RESEARCH ARTICLE | SEPTEMBER 12 2023

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AIP Conf. Proc. 2827, 030057 (2023)
https://doi.org/10.1063/5.0164583

Evaluation and Prioritisation of GSCM Barriers in Food and Beverage SMEs Using the AHP

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Abstract. The manufacturing sector, a major contributor to greenhouse gases (GHG), is struggling to reduce its negative environmental impacts. The GHG emissions of this sector highlight its misuse of environmental assets, waste, high energy usage and pollution. Green Supply Chain Management (GSCM) is a strategy aimed at addressing environmental issues and thus achieving a risk-free environment. This study had two objectives: the first was to determine which barriers might potentially constrain the introduction of GSCM into Small and Medium-Sized Enterprises (SMEs) engaged in the food and beverage (F&B) market in Malaysia. This would be achieved by interviewing 20 participants belonging to F&B organisations in Kelantan and Terengganu face-to-face. Secondly, the study aimed to adopt an approach based on the quantitative AHP to ascertain the impact of different priorities relating to the barriers. The findings reveal that technological barriers constitute the most prominent obstacle to the adoption of GSCM practices among SMEs, while further barriers were identified and are listed in order of significance: information, financial, organisational, and involvement and support. This study's findings will enable F&B organisations to identify their weakest areas and formulate strategies to effectively implement GSCM. In addition, this study assists the manufacturing industry by identifying the most appropriate approaches to reducing its negative externalities and protecting the environment.

INTRODUCTION

Recently, the manufacturing industry in Malaysia has experienced steady growth. The national industrial production index indicates that Malaysia's manufacturing industry grew by 6.6% in the first quarter of 2021, in comparison to the fourth quarter of 2020, which saw a rise of 3.0% [1]. Small and Medium-Sized Enterprises (SMEs) generally contribute to National Economic Development (NEP); in fact, such organisations constitute a vital component of Malaysia's economic growth strategy. The NEP was introduced by the Malaysian government in 1970 to improve the citizens' welfare and address ethnic economic imbalances [2]. Modern companies generally recognise sustainability issues and often pursue Green Supply Chain Management (GSCM). Increasing ecological awareness among customers, governments and multinational companies has encouraged manufacturers to develop and implement green initiatives. Previous research [3] has shown that the greening of supply chains has become a major business topic. The GSCM strategy is aimed at enhancing the efficiency of processes and products to align them more securely with environmental policies [4]. Businesses implementing the practices of GSCM gain several advantages: they save costs (materials are conserved, while less energy and water are required), improve their public image and reduce their environmental impact [5].

The food and beverages industry (F&B) in Malaysia has been recognised as a rapidly growing market and a leading contributor to the country's revenues. Approximately 10% of the national manufacturing output is contributed by the

11th International Conference on Applied Science and Technology 2022 (11th ICAST 2022)
AIP Conf. Proc. 2827, 030057-1–030057-7; https://doi.org/10.1063/5.0164583
Published by AIP Publishing. 978-0-7354-4644-1/$30.00

food-processing sector, which is worth around RM21.76 billion, with over 200 countries importing Malaysian processed food. Meanwhile, in 2019, processed food imports were valued at RM20.27 billion. Processed food exports experienced considerable growth, suggesting that foreign markets are increasingly accepting food products made in Malaysia. The main contributors to this sector are by-products like cocoa and its preparations, processed cereals and flour, as well as seafood preparations and dairy produce [6]. Malaysia's various cultural groups produce an extensive array of Asian-tasting processed food, giving the country's food industry diverse characteristics. Thus, its substantial export market characterises Malaysia's F&B industry. Primarily owned by Malaysians, the industry's key players are SMEs [7].

Nevertheless, a number of environmental issues have emerged due to the rapid expansion of the F&B industry. As [8] found, of all the world's industries, food production appears to be among the most carbon-intensive. This creates difficulties for policymakers, businesses and customers, all of whom have a stake in reducing the effects on the environment of modern food supply chains while ensuring that society has access to affordably priced, dependable and safe foods. As [9] argued, key reasons for the world's environmental damage are the production and consumption of food. These activities encompass permanent changes in land use for the cultivation of crops; food processing, which pollutes the air, land and water; and food supply networks and organic waste decomposition, which causes greenhouse gas (GHG) emissions to rise [10].

