GREEN MANUFACTURING ROADMAP ON THE SUSTAINABILITY OF MANUFACTURING INDUSTRIES IN MALAYSIA

BY

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ABSTRACT

Climate change is no more a fantasy subject portray in sci-fi movies. Climate change is real, and it is caused by the increasing amount of carbon dioxide (CO2) in the atmosphere. Reducing the amount of CO2 can reduce the risk of climate change. If the unprecedented changes are not made soon, there will be an irreversible damage to the planet such as global warming, drought, typhoon, flood and many other risks. Since the industrial sector is responsible as the third highest producer of CO2, reducing the carbon emission from this sector will significantly lessen the risk. As Malaysia is gearing into green sustainability environmental lifestyle, this research wish to study how the manufacturing management are doing for this challenge. With this intention, this study investigated the effort of manufacturing industries in Malaysia in practicing Green Manufacturing. In the first place, the government has outlined many regulations as a catalyst to boost the participation of the manufacturing industries to improve their operations to be more environmentally friendly. Some organization which is having business affairs with developed countries has practiced green culture in their organizations with the aid of green education. Though many organizations has taken a proactive step towards greening their activities, there are still many others who are reluctant to take part in the green calls. As though accepting the calling for greening would cause the increase in their cost and would reduce their profit. This perception could be caused by the lack of awareness on environmental sustainability. Thus, this study aims to see how the green awareness could was affected by the Government Regulations, Organisational Culture, and Education, and further the analysis to see the effect of Green Manufacturing operations impacts on Financial Performance and Green Performance. The Green Manufacturing concerns on all actions that can reduce the environmental impact during the operations of manufacturing the products, comprises of the green design of products, the use of environmentally friendly raw materials, eco-friendly packing, distribution, and reuse after the end of life of a product. The research was performed quantitatively using surveys, and the analysis of this study was done by adopting multivariate statistical analysis; Structural Equation Modelling (SEM). SEM was chosen because it is able to calculate the standardized path coefficient and correlation strength of the causal relationship for the objectives of the study. A questionnaire with 68 items were distributed and 355 sample size were collected from manufacturing industries. After all the 11 constructs were validated by the model fit in the measurement model, the structural analysis was done, and the research hypothesis was concluded. The result of the study shows that the Government Regulations, Organisational Culture, and Education are statistically significant towards the green awareness, just as the green awareness has statistically significant effect on the implementation of Green Management and consequently, the Green Management has statistically significant effect on Financial Performance and Green Performance. Finally, the Green Manufacturing roadmap has been established as a guideline for the policymaker to promote environmental sustainability.

