# Technological Determinants of Green Production Adoption by Malaysian Small and Medium Enterprises (SMEs): A Conceptual Framework

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***Abstract*—** During the United Nations Framework Convention on Climate Change Conference of the Parties (UNFCC COP) meeting at Copenhagen, prime minister of Malaysia Dato Seri Najib Razak pledged to reduce the Malaysia $CO_2$ emissions up to 40% by the year of 2020. Ever since that, organizations are called to embark on green innovation to achieve the target. The latest statistics from the economic census 2011 reported that Small and Medium Enterprises (SMEs) constitute 97.3% of total business establishment in Malaysia. This clearly shows that SMEs are an important economic entity in Malaysia and participation by them on adoption of green innovation is vital to reduce the CO2 emission. Thus, this paper suggested the conceptual framework to examine the technological determinants that may influence SMEs in Malaysia to adopt one of the green innovation methods which is green production and suggested to explores the influence of government interventions toward the relationship.

***Keywords*—**Government interventions, Green innovation, Green production, technological determinants.

## I. Introduction

EVER since attention on global warming, carbon footprint and green house gases was increasing, organizations nowadays is under pressure to develop and implement environmental friendly operations that would minimize their operations impacts toward the environment [1-6]. Green innovations emerged as one of the important business strategies to cope with current world situation. Green innovations are new environmental methods, ideas, products, processes or service that concern on minimizing negative environmental impacts of business operations [7]. Adopting green innovations can provide various benefits to organization such as improving environmental, operational and financial performance [8, 9]. It was also found that organizations who adopt green innovations can minimize the risk of employee's health and safety [10].

Despite of all benefits that can be obtained by adopting such technology, Small and Medium Enterprises (SMEs) are found usually to adopt "green reactive strategy" who is passive mover on green innovations [11]. They will only react in order to comply with environmental regulations and stake holder requests, to react on the changing environment, or to respond to competitors challenge. They did not see adopting green innovations as an opportunity and strategy for them. Moreover, some SMEs owner-managers believe that their business have only minimum impacts on the environment since their operations are usually in small scale and they are only using limited resources [2]. However, with the fact that SMEs constitute more than 80% of world businesses [12] and they are the primary sources of environmental problems [13], adoption of green innovations should not be an option for them.

Green production is one of the green innovations method that rapidly growing importance [14]. Green production is an application of environmentally and socially sensitive practices to reduce the negative impact of manufacturing activities, while at the same time, harmonizing the pursuit of economic benefits [15]. Green production emerged as one of the important green innovations method as traditional production systems that supply the growing demand for goods are linked to adverse environment impacts [14].

As green production can be considered as new technology, literature on green production adoption is still scarce and growing. However, green innovations adoption literature can be used to help us in understanding the adoption factors. Green innovations adoption literatures show that researches on such technology have been done based on few perspectives. Lin and Ho [16] and Weng and Lin [17] for example examined green adoption from technical innovation perspective, while Henrique and Sadorsky [18] examined environmental adoption based on innovation perspective. Le, Hollenhorst, Harris, McLaughlin and Steve Shook [19] on the other hand, examined adoption factor based on environmental

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management. This study will be done based on green innovations perspective.

## II. Problem Statement

Prime Minister Dato Seri Najib Razak pledged to reduce the Malaysia's $CO_2$ emission up to 40% by the year 2020 during the United Nations Framework Convention on Climate Change Conference of the Parties (UNFCC COP) meeting at Copenhagen. He also acknowledged that green innovations play a significant role to achieve it. To ensure that the target will be achieved, public organizations as well as government agencies are called to embark in green innovations. Statistic from SME Corporation Malaysia shows that there are 645, 136 SME companies in Malaysia currently and they contribute 31.9% of Malaysia Gross Domestic Product (GDP) and forecasted will be 41% by 2020 (SME Corporation Malaysia, 2011). Statistics also have indicated that large portion of the country's environmental problems is associated with the activities of SMEs [20] and it is also believed that SMEs are primary sources of environmental problems [13]. Thus, in order to ensure that the government aim to reduce 40% of Malaysia's CO2 emission will be achieved, understanding the factors influencing green innovation adoption such as green production is vital.

