Print ISSN: 1738-3110 / Online ISSN 2093-7717
JDS website: http://accesson.kr/jds
http://doi.org/10.15722/jds.23.11.202511.29

Investigating SMEs' Intention to Adopt Halal Traceability System in Malaysia Food and Beverage Supply Chain: A TOE Framework Approach

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Received: July 28, 2025. Revised: August 27, 2025. Accepted: November 05, 2025.

Abstract

Purpose: This study examines the determinants influencing Malaysian SMEs' intention to adopt Halal traceability systems in the food and beverage (F&B) industry, aiming to support Malaysia's goal of becoming a global Halal hub. Using the Technology-Organization-Environment (TOE) framework, the research explores technological, organizational, and environmental factors affecting adoption. **Research design, data and methodology:** A quantitative, cross-sectional survey was conducted with 245 SMEs using structured questionnaires, and relationships among perceived usefulness, perceived ease of use, top management support, employee training, government support, competitor pressure, and adoption intention were analyzed via Partial Least Squares Structural Equation Modeling (PLS-SEM). Results show that perceived usefulness, top management support, government support, and competitor pressure significantly and positively influence adoption, while perceived ease of use and employee training negatively affect it, indicating that complexity and insufficient training may hinder uptake. **Result:** The findings underscore the importance of management commitment, functional value, and external pressures, alongside the need to simplify implementation. **Conclusions:** The study concludes that government incentives, regulatory facilitation, and policy frameworks are crucial for overcoming adoption barriers, while industry collaboration can foster best practices and readiness. This research contributes to Halal supply chain literature and provides practical guidance for policymakers, industry players, and SMEs to enhance Halal traceability adoption.

Keywords: Halal Traceability Systems, Supply Chain, Small and Medium-Sized Enterprises.

JEL Classification Code : M31, M38, O33

1. Introduction

Malaysia, with its well-developed Halal system and geographic advantages, has placed itself on top of the global food and beverage Halal Industry. This goal is directed at SMEs which make up nearly 98.5 percent of all businesses in Malaysia (SME Corp Malaysia, 2023). SMEs as the backbone of any economy, need innovations to transform the entire supply chain and guarantee compliance to Halal policies and procedures. Still, these businesses struggle to implement advanced technologies such as Halal traceability systems due to the lack of resources and technical know-

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how accompanied with high cost of implementation (Nazri et al., 2024).

Additionally, the Halal food and beverage sector is a vital contributor to the economy of Malaysia. In 2018, the Halal industry contributed 7.8 percent of the GDP Malaysia and is projected to increase to 11 percent by 2030 (Shafii & Khadijah, 2021). The demand by consumers globally for Halal approved products is increasing which require cutting-edge traceability systems to improve supply chain transparency and consumer confidence. Blockchain and Internet of Things (IoT) devices offer solutions for full tracking and reporting of Halal status, thus reducing the risk of fraud and cross-contamination (Masverse, 2024). These technologies hold promise, but adoption by Malaysian SMEs has been slow due to perceived complexity and costs (Rahman et al., 2023).

The recent incidents revolving around the controversy of halal meat in Malaysia have raised worries sceptical on the credentials of halal products. The incident describes the sale and certification of non-ethically slaughtered meat which deeply affected consumer confidence on halal trust chains (Alam et al., 2022). As consumers become more concerned about these issues, halal traceability systems act as a helpful tool in appending borders with trust, enabling flagging of products from production to consumption (Hashim et al., 2023).

The motivation to adopt of halal traceability systems, therefore, resonates with the adoption intentions captured by the Technology-Organization-Environment (TOE) framework such as, technological adoption willingness, organization ability, and surrounding conditions (Tornatzky and Fleischer, 1990). Such a framework helps in assessing the conditions under which SMEs can adopt these systems and what factors support or hinder the processes. For instance, intentions of adoption integration stem from organizational readiness like, financial and technical resources available, and environmental concern such as, regulations set to control market competition (Rahim et al., 2023). Hence, this study endeavours to fill the void concerning the motives behind Malaysian SMEs' adoption or intention of adopting Halal traceability systems within the structure of TOE. Moreover, the research aims to assist Malaysia in capitalizing on the opportunities available and addressing the challenges faced as a nation moving towards a more distinct and prominent position at the centre of the global Halal trade, while also enabling SMEs to improve the integrity, compliance, and confidence in the supply chain.

