Drivers and barriers analysis for green manufacturing practices in Malaysian SMEs: A Preliminary Findings

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Abstract

Nowadays, the manufacturing industry is faced with the challenge to adhere to stringent environmental regulations due to the scarcity of natural resources, global warming and waste management issues. Increasing environmental concerns and awareness are the driving force which pushes manufacturers all over the world to adopt green manufacturing practices. However, the drivers and barriers of implementing green manufacturing practices in Small and Medium Enterprises (SMEs) differ from those for large enterprises since SMEs lack the data, resources, technical expertise and experience required to implement green initiatives. The environmental performance of SMEs is mostly driven by the intention of company owners. Since SMEs play a crucial role in a nation’s economic growth, it is imperative to identify the drivers and barriers which will motivate and hinder the implementation of green manufacturing practices in SMEs, which forms the main motivation of our work.

In this paper, we report preliminary findings on the drivers and barriers faced by SMEs in implementing green manufacturing practices, specifically in Malaysia. We use the Delphi survey method to explore, identify and verify the drivers and barriers of green manufacturing practices by obtaining consensus from a panel of experts. The experts are required to answer questionnaires in three rounds. The results of this study will offer insight to SMEs who intend to transform their manufacturing practices from conventional to green ones. We believe that our study will assist the manufacturing industry in prioritizing the key factors which will influence the adoption of green manufacturing practices.

1. Introduction

Nowadays, a growing number of companies have become increasingly aware of their responsibilities to develop green products, services and processes [1]. In general, large companies are more compelled to do so compared to small and medium enterprises (SMEs) due to the fact that they are more influential with better organizational management and good financial stability compared to SMEs. Many small businesses do not perceive their own environmental impact as significant compared to those of larger companies [2]. Most studies pertaining to environmental management in SMEs are centred towards the experience of companies when it comes to greening their production facilities [3].

It is known that SMEs play a crucial role in a country’s economic growth and they can be considered as the backbone of economic growth in all countries. In Malaysia, it has been reported that the SMEs’ contribution to the nation’s Gross Domestic Product (GDP) is 32.5% in year 2011, and these companies aim to contribute 41% to the nation’s GDP by year 2020. The Government of Malaysia has drafted plans which require SMEs to increase workforce from 59 to 61%, increase exports from 19 to 25% and increase the number of registered firms from 69 to 85% in Malaysia by year 2020 (The Star, 2212-8271 © 2015 Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
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SMEs contribute to the nation by providing job opportunities and they serve as suppliers of goods and services to large organizations. SMEs are defined by a number of criteria such as location, size, age, organizational structure, number of employees, sales volume or worth of assets and ownership through innovation and technology [4]. The majority of SMEs adopt simple systems and procedures which allow flexibility, immediate feedback and short decision-making chains. More importantly, SMEs provide better understanding and quick response to customer needs compared to large organizations [5].

The term ‘green manufacturing’ was coined to reflect a new manufacturing paradigm which implements various green strategies (objectives and principles) and techniques (technology and innovation) to become more efficient [6]. In general, green manufacturing includes generating processes which utilize inputs with low environmental impact, as well as processes which are profoundly productive with nearly zero waste and contamination. An example of green manufacturing practices (GMP) is the prevention of pollution which involves reducing energy use, raw materials and solid waste, reusing products as well as recycling water. Other green practices include the use of renewable materials, eco-friendly energy, redesigning products and processes, and training employees regarding product stewardship practices.

The drivers and barriers of green manufacturing practices in SMEs differ from those in large enterprises due to the fact that SMEs lack the data, resources, technical expertise and experience required to implement green initiatives. The environmental performance of SMEs is mostly driven by the intention of the company owners. In addition, the characteristics of SMEs differ greatly between geographical regions. Hence, we believe that there is a critical need to identify the drivers and barriers of green manufacturing practices in SMEs in order to expedite the implementation of such practices in SMEs, specifically in Malaysia.

We observed from the literature that there is a limited number of studies focused on the identification of drivers and barriers which motivate and hinder the implementation of GMP in SMEs, especially in a specific country. Most of the studies in this field are primarily dependent on the findings in the literature, which may be inapplicable for actual practices. In order to fill this gap, the objective of our work is to identify the drivers and barriers which influence the implementation of GMP in SMEs. We use the Delphi survey to collect views from a panel of experts recruited from the academia, government agencies and manufacturing industry regarding the list of drivers and barriers. However, since our study is still in the preliminary stage, we only present findings obtained from the first round of the Delphi survey.

