Integrated Single-Valued Neutrosophic Normalized Weighted Bonferroni Mean (SVNNWBM)-DEMATEL for Analyzing the Key Barriers to Halal Certification Adoption in Malaysia

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Abstract

The implementation of halal certification in Muslim-owned dining establishments in Malaysia faces various obstacles. This research aimed to analyze and investigate these challenges. The study used the DEMATEL approach with the integrated single-valued neutrosophic normalized weighted Bonferroni mean (SVNNWBM) to identify and understand the interrelationships among the obstacles. Three groups comprising academicians, industry professionals, and Muslim owner-restaurant representatives provided their perspectives. The findings highlighted three key obstacles hindering the acceptance and implementation of halal certification: customer perception, halal perception, and inadequate awareness. Fiscal constraints, inadequate awareness, and halal perception were significant barriers in Malaysia's restaurant sector. These obstacles were categorized as causal factors, generating additional barriers in the industry. By identifying these challenges, effective strategies can be developed to overcome them and improve the adoption of halal certification. This research provides valuable insights for policymakers, restaurant owners, and other stakeholders, enabling them to understand the obstacles better and develop targeted interventions. Employing the integrated SVNNWBM-DEMATEL approach and incorporating perspectives from experts in academia, industry, and Muslim owner-restaurant representatives ensures a comprehensive analysis of the obstacles faced in halal certification implementation.

Keywords: Halal certification; adoption; barriers; Malaysia; Muslim-owned restaurants; DEMATEL; SVNNWBM.

1. Introduction

Obtaining halal certification is of utmost importance for Muslim-owned restaurants in Malaysia catering to the predominantly Muslim population. However, adopting halal certification in small businesses within the restaurant industry has been a gradual and challenging process. This study investigates the barriers and challenges small business owners face in achieving halal certification. The research will address critical questions regarding the primary obstacles faced and the interrelationships between these barriers. By identifying and understanding these challenges, the study aims to provide valuable insights for government organizations, industry associations, and small business owners on overcoming these hurdles and promoting halal certification adoption. Ultimately, this research aims to contribute to the growth and sustainability of the halal market in Malaysia, benefiting both small business owners and the wider Muslim community. The Halal food sector is of considerable significance in the international consumer market, exerting a notable impact on customers' purchasing and consumption patterns

DOI: https://doi.org/10.54216/IJNS.210310
Received: February 04, 2023 Revised: May 22, 2023 Accepted: June 17, 2023

across the globe. The Department of Islamic Development (JAKIM) holds a pivotal position in Malaysia, as it is responsible for formulating guidelines for Halal product certification. This initiative is a crucial component of the nation's TPB2030 development plan, which seeks to establish Malaysia as a prominent Halal hub. The Halal industry's significance lies in its ability to cater to the dietary needs of Muslims, who consume Halal food irrespective of their cultural background, resulting in its prevalence in the worldwide food market [1] and [2].

Initially, acquiring Halal certification can be a protracted one, entailing comprehensive assessments of a dining establishment's food handling and preparation techniques, scrutinizations, and on-site assessments by certifying bodies. The task of conducting inspections and gathering essential documentation may present a significant challenge for small restaurant proprietors with limited resources and personnel [3], [4].

Furthermore, restaurant proprietors need help with financial constraints. The financial burden of certification fees, infrastructure investments, staff training, and consultation services can be substantial, particularly for restaurants with limited resources, as noted in studies by [4]–[6]

One additional obstacle pertains to the perception surrounding Halal certification. Particular proprietors of restaurants may perceive certification as redundant or onerous, as they believe their cuisine already follows Halal regulations. The perception as mentioned earlier may impede individuals' drive to obtain certification, despite their comprehension of the significance of Halal food, as indicated by [7]–[9].

More familiarity with the certification procedure and prerequisites poses an additional hindrance. Proprietors of dining establishments may need more familiarity with the requisite procedures, paperwork, and procedures for maintaining records to obtain certification. The lack of knowledge regarding Halal regulations, permissible ingredients, and proper food handling practises may impede individuals' capacity to make well-informed decisions concerning certification, as noted by [5], [9], [10].