1.1. Overview of Malaysia Halal Traceability System in Food and Beverage Industry

In terms of economic contribution, the Halal food and beverage sector in Malaysia is an important national market as well as a major international importer and exporter of Halal goods. This industry relies heavily on adopting and complying with comprehensive traceability systems that ensure full compliance with Halal regulations and the preservation of consumer confidence. These systems enhance Malaysia's capabilities in being a dominant international Halal center, while at the same time, meeting the needs of the consumers who are increasingly asking for more transparency and guarantee on Halal certified products. Nonetheless, the use and practice of Halal traceability systems in Malaysian SMEs within the food and beverage sector face a number of challenges.

Previously, emerging research has exposed important gaps in the adoption of Halal traceability systems in SMEs. For instance, Nazri et al. (2024) pointed out lack of awareness, poor knowledge of traceability technologies, and the costs of implementing traceability systems as some of the barriers. Integration of new technologies into existing systems presents numerous technical challenges while logistical problems also exacerbate these obstacles. In addition, effective separation of halal and non halal products, particularly in retail and distribution, is another important issue to ensure that cross contamination does not occur and that halal sterility is respected. These barriers underscore the importance of having effective policies, appropriate allocation of resources, and adequate training to enable traceability systems in SMEs.

However, these barriers need to be overcome in light of the importance of the Halal food and beverage industry in Malaysia's economy and culture. This research seeks to close the gap in understanding the obstacles and possible consequences results of SMEs which form a large chunk of the industry. This study intends to provide Malaysia with a competitive edge in the global halal market whilst maintaining the integrity of Halal certified products within Malaysia by overcoming systemic obstacles and using technological change.

2. Literature Review

2.1. Halal in Supply Chain

The Halal supply chain is an integral part of the food and beverage industry, making sure that Halal guidelines are followed at every stage of the chain. Products classified as Halal are not limited only to food; the components of the supply chain involve ethics, hygiene, and legal compliance (Ahmad et al., 2021). This process assures more than just keeping the people satisfied but also obeying the laws of Islam, specifically in the case of Malaysia, which aims to cement its status as the global center for Halal. Malaysia has a competitive advantage in the Halal market because of

active governmental policies, such as the Halal Development Master Plan, and the engagement of other bodies like JAKIM. These dynamics have thrust Malaysia into the forefront of Halal goods production (Halal Development Corporation, 2023). SME's in Halal food and beverage sector are vital for the economic progression of Malaysia. With the increasing worldwide interest in products that fit the Halal criteria, there arises the urgency for sophisticated supply chain systems that guarantee trust and proper regulations.

The food and beverage industry and the Halal ecosystem of Malaysia greatly rely on SMEs. In addition, SMEs such as producers, distributors, and retailers are crucial to nearly every stage in the supply chain. As much as they contribute, SMEs continually struggle against inadequate resources, access to sophisticated technology, and challenges meeting the strict Halal requirements (Ahmad & Wan Jusoh, 2022). These obstacles reduce their chances of successfully competing in the international marketplace and demonstrate the necessity of complying solutions. Ensuring Halal compliance within the supply chain is one of the greatest challenges due to high risks of cross-contact, limited transparency, and complicated logistics. For example, the tarnishing of the product's Halal status due to ineffective segregation during transport or storage will further distance consumers from trusting the products (Ali et al., 2023). Further, SMEs do not possess adequate knowledge or skills to design and integrate many traceability systems, adding to the multitude of problems. There are design solutions that traceability can be integrated into businesses to make them more inexpensive and convenient which in turn increases compliance, with these problems, compliance becomes effortless.

The inefficiency of a void traceability system and maintaining compliance in the Halal supply chain stems from distrust within the supply chain and culture specific factors particular to Malaysia. There exists a lack of trust regarding certificates issued, in addition to the fragmentation that exists in the halal certification market as well as the weak enforcement of the regulations within the supply chain. Malaysia can position itself as an international leader in the halal market by boosting the competence of its SMEs through the adoption of advanced technologies such as automated cross-functional traceability systems. This will not only maintain the trust and integrity of the halal supply chain but would also strengthen Malaysia's position in the global halal market.

2.2. Halal Traceability System

A Halal traceability system is crucial in guaranteeing that different processes within the supply chain comply with Islamic principles. Such a system can monitor and authenticate the sourcing, production, transportation, and distribution processes of Halal products. Traceability systems also secure the products' Halal integrity by monitoring all supply chain processes. Traceability in the food and beverage industry means that not only are the products Halal-compliant, but that they are also free from contaminations and frauds. Such claims are important to sustain and nurture consumer confidence as well as meet the stringent requirements of Halal certification. There are significant contributions to operational and supply chain efficiencies as a result of the Halal traceability systems. As Noor et al. (2020) state, such systems build trust in consumers because they can ascertain compliance with Islamic guidelines and check product details. Moreover, through enhanced monitoring, data sharing, and streamlined logistics, these systems reduce supply chain inefficiencies and minimize wastage. There is particular importance for Malaysia SMEs hoping to widen their market as Sulaiman et al. (2022) state, because such systems help access new Halal markets by proving compliance with international Halal requirements.