2. Literature Review

2.1 Definition of SMEs

According to the National SME Development Council (NSDC), an enterprise is considered as a SME based on either its annual sales turnover or the number of full-time employees. SMEs are divided into two sectors: (1) manufacturing related to physical or chemical products and (2) services and others. The latter category includes ICT services, private education, research and development, logistics, primary agriculture, construction, mining and quarrying. The definitions of SMEs based on its size of operation and sector are presented in Table 1.

| Category                     | Small                                       | Medium                                      |
|------------------------------|---------------------------------------------|---------------------------------------------|
| Manufacturing                | Sales turnover from RM 300,000 to less than RM 15 million OR 5 to 74 full-time employees | Sales turnover from RM 15 million to RM 50 million OR 75 to 200 full-time employees |
| Services and other sectors   | Sales turnover from RM 300,000 to less than RM 3 million OR 5 to 29 full-time employees | Sales turnover from RM 3 million to RM 20 million OR 30 to 75 full-time employees |

2.2 Green Manufacturing Practices

Green manufacturing leads to production efficiency (i.e. less energy and water usage), lower raw material costs due to (i.e. recycling waste rather than purchasing virgin materials), reduced environmental and occupational safety expenses (i.e. lower regulatory compliance costs and potential liabilities), and improved corporate image (i.e. decrease in negative environmental impact by the public) [7].

The green manufacturing process cycle is shown in Fig. 1, and it can be seen that the process begins with design, followed by procurement, manufacturing, packaging and distribution, customer use to a product’s end-of-life and remanufacture.

3. Research Methodology

We first search for literature pertaining to green manufacturing practices in SMEs such as scholarly books, journal articles, conference papers and the Internet. Following this, we identify and compile the list of drivers and barriers which influence the implementation of GMP in SMEs from the available literature. We also conduct a brainstorming session among our research group in order to finalize the list of drivers and barriers and their corresponding categories.
Literature review on drivers and barriers faced by SMEs in adopting green manufacturing practices
Identification of factors which influence GMP from literature and brainstorming session
Development of research instrument for Delphi survey
Collection of data and outcome of discussion with experts
Examination of drivers and barriers
Identification of key drivers and barriers

Fig. 2. Flow chart of the methodology adopted in this research

The flow chart of the methodology adopted in this study is shown in Fig. 2. Once we have identified the list of drivers and barriers, we apply the Delphi method to examine the key drivers and barriers based on the views obtained from the panel of experts. We prepare semi-structured questionnaires as the research instrument and conduct a pilot test prior to sending the questionnaires to the panel of experts to ensure that all questions can be interpreted accurately by the respondents.

We use the Delphi survey method for data collection. Delphi is basically a method which structures group communication process and makes the process more effective. Hence, the Delphi method enables a group of individuals to deal with a complex problem [8]. In this study, we use three rounds of questionnaires for data collection, which are described briefly as follows:

- **Round 1**: We ask the panel of experts who have agreed to participate in the survey to complete the first questionnaire which answers the following question: What are the most essential/important drivers and barriers for SMEs to implement green manufacturing practices?
- **Round 2**: We will consolidate the list of drivers and barriers extracted from the first round of the Delphi survey and send the results to the experts for verification. Following this, we will hold a meeting with the experts in order to achieve a consensus.
- **Round 3**: We will ask the panel of experts to make a pair-wise comparison based on the list provided in order to answer the following question: How do you prioritize the drivers with regards to achieving green manufacturing performance?

We will recruit 20 experts from the industry, academia and government agencies for this survey. We will collect data from 20 academicians from local universities having research interest in related fields. We will request the experts to complete the questionnaires in order to obtain a list of key drivers and barriers based on their opinion. We will identify the drivers and barriers based on the data gathered from the questionnaires. Since this study is still ongoing, the results presented in this paper are merely preliminary findings extracted from the first round of data collection.

4. Results from the first round of Delphi survey

Preliminary findings of the first round of the Delphi survey are presented in this section, based on the responses of 6 out of 20 experts who have participated in this study. The results indicate the factors which motivate and hinder the implementation of green manufacturing practices in SMEs and are summarized in Table 2 and 3, respectively. The mean value and rank of each factor is presented in the results.

