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**Research Paper**

# Advancing Halal Supply Chain Management in Taiwan: A DEMATEL-Based Approach to Integrating Consumer Awareness, Sustainability, and Certification Standards.

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**Abstract**

This study investigates Halal Supply Chain Management (HSCM) advancement in Taiwan using the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method. Focusing on four critical perspectives, Compliance and Certification, Ethical Sourcing and Sustainability, Quality Control and Traceability, and Consumer Awareness and Communication, the research identifies 18 key criteria influencing HSCM. Insights from 15 industry experts emphasize the central role of consumer awareness, including clear labelling and educational campaigns, alongside the need for advanced technologies like blockchain and IoT. Despite challenges such as limited product scope and early-stage adoption of technologies, the study aligns its findings with ESG principles and Sustainable Development Goals (SDGs), providing a pathway for optimizing halal supply chains globally.

**Keywords:** *DEMATEL; Halal; Management; Supply Chain; Taiwan*

## INTRODUCTION

Despite the growing global demand for halal-certified products and the increasing importance of sustainable supply chain practices, a significant research gap remains in integrating sustainability principles such as Environmental, Social, and Governance (ESG) criteria and Sustainable Development Goals (SDGs) with halal supply chain management (HSCM), particularly in non-Muslim-majority contexts like Taiwan. Most existing studies predominantly focus on halal supply chain challenges in Muslim-majority countries, leaving critical unanswered questions regarding how sustainability principles can be effectively applied, optimized, and institutionalized in diverse cultural, regulatory, and economic environments. This research gap hinders the development of robust, globally applicable HSCM frameworks, affecting industry stakeholders, businesses, and policymakers who aim to expand halal markets in non-traditional halal economies.

This study investigates the unique dynamics of the halal supply chain in Taiwan, where Muslims make up only 0.2% of the population (approximately 50,000 individuals). This relatively small yet growing demographic driven by immigration and foreign workers has led to Taiwan's increasing engagement with the halal economy (Ghalih & Chang, 2024a). The Taiwan Halal Center, established by the Taiwan External Trade Development Council (TAITRA) in 2017, reflects the government's commitment to integrating halal principles into its trade and industry policies. However, adopting halal-specific supply chain management practices remains early, and key challenges persist, particularly in ensuring halal integrity, operational efficiency, and sustainability (Pratiwi et al., 2024).

This research identifies three pivotal challenges in the halal supply chain's sustainability context: ensuring halal integrity throughout the supply chain to maintain compliance with Islamic guidelines, the limited adoption of halal-specific supply chain practices in logistics, procurement, and certification, and the underexplored intersection of sustainability and halal supply chains, particularly regarding ESG integration, ethical sourcing, and environmental responsibility (Ghalih

et al., 2024). Given the increasing global demand for halal-certified products, improving accessibility, transparency, and efficiency within Taiwan's supply chain aligns with the government's 'people-centred' policy, prioritising inclusivity and consumer diversity (Ghalih & Chang, 2024b). Addressing these challenges requires a robust decision-making framework to identify, prioritize, and structure the complex interdependencies between consumer awareness, sustainability, and certification standards in halal supply chain management.

To achieve this, the study employs the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method, a widely recognized multi-criteria decision-making (MCDM) approach that is particularly suited for analyzing complex systems with interdependent factors (Aaldering et al., 2018). The DEMATEL method is chosen for this research because it enables a systematic evaluation of cause-effect relationships among key variables influencing the halal supply chain. Given the interconnected nature of halal integrity, sustainability practices, and regulatory compliance, DEMATEL provides a structured, data-driven approach to identifying the most influential factors in optimizing HSCM. Unlike traditional analytical techniques, DEMATEL visually maps the causal relationships between different factors, making it easier for policymakers and industry stakeholders to prioritize actionable strategies. Furthermore, DEMATEL has been widely applied in supply chain analysis, especially in contexts where multiple stakeholders such as governments, certification bodies, businesses, and consumers must collaborate to ensure compliance and efficiency. Applying DEMATEL to Taiwan's halal supply chain will offer empirical evidence to support the development of policy recommendations, strategic improvements, and operational enhancements.

By integrating DEMATEL with sustainability principles, this study extends prior research in halal supply chain optimization, offering a comprehensive, evidence-based framework that aligns with global sustainability trends and Taiwan's evolving halal industry landscape. The research provides practical insights and strategic recommendations for industry professionals, policymakers, and halal certification bodies to enhance Taiwan's halal supply chain's functionality, traceability, and sustainability. As halal markets continue to globalize, understanding and optimizing halal supply chains in diverse regional contexts is critical for businesses looking to thrive in this expanding sector. Consequently, this study serves as a valuable resource for academics, industry experts, and policymakers, offering data-driven strategies to strengthen and navigate the halal supply chain landscape in Taiwan and globally.

## LITERATURE REVIEW
### The Consumer Awareness in HSCM

Consumer awareness shapes halal supply chain management (HSCM) (Ahmad et al., 2018). Clear communication on halal certification, product quality, and traceability fosters consumer trust and enhances market competitiveness. Studies show that halal-certified products significantly boost purchase intention and trust, even from non-Muslim countries. Brands leveraging halal logos and branding gain a competitive edge, as certification assures compliance with religious standards and product safety, driving demand and loyalty (Abdullah et al., 2023).

To sustain this trust, education and engagement strategies are essential. Transparent labelling empowers consumers, while awareness campaigns through workshops, halal expos, and social media enhance public understanding. Platforms like Facebook and Instagram facilitate real-time communication, addressing consumer queries and misconceptions and strengthening confidence in halal brands (Kurniawati & Cakravastia, 2023). Direct engagement with reputable certifying bodies and responsive customer service further reinforce authenticity. Trust deepens when consumers feel informed and heard, driving a more resilient halal supply chain (Saville & Mahbubi, 2021).

## Sustainability in Halal Supply Chain Management

Sustainability is now a key element of halal supply chain management (HSCM) (Zulfa et al., 2023), extending beyond ritual compliance to ethical and eco-friendly practices. Recent literature highlights ethical sourcing and environmental responsibility as core pillars alongside economic considerations (Zulfa et al., 2023). Halal supply chains increasingly adopt fair labor practices, community engagement, and transparency measures, ensuring Shariah compliance, social justice, and environmental stewardship (Keliat & Sentanu, 2022). These align with Islamic principles, such as avoiding waste (isrāf) and global sustainability goals (Soeroto et al., 2023).

Companies integrate Sustainable Development Goals (SDGs) by reducing their environmental footprint through water-saving technologies, renewable energy, and ethical ingredient sourcing (Tseng et al., 2022). Efforts like sustainable packaging, biodegradable materials, and waste management programs address regulatory demands and cater to eco-conscious Muslim consumers (Zuhri et al., 2023).

Technology-driven transparency further supports sustainability in HSCM (Tseng et al., 2022). Blockchain enhances halal traceability by providing tamper-proof records from farm to fork, ensuring integrity and consumer trust. Studies show that blockchain, often combined with IoT sensors and QR codes, allows stakeholders to instantly verify halal status, reducing waste and improving quality control (Tayob, 2021). Alongside blockchain, innovations such as AI-driven supply chain optimization and biodegradable tracking are advancing environmental performance. By integrating ethical sourcing, carbon reduction, and cutting-edge traceability, modern halal supply chains are evolving to be Shariah-compliant, socially responsible, and environmentally sustainable (Saffinee et al., 2024).

## Halal Certification Standards and Global Recognition

A robust certification framework ensures the integrity of the halal supply chain, with major certification bodies like JAKIM (Malaysia), MUIS (Singapore), and ESMA (UAE) setting global standards. While all three certify compliance with Islamic dietary laws, they operate within distinct regulatory contexts, leading to variations in standards and influence. JAKIM is renowned for its stringent halal certification under the Malaysia Halal Standard MS 1500, covering the entire supply chain from raw materials to final storage. Its certification is globally respected, recognized in 31 countries, and enforced through government oversight, periodic audits, and a Non-Conformance Report (NCR) system. JAKIM only recognizes select foreign certifiers, often requiring re-certification for imported halal products (Respati et al., 2024).