Therefore, the aim of the current study is to determine which barriers potentially limit the introduction of GSCM in (F&B) SMEs in Malaysia. Furthermore, the study used the Analytic Hierarchy Process (AHP) approach to identify the weighting of these barriers by assessing the respective priorities. Lastly, these research findings might additionally help policymakers to outline effective measures related to the proposal, development and implementation of GSCM by Malaysian SMEs. If policymakers offer the appropriate levels of assistance and resources, SMEs will be able to progress to higher levels of green practices and implement such methods in their existing supply chain.

LITERATURE REVIEW

Green Supply Chain Management (GSCM)

According to [5] GSCM evolved from SCM. The term 'Green Supply Chain (GSC)' has several different meanings in the literature. Some have described GSCs as closed-loop supply mechanisms, while they have also been referred to as 'Sustainable Supply Chains', 'Environmental Supply Chains' and 'Ethical Supply Chains'. Researchers have even referred to them explicitly as 'Socially Conscious Supply Chains' [11]. Traditional Supply Chain Management (SCM) focuses on achieving a finished product, regardless of the externalities of the manufacturing or delivery processes [12]. However, several positive traditional supply chain systems - such as environmental design, life-cycle analysis, total quality environmental management and ISO 14000 standards - now play an important role in achieving competitive advantages [10].

GSCM practices have become an increasingly important aspect of corporate strategy and constitute a significant strategic thrust for businesses. However, challenges remain in regard to the implementation of GSCM [13]. Implementing GSCM involves both obstacles and catalysts, which have direct or indirect effects on the pace and standard at which a company implements GSCM [14]. According to [15], some obstacles in the adoption of GSCM can be anticipated. The necessary transformations exhibit fairly consistent barriers, which organisations must equip themselves to overcome. While numerous studies have examined GSCM practices and strategies, few have used the AHP approach to analyse the barriers to GSCM with a focus on Malaysian food and beverage SMEs. For example, [4] used the AHP to analyse and prioritise the GSCM barriers affecting the Kerala plastics industry.

Meanwhile, [12] used Interpretive Structural Modelling (ISM) to assess the GSCM barriers in the Indian automotive industry. [16] suggested the use of an ISM-based model to identify the obstacles to GSC practices in Indian manufacturing. [17] used ISM to investigate the main barriers to GSCM among Indian clothing SMEs. In the context of SMEs in Malaysia and after securing a consensus from an expert panel, the Delphi survey method was employed by [18] with the aim of investigating, defining and verifying the catalysts of and obstacles that prevented green manufacturing activities. The AHP was utilised by [19] in their assessment of the weighting of different obstacles encountered by Malaysian electrical and electronics (E&E) production organisations trying to implement more efficient strategies.

Barriers to GSCM

Most manufacturing industries have begun to incorporate green concepts into their SCM practices, aiming to mitigate environmental issues. However, this incorporation has proven somewhat difficult, as organisations have consistently encountered barriers [20]. It is essential to understand the barriers to GSCM in this case, specifically in the context of Malaysian F&B SMEs, to successfully minimise waste and pollution. Its many characteristics make it difficult to define the critical obstacles facing GSCM implementation. As shown in Table 1, a review of the current literature revealed a significant number of GSCM barriers.

TABLE 1. Common Barriers to GSCM, According to Previous Studies.

Authors	GSCM Barriers
1. [21] - Electronic industry	Lack of awareness of benefits of sustainability, lack of regulations and enforcement of environmental standards and lack of commitment from top management.
2. [4] - Kerala plastic industry	Outsourcing, technology, knowledge, financial, involvement and support.
3.[19] - Malaysian E&E industry	Internal Barriers: lack of awareness, reluctance to adapt, cost of implementation, design restrictions, lack of information and experience and technological limitations. External Barriers: regulation, lack of external support, supply chain concerns and consumer expectations.
4. [18] - Malaysian SMEs	Organisational, environmental knowledge, business environment, societal influence, technology, regulation, finance, and suppliers.
5. [15] - Indian SMEs	Technology, financial, knowledge, outsourcing, involvement and support

As Table 1 suggests, while GSCM is widely practised and has been studied in many industries (e.g., E&E, plastic, clothing and manufacturing), few researchers have used the AHP, especially in the specific context of Malaysian F&B SMEs. As a result, this study addresses a major gap in the literature on GSCM.