خلاصة البحث

تغير المناخ هو ظاهرة حقيقية ويحدث نتيجة لزيادة كمية ثاني أكسيد الكربون في طبقات الجو. ان تقليل كمية ثاني أكسيد الكربون تقلل من مخاطر تغير المناخ. إذا لم يتم إجراء التغييرات غير المسبوقة قريبًا ، فسيكون هناك ضرر لا يمكن إصلاحه على كوكب الأرض مثل الاحتباس الحراري والجفاف والإعصار والفيضانات والعديد من المخاطر الأخرى. نظرًا لأن القطاع الصناعي مسؤول باعتباره ثالث أكبر منتج لثاني أكسيد الكربون ، فإن تقليل انبعاثات الكربون من هذا القطاع سيقلل بشكل كبير من المخاطر. نظرًا لأن ماليزيا تستعد لنمط حياة بيئي مستدام أخضر ، نود دراسة كيفية قيام إدارة التصنيع بهذا التحدي. بهذه النية ، تبحث هذه الدراسة في جهود الصناعات التحويلية في ماليزيا في ممارسة التصنيع الأخضر. في المقام الأول ، حددت الحكومة العديد من اللوائح كمحفز لتعزيز مشاركة الصناعات التحويلية لتحسين عملياتها لتكون أكثر صداقة للبيئة. مارست بعض المنظمات التي لها شؤون تجارية مع البلدان المتقدمة الثقافة الخضراء في منظماتها بمساعدة التعليم الأخضر. على الرغم من أن العديد من المنظمات قد اتخذت خطوة استباقية نحو تخضير أنشطتها ، لا يزال هناك العديد من المنظمات الأخرى التي لا ترغب في المشاركة في المكالمات الخضراء. كما لو أن قبول الدعوة إلى التخضير سيؤدي إلى زيادة تكلفتها ويقلل من أرباحها. يمكن أن يكون هذا التصور ناتجًا عن نقص الوعي بشأن الاستدامة البيئية. وبالتالي ، تهدف هذه الدراسة إلى معرفة كيف يمكن أن يتأثر الوعي الأخضر باللوائح الحكومية ، والثقافة التنظيمية ، والتعليم ، والمزيد من التحليل لمعرفة تأثير عمليات التصنيع الأخضر على الأداء المالي والأداء الأخضر. يهتم التصنيع الأخضر بجميع الإجراءات التي يمكن أن تقلل من التأثير البيئي أثناء عمليات تصنيع المنتجات ، ويتألف من التصميم الأخضر للمنتجات ، واستخدام المواد الخام الصديقة للبيئة ، والتعبئة الصديقة للبيئة ، والتوزيع ، وإعادة الاستخدام بعد نهاية حياة المنتج. تم إجراء البحث كمياً باستخدام المسوحات ، وتم تحليل هذه الدراسة باعتماد التحليل الإحصائي متعدد المتغيرات. نمذجة المعادلات الهيكلية (SEM) تم اختيار SEM لأنه قادر على حساب معامل المسار القياسي وقوة الارتباط للعلاقة السببية لأهداف الدراسة.

تم توزيع استبانة مكونة من 68 فقرة وتم جمع 355 عينة حجم من الصناعات التحويلية. بعد التحقق من صحة جميع التركيبات الإحدى عشر من خلال النموذج الملائم في نموذج القياس ، تم إجراء التحليل الهيكلي وتم الانتهاء من فرضية البحث. تظهر نتيجة الدراسة أن اللوائح الحكومية ، والثقافة التنظيمية ، والتعليم لها دلالة إحصائية تجاه الوعي الأخضر ، تمامًا كما أن للوعي الأخضر تأثير ذو دلالة إحصائية على تطبيق الإدارة الخضراء ، وبالتالي فإن الإدارة الخضراء لها تأثير كبير إحصائيًا على الأداء المالي والأداء الصديق للبيئة. أخيرًا ، تم وضع خارطة طريق التصنيع الأخضر كمبدأ توجيهي لصانع السياسة لتعزيز الاستدامة البيئية.

APPROVAL PAGE

The thesis of Siti Norhafiza Abdul Razak has been approved by the following:

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DECLARATION

I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

1 December 2021

Signature ..... Date .....

(Siti Norhafiza Abdul Razak)

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LIST OF ABBREVIATIONS

AMOS	Analysis of Moment Structure
CFA	Confirmatory Factor analysis
EFA	Exploratory Factor Analysis
SEM	Structural Equation Modeling
SPSS	Statistical Package for Social Science
AVE	Average Variance Extracted
PCA	Principal Component Analysis
MI	Modification Indices
GM	Green Manufacturing
GR	Government Regulations
EMS	Environmental Management System
LM	Lean Manufacturing
FP	Financial Performance
OC	Organizational culture
RMSEA	Root Mean Square Error of Approximation
GFI	Goodness of Fit Index
GE	Green Education
EN	Environmental Consciousness
CB	Green Cost Benefit Awareness
GD	Green Design
GP	Green Process
SMEs	Small and Medium Enterprises
PDCA	Plan-Do-Check-Act
RE	Remanufacturing
WA	Waste and Disposal