MUIS, as Singapore's religious authority and halal certifier, places strong emphasis on ingredient verification and documentation, requiring halal certificates, lab reports, and supply chain audits. Its MUIS-HC-S001 standard aligns with international guidelines and is adopted by 31 certification bodies across 24 countries. Certified establishments are subject to rigorous inspections, and MUIS certification is highly valued by multinational companies seeking broader market acceptance. Similarly, ESMA enforces halal certification under GSO 2055-1:2015, ensuring compliance with the UAE's national halal standards. The UAE mandates halal certification for a wide range of products, including meat, poultry, and cosmetics, under strict legal frameworks such as Cabinet Decision No. 35 of 2015. The UAE's GSO halal standard influences global markets, particularly within GCC and parts of Asia, requiring strict oversight through federal laws, halal quality managers, and traceability controls (Bux et al., 2022).

Despite enforcing core halal principles such as the prohibition of pork, improper slaughter, and contamination, differences in certification criteria remain. JAKIM requires specific traceability and recall procedures, while MUIS mandates extensive documented proof of every ingredient's halal status. ESMA follows GSO standards, sometimes allowing mechanical slaughter under

controlled conditions. This lack of a unified global halal standard forces companies to obtain multiple certifications to enter different markets, increasing complexity and costs (Huda et al., 2024).

Efforts toward harmonization are ongoing, with organizations like SMIIC (under the OIC) working to establish a unified halal standard. JAKIM, MUIS, and ESMA participate in international halal forums to align regulations, though full integration remains challenging. Nonetheless, these certification bodies set benchmark halal standards, ensuring transparency and trust in supply chains (Al-shami & Abdullah, 2023). As the industry moves toward greater standard harmonization and mutual accreditation, it will streamline halal supply chain management (HSCM), reduce redundancy, and reinforce global consumer confidence in halal products (Al-shami & Abdullah, 2023).

**RESEARCH METHOD**

The Decision-Making Trial and Evaluation Laboratory (DEMATEL) method was initially developed by the Science and Human Affairs Program of the Battelle Memorial Institute in Geneva to analyze and resolve complex, interdependent problems. This method is widely used in decision-making studies because it can map causal relationships between factors and structure them hierarchically (Mathivathanan et al., 2018). By constructing an influence matrix, DEMATEL helps identify the most influential factors and distinguishes between cause-and-effect variables, making it an effective tool for analyzing halal supply chain management (HSCM) in Taiwan (Gardas et al., 2018). Given the complexities of ensuring halal integrity, sustainability practices, and certification compliance, DEMATEL provides a structured and empirical approach to decision-making in the halal industry.

Recent applications of DEMATEL demonstrate its utility across various domains, including manufacturing, risk management, and urban sustainability. For example, Madan Shankar et al. (2017) applied DEMATEL in an Indian manufacturing firm to model supply chain complexities, while (Ha et al. 2017; Ha & Yang 2017) examined technological risk in port systems using causal mapping techniques (Bavafa et al., 2018). Extended DEMATEL's capabilities by integrating it with System Dynamics (SD) to predict construction delays, and Tsai (2018) employed the DEMATEL model to explore the job satisfaction of research and development professionals in China's photovoltaic cell industry. Such applications highlight the method's flexibility in addressing interrelated supply chain issues, making it particularly suitable for evaluating halal supply chain challenges in non-Muslim-majority markets like Taiwan.

To ensure the robustness of the analysis, this study conducted a structured expert evaluation involving a panel of fifteen professionals, each with at least five years of experience in halal supply chain management, halal product certification, or business operations within the halal industry. The expert panel was carefully structured to cover different perspectives within the industry: five professionals managing and operating halal supply chains, five experts specializing in halal product certification, and five business owners involved in halal product distribution and retail. This diverse composition comprehensively evaluated the critical factors influencing HSCM in Taiwan (Al-Mahmood et al., 2021; Al-shami & Abdullah, 2023; Mansur et al., 2022). Each expert participated in a structured pairwise comparison process, allowing the identification of cause-effect relationships among supply chain factors (Ahmad et al., 2017).

The pairwise comparison technique was employed to quantify the relationships between the identified factors. Experts were asked to assess the direct influence of one factor on another using a pairwise comparison scale ranging from 0 to 4, where 0 represents no influence, 1 represents low influence, 2 represents moderate influence, 3 represents high influence, and 4 represents very high influence. The expert responses were compiled into an initial direct-relation matrix, which captures

the raw input of pairwise comparisons. The average of all expert judgments was calculated for each criterion pair to enhance accuracy and consistency, forming a normalized direct-relation matrix (N). The total influence matrix (T) was then derived using the transformation formula:

$$T = N \times (I - N)^{-1}$$

where I is the identity matrix. This transformation allows the detection of indirect influences, helping to distinguish between direct and indirect causal relationships within the halal supply chain. The influence degree (D) and dependence degree (R) were computed for each factor using the equations:

$$D_i = \sum_j T_{ij}, R_i = \sum_j T_{ij}$$

D (Influence Degree) represents the total impact exerted by a factor on others, and R (Dependence Degree) indicates the total impact received from other factors. By plotting (D + R) vs (D - R), a causal diagram was generated, classifying variables into cause factors (which have a strong influence on the system) and effect factors (which are primarily influenced by other elements). This visualization of causal relationships helped to identify the most influential drivers of halal supply chain efficiency in Taiwan.

The application of DEMATEL in this study provides a structured and empirical basis for understanding the complexities of halal supply chain management in Taiwan. By quantifying consumer awareness, sustainability integration, and certification challenges, this method enables stakeholders to identify the most critical influencing factors, prioritize interventions based on cause-effect analysis, and develop an optimized decision-making framework. The findings contribute to the advancement of decision-making in halal logistics by offering practical insights for businesses, policymakers, and certification authorities to enhance supply chain transparency, regulatory compliance, and consumer trust. This study fills the research gap in halal supply chain sustainability by integrating expert evaluations with mathematical modelling. It provides practical tools for industry stakeholders to improve operational efficiency in a non-Muslim-majority market like Taiwan.

Stage 1: This phase involves identifying and defining the diverse influential factors of complex systems, utilizing data sourced from literature reviews, expert consultations, or brainstorming sessions. Additionally, a scale measuring the degree of influence is developed to facilitate pairwise comparisons among the factors. This process assists in elucidating the causal relationships and the extent of influence exerted by each factor.

Stage 2: Upon establishing the significance of the measurement scales, the questionnaire survey method is utilized, wherein experts conduct pairwise assessments of the factors to ascertain both the magnitude and orientation of their interactive influences. Consequently, a direct relation matrix is constructed. Each non-diagonal entry in this matrix denotes the magnitude of the interactive influence between respective factors. In contrast, all diagonal entries are systematically set to zero to indicate no self-influence.

$$X = \begin{bmatrix} 0 & x_{12} & \cdots & x_{1n} \\ x_{21} & 0 & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & 0 \end{bmatrix}$$

Stage 3: Compute a normalized direct relation matrix by employing the column vector's maximum value as the threshold for normalization. This method involves adjusting the values within the matrix such that each element is divided by the maximum value found in its respective column. This approach ensures that the matrix elements are proportionally scaled down to a range between zero and one, facilitating comparisons and further analytical processing. The normalization of the direct relation matrix is crucial for maintaining consistency and enhancing the interpretability of the data, especially when assessing the relative strength of interactive influences between factors.

$$\lambda = \frac{1}{\underset{1 \le i \le n}{Max}\left(\sum_{j=1}^{n} x_{ij}\right)}$$

$$N = \lambda X$$

Stage 4: Compute the matrix $T$, which is also known as the total relation matrix, encompassing both direct and indirect relational influences among factors. This matrix represents the aggregation of all possible pathways through which factors can influence one another, both directly and through their interactions with other factors. The calculation of $T$ is essential for capturing the comprehensive network of influences within the system, thereby providing a holistic view of how factors contribute to the overall dynamics. This detailed understanding aids in identifying key leverage points within the system and facilitates strategic planning and decision-making based on the interconnected nature of the system components.