## III. Literature Review

### A. Small and Medium Enterprises (SMEs) in Malaysia

Small and Medium Enterprises (SMEs) play a vital role in the Malaysian economy and are considered as the backbone of industrial development in the country. Latest SMEs economic census which was published in 2011 by Department of Statistics Malaysia shows that 97.3% organizations in Malaysia are categorized as SMEs. They also contribute 52.7% of total employment in Malaysia. Most of the SMEs in Malaysia are located in Selangor, Wilayah Persekutuan and Johor. Malaysian SMEs can be defined according to number of employees and annual sales turnover (Source: SME Corporation, Malaysia) as presented in Table I.

TABLE I
Definition Of SMEs In Malaysia

| INDUSTRY | Micro | Small | Medium |
|---|---|---|---|
| Manufacturing, manufacturing related services and Agro-based industry | Annual sales turnover less than RM 250 000 or full time employee less than 5. | Annual sales turnover from RM 250 000 to less than RM 10 Mil or full time employee 5 to less than 50. | Annual sales turnover from RM 10 Mil to less than RM 25 Mil or full time employee 51 to less than 150. |
| Services, primary agriculture and information & communication technology | Annual sales turnover less than RM 250 000 or full time employee less than 5. | Annual sales turnover from RM 200 000 to less than RM 1 Mil or full time employee between 5 to 19. | Annual sales turnover from RM 1 Mil to less than RM 5 Mil or full time employee between 20 to 50. |

### B. Adoption of Green Innovation

Green innovations can be defined as new environmental methods, ideas, products, processes or services that concern on minimizing negative environmental impacts of business operations [7]. Green innovations are categorized into four types of innovations namely product innovation, process innovation, managerial innovation, and marketing innovation. Various green innovations have been studied in the past, however very limited research focusing on the method to green the internal production processes. In Malaysia, very limited researches found to study the factors influencing green innovations adoption. These studies have been summarized in Table II.

TABLE II
Green Innovation Studies In Malaysia

| Author/s | Green Innovations | Finding | Focus |
|---|---|---|---|
| Ratnasingam and Wagner [21] | Green Manufacturing | • Price of green furniture products<br>• Cost | Large manufacturers (furniture) |
| Eltayeb, Zailani and Jayaraman [1] | Green Purchasing | • Regulation | EMS 14001 certified firms |

### C. Green Production

Research on green production was started during the 1970s, with a focus on avoiding unresponsive dispersion of pollutants and wastes, than, evolve to the concentration on clean production process during the 1980s, then emerged into a broader concept related to product stewardship and sustainability in the 1990s and most recently post 2000 into use productivity [15]. There are relatively few formal definitions of green production given within the literature as illustrated in Table III.

TABLE III
Definitions Of Green Production

| Author | Definition |
|---|---|
| Melnyk and Smith [22] | A system that integrates product and process design issues with issues of manufacturing planning and control in such a manner as to identify, quantify, assess, and manage the flow of environmental waste with the goal of reducing and ultimately minimizing environmental impact while also trying to maximize resource of efficiency |
| Liu, Chen, Kang, Ngai and Li [23] | A modern manufacturing mode considering both environmental impact and the resources consumption during the whole product life cycle, from design, fabrication, packaging, transportation, usage, recycling, |

| | |
|---|---|
| | to waste proposal, and its objective to minimise the negative environmental impacts and maximize the utilization rate of resources, and harmonize optimization of economic benefit and social benefit with the maximum integrated benefit. |
| He, Liu, Cao, and Zhang [24] Glavic & Lukman, [25] | Creating goods by using processes and systems that are non polluting, that conserve energy and natural resources in economically viable, safe and healthy ways for employee, communities and consumers and which are socially and creatively rewarding for all stakeholder for the short and long term future |
| Baines, Brown, Benedettini and Ball [15] | Application of environmentally and socially sensitive practices to reduce the negative impact of manufacturing activities while, at the same time, harmonising the pursuit of economic benefits |

As illustrated in Table III, green production has a broad definition. To be considered as green producer, organization can implement and use various kinds of credentials. For example, business may use environmental friendly production technologies, procurement policies, transport, packaging and improve resource use. Four forms of green production by Baines, Brown, Benedettini and Ball [15] as illustrated in Table IV.