METHODOLOGY

In the first phase of this study, 20 respondents from F&B companies in Kelantan and Terengganu were asked about the main barriers facing the implementation of GSCM at their companies. A random selection was conducted of the specific company types under the F&B SMEs umbrella, such as processed food, bottled products, sauces, biscuits and cookies, frozen processed foods, dairy, chocolate and carbonated soft drinks. The data gathered for this study needed to be reliable and high-quality, so recruitment was only extended to experienced managerial staff. Each subject had to be, for instance, a production manager, a director of a department, an engineer, a procurement manager or a logistics manager. All the interview data was anonymised to protect the confidentiality and anonymity of the participants, who are referred to as respondents *R1* to *R20*.

The second part of the study involved the use of the quantitative AHP method to assess how the priorities were weighted in respect of the barriers. The AHP uses a hierarchical structure to represent problems and determine priorities. It calculates weights for each barrier and uses them to determine the value of the consistency ratio (CR) in a paired comparison. If the CR exceeds 0.1, the comparative value of the criteria must be reconsidered. However, if the CR is less than 0.1, the process of comparison between the criteria is consistent [22]. The general steps of the AHP, as outlined by [23], are as follows:

(1) Define goals, problems or questions and develop a hierarchical structure;
(2) Develop a paired comparison matrix for each related element. Each comparison was undertaken according to the evaluators' selections and beliefs by assessing how important an element was and making a comparison of this importance to the alternative elements;
(3) Normalise the data. The matrix element values were divided by the overall value of the columns;
(4) Calculate the value of the eigenvector and test its consistency. If it is inconsistent, data retrieval must be repeated;
(5) Repeat steps c, d and e for the entire hierarchical level;
(6) Calculate the eigenvector from each paired comparison matrix;
(7) Test the consistency of the hierarchy. If its CR value is >0.1, the assessment must be repeated.

Using too many criteria or factors can overcomplicate the AHP and make the decision-makers' assessment of the importance of criteria more difficult [22]. Therefore, this study focused on only five factors. The development of the decision-making measurements consisted of four stages, which were outlined by [24] and [25] as follows:

(1) Identifying the Factors (Barriers)

Following the first phase of this study, during which a preliminary questionnaire was issued to 20 respondents, five evaluation factors were finally selected. Each factor is referred to as a barrier (B). The set of barriers = (B1, B2, B3…., Bn), where B1: Information; B2: Technology; Financial; B4: Organisation; B5: Involvement and Support; Bn: The next n barrier.

(2) Establishing the Hierarchical Structure

The first step of the AHP is developing a hierarchy that represents the overall goals, criteria and alternative outcomes [34]. The first level of the hierarchy consists of the overall goal (i.e., selecting the appropriate barriers to GSCM). The second level involves a list of factors that contribute to the overall goal. The third level consists of the priorities of the essential barriers.

(3) Ranking the Factors (Barriers)

The factors obtained during the first and second phases are ranked from highest to lowest in terms of priority. These factors are then compared in pairs to gauge their relative importance. The five factors form ten factor pairs. A comparison scale was constructed between the factor pairs, based on the differences in the order of factor levels, starting from B1 to B5. This comparison value illustrated the comparison of the pair between the two factors and produced a better value.

(4) Constructing the Decision Matrix

To determine the priority vector of the five selected factors, a pair-wise comparison matrix was developed. The AHP was employed to calculate the matrix results by ascertaining the value of the normal vector of the pair-wise comparison matrix. From the results of the matrix, the value represents the priority vector of the selected barrier.

RESULTS AND DISCUSSION

The hierarchical structure involving the five barriers is presented in Figure 1. Each phase consists of decision-making elements. The first phase consists of the main goal. The second phase includes the five barriers: Information (B1); Technology (B2); Financial (B3); Organisation (B4); and Involvement and Support (B5).