A number of gaps still remain within the literature on Halal traceability systems. Gaps such as SMEs remain unexploited even though their role in Malaysia's Halal food and beverage industry is ever so critical. Previously, Noor et al. (2020) pointed out one such gap regarding a small and medium-sized enterprises' capability to adopt systems of modern technological advancement. Moreover, not much has been done to apply the TOE framework with regards to Halal traceability systems. Although this framework offers rich avenues to analyse the technology, organization, and environment issues that affect adoption, it is still underutilized (Ahmad et al., 2022). Moreover, there are no studies that focus on Malaysia's position as a focal point for global Halal trade and are able to create an impact on adoption of traceability systems. In a similar context, as Malaysia endeavours to promote itself as a key global player, the need for a Halal traceability system becomes increasingly crucial. Traceability of Halal goods food in particular has been marked by the Malaysian government and the Halal certifying entities as a matter of sustaining competitive advantage in the global scheme of things (Hassan et al., 2021). This has dire consequences for SMEs that make up a sizeable portion of Malaysia's food and beverage industry because compliance with the local and global Halal requirements is now legislation.

2.3. T-O-E Framework

Tornatzky and Fleischer (1990) proposed the Technology-Organization-Environment (TOE) framework which divides context into three context technological, organizational, and environmental. The TOE framework,

which is commonly used for the adoption of innovations in organizations, is relevant for understanding the intent of SMEs to implement Halal traceability systems in Malaysia's food and beverage supply chain. The technological context includes the adoption of technology which has factors such as relative advantage, compatibility, and complexity, which influence its adoption (Ahmad et al., 2021). In addition, sustaining and acquiring resources, providing managerial support, and the size of the firm as internal factors for adoption are accounted in the organizational context (Ali et al., 2022). Lastly, the environmental context comprehends the external market, competition, and the policy which affect the organizational decision making processes (Hassan et al., 2023). With respect to this research, using TOE framework allows examining the systems adoption from the perspective of its benefits and barriers which makes this framework suitable for this study.

2.3.1. Technology Context

The technology context of the TOE framework looks at the components that accompany the adoption of the technological innovation. Previously, Tamin and Adis (2022) highlight relative advantage and compatibility as important variable which significantly influence SMEs' adoption of digital system in online distribution. In this study, the Technology Acceptance Model (TAM) is incorporated into the context of technology to analyse perceived usefulness and perceived ease of use as critical factors influencing SMEs' intentions to adopt Halal traceability systems. Davis (1989) argues that TAM is perceived usefulness, which is defined as the extent to which users believe a technology will aid in performing their tasks to a higher level within an organization, and perceived ease of use, which is defined as the degree to which users believe a system is user friendly. These factors are two of the most important drivers of technology adoption. Recent studies affirm postulations made about the contextual factors of Halal traceability systems with particular focus on the ease and utility of the technologies. For instance, Ahmad et al. (2021) reported that SMEs' perceived usefulness of traceability systems in the agriculture supply chain enhanced their operational efficiency as well as compliance with the Halal standards. Ali and Noor (2022) were able to determine that systems believed to be perceived ease of used are more readily accepted as SMEs tend to prefer adopting systems that are designed to be user friendly and do not require a lot of skills. Also, Hassan et al. (2023) underscored that the ease of integrating new systems with existing processes increases the probability of adoption.

Integrating the elements of perceived usefulness and perceived ease of used into a technology framework is critical for the Malaysian Halal food and beverage supply chain, especially among SMEs with limited resources and technical capabilities. Knowing these elements helps stakeholders to develop effective traceability systems that are user-friendly and serve the purposes of SMEs while enhancing compliance and consumer confidence. Thus, the following hypotheses are formulated:

H1: There is a significant relationship between perceived usefulness and intention to adopt Halal traceability systems in SMEs' Halal F&B supply chain.

H2: There is a significant relationship between perceived ease of use and intention to adopt Halal traceability systems in SMEs' Halal F&B supply chain.