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Environmental sustainability is not an option but a mandate for industrial organisations. Hurricanes, floods, droughts, ecosystem changes, depletion of the ozone layer, and other tribulations have strongly attracted the world's attention. It can be observed that sustainability becomes an important topic in the manufacturing industries (Afum, Osei-Ahenkan, Agyabeng-Mensah, Owusu, Kusi and Ankomah (2020). Year 2016 is reported as the hottest year. In fact, since the Industrial Revolution in the early 19th century until today, the world temperature has increased by 2°Celcius. To address these concerns, Intergovernmental Panel on Climate Change (IPCC) was established in 1988. It is a body that is responsible for making assessment reports on the climate change caused by human activities.

In addition, to solve issues on climate change, international communities have agreed to form a United Nation Framework Convention on Climate Change (UNFCCC). Their goal is to avoid and reduce the anthropogenic environmental change by maintaining the greenhouse gas concentrations (Sands, 1992). Several meetings has been held in order to managed the carbon emission such as Kyoto Protocols in 1997 which focus on the developed countries on legal binding of the carbon reduction, but no restriction were imposed to developing countries like China and India despite both being the significant polluters, and the most recent was COP21 held in Paris aims to so that the temperature rise will never be above 2 degree Celsius by controlling the

greenhouse gas (GHG) which theagricultural sector contributed to the increase of the greenhouse gases (GHGs) concentrations into the atmosphere (Dachraoui, M., & Sombrero, A. 2020).

To begin with, the atmosphere consists of water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and the chlorofluorocarbons (CFC_s) including CFC-12 (CCl_2F_2) and CFC-11 (CCl_3F)) (National Research Council, 2001). These gases are called greenhouse gas (GHG) and considered very important to keep our earth warm, through a greenhouse effect process. It is good if GHG is of the right quantity. However, GHG has increased since the Industrial Revolution began around 1750. According to Soytas & Sari (2009), the increase of GHG is the biggest problem faced by the world. This is due to the increase level of carbon dioxide (CO_2), which contributes 65% of the total GHG (IPCC, 2014). Figure 1.1 portrayed carbon dioxide (CO_2) as the major component of GHG, which cause more heat trapped in the atmosphere, resulting a warmer Earth's temperature.

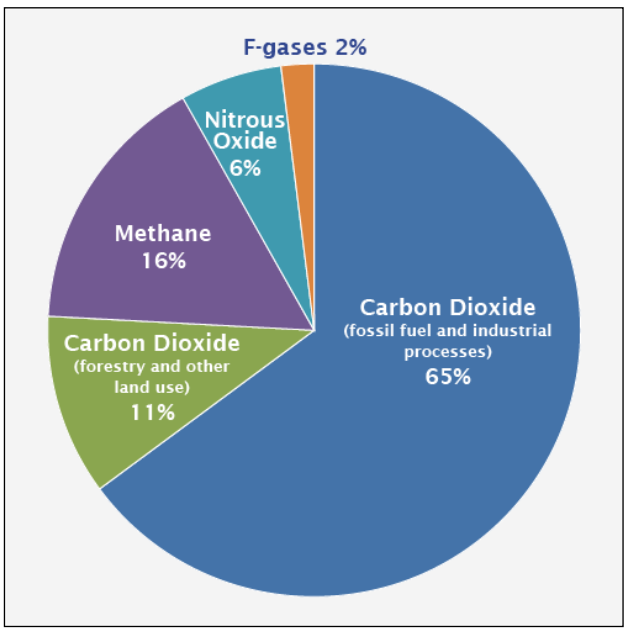

Figure 1.1 Global GHG emissions by gas
Source: IPCC (2014)