Table 2: Drivers which motivate the implementation of GMP in SMEs

| No | Drivers | Mean | Rank |
|----|---------|------|------|
| 1  | Voluntary GMP regulations and standard (e.g. ISO 14000 and Eco Labelling) | 4.000 | 23 |
| 2  | Compulsory GMP regulation mandated by local government (e.g. hazardous and toxic regulation) | 4.000 | 23 |
| 3  | GMP regulation in place by other countries (e.g. WEEE, EU Directive) | 3.000 | 38 |
| 4  | Financial incentives or penalties from the government (e.g. tax, rebate, soft loan) for GMP | 4.250 | 15 |
| 5  | Compulsory or voluntary corporate social responsibility pushed by authorities for GMP | 4.250 | 15 |
| 6  | Type of organizational culture supportive of GMP | 3.500 | 35 |
| 7  | Self-directed and facilitated organization facilitating GMP | 4.200 | 17 |
| 8  | Organisational Commitment for GMP | 4.000 | 23 |
| 9  | Owner values or employee aspirations towards GMP | 3.000 | 38 |
| 10 | Internal organizational capabilities to support GMP | 4.000 | 23 |
| 11 | Internal sustainable efforts toward GMP | 4.000 | 23 |
| 12 | GMP awareness within organization’s management | 4.400 | 10 |
| 13 | Awareness of GMP impact throughout the organisation | 4.200 | 17 |
| 14 | Good community and employee relations supportive of GMP | 3.250 | 37 |
| 15 | Availability of Comprehensive training and education in GMP | 4.000 | 23 |
| 16 | GMP education are part of organisational training | 4.200 | 17 |
| 17 | Availability of GMP information | 4.600 | 4 |
| 18 | Commitment from various business stakeholders towards GMP | 4.400 | 10 |
| 19 | Professional network to support GMP | 4.200 | 17 |
| 20 | New market opportunities towards GMP | 4.600 | 4 |
| 21 | Competitors pressures towards GMP | 4.600 | 4 |
| 22 | Industrial sectors initiatives for GMP | 4.000 | 23 |
| 23 | Support from external stakeholders for GMP | 4.000 | 23 |
| 24 | Business to business pressure from larger organizations towards GMP | 3.400 | 36 |
| 25 | Promotion of successful GMP practices as case examples | 4.400 | 10 |
| 26 | Public awareness to Green initiatives | 4.600 | 4 |
| 27 | Customer’s demand of Green products/process | 4.600 | 4 |
| 28 | Customer collaborations towards green initiatives | 4.200 | 17 |
| 29 | Socio cultural responsibility towards Green Practices | 4.400 | 10 |
| 30 | Financial incentives (penalties, support) from government for GMP | 4.000 | 23 |
| 31 | Organizational belief of cost reductions through GMP | 4.000 | 23 |
| 32 | Holistic intervention programs | 4.000 | 23 |
| 33 | Organizational belief of innovation opportunities through GMP | 3.800 | 34 |
| 34 | Better competitiveness through GMP | 4.800 | 2 |
| 35 | Improved company image through GMP | 5.000 | 1 |
| 36 | Desire to promote environmental benign product | 4.200 | 17 |
| 37 | Perception of increase product quality | 4.800 | 2 |
| 38 | Business performance commitment | 4.600 | 4 |
Table 3: Barriers which hinder the implementation of GMP in SMEs