2.3.2. Organization Context

The organization context is considered in terms of the internal factors that affect a firm's ability to adopt new technologies in the TOE framework. This research identifies top management support as well as employee training as additional key factors in the organizational context. Furthermore, top management support demonstrates a leadership's readiness to allocate resources to nurture development and stimulate their innovation adoption. Meanwhile, employee training is defined by the organized actions aimed at preparing the employees to use a new system proficiently. In the other hand, top management support serves as a major predictor of effective technology adoption. For instance, Ismail and Hassan (2021) highlighted top management support helps organizational determination and effort towards minimizing resistance to change. Regarding the Halal traceability systems, the engagement of leaders ensures that business operations are aligned with compliance to the Halal requirements. However, Ali and Noor (2022) found a lack of leadership engagement in SMEs, where their limited resource capacities make it difficult for top management to pay attention and fund technological initiatives. Moreover, employees training is yet, another important but rarely discussed issue in the context of technology adoption. Abdullah et al. (2023) suggest, employees may be unable to operate advanced systems without comprehensive training programs being put into place. System adoption within the Halal food and beverage supply chain is aided by well-structured training programs in SMEs because, as Hassan and Ahmad (2023) assert, trained employees are readily able to implement processes enhancing traceability within a company's already existing workflows. Moreover, Ali et al. (2022) found the resources as well as the manpower constraints that many SMEs face make it hard for them to implement training. This ultimately results in an inability to continuously build long-term skill in the workforce.

Given the importance of these factors, this study seeks to address the following hypotheses:

H3: There is a significant relationship between top management support and intention to adopt Halal traceability systems in SMEs' Halal F&B supply chain.

H4: There is a significant relationship between employee training and intention to adopt Halal traceability systems in SMEs' Halal F&B supply chain.

2.3.3. Environment Context

The environmental context in the TOE framework reviews external elements that can affect an organization's choice in adopting new technologies. This study expands the environmental context by integrating government support and competitor pressure, which are two important considerations in the adoption of the Halal traceability systems in Malaysia's food and beverage supply chain. Government support includes not only the policies and regulations that facilitate technology adoption, but also the incentives provided for the adoption. Meanwhile, competitor pressure stems from the innovations already adopted by other businesses within the industry that demand to be emulated in order to stay competitive. It has been noted that government support is a critical factor in the adoption of technologies. As noted by Hashim et al. (2022), government spending in form of grants and other regulations centralizes the new technologies upgraded into SMEs. Nonetheless, Ali and Rahman (2023) found a lack of focus in governmental support for the adoption of the Halal traceability systems in Malaysia's food and beverage industry, especially among SMEs. Because there is no single unified national regulation that prescribes the standards for Halal supply chains, many SMEs are left stranded, uncertain of what assistance might be available to them. In addition, competitor pressure is one of the external factors that has a direct ability to foster the rapid adoption of new technologies. One of the notable external influences that have direct potential to rapidly expedite the adoption of new technology is competitor pressure. This has been researched extensively by Sulaiman et al. (2023) explained that SMEs in competitive environments tend to adopt traceability technologies whenever they notice their competitors using them for market leverage. On the other hand, Noor and Ahmad (2021) point out a deficit where Malaysian SMEs are unable to meet the competition because of their limited financial capabilities and resources. Lack of knowledge and understanding about the importance of the Halal traceability systems can influence SMEs, and adoption becomes harder even when they feel competitive pressure.

Given these factors, the following hypotheses are proposed:

H5: There is a significant relationship between government support and intention to adopt Halal traceability systems in SMEs' Halal F&B supply chain.

H6: There is a significant relationship between competitor pressure and intention to adopt Halal traceability systems in SMEs' Halal F&B supply chain.

3. Methodology

This research uses a cross sectional survey method in ascertaining the adoption intention of Halal traceability system among the SMEs in the food and beverage industry in Malaysia. This study employs a quantitative research method by using a structured survey instrument to gather information. The theoretical framework of the study underscores six independent variable and one dependent variable which captures the intentions of SMEs to adopt Halal traceability system. The cross sectional survey design is popular in adoption studies because they ease the collection of data at a singular moment (Creswell, 2014). Moreover, the target population for this research includes small and medium enterprises in the halal food and beverage industry in Malaysia. In particular, the respondents are managers, executives, and senior marketing or branding officers in these companies. This selection was made because of their roles in the strategic management concerning halal compliance and technology incorporation. The adoption of halal traceability system in Malaysia has been suggested this being a growing emerging market with great importance to the economy (Halim & Salleh, 2018). In addition, as these products offer as the adoption of these traceability systems are highly competitive, which means that the industry is very fragmented (Tieman, 2017).