TABLE IV
GREEN PRODUCTION POLICIES

| Green Policies | Description |
|---|---|
| Green products | Reducing the negative impact of the materials included in the product and its packaging |
| Green processes | Reducing the negative impact of the transformation of raw materials into finished goods |
| Green use | Reducing the negative impact associated to the use phase |
| Green end-of-life management | Enabling reuse or recycle of products at the end of the useful life |

### *D. Technological Determinants of Green Production*

The technological determinant relates to the technologies or innovation characteristic itself. Its main focus is on how these characteristics can influence the adoption process [26]. Many characteristics of the innovation can influence its adoption, however not all innovations are relevant to an organization and the degree of relevance depends on the potential benefits received and the ability to adopt [27]. Past research of green innovation suggested technological determinants such as relative advantages of innovation, complexity of innovation, and compatibility of innovation may influence green innovation adoption [28, 29].

Relative advantages are referring to the extent to which innovation is seen as beneficial compared to other innovations [28, 30]. Relative advantage is the perception that specific innovation is more beneficial than its alternative [17]. The benefits may be seen in term of economic gain such as increasing profit, sales and market share or social term such as satisfaction. Chinese logistic companies are found to be more likely to adopt green practices when they perceived that the practices are more helpful for improving environmental and economic performance [28]. This is consistent with Le, Hollenhorst, Harris, McLaughlin and Steve Shook [19] finding on Vietnamese hospital, where relative advantage in term of cost saving and increase in sales volume and reputation appear to be effective motivation to adopt environmental practices. However, cost saving and increase in sales volume seems to be more attractive to Vietnamese hospital rather than increase in reputation.

Other than relative advantages, Le, Hollenhorst, Harris, McLaughlin and Steve Shook [19] also found that complexity is also another significant determinant that may influence organization to adopt environmental practice. Complexity is the degree in which the complexity of the innovation is seen as difficult to understand and use [28, 30]. Weng and Lin [17] suggested that SMEs in China should attempt to accumulate more environmental knowledge and increase the explicitness of green innovation to reduce perceived complexity. This is based on their finding that shows the green practice complexity has a negative influence on green practices adoption.

Another determinant that shows the consistent finding to influence green innovation adoption is compatibility of the innovation. How the new technology is seen as being consistent with existing value of organization seems to play important role on adoption of green innovation [30]. Green innovations that are more compatible to a company current technologies will be easily diffuse within the organization [17]. A study by Weng and Lin [17], Le, Hollenhorst, Harris, McLaughlin and Steve Shook [19] and Lin and Ho [28] all show that compatibility is positively influence the green innovation adoption. Therefore, we postulated the following hypotheses for the three technological determinants.

H1a: Relative advantage positively affects green production adoption.
H1b: Complexity negatively affects green production adoption.
H1c: Compatibility positively affects green production adoption.

### *E. Government Interventions on Green Production*

Government plays an important role on innovation regardless the type of innovations. The studies of green innovations also have proved that government interventions especially legislation and regulation are one of the important determinants to diffuse the new innovation [31]. Gadenne, Kenedy and McKeiver [2] stated that government legislations and legitimizations are one of the key influences and are one of the major motivations for environmental responsiveness. In examining external factors influencing technology adoption diffusion decision among SMEs in Malaysia, Murad and Thomson [32] found that government interventions in term of regulations are one of the factors that may influence Malaysia SMEs to adopt the new technology. Lee [12] found that government interventions in term of government support will link to greater willingness of SMEs in South Korea to participate in Green Supply Chain initiatives. Lin and Ho [28] also, found that governmental support is an important determinant for a participation in energy saving practice.