On the other side, Carbon dioxide (CO_2) is the principal element in the anthropogenic GHG, that affects the earth's radiate balance (Baede et al., 2007). It is emitted due to human activities, such as the burning of fossil fuels. Wiedmann and Minx (2007) define carbon dioxide (CO_2) produced by human's everyday activities as carbon footprint. The term "carbon footprint", which attracted public and academic attentions because it has huge impacts on global warming for a climate change (Chakrabarty, 2014; Oreskes, 2005). If carbon footprint is not treated properly, a higher risk of climate change will occur. Recently, Sarkodie (2020) argued that the absent link in carbon dioxide productions might have deluded the assessment of environmental degradation through countries in extant literature. Additionally, the Ministry of Natural Resources and Environment Malaysia has documented GHG inventory and recorded that carbon footprint produced by the industrial process is the second highest next to the energy sector. Similarly, IPCC (2014) has reported that industries are among the top three sectors that emit the highest GHG as shown in Figure 1.2.Therefore, the reduction of carbon footprint in the industry sector will have significant impacts to the reduction of overall GHG. Thus, it is an urgent priority to mitigate carbon footprint as compared to other GHG (Cordero, 2013) within the industry sector. Both (Ridhosari and Rahman, 2020) explored the assessment of carbon footprint at universities from the different issues of electricity, transportation and waste generation.

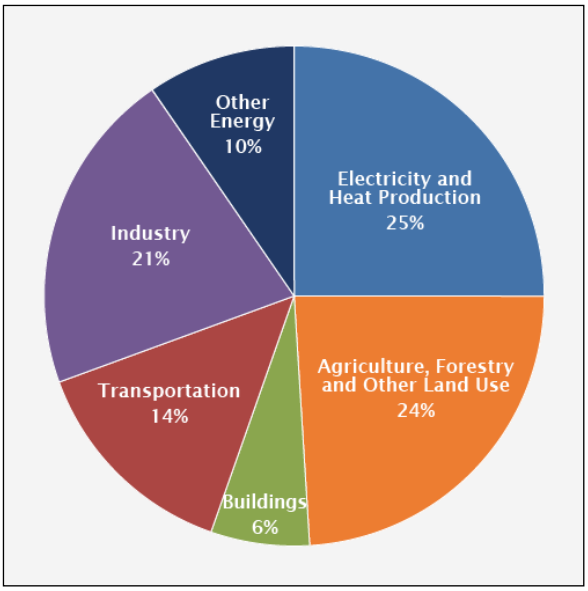

Figure 1.2 GHG emission by economic sector (IPCC, 2014)

An industry can be defined as a group of manufacturers or businesses that produce a particular kind of goods or services. Manufacturing is the value added production of goods for use or sale using process or steps of labour and machines, tools, chemical and biological processing, or formulation. The manufacturers are being more responsible to improve the environmental sustainability since 1990's. Started with one of the possible ways to strike out environmental problems is Green Manufacturing (GM). Due to the rapid development of GM, several researchers focused their attention on this theme and conducted various studies with extensions. It can be applied to all manufacturing sectors that minimize waste and pollution, enables economic progress and conserve resources. Green Manufacturing opportunities, challenges, drivers and barriers has been identified to reduce their carbon impact to the environment.

GM sometimes used interchangeably with Cleaner Production, Industry Ecology, Sustainability Production and Environmental Conscious Manufacturing. According to Mittal et al. (2013) since year 1989, there were 2551 articles were published in the area of operations concerning environmental sustainability. Even

though the bottom line of each approach are slightly different, the most common concern among all these concept are their aims is to achieve the environmental sustainability besides the economic sustainability as well as the social sustainability as registered in the Triple Bottom Line philosophy (Elkington, 1997). Growing numbers of review studies, empirical studies and analytical studies were done in this area since year 1990. This is because, many organisations are widely diverse in types of operation thus need different approach to tackle the carbon issues. GM is the concept of reducing and eliminating any risk of harm to the environment during the production process, beginning with the stages of raw material, to production operation into packaging stage, up to distribution and end of life stages (Sezen & Çankaya, 2013; Chuang & Yang, 2014; Digalwar et al.,, 2017). Every stages of the operation in every life cycle stages of a product, needs energy, correspondingly, every stages produce carbon. However, if GM practices are applied, the amount of carbon emission could be lessened. Holistically, the concept of GM covers all the technological approach including the physical approach that could lessen the carbon emission.