For the purpose of this study, a sample that could be generalized was obtained through the application of a probability sampling technique, especially stratified random sampling. The study sample was comprised of registered SMEs within the halal food and beverage industry derived from the SME listings of Majlis Amanah Rakyat (MARA) and SME Corp Malaysia. This approach guarantees that the sample represents the entire population with regard to the varying types of businesses in the industry while avoiding selection bias. Sekaran and Bougie (2016) suggest that stratified random sampling improves accuracy of estimates by the use of subgroups in the population instrument. The sample size was calculated using G*Power analysis, which computes a minimum required sample for 185 respondents for statistical soundness. 270 questionnaires were distributed during the data collection period, including 138 online and 132 offline. From the total distributed, 258 were filled and returned. Following data screening and cleansing, 245 were determined to be complete and valid after removing 13 respondents that provided incomplete data or inaccurate information.

The main primary data collection tool was a self-administered questionnaire which had eight parts to it. The survey was prepared in two languages (English and Malay) which was likely to help in responding to the survey accurately. The questionnaires were drafted after carefully going through several literary pieces to obtain pre-tested and validated measurement scales (Ajzen, 1991). These measurement items were then adjusted to reflect the study's context and intended audience. The concluding draft of the questionnaire underwent a multi-stage refinement process in which the researchers tested the content validity and reliability of the questionnaire through cognitive interviews, focus group discussion, and pilot study (Bryman, 2015).

Data was collected and analyzed using the Statistical Package for the Social Sciences (SPSS) Version 23.0 and SmartPLS 3.2.7. SPSS was used for calculating descriptive statistics, preliminary data analysis, and basic screening of data while Smart PLS was used to carry out Partial Least Squares Structural Equation Modeling (PLS-SEM) to confirm the proposed hypotheses and evaluate the measurement and structural models (Hair et al. 2017). In terms of exploratory research in new domains, Chin (1998) argued that PLS SEM is particularly advantageous given its ability to produce acceptably accurate results with small sample sizes. This is why this study intends to shed light on aspects regarding Halal traceability system adoption by SMEs in Malaysia's food and beverages supply chain.

4. Analysis

The analysis of this study begins with profiling the respondents who participated in this research. Table 1 demonstrates the overall demographics of the characteristics of the sample. Most respondents are small-sized enterprises (44.9%), followed by micro-sized (39.5%) and medium-sized (15.6%) businesses. This is evidence of the high density of small enterprises in Malaysia's food and beverage industry. In terms of years of operation, 39.2% of SMEs have been in business for less than three years and 31.8 % have operated for more than eleven years, thus indicating a mix of younger and older firms. Half of the SMEs (50.2%) report an annual turnover volume equals or less than RM300,000, which indicates the low scale of many businesses in the sample. The respondents also have an even distribution in all the major states of Malaysia, including Selangor, Johor, Sarawak, Sabah, Pulau Pinang, and Pahang, which adds to the regions' representative sample. Furthermore, 73.9 percent of SMEs are operated domestically with only 26.1 percent selling in international markets, thus reaffirming the primary focus of most of the businesses. The results are consistent with other studies which have stated that the small and local oriented firms are the most predominant in Malaysia's SME context (Abdul-Halim et al., 2019).

Table 1: Profile of Respondents

Demographic Variables	Categories	Freq.	%
Company Size	Micro	97	39.5
	Small	110	44.9
	Medium	38	15.6
Years of Operation	Less than 3 years	96	39.2
	6 to 10 years	71	29.0
	11 years above	78	31.8
Average Sales Annual Turnover	Less than RM300 000	123	50.2
	RM300 000 to RM500 000	50	20.4
	RM500 000 to RM1 Million	39	15.9
	More than RM1 Million	33	13.5
Market Level	International	64	26.1
	Domestic	181	73.9
Average Market Share	Less than 5 per cent	118	48.1
	6 per cent to 10 per cent	79	32.2
	11 per cent to 15 per cent	28	11.4
	Above 16 per cent	20	8.3
State	Selangor	40	16.3
	Johor	40	16.3
	Sarawak	40	16.3
	Sabah	45	18.5
	Penang	40	16.3
	Pahang	40	16.3

This research encompasses a descriptive statistical analysis using the mean score and standard deviation to better understand the sample. This analysis was carried out to facilitate capture of trends within the data and achieve clear understanding of various perceptions of respondents with specific regard to central variables of interest. The mean scores and standard deviations are summarized in Table 2 that shows the constructs related to the TOE framework. With regard to technology context, SMEs rated the perceived usefulness of the Halal traceability system very highly (mean = 4.24), while perceived ease of use was rated as moderate (mean = 3.88). These results indicates that SMEs are aware of the advantages coming with the Halal traceability system, however, there are challenges concerning its effectiveness, especially usability. In the organizational context, high mean scores were obtained for top management support (mean = 4.06) and employee training, (mean = 4.00), which indicate strong internal readiness for adoption of Halal traceability system. In the environmental context, government support averaged means of (mean = 4.10) and competitor pressure (mean = 4.02). Lastly, the intention to adopt Halal traceability system, scores moderately (mean = 3.84) suggesting a positive but not strong inclination toward adoption. These results stressed the complexity of factors and processes at play with respect to the adoption of Halal traceability systems influenced at both external and internal levels.