The perception of customers also influences the barriers encountered by restaurant owners. Although individuals may identify as followers of Islam, specific customers may view Halal certification as redundant or insignificant. Halal certification misconceptions, such as the notion that it solely pertains to Muslim consumers or the assumption that non-certified food is not Halal, have the potential to diminish the demand for Halal-certified food and deter restaurateurs from seeking certification [5], [10], [11]. In addition, the insufficiency of infrastructure, encompassing essential facilities, resources, and apparatus, presents obstacles for proprietors of dining establishments in adhering to Halal mandates. The need for more infrastructure may necessitate additional expenses for the installation of equipment, procurement of Halal-certified ingredients, and provision of suitable personnel training. The constraint in question has a notable impact on modest dining establishments that have restricted means [3], [11], [12].

Finally, obstacles related to governance, such as the need for more well-defined regulations, restricted governmental assistance, and insufficient monitoring of Halal regulations, are among the difficulties encountered by proprietors of dining establishments. The lack of uniformity in the implementation of Halal regulations and the intricate certification processes pose challenges for proprietors who aspire to obtain certification, resulting in confusion and increased costs [6], [10], [13]–[16]. Numerous studies have been conducted to establish the correlation between these obstacles, including the DEMATEL method.

The DEMATEL method ascertains and delineates the factors germane to a given decision-making quandary. Furthermore, this entails a thorough examination of the causal connections and interrelatedness that exist among these variables. The DEMATEL methodology finds extensive utility in a variety of contexts. Shahla [17] employed the DEMATEL method to assess various factors in response to the COVID-19 pandemic. Garg [18] employed the DEMATEL to construct a model for strategies intended to alleviate the issue of electronic waste. Gozde Koca [19] has proposed using the DEMATEL technique to evaluate intelligent cities. Rodzi [20] utilises the DEMATEL to ascertain the causal relationships among the obstacles to household waste recycling in Seremban, Malaysia. Numerous research studies have been conducted on the application of DEMATEL utilising various types of fuzzy sets and neutrosophic sets, which also encompasses the employment of single value neutrosophic set (SVNS).

Single-valued neutrosophic sets (SVNS) have gained significant attention in dealing with uncertain and inconsistent information in decision-making processes [21]–[26]. SVNS utilize three membership functions to represent the degree of truth, indeterminacy, and falsity of an element's membership. Abdullah [27] proposed the application of single-valued neutrosophic DEMATEL in segregating types of criteria for subcontractor selection. This methodology combines SVNS and the DEMATEL technique to handle uncertainty and vagueness in decision-making. Mulla presented a single-valued neutrosophic inventory model that incorporates neutrosophic random variables [28]. This model considers the uncertainty and randomness associated with inventory parameters and provides a framework for effective decision-making in inventory management. Bera [29]introduced an approach

DOI: https://doi.org/10.54216/IJNS.210310
Received: February 04, 2023 Revised: May 22, 2023 Accepted: June 17, 2023

to solve linear programming problems using single-valued trapezoidal neutrosophic numbers. Extending the traditional linear programming method enables decision-makers to handle uncertain and imprecise information represented by single-valued trapezoidal neutrosophic numbers. Stanujkic [30] proposed a novel approach for assessing the reliability of data contained in a single-valued neutrosophic number and its application in multiple criteria decision-making. This approach plays a crucial role in evaluating the quality and credibility of information in decision-making processes. This paper is organized as follows: In Section 2 we give basic definitions of the methods used in this article. In Section 3, we describe the methodology used as well as the methods used and the types of data studied in this article. The results obtained are analyzed and discussed in Section 4. Finally, the difficulties and importance of the study were discussed in the conclusion section.

2. Preliminaries

This section provides an overview of SVNSs, Bonforeonni mean, and SVNNWBM operators definitions. These will be utilised in subsequent studies.