$$T = \lim_{k \to \infty} (N + N^2 + \cdots + N^k) = N(1 - N)^{-1}$$

Stage 5: Calculate the cumulative sums of the values in each column and each row within the total relation matrix. This analytical step involves aggregating the values across each column and each row, designated as $C_j$ and $R_i$ respectively, where $R_i$ represents the sum of the $i^{th}$ row and $C_j$ denotes the sum of the $j^{th}$ column. These sums, $R_i$ and $C_j$, encapsulate the aggregate direct and indirect influences exerted and received by the factors, respectively. By determining these sums, researchers can quantify the overall influence dynamics within the matrix, providing valuable insights into the predominant trends and interaction patterns between the factors in the system. This methodological step is crucial for a deeper understanding of the relational structure and influence distribution among the factors analyzed.

$$R_i = \sum_{j=1}^{n} t_{ij} \;\; (i = 1,2, \dots, n)$$

$$C_j = \sum_{i=1}^{n} t_{ij} \;\; (j = 1,2, \dots, n)$$

Stage 6: Formulate the DEMATEL cause and effect diagram in this analytical phase. Here, the sum of the $i^{th}$ row and the $j^{th}$ column ($R_i+C_j$) is conceptualized as the 'notability' of each service attribute, where $k = i = j = 1,2,\dots,n$, providing a quantitative measure that reflects the overall influential directions associated with each service attribute under scrutiny. This notability metric serves to identify the core significance of the service attribute $k$ within the matrix. Conversely, the difference between the row and column sums ($R_i-C_j$) is defined as 'relation,' which quantifies the

differential influence exerted by the service attribute. A positive value in this metric indicates that the attribute acts predominantly as a causal factor, while a negative value denotes its role primarily as an effect within the system. In the visualization phase of the DEMATEL technique, attributes are systematically positioned on a two-dimensional graph; the horizontal axis represents the 'notability' ($R_i+C_j$) interdependencies into a digestible and intuitive visual representation, thereby enabling stakeholders to perceive and analyze the intricate causal relationships among service attributes more effectively. The resultant diagram aids in the visualization of dominant influences and interactions, enhancing the decision-making process by providing a clear and structured depiction of causality and effect within the evaluated system.

Stage 7: A threshold, denoted as (α), is established by computing the average of the elements within the matrix $T$, as delineated by equation (7). This computation serves the purpose of identifying and subsequently eliminating elements in matrix $T$ that represent negligible effects. By setting this threshold, the analysis is refined to focus only on those interactions that surpass a certain level of significance, thereby streamlining the evaluation process and enhancing the clarity and precision of the results. The adoption of this threshold ensures that the analysis excludes minor influences that may otherwise obscure the interpretation of the data, leading to a more robust and focused understanding of the dominant relational dynamics within the system.

$$\alpha = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}\left[t_{ij}\right]}{N}$$

where $N$ is the total quantity of features in the matrix $T$.

Stage 8: Develop a cause-and-effect relationship diagram by plotting all coordinate sets ($R_i+C_j$, $R_i-C_j$) to visually map the complex interrelationships among factors. This diagrammatic representation provides a clear and intuitive visualization that aids in evaluating the intricate connections and interactions between factors. It furnishes empirical evidence to discern the most pivotal factors within the system and elucidates how these factors exert influence over others. In the construction of this diagram, only those factors whose notability and relation metrics exceed a predetermined threshold value α, are included. This selective inclusion ensures that the diagram highlights only the most influential factors, thereby offering a focused and strategic insight into the causal dynamics that are most significant within the evaluated framework. This methodological approach enhances decision-making by pinpointing key areas of impact and influence, crucial for informed strategy development and intervention planning.

**FINDINGS AND DISCUSSION**

In this context, the study directs its attention to the domain of halal supply chain management (Ghalih & Chang, 2024a) within Taiwan. Subsequently, the computation of the average matrix $A$, derived from the application of equation (2) to the processes at the Perspective ($P$) stage in the implementation of the DEMATEL method, is presented.

$$A^1 = \begin{pmatrix} 0 & 2 & 4 & 4 \\ 2 & 0 & 4 & 4 \\ 4 & 4 & 0 & 1 \\ 4 & 4 & 1 & 0 \end{pmatrix} \quad A^2 = \begin{pmatrix} 0 & 1 & 2 & 4 \\ 1 & 0 & 0 & 0 \\ 2 & 0 & 0 & 1 \\ 4 & 1 & 1 & 0 \end{pmatrix}$$

$$A^3 = \begin{pmatrix} 0 & 2 & 2 & 4 \\ 2 & 0 & 2 & 2 \\ 4 & 2 & 0 & 1 \\ 3 & 1 & 0 & 0 \end{pmatrix} \quad A^4 = \begin{pmatrix} 0 & 3 & 3 & 4 \\ 2 & 0 & 3 & 1 \\ 3 & 1 & 0 & 1 \\ 4 & 1 & 0 & 0 \end{pmatrix}$$

$$A^5 = \begin{pmatrix} 0 & 4 & 4 & 4 \\ 4 & 0 & 4 & 4 \\ 4 & 4 & 0 & 4 \\ 4 & 4 & 4 & 0 \end{pmatrix} \quad A^6 = \begin{pmatrix} 0 & 2 & 3 & 3 \\ 4 & 0 & 3 & 1 \\ 3 & 3 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{pmatrix}$$

$$A^7 = \begin{pmatrix} 0 & 3 & 2 & 3 \\ 1 & 0 & 2 & 2 \\ 3 & 3 & 0 & 0 \\ 2 & 3 & 2 & 0 \end{pmatrix} \quad A^8 = \begin{pmatrix} 0 & 2 & 3 & 2 \\ 4 & 0 & 2 & 2 \\ 4 & 2 & 0 & 2 \\ 2 & 2 & 2 & 0 \end{pmatrix}$$

$$A^9 = \begin{pmatrix} 0 & 4 & 1 & 4 \\ 4 & 0 & 1 & 4 \\ 4 & 1 & 0 & 4 \\ 4 & 4 & 1 & 0 \end{pmatrix} \quad A^{10} = \begin{pmatrix} 0 & 3 & 3 & 3 \\ 3 & 0 & 3 & 3 \\ 2 & 1 & 0 & 0 \\ 4 & 1 & 0 & 0 \end{pmatrix}$$

$$A^{11} = \begin{pmatrix} 0 & 4 & 2 & 4 \\ 4 & 0 & 3 & 2 \\ 2 & 4 & 0 & 4 \\ 4 & 0 & 0 & 0 \end{pmatrix} \quad A^{12} = \begin{pmatrix} 0 & 2 & 3 & 2 \\ 3 & 0 & 2 & 3 \\ 3 & 2 & 0 & 2 \\ 2 & 3 & 2 & 0 \end{pmatrix}$$

$$A^{13} = \begin{pmatrix} 0 & 2 & 3 & 3 \\ 2 & 0 & 0 & 2 \\ 0 & 3 & 0 & 1 \\ 2 & 2 & 0 & 0 \end{pmatrix} \quad A^{14} = \begin{pmatrix} 0 & 1 & 3 & 2 \\ 1 & 0 & 2 & 1 \\ 3 & 1 & 0 & 0 \\ 3 & 1 & 1 & 0 \end{pmatrix}$$

$$A^{15} = \begin{pmatrix} 0 & 3 & 3 & 3 \\ 3 & 0 & 3 & 3 \\ 0 & 3 & 0 & 1 \\ 3 & 3 & 0 & 0 \end{pmatrix}$$

Then, this is the average matrix $A$ generated by using equation (2).

$$A = \begin{pmatrix} 0 & 2.53 & 2.73 & 3.26 \\ 2.66 & 0 & 2.26 & 2.33 \\ 2.73 & 2.26 & 0 & 1.46 \\ 3.06 & 2 & 0.86 & 0 \end{pmatrix}$$

The normalized initial direct-relation matrix $N$ calculated by using equation (3).

$$N = \begin{pmatrix} 0 & 0.29 & 0.32 & 0.38 \\ 0.31 & 0 & 0.26 & 0.27 \\ 0.32 & 0.26 & 0 & 0.17 \\ 0.35 & 0.23 & 0.10 & 0 \end{pmatrix}$$

The total relation matrix $T$ was computed utilizing equation (4), as delineated in the following section.

$$T = \begin{pmatrix} 1.42 & 1.42 & 1.31 & 1.54 \\ 1.50 & 1.07 & 1.16 & 1.34 \\ 1.41 & 1.20 & 0.89 & 1.19 \\ 1.36 & 1.12 & 0.93 & 0.99 \end{pmatrix}$$

The summation of rows and columns in matrix $T$ was computed using equations (5) to (6), and the calculated values are presented in Table 1.