Table 2: Descriptive Statistic

	Variables	Mean	Std. Deviation
Technology Context	Perceived Usefulness	4.24	0.53
	Perceived Ease of Used	3.88	0.67
Technology Context	Top Management Support	4.06	0.57
	Employee Training	4.00	0.62
Environment Context	Government Support	4.10	0.60
	Competitor Pressure	4.02	0.76
Dependent Variable	Intention to Adopt Halal Traceability System	3.84	0.52

Table 3 illustrates the assessment of cross reliability and validity of the constructs of the study. A high level of internal consistency across all variables was noted. The values of Composite Reliability (CR) surpassed the recommended threshold of 0.7 (Hair et al., 2019). For example, perceived usefulness (CR = 0.821) and perceived ease of used (CR = 0.935) were strongly reliable with factor loadings ranging from 0.679 to 0.874. In the same manner, top management support (CR = 0.821) and government support (CR = 0.895) were reliable with factor loading above 0.7. Moreover employee training and competitor pressure score CR value as 1.068 and 0.778 respectively. Also, convergent validity was proved because most of the constructs had average variance extracted (AVE) values above 0.5. The measurement model, as a whole, validates the constructs used in the study which aids in establishing the credibility and reliability of the research findings.

Table 3: Result of Measurement Model (Internal Consistency Reliability and Convergent validity)

Construct	Items	Loadings	AVE	CR
Perceived Usefulness	PU1	0.748	0.553	0.821
	PU2	0.752		
	PU3	0.679		
	PU4	0.737		
	PU5	0.688		
	PU6	0.710		
	PU7	0.725		
	PU8	0.844		
Perceived Ease of Used	PEU1	0.874	0.647	0.935
	PEU2	0.841		
	PEU3	0.713		
	PEU4	0.803		
	PEU5	0.663		
	PEU6	0.830		
	PEU7	0.846		
	PEU8	0.838		
Top Management Support	TMS1	0.729	0.553	0.821
	TMS2	0.785		
	TMS3	0.708		
	TMS4	0.695		
	TMS5	0.795		
Employee Training	ET1	0.670	0.511	1.068
	ET2	0.687		
	ET3	0.677		
	ET4	0.630		
	ET5	0.884		
Government Support	GS1	0.812	0.676	0.895
	GS2	0.815		
	GS3	0.736		
	GS4	0.886		
	GS5	0.855		
Competitor Pressure	CP1	0.744	0.595	0.778
	CP2	0.827		
	CP3	0.770		
	CP4	0.742		
Intention to Adopt Halal Traceability System	INT1	0.754	0.520	0.873
	INT2	0.708		
	INT3	0.703		
	INT4	0.777		
	INT5	0.638		
	INT6	0.749		
	INT7	0.688		
	INT8	0.741		

Note: PU= Perceived Usefulness, PEU= Perceived Ease of Used, TMS= Top Management Support, ET= Employee Training, GS= Government Support, CP= Competitor Pressure, INT= Intention to Adopt Halal Traceability System, AVE= Average Variance Extracted, CR= Composite Reliability.

Table 4 presents the results of hypothesis testing within the structural model, which examines the relationships between the TOE framework factors and the intention to adopt the halal traceability system among SMEs in Malaysia. Hypothesis testing is a critical step in determining whether the proposed relationships between variables are statistically significant and supported by the data. In this study, the hypotheses are tested using path coefficients, which indicate the strength and direction of the relationships, and p-values, which determine the statistical significance of these relationships.