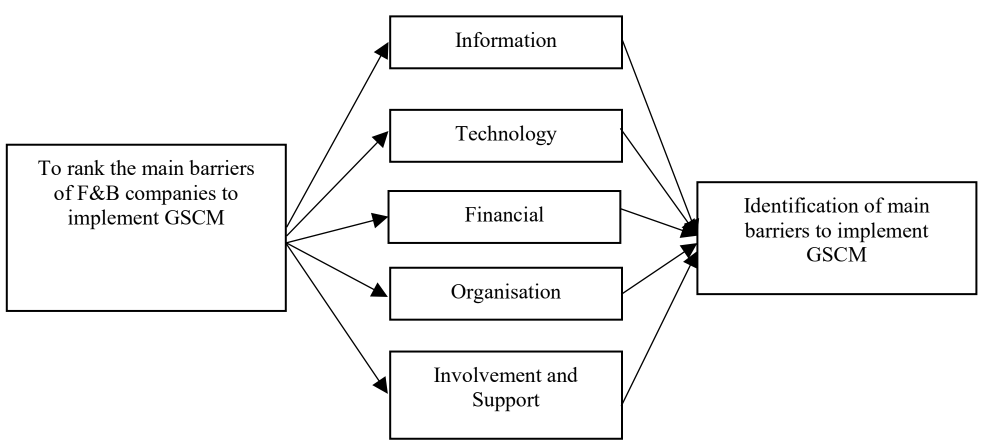

FIGURE 1. Hierarchical Structure to Identify Barriers to GSCM Practices among F&B Companies.

Table 2 displays the comparison values between the five factors. The data gathered from each interview provided the pair-wise comparison matrix, known as Matrix A. In Matrix A, Bij was used to denote entries in each ith row and jth column of A, whereby i = 1…5 and j = 1…5. The complete matrix depicting the comparison of the factor pairs is shown as follows:

TABLE 2. Pair-Wise Comparison Matrix.

Factor (B)	**B_1**	**B_2**	**B_3**	**B_4**	**B_5**
B_1	1 ($_{ij}$)	2	1	1	2
B_2	0.5	1	1	3	4
B_3	0.5	0.5	1	2	3
B_4	0.5	0.33	1	1	2
B_5	1	0.25	0.33	0.5	1
Total Column	3.5	4.08	4.33	7.5	11

From the pair-wise comparison matrix (Table 2), each value was divided by the sum of the values in the relevant column to obtain the normalisation matrix and confirm the priority results.

TABLE 3. Normalisation Matrix and Priority Factors.

Factor	**B_1**	**B_2**	**B_3**	**B_4**	**B_5**	**Priority Factors (W_{ij})**
B_1	0.29	0.49	0.23	0.13	0.18	0.26 (26%)
B_2	0.14	0.25	0.23	0.4	0.36	0.28 (28%)
B_3	0.14	0.12	0.23	0.27	0.27	0.20 (20%)
B_4	0.14	0.08	0.23	0.13	0.09	0.13 (13%)
B_5	0.28	0.06	0.76	0.07	0.09	0.09 (9%)

According to the priority results in Table 3, technology (28%) constituted the most critical barrier to GSCM, followed by information (26%), financial (20%), organisation (13%) and involvement and support (9%). The CR is 0.045, indicating that the comparison of the pair factors is consistent, since [23] asserted that any CR under 0.1 is acceptable. The formula for the CR-calculation is given in the next equation [23], while the random consistency index (RI) values are presented in Table 4.

$$\mathrm{CR} = \mathrm{CI} / \mathrm{RI} \tag{1}$$

$$\mathrm{CI} = (\lambda\max - \mathrm{n}) / (\mathrm{n} - 1) \tag{2}$$

n = Number of factors
CI = Consistency Index
RI = Random Consistency Index

TABLE 4. RI Values.