Definition 1. [31] Consider a space X consisting of points or objects, where the generic elements in X are represented by x. A type of SVNS denoted as S in X is defined by three distinct membership functions: truth-membership function $T_S(x)$, indeterminacy-membership function $I_S(x)$ and falsity-membership function $F_S(x)$. A *symbol* can represent an SVNS S.

$$S = \left\{ \left\langle x, T_S(x), I_S(x), F_S(x) \right\rangle \mid x \in X \right\} \tag{1}$$

each function maps a point x in S to a value in the interval [0, 1]. Consequently, the summation of $T_S(x)$ $I_S(x)$ and $F_S(x)$ conforms to the criterion of being greater than or equal to zero and less than or equal to three, as expressed by the inequality $0 \le T + I + F \le 3$.

Definition 2. [31] Let $p, q \ge 0$, and $a_i (i = 1, 2, ..., n)$ be a collection of non-negative numbers, then Bonferroni Mean (BM) is defined as

$$BM^{p,q}(a_1, a_2, ..., a_n) = \left(\frac{1}{n(n-1)} \sum_{\substack{i,j=1 \\ i \ne j}}^{n} a_i^p a_j^q \right)^{\frac{1}{p+q}} \tag{2}$$

Definition 3. [32] Consider Let $x_i = (T_i I_i F_i)(i = 1, 2, ..., n)$ be a collection of SVNNs SVNNWBM^{p,q} : and $\mho^n \to \mho$, where $\mho$ is the set of all SVNNs $p, q \ge 0$ and $w = (w_1, w_2, .., w_n)^T$ is the weight vector of satisfying and . Then SVNNWBM^{p,q} is called SVNNWBM and denoted by,

.

$$SVNNWBM^{p,q}\left(b_{ij}^1, b_{ij}^2, ..., b_{ij}^m\right) = \left(\begin{array}{c} \left(1 - \prod_{\substack{k,h=1 \\ k \ne h}}^{m} \left(1 - \left(T_{ij}^{\ k} \right)^p \left(T_{ij}^{\ h} \right)^q \right)^{\frac{\omega_k \omega_h}{1-\omega k}} \right)^{\frac{1}{p+q}}, \\ \left(1 - \left(1 - \prod_{\substack{k,h=1 \\ k \ne h}}^{m} \left(1 - \left(1 - I_{ij}^{\ k} \right)^p \left(1 - I_{ij}^{\ h} \right)^q \right)^{\frac{\omega_k \omega_h}{1-\omega k}} \right)^{\frac{1}{p+q}} \right), \\ \left(1 - \left(1 - \prod_{\substack{k,h=1 \\ k \ne h}}^{m} \left(1 - \left(1 - F_{ij}^{\ k} \right)^p \left(1 - F_{ij}^{\ h} \right)^q \right)^{\frac{\omega_k \omega_h}{1-\omega k}} \right)^{\frac{1}{p+q}} \right) \end{array} \right) \tag{3}$$

3. Methodology

This study utilizes an integrated SVNNWBM (single-valued neutrosophic normalized weighted Bonferroni mean) operator with DEMATEL analysis to investigate the main obstacles hindering the adoption of Halal certification

DOI: https://doi.org/10.54216/IJNS.210310
Received: February 04, 2023 Revised: May 22, 2023 Accepted: June 17, 2023

in Muslim-owned restaurants in Malaysia. The methodology employed in this research involves three distinct phases, as illustrated in Figure 1. The integration of the SVNNWBM operator enhances the analysis by considering uncertain and imprecise information, while DEMATEL analysis facilitates the identification of interrelationships among the obstacles. This combined approach allows for a comprehensive examination of the barriers faced by Muslim-owned eateries in implementing Halal certification.