| No. | Barriers                                                                 | Mean | Rank |
|-----|---------------------------------------------------------------------------|------|------|
|     | **Organizational**                                                        |      |      |
| 39  | Organisational belief of Long term benefit through GMP                   | 4.400| 10   |
| 40  | Lack of GMP knowledge                                                    | 4.400| 3    |
| 41  | Inadequate R&D, design and testing within the organization to support GMP | 5.000| 1    |
| 42  | Lack of new technology, materials and processes to support GMP           | 4.200| 9    |
| 43  | Lack of flexibility to switch over to GMP-based systems                  | 4.600| 20   |
| 44  | Existence of owner-manager leadership issues which hinder GMP            | 4.000| 43   |
| 45  | Lack of experience in allocating resources for GMP                       | 4.300| 12   |
| 46  | Deficiency regarding the benefits of GMP                                 | 4.200| 29   |
| 47  | Weak public pressure towards green manufacturing practices               | 4.400| 20   |
| 48  | High initial capital cost to implement GMP                              | 4.800| 3    |
| 49  | High internal politics which delay execution of decisions concerning GMP| 4.600| 12   |
| 50  | High risk of GMP transformation to positive GMP attitudes into actions  | 4.400| 20   |
| 51  | Lack of involvement from external stakeholders                           | 4.000| 43   |
| 52  | Lack of financial gains through GMP                                      | 4.000| 43   |
| 53  | Lack of awareness of the benefit of GMP                                  | 4.000| 43   |
| 54  | Lack of new financial gains through GMP                                  | 4.000| 43   |
| 55  | Lack of involvement from external stakeholders                           | 4.000| 43   |
| 56  | Lack of commitment to environmental actions                               | 4.000| 43   |
| 57  | Poor corporate social responsibility for GMP                             | 3.600| 56   |
| 58  | Limited financial resources                                             | 3.400| 59   |
| 59  | Difficulties in obtaining GMP information for potential improvements     | 3.600| 56   |
| 60  | High initial capital cost to implement GMP                              | 4.800| 3    |
| 61  | Poor performance to initiate GMP                                        | 4.200| 29   |
| 62  | Lack of GMP implementation guidelines                                    | 4.000| 43   |
| 63  | High cost of GMP certification/verification which disproportionately penalizes small organizations | 4.400| 20   |
| 64  | Low cost of GMP certification/verification                               | 4.200| 29   |
|     | **Environmental Knowledge**                                              |      |      |
| 65  | Existence of sunk costs in GMP which can cause organizations to incur losses | 4.200| 29   |
| 66  | Difficulties in acquiring financial capital for GMP initiatives          | 4.600| 12   |
| 67  | High initial capital cost to implement GMP                              | 4.800| 3    |
| 68  | Poor financial performance to initiate GMP                              | 4.200| 29   |
| 69  | Lack of financial gains through GMP                                      | 4.000| 43   |
| 70  | High cost of GMP certification/verification which disproportionately penalizes small organizations | 4.400| 20   |
| 71  | Low cost of GMP certification/verification                               | 4.200| 29   |

5. Discussion

We have identified 39 drivers and 64 barriers which motivate and hinder the implementation of GMP in SMEs from the literature. The drivers are categorized into seven categories whereas the barriers are categorized into eight categories (Table 2-3). Following this, we elicit the views of academicians regarding the list of drivers and barriers of implementing GMP in SMEs via questionnaire during the first round of the Delphi survey. Our preliminary findings reveal that the top critical drivers which motivate GMP in Malaysian SMEs are improved company image, improved competitiveness and enhanced product quality through GMP. In general, the SMEs’ commitment to environmental initiatives such as green manufacturing practices is not only driven by economic aspects, but also the desire to gain approval from the public. We expect that the public may not be fully aware of SMEs due to the small coverage of these organizations by the media compared to large organizations. Hence, the implementation of GMP in SMEs can be one of the factors which will draw attention from the public since consumers have grown more environmentally-conscious over the years. We believe that SMEs can improve their performance, gain profits and increase their competitiveness in the local and global markets by implementing GMP.

In addition, our findings reveal that the top critical barriers which hinder the implementation of GMP in SMEs are weak organizational structure to support GMP as well as inadequate R&D, design and testing within the organization to support GMP. In Malaysia, SMEs are typically owned by families, in
which the management primarily focuses on daily business operations and exhibits the tendency to respond only to critical situations. In other words, SMEs do not have a structured environmental management. In general, the owners’ knowledge on green practices is not translated usefully into actual business practices as they perceive that implementing green practices will incur high cost. Furthermore, SMEs have inadequate R&D support due to lack of resources and technical expertise concerning green practices. Our preliminary findings are encouraging and therefore we intend to proceed with the second and third rounds of the Delphi survey in order to elicit views from government and industrial experts regarding the drivers and barriers of implementing GMP in SMEs. We believe that our findings will be beneficial as the changes towards green manufacturing in SMEs can only be made by all relevant stakeholders once the key factors are clearly identified.