Table 4: The Result of Direct Effect

	Parth	t-value	p-value	Decision
H1	Perceived Usefulness Intention to Adopt Halal Traceability System	2.763	0.016	Supported
H2	Perceived Ease of Used Intention to Adopt Halal Traceability System	0.434	0.664	Not Supported
H3	Top Management Support Intention to Adopt Halal Traceability System	2.408	0.016	Supported
H4	Employee Training □ Intention to Adopt Halal Traceability System	1.107	0.268	Not Supported

	Parth	t-value	p-value	Decision
H5	Government Support Intention to Adopt Halal Traceability System	2.539	0.011	Supported
H6	Competitor Pressure Intention to Adopt Halal Traceability System	2.237	0.025	Supported

The results reveal several key findings. First, perceived usefulness (a technological context) has a significant positive relationship with the intention to adopt Intention to Adopt halal traceability system, as indicated by a high path coefficient ($t = 2.763$, $p < 0.05$). Second, top management support (an organizational context) also shows a significant positive relationship with adoption intention ($t = 2.408$, $p < 0.05$). Third, government support (an environmental context) is found to significantly influence the intention to adopt halal traceability system ($t = 2.539$, $p < 0.05$). Fourth, competitor pressure (an environmental context) also found to significantly influence the intention to adopt halal traceability system ($t = 2.237$, $p < 0.05$). Thus, hypothesis 1, 3, 5, and 6 were accepted.

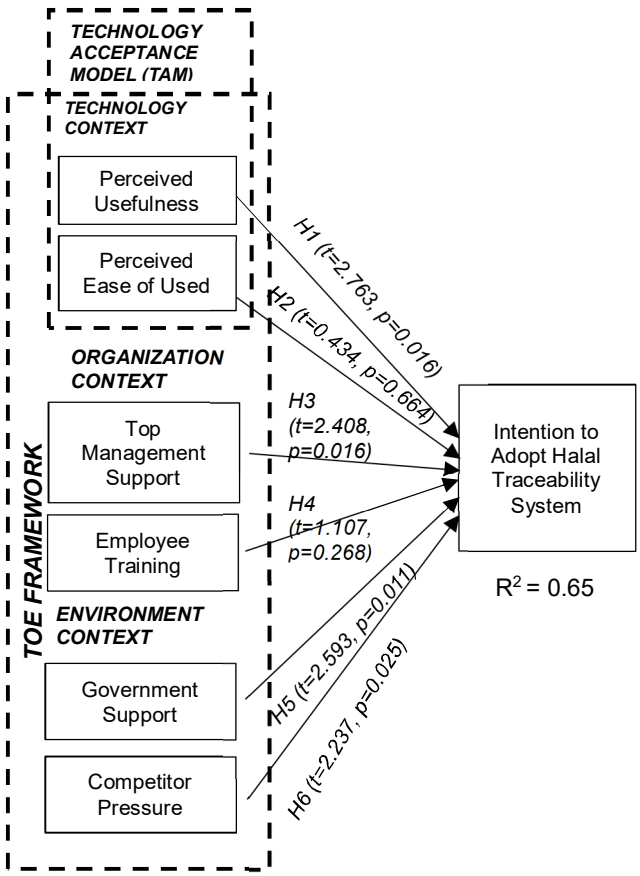

Figure 1: Hypothesis Testing

However, while perceived ease of use (a technological context) and employee training (an organizational context) show no relationships with intention to adopt halal traceability system with t-value 0.032 and 1.107 respectively, while $p > 0.05$. This suggests that while ease of use and employee preparedness are important, they may not be as decisive as perceived usefulness, top management support, government support or competitor pressure in driving adoption.

Also, from Figure 1, the R^2 value which measures the variance on dependent variable (intention to adopt Halal traceability system) and is explained by the independent variables indicate robustness. That is, $R^2 = 0.65$. This suggests that the model captures the variables associated with adoption intentions sufficiently since a high proportion of the variance, is accounted for. This is in accordance with previous studies which highlighted the need for an integrated approach to be taken when dealing with the adoption of a particular technology (Ali et al., 2021).

5. Discussion

This research shed important light on the processes that affect the intention of SMEs to adopt the Halal traceability system within the context of Malaysia's food and beverage supply chain from the perspective of the TOE framework. The results of the hypothesis testing reveal that the following factors have a significant and positive effect on the intention to adopt Halal traceability system: perceived usefulness, top management support, government support, and competitor pressure. On the contrary, perceived ease of use and employee training show no relationships with intention to adopt Halal traceability system. This research elucidate the specific factors for and against the adoption of the halal traceability system among SMEs.