**Table 1.** Prominence and relation results

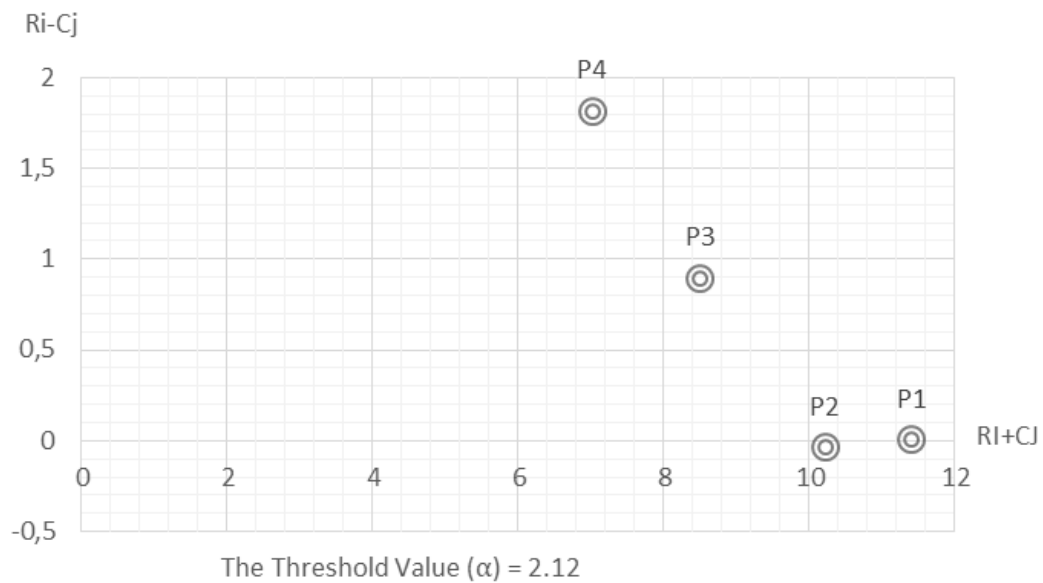|  | **P1** | **P2** | **P3** | **P4** | $R_i$ | $C_j$ | $(R_i+C_j)$ | $(R_i-C_j)$ |
|---|---|---|---|---|---|---|---|---|
| **P1** | 1.42 | 1.43 | 1.31 | 1.54 | 5.70 | 5.70 | 11.40 | 0.0031 |
| **P2** | 1.50 | 1.07 | 1.17 | 1.34 | 5.10 | 4.28 | 9.37 | 0.8083 |
| **P3** | 1.41 | 1.20 | 0.89 | 1.19 | 4.70 | 2.78 | 7.47 | 1.9199 |
| **P4** | 1.36 | 1.12 | 0.94 | 0.99 | 4.40 | 1.37 | 5.78 | 3.0493 |
| **Mean** |  |  |  |  |  |  | **8.42** | **1.3641** |



**Figure 1.** The causal relationship between the Perspective ($P$)

The cause-and-effect diagram incorporating four distinct perspectives is illustrated in Figure 1. This diagram is constructed based on the analysis of both direct and indirect effects of eighteen criteria and four core perspectives, as detailed in Table 3. Utilizing the DEMATEL method, this study effectively captures the complex interrelationships among these criteria and perspectives. The threshold value (α) used in the analysis is derived from the average of the elements in matrix $T$, calculated according to equation (7). The significance of each evaluation perspective within the matrix is quantitatively assessed by the values of ($R_i$+$C_j$), which determine their relative importance. This structured approach allows for a comprehensive understanding of the influential dynamics at play, highlighting key areas for focus in subsequent analyses and decision-making processes.

The cause-and-effect diagram encompassing four distinct perspectives is delineated in Figure 1. This diagram is constructed based on the comprehensive analysis of both direct and indirect effects associated with eighteen criteria and four core perspectives, as outlined in Table 3. Employing the DEMATEL method, this research meticulously captures the intricate relationships among these criteria and perspectives. The threshold value (α), critical for this analysis, is derived from the average of the elements within matrix $T$ as calculated using equation (7). This threshold is instrumental in identifying significant interactions by excluding less impactful ones. The evaluation of the relative importance of each perspective is quantitatively assessed through the aggregation of values ($R_i$+$C_j$), which effectively determines the prominence of each perspective in influencing the system's dynamics. This rigorous approach not only facilitates a deeper understanding of the interdependencies among the criteria but also enhances the clarity in interpreting how these factors collectively influence broader strategic outcomes.

$$\alpha = \frac{34.03}{16} = 2.12$$

In Table 3, the interactions between perspectives are characterized by values of $t_{ij}$ that are compared to the threshold α (2.12). For example, when the value of $t_{ij}$ (1.42) is less than α (2.12), an arrow in the cause-and-effect diagram is drawn from perspective P1 (Compliance and Certification) to P2 (Ethical Sourcing and Sustainability). This visual representation in the diagram underscores the significant roles that both Compliance and Certification (P1) and Ethical Sourcing and Sustainability (P2) play in the determination of policies and practices within Taiwan's halal supply chain management. These factors are crucial in shaping strategic decisions in the region. Conversely, the other two perspectives, Quality Control and Traceability (P3) and Consumer Awareness and Communication (P4), are depicted as having a lesser impact on decision-making processes within the halal supply chain management in Taiwan. This distinction highlights the varying degrees of influence that different perspectives expert on the overall management strategy.

**Table 2.** The list of Interview Respondents

| Code | Job title | Location | Interview type |
|------|-----------|----------|----------------|
| **P** | Professor | Kaohsiung | Face-to-face |
| **P** | Professor | Kaohsiung | Face-to-face |
| **M** | Manager | Tainan | Face-to-face |

| Code | Job title | Location | Interview type |
|---|---|---|---|
| **M** | Manager | Taipei | Zoom |
| **M** | Manager | New Taipei | Zoom |
| **M** | Manager | Taoyuan | Face-to-face |
| **M** | Manager | Chiayi | Face-to-face |
| **M** | Manager | Taichung | Zoom |
| **RO** | Restaurant Owner | Douliu | Face-to-face |
| **RO** | Restaurant Owner | Hualien | Face-to-face |
| **RO** | Restaurant Owner | Pingtung | Face-to-face |
| **RO** | Restaurant Owner | Pingtung | Face-to-face |
| **RO** | Restaurant Owner | Taitung | Face-to-face |
| **RO** | Restaurant Owner | Hsinchu | Face-to-face |
| **RO** | Restaurant Owner | Keelung | Face-to-face |

Note: P (Professor), M (Manager), RO (Restaurant Owner)

The authors conducted a meticulous case study to delve into how halal practices are woven into performance measurement systems within Taiwan. Case studies of this nature provide a profound understanding of current phenomena in their actual contexts. For this research, fifteen interviews were carried out, involving two professors, six managers, and seven restaurant owners, as detailed in Table 2. Given the scarcity of suitable respondents, a purposive sampling technique was utilized to select individuals who could offer distinct and valuable perspectives. Each interview varied in duration from 45 to 60 minutes and took place across a variety of Taiwanese cities including Kaohsiung, Pingtung, Tainan, Taipei, New Taipei, Taoyuan, Chiayi, Taichung, Douliu, Hualien, Taitung, Hsinchu, and Keelung. Of these, twelve interviews were conducted in person, while three were facilitated using Zoom to accommodate logistical constraints. An interview protocol was rigorously followed to maintain consistency in gathering insights, encouraging informants to express themselves using their own linguistic structures as suggested by Sucipto et al. (2023).