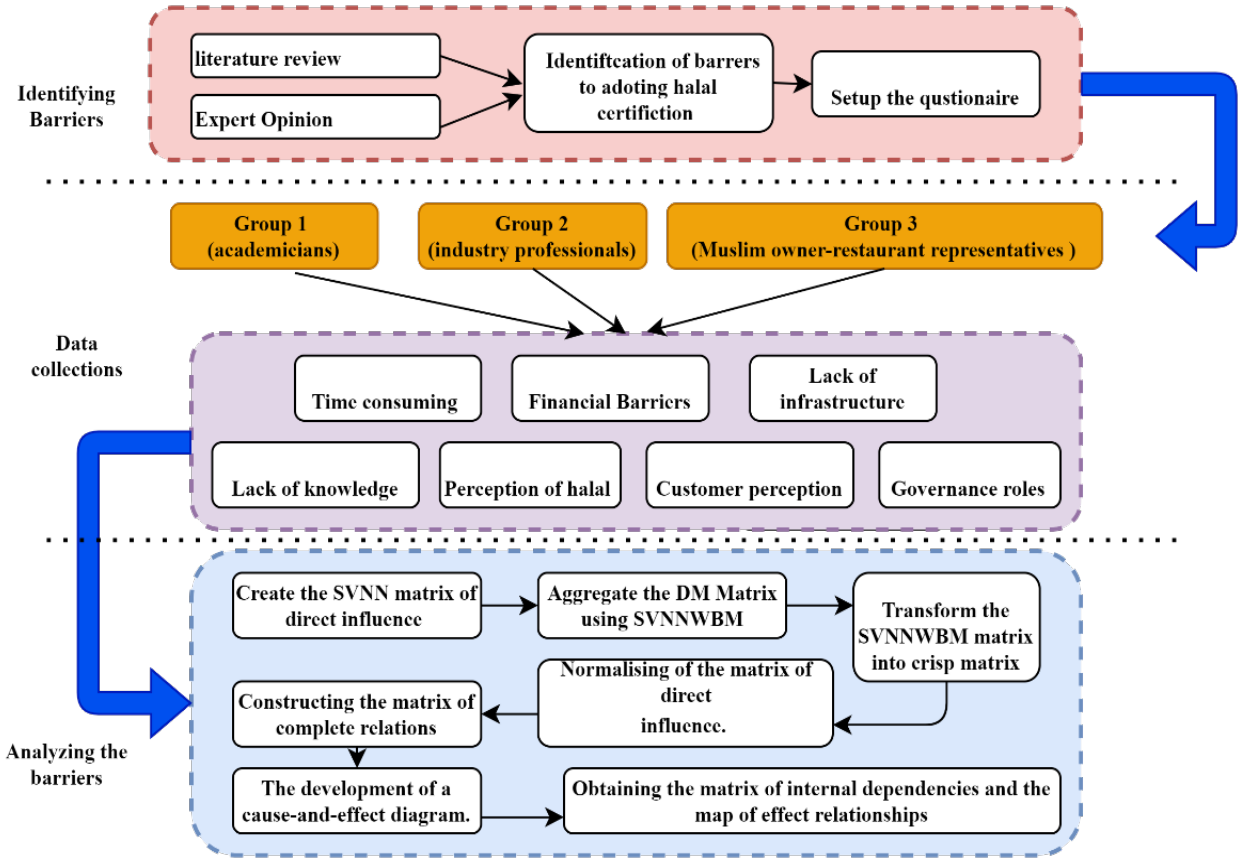

Figure 1: Research Methodology

Phase 1: Identifying Barriers

In the initial stages of the research, a thorough examination of scholarly literature and expert opinions was carried out to investigate the execution of Halal certification in the restaurant sector of Malaysia. The literature review aimed to identify previously examined barriers to accepting Halal certification. In addition, expert consultations were carried out with professionals in Halal certification and restaurant industry to gather their insights on the barriers to implementing Halal certification in Malaysia's restaurant sector**.**

Phase 2: Data Collection

Data was collected from three groups of experts, each comprising an academic, a Halal regulatory representative, a consultant, and a Muslim restaurant owner. Semi-structured interviews were conducted to gather insights on barriers to integrating Halal certification in Malaysia's restaurant industry. The experts provided their viewpoints on the challenges through pairwise questions, allowing for a comprehensive exploration of the topic. The data collected was in the form of linguistic variables, capturing the nuanced perspectives of the experts. These variables were then presented using Single Value Neutrosophic Sets (SVNS), concisely representing the experts' opinions.