The positive correlation between perceived usefulness and intention to adopt Halal traceability system confirms the Technology Acceptance Model (TAM), which asserts that the perceived advantages of a system are an important factor for its adoption (Davis, 1989). SMEs will be more willing to accept the Halal traceability system if their beliefs relate to enhanced operational efficiency, product quality, and market share. This result is in line with other studies focusing on the significance of perceived usefulness in technology adoption within the Halal industry (Zailani et al., 2020). Moreover, top management support facilitates this adoption due to their willingness to support as managers' engagement is critical for resource mobilization, managerial transformation, and innovative cultures. This, in turn, suggests the need for comprehensive internal leadership that deals with the implementation of new technologies (Ali et al., 2021). Furthermore, the presence of government aid emerges as

one of the key factors in the adoption of halal traceability system. This highlights the importance of external factors, such as the government, on the adoption of new technologies. Financial and operational barriers to adoption by SMEs are eased through government policies, incentives and regulatory frameworks. This is consistent with the literature which argues that SMEs require active government support to adopt new technologies (Abdul-Halim et al., 2019). Furthermore, competitive pressure is also found to have positive effect on the adoption intention which means that SMEs are willing to adopt halal traceability systems because they want to stay in the competition. This supports institutional theory, which claims that firms adopt innovative practices as a response to competition (DiMaggio & Powell, 1983).

Interestingly, perceived ease of use and employee training have no relationships with intention to adopt halal traceability system. This unexpected result is likely due to the system's ease of use combined with the training provided for use of the system does not outweigh the difficulty of system implementation. Halal traceability system is likely viewed by SMEs as a sophisticated, time consuming, and resource intensive system that, regardless of the training and its ease of use, is difficult to use. These results challenge traditional technology adoption models, but are in agreement with recent literature which argue that complexity, even when training is available, can be a barrier to adoption (Venkatesh et al., 2016). At the organizational level, adoption decisions are made by top managers and hinge on relative advantage/performance, strategic fit, partner pressure, and readiness—not end-user usability per se. In such settings, perceived ease of use (an individual-level TAM construct) often gets eclipsed by performance/benefit beliefs, top management support, and environmental pressures. Meta-reviews of firm-level adoption under TOE/DOI emphasize relative advantage, compatibility, competitive pressure, and readiness—while "complexity/PEOU" shows mixed or weak effects (Oliveira & Martins, 2011).

Hence, this study illustrates the complex and multifaceted interactions of intention to adopt a Halal traceability system for SMEs, especially with regard to the influence of technological, organizational, and environmental context. It also shows shed light on important determinants such as perceived usefulness, top management support, government support, and even competitor pressure that underline the need for a more collaborative approach towards promoting Halal traceability system adoption. On the contrary, the lack of relations with perceived of ease of use and employee training suggests that SME's face dire obstacles in accepting Halal traceability systems, whether they desire to or not. Those observations can aid policymakers, industry participants, and SMEs themselves in enhancing their understanding and adoption of Halal traceability systems, improving the overall integrity of Halal supply chains.

6. Managerial Implication, Limitation, and Future Research

This research offers recommendations for SMEs, policymakers, and other stakeholders in Malaysia's Halal F&B value chain. The significant positive impact of perceived usefulness on adoption intentions suggests SMEs should highlight Halal traceability's benefits, including increased productivity, improved product quality, and enhanced market competitiveness (Zailani et al., 2020). Managers should develop targeted marketing campaigns and training sessions demonstrating how the system addresses business challenges and adds value. Strong top management support is essential for resource allocation and innovation (Ali et al., 2021), while leveraging government incentives, tax relief, and regulatory guidance can ease cost barriers (Abdul-Halim et al., 2019). SMEs should also track competitor initiatives to remain competitive (Sulaiman et al., 2023) and collaborate with industry associations to enhance knowledge sharing and accelerate adoption.

Moreover, the positive influence of government support underscores the need for policymakers to create an enabling environment for Halal traceability adoption. This includes offering financial assistance, tax incentives, and favourable regulations to reduce costs and implementation challenges. Public–private partnerships should be established to improve information dissemination and build knowledge among SMEs. In addition, competitor pressure highlights the importance for SMEs to monitor market developments and adopt Halal traceability systems to remain competitive. Industry associations can further contribute by facilitating information sharing and fostering networks to accelerate and broaden system implementation.

This study makes notable contributions but has limitations that should be acknowledged. First, it focuses solely on SMEs in Malaysia's food and beverage industry, limiting the generalizability of results to other sectors or regions. Future research should validate the findings by including larger firms and SMEs in other industries. Second, as a cross-sectional study, it captures intentions at a single point in time, providing only a snapshot of adoption behaviour; longitudinal studies would better capture changes over time. Further, qualitative approaches such as interviews or case studies could offer richer insights into barriers and enablers of adoption. Exploring how technological infrastructure, supply chain capacity, and consumer requirements influence adoption is also recommended. Lastly, the non-significant relationships

between perceived ease of use, employee training, and adoption intention warrant deeper investigation, as they may reflect contextual challenges and system complexity. Overall, this study advances understanding of factors influencing SMEs' adoption of Halal traceability systems and offers valuable guidance for managers and policymakers.

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