Within each Evaluation Perspective ($P$), the identification of critical criteria (C) is accomplished utilizing the methodologies previously described. This analysis incorporates both direct and indirect effects of the criteria under four perspectives (P), which are comprehensively summarized in Table 3. Additionally, the causal relationships between criteria within each perspective are visually represented in the cause-and-effect diagrams, as depicted in Figure 2. The complete data for rows and columns of matrix $T$ are processed in accordance with equations (5)

through (6), with the resultant calculations presented in Table 3. The significance of each evaluation perspective is determined based on the computed values. For instance, as per the data presented in Table 1, the perspective of Compliance and Certification (P1) emerges as the most critical, exhibiting the highest computed value of 11.4074, whereas Consumer Awareness and Communication (P4) registers as the least significant perspective, with the lowest value of 7.0138. Consequently, the prioritization among the four evaluation perspectives is established as P1 > P2 > P3 > P4, indicating a hierarchy of importance based on the aggregate influence of the criteria under each perspective. This structured analysis aids in discerning the relative importance of each perspective, guiding strategic focus and resource allocation within the evaluated framework.

**Table 3.** The Direct and Indirect Effects

| Perspectives and Criteria | $(R_i+C_j)$ | $(R_i+C_j)$ |
|---|---|---|
| **Compliance and Certification (P1)** | | |
| Adherence to Halal Standards (C1) | 5.68 | -0.16 |
| Certification Processes and Documentation (C2) | 5.55 | 0.01 |
| Supplier and Vendor Accountability (C3) | 4.83 | -0.27 |
| Continuous Improvement and Training (C4) | 4.21 | -0.58 |
| **Ethical Sourcing and Sustainability (P2)** | | |
| Fair Labor Practices (C5) | 4.05 | -0.43 |
| Environmental Responsibility (C6) | 4.19 | 0.03 |
| Community Engagement and Support (C7) | 4.45 | 0.65 |
| Transparency and Traceability (C8) | 4.13 | 0.75 |
| **Quality Control and Traceability (P3)** | | |
| Stringent Quality Assurance Processes (C9) | 4.63 | 1.65 |
| Implementation of Traceability Technologies (C10) | 2.92 | 0.42 |
| Quick Response Mechanisms (C11) | 2.43 | 0.21 |
| **Consumer Awareness and Communication (P4)** | | |
| Clear and Transparent Labeling (C12) | 2.16 | 0.22 |
| Educational Campaigns (C13) | 3.02 | 1.34 |
| Engagement with Halal Certifying Bodies (C14) | 2.72 | 1.41 |
| Responsive Customer Service (C15) | 2.01 | 0.97 |
| Social Media Engagement (C16) | 2.05 | 1.30 |
| Participation in Industry Events (C17) | 1.58 | 1.13 |
| Feedback Mechanisms (C18) | 1.37 | 1.17 |
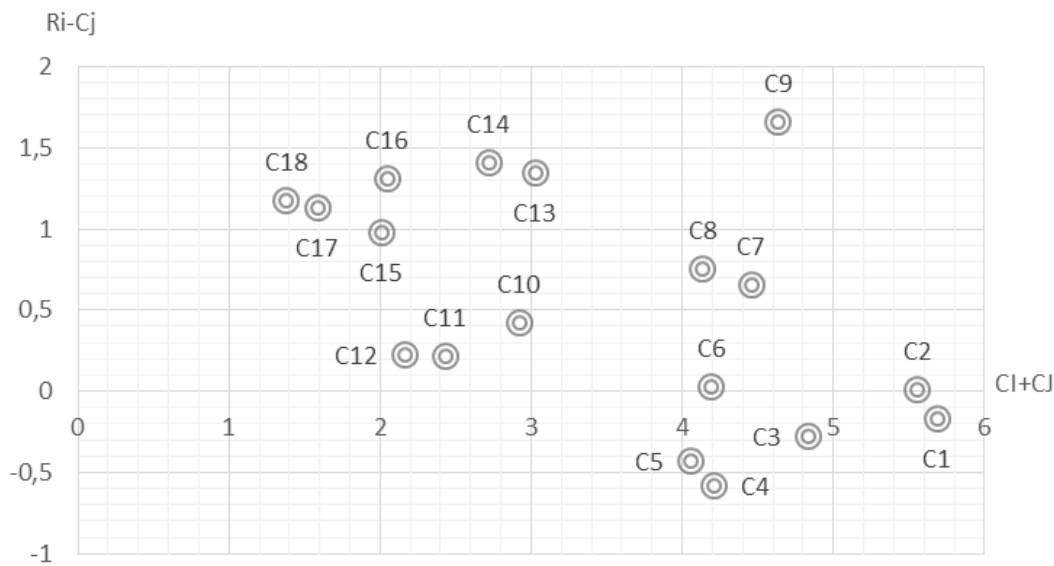
**Figure 2.** The Causal Relationship Between the Criteria (C)

The graph provides valuable insights into the critical aspects of HSCM in Taiwan, indicating the importance of various criteria based on their alignment with a reference point of 0. Among the criteria examined, Certification Processes and Documentation (C2) and Environmental Responsibility (C6) emerge as particularly significant, with values close to 0. This suggests that ensuring compliance with halal standards through robust certification processes and transparency through comprehensive documentation are paramount for HSCM in Taiwan. Similarly, Quick Response Mechanisms (C11) and Clear and Transparent Labeling (C12) are identified as important but slightly less critical, with values hovering around zero or just above 0.5. These criteria play crucial roles in addressing issues promptly and providing consumers with essential information about product halal status. However, they do not surpass the foundational importance of certification and environmental responsibility.

On the other hand, criteria such as Adherence to Halal Standards (C1), Supplier and Vendor Accountability (C3), Continuous Improvement and Training (C4), and Fair Labor Practices (C5) are deemed less urgent, with values falling below 0. While these factors remain essential components of HSCM, their relatively lower scores suggest that existing regulations and practices may adequately address them within the Taiwanese context. These insights offer strategic guidance for optimizing HSCM practices in Taiwan, emphasizing the need to prioritize certification, documentation, and environmental responsibility while addressing other important criteria to ensure a robust and ethical halal supply chain.

In addition to the insights provided by the graph, it is crucial to note the significant gap highlighted by the Stringent Quality Assurance Processes (C9) criterion in relation to other criteria. With its notable distance from the rest, this aspect underscores a critical area that demands increased attention to enhance HSCM in Taiwan. Stringent Quality Assurance Processes are essential for ensuring halal products' consistent quality and integrity throughout the supply chain. These processes encompass various measures such as standardized testing, rigorous inspections, and adherence to strict quality control protocols. By implementing robust quality assurance practices, organizations can mitigate non-compliance risk, maintain product authenticity, and uphold consumer confidence in halal products. In the context of HSCM in Taiwan, the substantial disparity in the importance assigned to Stringent Quality Assurance Processes compared to other

criteria signals a potential area of improvement. Addressing this gap requires a concerted effort to bolster quality control mechanisms, enhance monitoring capabilities, and invest in advanced quality assurance and testing technologies.