Phase 3: Data Analysis

The barriers to Halal certification adoption in Malaysia's restaurant sector were analyzed using an integrated approach of SVNNWBM-DEMATEL methodologies. The step SVNNWBM-DEMATEL is shown as follows:

Step 1. Create the SVNN matrix of direct influence

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Received: February 04, 2023 Revised: May 22, 2023 Accepted: June 17, 2023

This stage entails establishing a connection between the criteria. The data was gathered utilizing the linguistic term presented in Table 1.

Table 1: Linguistic variable of SVNN

Linguistic Variable	SVNNS
No Influence	<0.10, 0.80, 0.90>
Low Influence	<0.35, 0.60, 0.70>
Medium Influence	<0.50, 0.40, 0.45>
High Influence	<0.80,0.20,0.15>
Very High Influence	<0.90,0.10,0.10>

Step 2: Aggregate the DM Matrix using SVNNWBM

Aggregate the group experts' matrix using the SVNNWBM operator, incorporating predetermined weights for each expert. This process combines the linguistic terms and influence scores to determine the overall influence of each criterion.

Step 3: Transform the SVNNWBM matrix into a crisp matrix

To convert the aggregated single neutrosophic relation matrix into a real number matrix, the following equation is used:

$$A = \frac{(3+T-2I+F)}{4} \tag{4}$$

Step 4. Normalising of the matrix of direct influence

The normalised direct-relation matrix S is obtained from matrix A using formulas (5) and (6).

$$S = k \cdot A \tag{5}$$

$$k = \min\left(\frac{1}{\max_{1\le i\le n}\sum_{j=1}^{n}\left[a_{ij}\right]}, \frac{1}{\max_{1\le j\le n}\sum_{i=1}^{n}\left[a_{ij}\right]}\right) i, j \in (1,2,...,n) \tag{6}$$

Step 5. Constructing the matrix of complete relations

The total-relation matrix M is calculated using the formula (7), where I stand for the Identity Matrix after the direct-relation matrix S has been normalised.

$$M = S(I-S)^{-1} \tag{7}$$

Step 6. The development of a cause-and-effect diagram.

Formulas (8) to (10) demonstrate the implementation of $C+R$ and $R-C$ in matrix M, where C denotes the summation of rows, and R denotes the summation of columns. Criteria with higher $R-C$ values have a more significant impact on the other criteria. The term "dispatchers" is frequently employed to denote the standards. Criteria that possess lower R-C levels are observed to be more vulnerable to external influences. The term "receivers" is frequently used to refer to the criteria. On the other hand, the aggregate of R and C represents the degree of correlation between a single criterion and the remaining ones.

$$M = \left[m_{ij}\right]_{n\times n} \quad i, j \in (1,2,...,n) \tag{8}$$

$$R_i = \sum_{j=1}^{n}\left[m_{ij}\right]_{n\times 1} = \left[m_i\right]_{n\times 1} \tag{9}$$

$$C_i = \sum_{i=1}^{n}\left[m_{ij}\right]_{1\times n} = \left[m_j\right]_{1\times n} \tag{10}$$

Step 7. Obtaining the matrix of internal dependencies and the map of effect relationships

The dataset was mapped utilising the ($R+C$, $R-C$). The parameter known as the threshold value is employed to denote the degree of influence present between a set of criteria.