Matrix Size (n)	**RI**
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45

For the CR calculations, the pair-wise comparison matrix, Bij (Table 2), was multiplied by the priority factor, Wij (Table 3). Next, the results of the matrix were divided by the priority factors as follows:

$$\begin{bmatrix} 1 & 2 & 1 & 1 & 2 \\ 0.5 & 1 & 1 & 3 & 4 \\ 0.5 & 0.5 & 1 & 2 & 3 \\ 0.5 & 0.33 & 1 & 1 & 2 \\ 1 & 0.25 & 0.33 & 0.5 & 1 \end{bmatrix} \times \begin{bmatrix} 0.264 \\ 0.277 \\ 0.207 \\ 0.136 \\ 0.116 \end{bmatrix} = \begin{bmatrix} 1.392 \\ 1.488 \\ 1.098 \\ 0.683 \\ 0.586 \end{bmatrix} \quad (3)$$

The average matrix result is 5.204, a value that represents λmax. The RI for the five factors (n = 5) was 1.12 (based on Table 4), while the CI for the five factors was obtained as follows:

CI = (5.204 -5) / (5-1)
= 0.051
CR = CI / RI
= 0.051 / 1.12
= 0.045

As shown in Table 3, technology (B2) was the leading priority among the barriers (28%). The majority of the respondents from the F&B SMEs agreed that green technology had become an important factor in food processing because it would considerably reduce the environmental impact.. Respondents *R8, R12* and *R15* confirmed that solar systems can provide long-term savings, so renewable energy is very useful for reducing electricity consumption. Therefore, the government needs to play a role. This aligned with [15] assertion that GSCM implementation is often hindered by a lack of technological processes, applications, resources and expertise, as well as a fear of failure on account of the complexity of designing GSCM practices. The failure to keep updated on new GSCM technologies causes organisations to lose their competitive advantage, as green practices have dramatically risen in importance [26]. Given the rapid rate of technological advancement, this barrier is only likely to become more significant over time [27].

Information (B1) (26%) fell just below technology (B2) in terms of priority. An information barrier involves the inability to obtain data accurately. This aligns with [28] Abdullah, who asserted that a lack of knowledge and information is a significant obstacle to implementing GSCM among F&B manufacturing companies. Respondent *R10* emphasised the difficulty of selling recycled boxes from their company because not all recycling centres accept recycled items such as paper boxes. It is highly important to centralise the locations of reverse logistics, especially in Kelantan. Standard operating procedures or information flows connected with the recycling of materials remain unclear among SMEs. The lack of information-sharing among firms and suppliers also constitutes an extreme barrier [29].

In this study, the financial barrier ranked third out of five barriers, contributing about 20% in terms of priority. The majority of the respondents from the F&B SMEs indicated that financial incentives serve as significant drivers for organisations to implement GSCM. Many SMEs believe that grants, loans and tax concessions would encourage them to implement green practices [30]. Respondent *R5* reported that the government offered a 50% incentive to develop a solar system for his company; however, the company needed to find the other 50% to pay for the system, while the building would need to be modified in order to install it, which would also incur a cost. Such cases, particularly those involving small companies, mean the overall situation must be reviewed by the government and/or stakeholders.

The organisational barrier ranked fourth in this study, at about 13%. According to the respondents, resource restrictions hindered their companies' capacity to implement GSCM. Furthermore, most F&B SMEs lack corporate social responsibility for green practices and the environment. This study found a general lack of concern about recycling and sustainability efforts throughout the manufacturing industry. Managerial commitment would encourage the pursuance of green initiatives and GSCM [29].

CONCLUSION

This study ranked the barriers to GSCM among Malaysian F&B SMEs. the findings demonstrate that technology barriers constituted the most prominent obstacle to the adoption of GSCM practices among SMEs, followed by the various other barriers, listed here in order of significance: information, financial, organisation, and involvement and support.

This study proposes that the Malaysian government should help SMEs to invest in green IT, which should include hardware, tools and infrastructure aimed at minimising energy consumption, carbon emissions and e-waste while also actively contributing to ecological sustainability. This would help manufacturing companies enhance their efficiency and minimise their negative environmental externalities. Furthermore, it is vital that education on the environment is available for both individuals and organisations because this should assist the public exploration of environmental matters, their engagement in environmental issues and their environmental improvement actions. Finally, this study was limited to SMEs in the Kelantan and Terengganu manufacturing industries. Future researchers should conduct a similar study elsewhere in Malaysia to determine how the results may vary by state or region.

ACKNOWLEDGEMENT

The authors would like to express gratitude to the Ministry of Higher Education Malaysia for awarding the Fundamental Research Grant Scheme (FRGS/1/2021/SS02/UMK/02/3) and the University of Malaysia Kelantan (UMK) for providing research facilities.

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