Furthermore, fostering collaboration among stakeholders, including halal certifying bodies, regulatory agencies, and industry players, is essential for developing standardized frameworks and best practices for quality assurance in the halal supply chain. By prioritizing strengthening quality assurance processes, Taiwan can further solidify its position as a trusted provider of halal products domestically and internationally. This strategic focus not only aligns with the overarching goals of HSCM but also underscores Taiwan's commitment to excellence, compliance, and consumer satisfaction in the halal market.
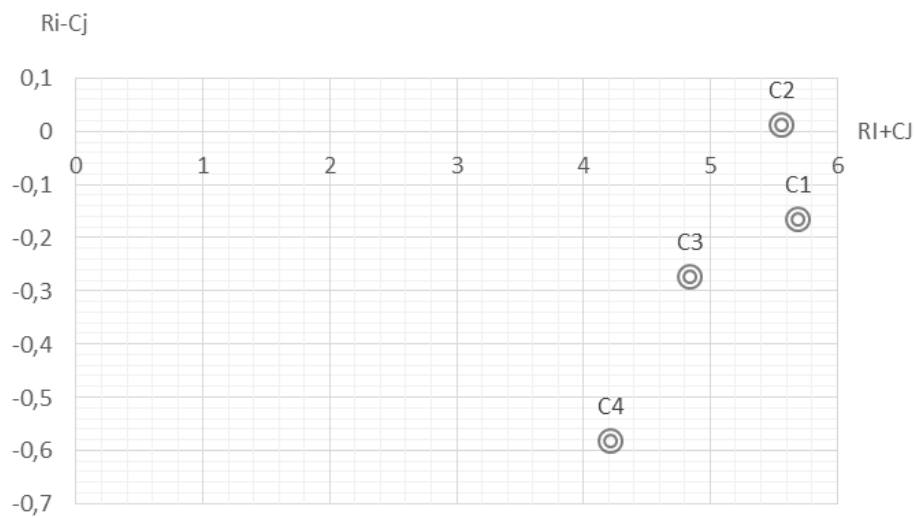


**Figure 3.** The Causal Relationship Compliance and Certification (P1)

To enhance halal supply chain management in Taiwan, it is imperative to focus on several key areas. Firstly, ensuring compliance and certification (P1) with halal standards is essential. This involves strict adherence to established halal guidelines and procedures throughout the supply chain. Additionally, improving adherence to halal standards (C1) at every stage of production, distribution, and handling of halal products is crucial.
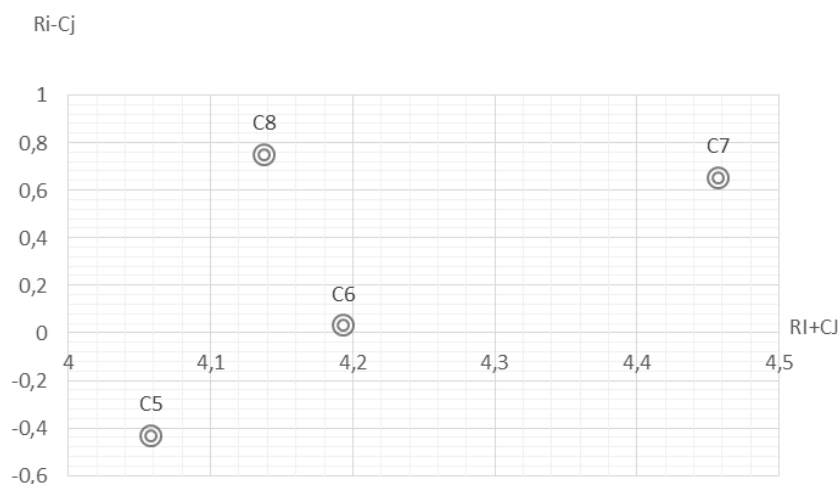


**Figure 4.** The Causal Relationship Between Ethical Sourcing and Sustainability (P2)

Certification processes and documentation (C2) should be streamlined and digitized to ensure transparency and efficiency. This includes implementing digital systems for certification and documentation to facilitate easier tracking and monitoring. Supplier and vendor accountability (C3) is another critical aspect. Businesses should hold their suppliers and vendors accountable for halal compliance through regular audits and inspections. This ensures that all products and ingredients sourced are halal certified. Continuous improvement and training (C4) programs should be implemented to enhance the skills and knowledge of employees involved in the halal supply chain. This will help ensure they are aware of and adhere to halal requirements. Collaboration with halal certification institutions in Taiwan is also essential. By working closely with these institutions, businesses can stay updated on the latest halal standards and best practices, ensuring they are well-equipped to meet the needs of Muslim consumers in Taiwan and globally.

The graph provides valuable insights into the relative importance of different criteria in HSCM in Taiwan, particularly emphasizing Environmental Responsibility (C6) as a crucial criterion, given its alignment with 0. This suggests that Taiwan recognizes the significance of environmental sustainability in the halal supply chain and places importance on practices that minimize environmental impact. However, the graph also highlights Fair Labor Practices (C5) as falling below 0, indicating the need for increased attention in this area. This discrepancy underscores the importance of addressing labor-related issues and ensuring ethical practices throughout the supply chain, including fair wages, safe working conditions, and respect for worker rights.

Additionally, Community Engagement and Support (C7) and Transparency and Traceability (C8) are identified as having a slightly lesser impact but warrant consideration due to Taiwan's focus on Environmental, Social, and Governance (ESG) principles and Sustainable Development Goals (SDGs). Integrating community engagement initiatives and enhancing traceability measures can further strengthen Taiwan's commitment to responsible business practices and contribute to its sustainability objectives in the halal supply chain. Therefore, while Environmental Responsibility remains a priority, attention to Fair Labor Practices, Community Engagement, and Transparency and Traceability is essential for comprehensive and ethical HSCM practices in Taiwan.
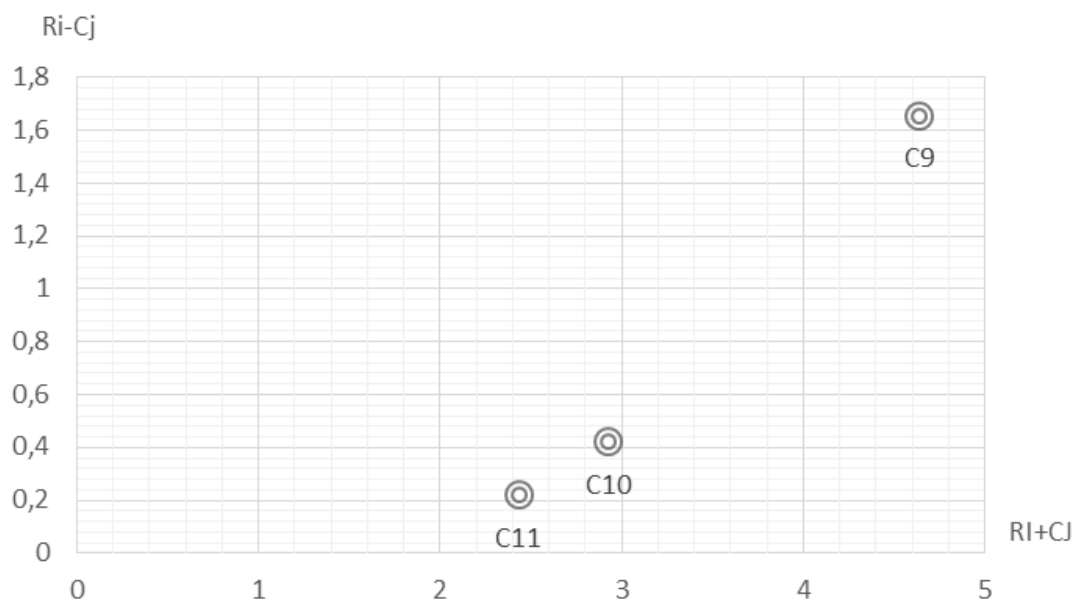


**Figure 5.** The Causal Relationship Between Quality Control and Traceability (P3)

In the scope of HSCM in Taiwan, the pursuit of enhanced Quality Control and Traceability

