*, 2021). While the most significant inhibiting factor is the funding of technological innovation (Indrawati *et al.*, 2020), other obstacles include poor government support, quality of human resources, economic conditions and business partners, technological complexity, lack of capability, cost efficiency, and return of investment uncertainty, which is also an essential concern in the innovation adoption literature (Ali *et al.*, 2021; Indrawati *et al.*, 2020; Ngah *et al.*, 2022). The complexity of some technological innovations is another major obstacle confronting SMEs in their efforts to maximise the benefits of such innovations. Literature shows that firms prefer innovations that are simple, user-friendly, available, and specifically tailored; hence, SMEs are facing difficulties in adopting blockchain technology (Ali *et al.*, 2021; Ngah *et al.*, 2022).

Furthermore, technological immaturity, lack of user acceptance, and regulatory barriers also constitute challenges to halal SMEs' technological innovations, as many SMEs are low in sophisticated knowledge of IT and equipment (Ali *et al.*, 2021; Rejeb *et al.*, 2021). Due to their limited economic scale, halal SMEs cannot negotiate the unification of data formats and cannot outsource difficult and costly supply chain technological activities (Ali *et al.*, 2021). Also, the application of technological innovation among SMEs is still limited due to its high cost and uncertainty surrounding its return on investment—the price of the technology adoption may be higher than the product's value, making the investment raise costs without necessarily increasing revenue (Ali *et al.*, 2021; Indrawati *et al.*, 2020).

2.4 Supply chain performance

While enterprise performance has attracted considerable attention recently, SMEs' performance has become a significant concern for industrialisation and modern economies despite technological innovation's imperative role (Hussain *et al.*, 2022). Supply chain performance can be measured through cost, financial, and non-cost or non-financial metrics (Hajar & Hadi, 2021; Piprani *et al.*, 2020). Cost measures may include inventory and operating costs to fulfil cost efficiency goals, such as cost optimisation in production, warehouse, and logistics (Piprani *et al.*, 2020). Non-financial indexes include flexibility, reliability, responsiveness, customer satisfaction, innovation, time, availability, and information sharing (Hajar & Hadi, 2021; Kumar *et al.*, 2017; Piprani *et al.*, 2020). Hence, companies invest in technological innovations to build effective information-sharing and collaboration mechanisms and improve supply chain performance (Hajar & Hadi, 2021). Supply chain performance as a firm's non-financial performance can be measured by customer satisfaction, advanced technological innovation, and reduced production time (Hussain *et al.*, 2022).

2.5 Sustainability practices and technological innovation

Due to pressures from public policies, international environmental legislations, growing customer demand, and socio-environmental awareness, firms are increasingly inclined towards more sustainable and socially responsible practices

(Salaheldeen & Battour, 2024). Hence, incorporating technological innovations such as blockchain applications is appreciable, as they can aid the efficient use of resources, making sustainable performance a key feature in smart factories (Ali *et al.*, 2021; Hajar & Hadi, 2021). According to Alraja *et al.* (2022), this has led organisations to adopt environmentally friendly and technologically advanced approaches that result in sustainable performance. Sustainability policies are becoming more popular among SMEs because sustainable practices are equally important as innovation in compliance for in today's highly competitive business environment (Du *et al.*, 2022). By prioritising technological innovations, enterprises are changing their products and process portfolios, proactive and involved in environmentally friendly practices to sustain themselves (Alraja *et al.*, 2022)Moreover, halal production is considered sustainable due to its specific processes and goals of producing safe, high-quality products with intact consumer integrity. (Ali *et al.*, 2021).

It is also believed that transitioning to green could be implemented more successfully through advanced technological innovation. For instance, halal green supply chain and logistics, which involves cost reductions, raising the value to end consumers, and halal compliance without excluding profitability, may not be achieved without technological innovation. (Ahmad *et al.*, 2023). Quality assurance control (halal assurance systems) in the entire halal green supply chain management entails requirements such as saving output (non-toxic), proven harmful-free, hygienic, and lawfully permitted - which depend on technology such as radio frequency identification (RFID), and Artificial Intelligence (AI) (Ahmad *et al.*, 2023).

However, technological innovation is considered a "double-edged sword" due to its significant contribution to climate change, ecological imbalances, and worsening pollution while effectively solving environmental and sustainable development problems. (Irfan *et al.*, 2022). Hence, Du *et al.* (2022) suggested that SMEs dedicate more resources towards sustainable development by adopting recruitment strategies based on environmental standards. Other measures suggested to aid SMEs' sustainability performance include higher investment in research and development to improve ecological efficiency, updated technology in the production process and service delivery, and promoting eco-friendly services and goods via environmentally conscious digital platforms (Du *et al.*, 2022).

2.6 Conceptual framework of the study

The conceptual framework in Figure 1 was developed in line with the evidence in the reviewed literature. It depicts the relationship between this study's independent, mediating, and dependent variables. The framework indicates that technological Innovation (TI) - the independent variable, has a positive and significant relationship with Supply chain Performance (SCP) - the dependent variable, through the mediating role of Sustainability Practice (SP) - the mediating variable.