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Received: February 04, 2023 Revised: May 22, 2023 Accepted: June 17, 2023

4.0 Results and Discussion

The analysis conducted by SVVNBM - DEMATEL, which yielded important insights into the critical barriers to restaurant owners in Malaysia adopting Halal certification and the underlying fundamental causes of such barriers, is presented in this part. The study identified causal linkages between them to suggest efficient solutions for reducing barriers. The main conclusions of the DEMATEL analysis are clarified in this paper, together with their implications for the promotion of the acceptance of Halal certification in Malaysia's restaurant sector. Table 3 and Figure 2 show the values of $Ri + Ci$ and $Ri - Ci$ of the barriers and the network relation map, respectively

Table 3: The $R_i + C_i$ and $R_i - C_i$ *of the barriers*

Barriers	R_i	C_i	$R_i + C_i$	$R_i - C_i$	Identify	Ranking
Time-consuming	6.67	6.95	13.63	-0.28	Effect	6
Financial Barriers	8.15	7.36	15.52	0.79	Cause	5
Lack of infrastructure	7.65	8.09	15.75	-0.44	Effect	4
Lack of knowledge	8.62	7.31	15.93	1.31	Cause	3
Perception of halal	8.59	8.37	16.96	0.22	Cause	2
Customer perception	8.34	8.87	17.21	-0.53	Effect	1
Governance roles	6.27	7.35	13.62	-1.08	Effect	7

The primary obstacle to implementing Halal certification in Malaysia's restaurant industry was customer perception, with a value of 17.21. The statement suggests that the attitudes held by customers regarding Halal certification hold considerable sway in determining whether dining establishments opt to pursue certification.
The perception of Halal itself was identified as the second-ranked barrier, with a value of 16.96. This suggests that inadequate comprehension or erroneous beliefs regarding the notion of Halal may significantly hinder the execution of Halal certification. The third most significant obstacle was the absence of knowledge, with a numerical value of 15.93. This implies that there could be a necessity for increased educational and awareness campaigns regarding the advantages and prerequisites of obtaining Halal certification.
Additional identified barriers include financial constraints, inadequate infrastructure, time-intensive procedures, and governance responsibilities. The factors were ranked in the fourth to seventh positions, respectively.