(P3) underscores the critical importance of several key criteria. Notably, the graph indicates that Stringent Quality Assurance Processes (C9), Implementation of Traceability Technologies (C10), and Quick Response Mechanisms (C11) merit significant attention within this context. These criteria represent foundational pillars in the endeavor to elevate HSCM standards, aligning closely with the overarching goal of ensuring product quality, integrity, and responsiveness to market dynamics. Stringent Quality Assurance Processes encompass rigorous testing, inspection, and compliance measures aimed at upholding the highest standards of product quality and safety throughout the supply chain. Implementation of Traceability Technologies involves the adoption of advanced systems such as blockchain and RFID to enable comprehensive tracking and monitoring of product movements, enhancing transparency and accountability.
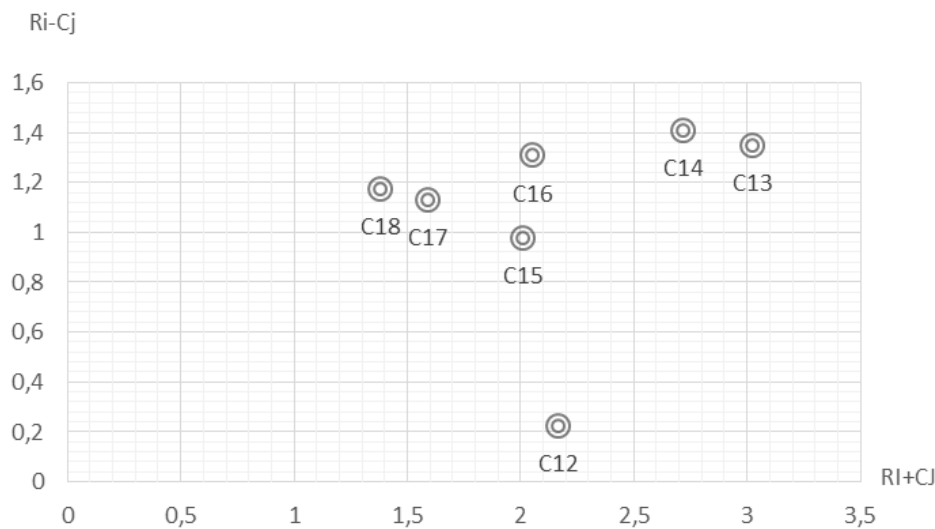


**Figure 6.** The Causal Relationship Between Consumer Awareness and Communication (P4)

Additionally, Quick Response Mechanisms facilitate swift and effective responses to potential issues or disruptions, minimizing risks and safeguarding the integrity of halal products. Recognizing the pivotal role of these criteria, Taiwan's HSCM initiatives are poised to prioritize investments and strategic interventions aimed at fortifying Quality Control and Traceability measures. By nurturing a culture of continuous improvement and innovation in these areas, Taiwan can enhance its competitiveness in the global halal market while fostering consumer trust and confidence in the authenticity and reliability of its halal products.

Clear and Transparent Labeling (C12) emerges as a focal point in HSCM in Taiwan, signifying a concerted effort towards enhancing consumer transparency and empowerment. However, the prominence of this criterion accentuates the necessity for additional support and practical measures to bolster several other critical aspects of HSCM. Educational Campaigns (C13), Engagement with Halal Certifying Bodies (C14), Responsive Customer Service (C15), Social Media Engagement (C16), Participation in Industry Events (C17), and Feedback Mechanisms (C18) collectively represent a comprehensive framework for fostering consumer awareness, trust, and satisfaction in the halal supply chain.

Educational Campaigns play a pivotal role in increasing consumer understanding of halal principles and the significance of certification. Engaging with Halal Certifying Bodies ensures rigorous adherence to halal standards and reinforces the authenticity of products. Responsive

Customer Service channels provide consumers with accessible avenues for inquiries and assistance, fostering trust and loyalty. Social Media Engagement leverages digital platforms to disseminate information, encourage dialogue, and address consumer concerns in real time. Participation in Industry Events enables networking opportunities and showcases Taiwan's commitment to halal excellence on a global stage. Feedback Mechanisms facilitate continuous improvement by soliciting consumer input and addressing evolving needs and preferences.

While Clear and Transparent Labeling signifies progress in HSCM, sustained government support and practical initiatives are essential to fortify these complementary criteria. By allocating resources, facilitating partnerships, and implementing supportive policies, the Taiwanese government can empower businesses to enhance their educational, engagement, and communication efforts. This collaborative approach reinforces consumer confidence and strengthens Taiwan's position as a leader in ethical, transparent, and consumer-centric HSCM practices.

The halal certification process in Taiwan is a meticulous procedure designed to ensure that products and practices comply with Islamic dietary laws and regulations. Firstly, businesses seeking certification must thoroughly prepare by ensuring that their products and processes adhere to halal requirements. This includes sourcing ingredients from halal-certified suppliers, implementing halal-compliant production practices, and training employees on halal principles. Once prepared, businesses can apply for halal certification from a recognized certification body in Taiwan. This application typically includes detailed information about the business, its products, and its production processes, along with supporting documentation such as ingredient lists and certificates of analysis. Upon receiving the application, the certification body will conduct a thorough review, which may include an on-site inspection of the premises. The certification body will assess the production processes, storage facilities, and handling practices during the inspection to ensure they meet halal requirements. If the certification body is satisfied that the products and processes comply with halal standards, they will issue a halal certificate. This certificate guarantees consumers that the products are halal-compliant and can be used for marketing purposes. After obtaining certification, businesses must usually undergo regular monitoring and audits to ensure continued compliance with halal standards. Certification is typically valid for a specific period, after which it must be renewed through a similar process. Overall, the halal certification process in Taiwan is a rigorous and comprehensive procedure designed to uphold the integrity of halal products and give consumers confidence in their halal status.

Despite its lower overall influence, Consumer Awareness and Communication (P4) remains a crucial aspect of the halal supply chain, particularly for market penetration and consumer trust. Among its associated criteria, Clear and Transparent Labeling (C12), Educational Campaigns (C13), and Engagement with Halal Certifying Bodies (C14) rank higher, indicating that proper labeling and direct engagement with certification bodies are the most effective strategies to enhance consumer awareness. However, criteria such as Social Media Engagement (C16), Participation in Industry Events (C17), and Feedback Mechanisms (C18) register lower influence, suggesting that existing consumer engagement strategies require greater institutional support and promotional efforts to maximize their impact. A lack of proactive outreach efforts may hinder consumer confidence, making implementing more targeted awareness programs that emphasize transparency, education, and direct consumer engagement essential.

Similarly, Fair Labor Practices (C5) under Ethical Sourcing and Sustainability (P2) ranks low in prominence, indicating a potential gap in policy enforcement and industry commitment to labor ethics in Taiwan's halal supply chain. While Environmental Responsibility (C6) and Community Engagement (C7) receive greater emphasis, fair labor practices appear less prioritized by halal businesses, possibly due to a stronger focus on product certification and sustainability compliance

over social equity concerns. This finding suggests greater regulatory enforcement and industry-driven initiatives to promote ethical labor standards alongside environmental sustainability. Ensuring fair wages, safe working conditions, and adherence to international labor standards can enhance Taiwan's reputation as a responsible player in the global halal industry.

Given the low ranking of Consumer Awareness and Communication (P4), businesses and regulatory bodies should increase efforts to educate consumers on halal standards, traceability, and certification authenticity. This can be achieved by expanding halal education campaigns using traditional and digital media platforms, ensuring halal labeling regulations are clear and consistent, and fostering stronger collaborations with halal certification bodies to improve transparency and awareness. Additionally, leveraging social media engagement and direct consumer feedback mechanisms can help build trust and encourage informed purchasing decisions.

The low ranking of Fair Labor Practices (C5) suggests a gap in ethical labor policies within Taiwan's halal industry. This gap requires industry stakeholders to implement stronger compliance mechanisms for labor standards, including fair wages and safe working conditions. Moreover, integrating labor ethics into halal certification requirements can reinforce their significance within sustainability efforts, while encouraging corporate social responsibility (CSR) initiatives can promote industry-wide commitments to fair labor rights.