This clearly shows that government interventions are one of the important factors influencing green innovations adoption. However, if we see the aim of the government interventions such as subsidies and taxes, these interventions are actually aim to tune the speed of innovations [33, 34]. For that reason, rather than examining the government interventions as one of the factors influencing adoption of green production, this paper suggest future research on green production try to examines the moderating effect of government interventions toward the relationship of technological determinants and green production adoption.

Prior to date, there is no research examines the moderating effect of governmental interventions toward green production adoption. However, there were studies who tried to study the moderating effects of government interventions in other context. Shariff, Peou and Ali [35] tried to study the moderating effect of government policy on entrepreneurship and growth performance of SMEs in Cambodia. They lastly concluded that the government policy does moderate the relationship between entrepreneurial value, management and market practice, and the growth performance of SMEs.

On the other hand, a study on the effects of international experience, organizational learning for export activities, and global competitive forces on export marketing strategy, export advantage and performance of export firm in Thailand found that government support fail to act as moderating variable on this study [36]. However, as governmental interventions are aim to tune the speed of innovation, we expect that government interventions will moderate the relationship between technological determinants with green production adoption. Thus, we postulated the following hypotheses.

H2a: Government interventions moderate the relationship between relative advantages and green production adoption.

H2b: Government interventions moderate the relationship between complexity and green production adoption.

H2c: Government interventions moderate the relationship between compatibility and green production adoption.

## IV. Proposed Conceptual Framework

As discussed in previous section determinants of technological factor such as relative advantages of innovation, complexity of innovation and compatibility of innovation show consistent result to influence adoption of green innovation. However, this paper suggested future research on green production to study the influence of the government intervention towards the relationship of the technological determinants and green production adoption. This is because the aim of the government interventions is actually to tune the speed of innovation, not just influence firm to adopt the innovation. Therefore, we proposed conceptual framework as in fig 1.

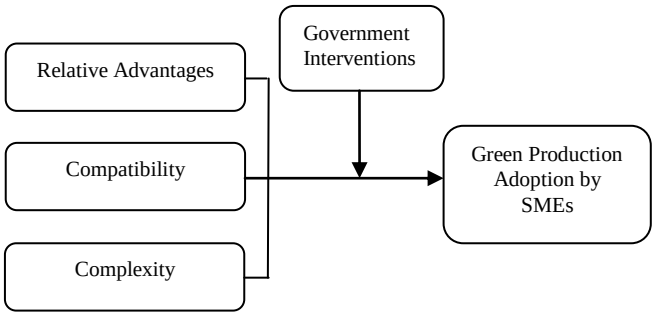


Fig. 1 Proposed conceptual framework

## V. Methodology

This study will be using self administrated questionnaire. Respondent will be asked to indicate the extent of their agreement or disagreement to each statement based on a seven-point numerical scale ranging from 1 ("Strongly Disagree") to 7 ("Strongly Agree"). The questions in this questionnaire were adapted and adopted from literature. For green production construct, it will be measured by respondent's willingness to adopt green production form by Baines A population for this study comprised of 220 Small and Medium (SMEs) manufacturer of chemical and petrochemical products in Selangor. The sampling frame for this study was obtained from the SME Corporation of Malaysia's database. Selangor has been chosen because of 36% of total SMEs manufacturing located in Selangor (SME Corporation Malaysia, 2011). While on the other hand, chemical and petrochemical manufacturing companies have been chosen because of the industry contributions towards the environmental problems [37]. From the population of 235, total sample adequate is 140 [38]. The data will be analyzed by using Structural Equation Modelling (SEM) Amos.

## VI. Expected Findings

This study expects all hypotheses for technological determinants will be accepted. For the moderating effects of government interventions, this study also expects all hypotheses will be accepted. This is because government interventions such as subsidies, taxes and monitoring, are actually to tune the speed of adoption of innovation.

## VII. Conclusion

This study attempts to suggest a conceptual framework for future study on green production. This is important since literature on green production is still scarce. This framework will help future researcher to understand green production adoption as well assisting us to understand the impact of government interventions toward green production adoption.

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