6. Conclusion

In this study, we have identified the drivers and barriers which encourage and inhibit the implementation of green manufacturing practices in SMEs, specifically in Malaysia. We have compiled a list of drivers and barriers which we extracted from a comprehensive literature review. Furthermore, we have begun the first round of the Delphi survey, whereby we send out questionnaires to a panel of experts, primarily academicians from local universities. Even though the results presented in this paper are merely obtained from the preliminary stage of this study, the results provide an overview on the drivers and barriers which encourage and inhibit the implementation of GMP in SMEs. We are still carrying out the first round of the Delphi survey and we will proceed with the second and third stages of the survey in order to provide a detailed insight on the views from all relevant stakeholders concerning the implementation of GMP in SMEs. We will use pair-wise questionnaires during the second and third rounds of the Delphi survey in order to determine the level of importance for all drivers and barriers. We intend to obtain the opinions of government officials and industrial experts next since this will give a holistic view of the factors which motivate and hinder the implementation of GMP in SMEs in Malaysia.

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APPENDIX A

Summary of literature used to determine the drivers of GMP

| Drivers                                                                 | Sources |
|------------------------------------------------------------------------|---------|
| Holistic intervention programmes; high commitment from various stakeholders | [9]     |
| Support from external stakeholders; internal organization             | [10]    |
| Regulations                                                            | [11, 12], [13, 14] |
| Good environmental education                                           | [15]    |
| Competitiveness; culture; use and availability of information; advice from stakeholders | [16]    |
| Regulation and social concerns; customers’ requirements                | [17]    |
| Pressure from external and internal stakeholders such as government, investors, customers, suppliers and community | [18]    |
| Awareness of environmental impact: long-term benefits                  | [19]    |
| Professional network                                                   | [20]    |
| Regulatory measures; pressure from competitors; pressure from customers; socio-cultural responsibility | [21]    |
| Organizational factors; customers; competitor; society                | [22]    |
| Environmental collaboration between suppliers and customers            | [23]    |
| Pressure from customers; owner values or employee aspirations         | [24]    |
| Business pressure from larger organizations; cost reductions          | [25]    |
| Financial: markets; legislation; community and employee                | [26]    |
| Social responsibility; Regulations; Public awareness; financial benefits, improved company image; improved competitiveness | [27]    |
| Environmental education                                                | [28]    |

Summary of literature used to determine the barriers of GMP

| Barriers                                                                 | Sources |
|------------------------------------------------------------------------|---------|
| High investment and loss return of investment; unavailability of bank loans; high cost for hazardous waste disposal | [29]    |
| Sunk costs; improper communication structures; politics                | [30]    |
| Lack of human resources; disbeliefs that environmental initiatives will benefit businesses | [31]    |
| Difficulties in obtaining information for potential environmental improvements | [32]    |
| Lack of effective environmental measures                                | [33]    |
| Limited resources which affect the ability to adopt new practices; limited range of technological competencies | [34]    |
| Undeveloped organizational environmental culture; limited financial and staff resources; environmental legislation | [35]    |
| Lack of technology, knowledge and financial resources                  | [36]    |
| Lack of resources and capabilities                                     | [37]    |
| Lack of human resource capabilities, knowledge, technical skills and professional consultation | [38]    |
| Organizational structure; owner-manager leadership issues; lack of empowerment and employee ideas | [39]    |
| Tools, business case milestones and verification procedures are primarily aimed at large businesses | [40]    |
| Lack of training courses/consultancy to train and monitor progress of each industry; lack of environmental knowledge | [41]    |
| Problems in maintaining environmental awareness of suppliers           | [42]    |
| Lack of new technology and R&D                                         | [43]    |
| Lack of guidelines; low environmental awareness                        | [44]    |
| Effect of legislation; suppliers; environmental attitudes              | [45]    |
| Lack of green system exposure professionals; low involvement from the top management | [46]    |
| Complexity of design to reuse/recycle products; restrictive company policies towards product/process stewardship | [47]    |
| Requirement of additional effort and high costs                        | [48]    |
| Environmental legislation and requirements                             | [49]    |
| Type of organizational structure; lack of environmental training and awareness; lack of capability to innovate; lack of relationship with external stakeholders | [50]    |
| Lack of commitment and communication by SME owners to reduce negative environmental impact; difficulties in transforming positive environmental attitudes | [51]    |

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