While Quality Control and Traceability (P3) ranks third in importance, Stringent Quality Assurance Processes (C9) and Implementation of Traceability Technologies (C10) remain highly relevant. To further optimize halal supply chain management (HSCM) in Taiwan, adopting advanced traceability systems such as blockchain and RFID technology should be widely implemented. Additionally, real-time monitoring tools should be integrated into halal logistics to enhance supply chain transparency, while quick response mechanisms (C11) should be developed to address non-compliance cases swiftly. These improvements will strengthen halal supply chain reliability, mitigate risks, and enhance consumer confidence.

The findings also underscore that sustainability (P2) is a key driver of HSCM, with Environmental Responsibility (C6) ranking highly. To reinforce sustainability efforts, Taiwan's halal industry should adopt sustainable sourcing policies that minimize environmental impact, encourage green manufacturing practices and halal-compliant waste management, and leverage ESG reporting standards to enhance transparency and global market acceptance. Aligning halal certification with ESG and SDG principles will strengthen Taiwan's competitiveness in the international halal market while ensuring compliance with global sustainability standards.

This study comprehensively analyses the causal relationships within Taiwan's halal supply chain, highlighting the dominance of compliance, certification, and sustainability concerns while identifying gaps in consumer awareness and fair labor practices. While regulatory compliance (P1) and sustainability (P2) drive decision-making, consumer engagement (P4) and fair labor ethics (C5) require further strategic attention to strengthen Taiwan's position in the global halal market. Taiwan can foster a more ethical, transparent, and competitive halal industry by prioritizing educational campaigns, enhancing labor rights enforcement, and improving supply chain traceability. Strengthening consumer trust through transparency, ensuring fair labor conditions, and aligning with global sustainability goals will enhance Taiwan's credibility as a trusted halal supplier internationally.

**CONCLUSIONS**

By utilizing the DEMATEL method, this research provides a structured and systematic approach to identifying, categorizing, and prioritizing causal criteria (C) and perspectives (P) within Taiwan's halal supply chain. The study effectively illustrates the cause-and-effect relationships among key attributes through directed graphs, offering decision-makers valuable

insights into optimizing halal product production, distribution, and certification processes. By challenging the traditional assumption of independence between supply chain factors, this study enables policymakers and business leaders to allocate resources to the most influential factors strategically, ensuring greater efficiency and market competitiveness. This paradigm shift in managing halal supply chains allows businesses to enhance operational efficiency, reduce risks, and improve compliance while ensuring consumer confidence and regulatory alignment.

The study's findings emphasize the importance of compliance and certification (P1) and ethical sourcing and sustainability (P2) as the dominant drivers of halal supply chain effectiveness. These insights underscore the need for businesses to strengthen halal certification processes, regulators to enforce sustainability and ethical sourcing policies, and policymakers to develop comprehensive strategies for integrating ESG principles into halal supply chains. Meanwhile, consumer awareness and communication (P4) and fair labor practices (C5) rank lower, highlighting the need for greater investment in public education campaigns, digital marketing strategies, and corporate social responsibility initiatives. Businesses must invest in consumer engagement efforts, regulators should enhance transparency measures, and policymakers must ensure fair labor policies are incorporated into halal certification requirements to create a more inclusive and sustainable halal ecosystem.

Beyond these managerial and policy recommendations, technology adoption emerges as a key enabler in strengthening halal supply chain management. Blockchain and the Internet of Things (IoT) can revolutionize traceability and transparency in halal supply chains by ensuring secure, immutable records of product movements from sourcing to consumer purchase. Blockchain enables real-time verification of halal certification, preventing fraud and ensuring compliance with halal standards at every stage of the supply chain. IoT devices, such as RFID tags and smart sensors, can be integrated to monitor storage conditions, track transportation, and detect contamination risks in halal food production. Businesses that adopt these technologies can enhance their market competitiveness, improve regulatory compliance, and gain consumer trust by providing verifiable halal authentication.

However, while this methodological approach offers significant improvements in halal supply chain decision-making, it also presents challenges that warrant further attention. The study's focus on a restricted set of halal products calls for further validation across a broader range of halal-certified goods to enhance generalizability. The Taiwan-specific regulatory and cultural context may also limit global applicability, necessitating comparative studies across different regions. Future research should explore how advanced analytical methods such as fuzzy DEMATEL and Analytic Network Process (ANP) could refine decision-making by incorporating uncertainty and dynamic changes in supply chain factors. Furthermore, integrating blockchain and IoT into halal logistics should be empirically tested to identify challenges, implementation barriers, and cost-effectiveness in real-world applications.

In conclusion, this study provides a strategic foundation for optimizing halal supply chain management, equipping businesses, regulators, and policymakers with actionable insights to enhance operational efficiency, sustainability, and consumer trust. Decision-support systems tailored to halal supply chains should incorporate advanced data analytics, AI-driven forecasting, and regulatory compliance tracking to enhance traceability, mitigate risks, and promote global halal market expansion. Strengthening cross-sector collaborations, investing in technological innovations, and aligning halal certification with sustainability standards will ensure a resilient, transparent, and ethically sound halal supply chain in an increasingly globalized market environment.

**LIMITATION & FURTHER RESEARCH**

While this study provides valuable insights into halal supply chain optimization, certain limitations should be considered when interpreting its findings. The research focused on a limited range of halal products in Taiwan, making it necessary for future studies to expand their scope to include various halal-certified goods such as cosmetics, pharmaceuticals, and non-food items to enhance generalizability. The Taiwan-specific regulatory and cultural context may also limit the global applicability of the findings. Conducting cross-cultural comparative studies in Muslim-majority and non-Muslim markets would provide a deeper understanding of the universal and region-specific challenges in halal supply chain management.

Another limitation concerns the expert sample size, as the study relied on insights from fifteen professionals. While their expertise covered diverse aspects of the halal supply chain, increasing the sample size and incorporating a broader range of stakeholders, such as retailers, logistics providers, and consumers, could provide more robust data and reduce potential biases. Methodologically, while DEMATEL effectively captures interdependencies among supply chain factors, integrating fuzzy DEMATEL, Analytic Network Process (ANP), or hybrid Multi-Criteria Decision-Making (MCDM) models could offer deeper insights into complex relationships and enhance decision-making accuracy.

The study also lacks empirical exploration of emerging technologies such as blockchain and IoT, which have been recognized for enhancing traceability and transparency in supply chains. Future research should assess the practical challenges of implementing these technologies, their cost implications, and their regulatory compliance in halal logistics. Additionally, as this study presents a snapshot in time, conducting longitudinal research would allow for an analysis of how halal supply chain practices evolve in response to technological advancements, regulatory changes, and shifting consumer expectations.

To build upon these limitations, several research directions are recommended. Cross-cultural analysis should be conducted to investigate halal supply chain practices across different countries, identifying global best practices and region-specific regulatory barriers. Integrating advanced technologies such as blockchain, IoT, and AI should be explored to determine their effectiveness in halal certification processes and supply chain transparency. Sustainability metrics should be developed in alignment with ESG and SDG principles to assess halal supply chains' long-term environmental and social impacts. Consumer-centric studies should also examine consumer behavior, awareness, and perceptions of halal products, allowing businesses to design more effective marketing strategies and educational campaigns.

Additionally, hybrid methodologies combining DEMATEL with AHP, TOPSIS, or Best Worst Method (BWM) could validate and refine the interrelationships among supply chain factors. Lastly, regulatory impact analysis should be conducted to evaluate the role of government policies, certification standards, and international trade regulations on the effectiveness of halal supply chain management. By addressing these areas, future research can provide a more holistic, data-driven understanding of halal supply chains, ensuring greater transparency, sustainability, and market adaptability. Strengthening technological integration, regulatory alignment, and consumer engagement will be key to shaping the future of halal industries worldwide.

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