3. Research design and methodology for future research

To achieve the research objectives of this study, extant studies found relevant from academic journal articles housed in various popular databases, such as Scopus, Emerald, Elsevier, etc., were comprehensively reviewed and incorporated into this study (Jaiyeoba & Azam, 2023; Showole & Jaiyeoba, 2024). In congruence with the proposed conceptual model, it is suggested that future investigations be conducted using a positivist research paradigm. This approach will enable future research to objectively test causal relationships among the variables in the developed model (Khaldi, 2017). The positivist research paradigm is based on the ontological assumption of a reality independent of the observer (Dahler-Larsen, 2015): realities of the world is objective and knowable in its entirety; a researcher can be separated from the research's object; hence, their task is to describe and analyse this reality in a neutral way (Khaldi, 2017). Future researchers should also consider the ethical and procedural implications of the positivism paradigm, such as confidentiality, informed consent, and avoidance of coercion (Dahler-Larsen, 2015).

In addition, future research is expected to develop a questionnaire based on the existing literature to consider all model variables. To investigate these variables, the questionnaire should be employed to collect data from employees of halal SME owners and managers. The procedure for data collection could be a probability or non-probability sampling approach using a valid instrument (Likert scale) that measures the impacts of Technological Innovation (TI) on the supply Chain Performance (SCP) of halal SMEs. The sample population to be studied by future research should be SME owners and managers with at least three years of experience and currently working in the halal SME sector. A sample size between 100 and 500 participants is recommended for structural equation modelling, which is appropriate for the proposed model (Hair *et al.*, 2018; Jaiyeoba *et al.*, 2022; Memon *et al.*, 2020).

4. Theoretical implications and practical implications

One of the theoretical implications of this conceptual paper is its potential to address some vital gaps identified in halal SMEs' supply chain literature. Available literature has revealed that studies on SMEs do not cover the effects of halal SMEs' technological innovation on sustainability practices and their supply chain performance (Alraja *et al.*, 2022). Most research on innovation has been focused on large companies; relatively few studies analyse technological innovation in SMEs; exploration of impacts of innovation on SMEs in developing countries is at a very low level (Osman & Abbas, 2016; Radicic & Petković, 2023).

Figure 1. Conceptual framework.

Also, this conceptual paper and proposed models will contribute more to the literature and knowledge on supply chain theories, such as Resource Base View and Dynamic Capabilities theories. These theoretical frameworks treat technological innovations as a valuable resource and a dynamic capability that enables SMEs to respond and adapt to changing market and environmental and social conditions, thereby contributing to long-term competitiveness and improved supply chain performance. Also, SMEs' resource base and dynamic capabilities will be further enhanced when sustainability practice mediates the relationship between technological innovation and supply chain performance.

As part of the practical implications, this paper will spur further research that enhances understanding of how technological innovation impacts halal SMEs' supply chain performance and the mediating role of sustainability practices leading to their competitive advantage. This study has shed light on how halal SMEs can leverage technological advancements and integrate sustainability practices to achieve improved efficiency, supply chain-associated cost reductions, and market differentiations. More research based on this proposed model will help halal SMEs strengthen their supply chain integration - communication, coordination, and information sharing with suppliers and customers. Also, studies on sustainability practices can further improve halal SMEs' resource optimisation, reduce transaction costs by mitigating risks linked to environmental regulations, and boost social compliance and stakeholders' expectations management. Hence, sustainability practices as a mediator will enhance environmental and social performance by reducing halal SMEs' carbon footprints, minimising waste, and promoting fair labour practices.

In addition, research outcomes from this conceptual paper can provide policymakers with quality data and information about the potential benefits of promoting technological innovation and sustainability practices among halal SMEs. This will facilitate designing, formulating, and implementing rich policy frameworks, incentives, and other initiatives that will motivate halal SMEs to adopt innovative technologies and sustainable practices. for instance, future research derived from this conceptual paper can enhance the implementation of the Twelfth Malaysian National Development Plan (2021-2025), which 'focuses on restoring the growth momentum of key economic sectors, and propelling strategic and high impact industries as well as micro, small and medium enterprises (MSMEs) to realign growth in a sustainable trajectory as well as strengthening Malaysia's position in the global supply chain' (Economic Planning Unit, Prime Minister's Department, 2021). The plan outlines seven strategic thrusts to produce high-quality products and services along the halal supply chain. (Marketing-Interactive.com, 2021). Hence, the technological innovations and sustainability practices forming the crust of this study are essential to the Twelfth Malaysian National Development Plan.

Generally, this conceptual paper on the impact of technological innovation on halal SMEs' supply chain performance with sustainability practices as a mediator has wide-ranging significance. It can improve competitiveness, sustainability, and resilience in halal SMEs while contributing to broader socio-economic growth and environmental stewardship by aiding the design of effective data-based halal SME policies.

5. Conclusions

The researchers have proposed a model and conceptual framework with the assumption that halal SMEs' Technological Innovation (TI) positively impacts Supply Chain Performance (SCP) with Sustainability Practices (SPs) as a mediating variable in the established relationship. After reviewing relevant studies, the researchers have shown how technological innovation can contribute to halal SMEs' supply chain performance. Similarly, researchers have revealed the importance of sustainability practices in mediating the relationship between technological innovations and halal SME supply chain performance. Building on this model proposed by the researchers and various empirical findings mentioned so far, this study has demonstrated how the developed conceptual model and the relationship therein can enhance the supply chain performance of halal SMEs by contributing to their competitiveness. Concerning the limitation of this study, the developed conceptual framework has not been tested empirically; the researchers call on future studies to collect data to test the established model empirically. Also, this study has mainly identified the impact of technological innovations on halal SME supply chain performance with the mediating role of sustainability practices; future research may incorporate other relevant variables while investigating the suggested model.

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