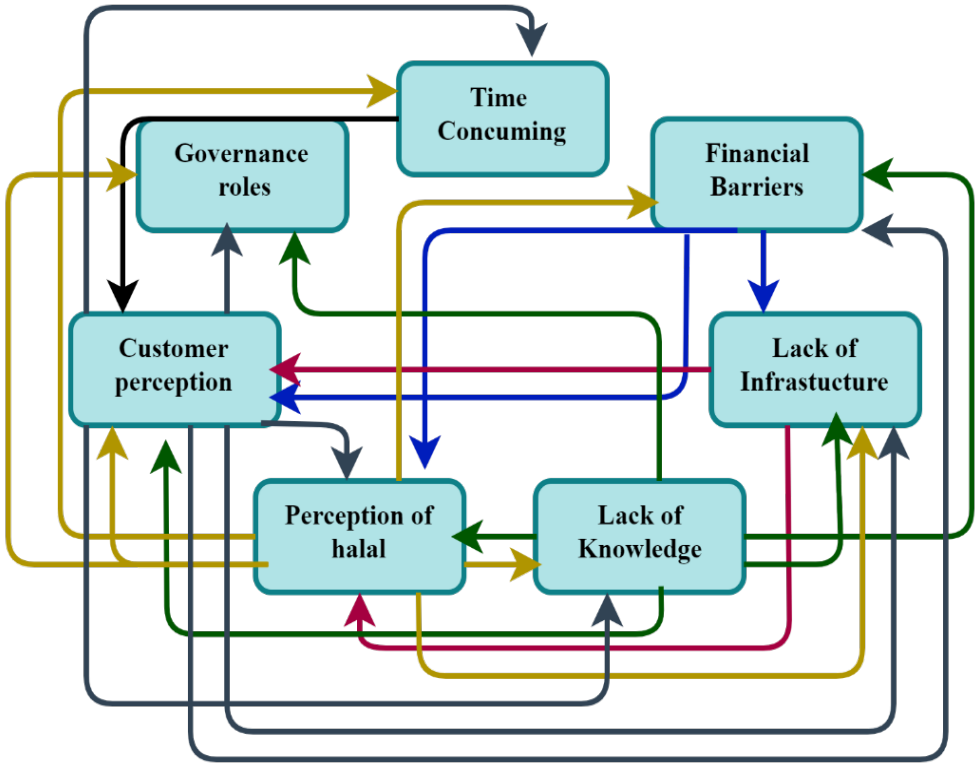

Figure 2: Network relation map

DOI: https://doi.org/10.54216/IJNS.210310
Received: February 04, 2023 Revised: May 22, 2023 Accepted: June 17, 2023

The attitudes of both customers and owners towards halal can influence the challenges associated with introducing halal certification in the restaurant industry, as shown in Figure 2. Suppose customers presume that all individuals of Muslim faith-owned dining establishments are intrinsically compliant with halal standards. In that case, they may need to make inquiries or conduct research regarding the halal certification status of these establishments, leading to a lack of awareness among owners and operators. Additionally, the insufficient knowledge of consumers regarding the significance and meaning of halal may lead to a reduction in the desire for certified halal restaurants. This may cause restaurant owners to view the costs and efforts associated with obtaining halal certification as not being worth the investment. Consequently, this may give rise to additional barriers, including the complexity and costs involved in obtaining halal certification and the need for uniformity in industry regulations.

The assumption made by restaurant owners that their food and drinks are halal based solely on their adherence to the Muslim religion can hinder the process of obtaining halal certification. The perception may result in a lack of awareness regarding the halal certification process and a failure to recognize its importance, ultimately disregarding the potential advantages of investing in it. Furthermore, the experience of self-satisfaction may create a false sense of security among customers, potentially leading to breaches of trust and damage to one's reputation. The perception may lead to resistance towards alterations and reluctance to comply with the regulations and directives instituted by the halal certification bodies. The acceptance of halal certification can be influenced by restaurant owners' personal beliefs or identities, which may lead to several barriers, such as insufficient knowledge, satisfaction with the current situation, and resistance to change.

Implementing educational and awareness campaigns can be instrumental in mitigating these misconceptions and hindrances, thereby facilitating the pervasive integration of halal certification within the industry. The importance of customer perception extends beyond the understanding, demands, expenditures, and complexities associated with obtaining halal certification. The acceptance of halal certification and other potential barriers, such as the lack of industry standards, may be impacted by this factor. Consequently, promoting knowledge and understanding regarding the importance and advantages of halal certification to both customers and owners of dining establishments may expedite halal certification implementation within the sector.

5. Conclusion

In conclusion, the integrated SVNNWBM-DEMATEL approach used in this study has provided valuable insights into the barriers hindering the adoption of Halal Certification in Malaysia. The integration of these methods is crucial as it allows for a more comprehensive analysis of the causal relationships among the identified barriers. By incorporating the SVNNWBM operator, the study effectively addresses uncertain and imprecise information, while the DEMATEL analysis helps identify the influential and influenced barriers.

The findings emphasize the significance of customer perception and perception of halal as the most significant barriers. To overcome these barriers, strong top management commitment and positive attitudes, coupled with extensive government support, are necessary to adopt Halal Certification successfully. The outcomes of this study can guide stakeholders in developing effective strategies to overcome the identified barriers and promote the growth and development of the Halal industry in Malaysia

Funding: This research was supported by Geran Dana Dalaman Negeri Collaborative Research Seed Fund (Crsf) 2022 “Beyond Halal Certification -Hesitant Fuzzy DEMATEL For Knowledge Challenges And Improvement” 600-TNCPI 5/3/DDN (05) (001/2022)

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DOI: https://doi.org/10.54216/IJNS.210310
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Received: February 04, 2023 Revised: May 22, 2023 Accepted: June 17, 2023

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DOI: https://doi.org/10.54216/IJNS.210310
Received: February 04, 2023 Revised: May 22, 2023 Accepted: June 17, 2023