1.1.1 Overview of Manufacturing Industries in Malaysia

Manufacturing industries in Malaysia is growing healthy with contribution of more than 23% in the year of 2017 as second highest after the service sector which contribute 54.3% (Nathan, 2018). Having this in mind, this study can say that manufacturing industries does having high impact towards Malaysia's economic impact as well as the environmental impact in terms of carbon emission. There seven main sub-sector that contribute the highest in Malaysia's manufacturing industries as shown in Figure1.3 below. Important to realize that Electrical, Electronics and Transport Equipment sub-sectors contribute 37% of total manufacturing. Thus, the study scope are focusing in

this three sub-sectors. In Malaysia, MIDA act as government agency that supports manufacturing industry to advance the knowledge of smart manufacturing, Internet-of-Thing (IOT) and many other initiatives. Notably, the revolution of industry 4.0 has widely influenced the prospect of Electrical and Electronics to progress further. Besides, Malaysia also expanding their potential in research and development towards the high-value manufacturing to face internalisation competitiveness(Lai Wan, 2016).

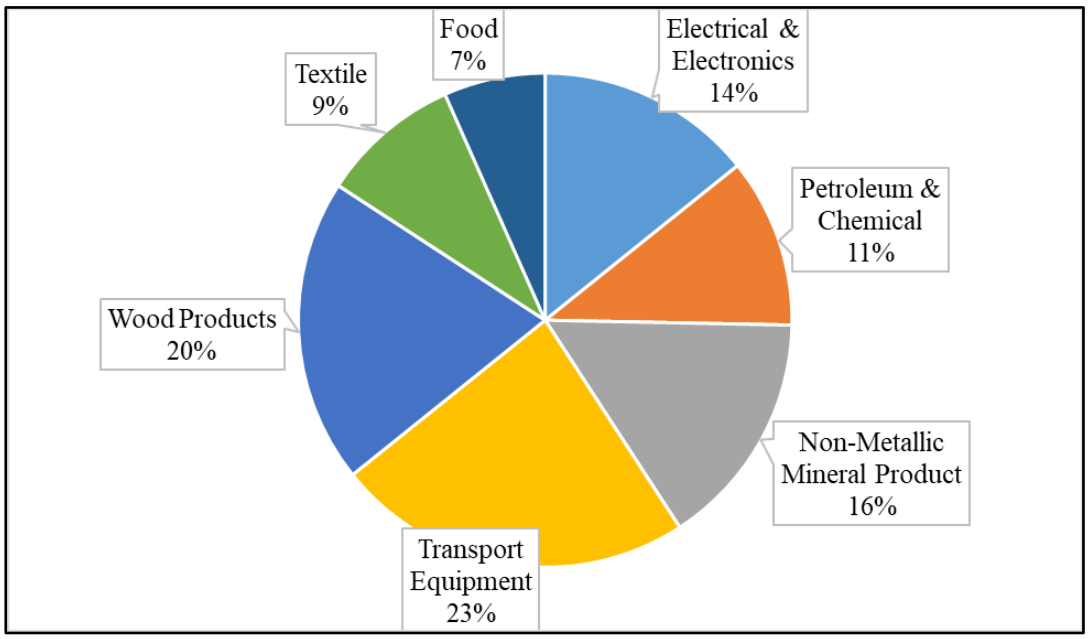

Figure 1.3 Seven main sub-sector in Malaysia's Manufacturing

According to Sulaiman and Ismail (2019), the manufacturing sector subsidized significantly to the development of Malaysian economy, though its present impact is comparatively smaller compared to the service sector. They suggest that the manufacturing sector should changed from relying on labor to the capital demanding, so that, low skilled labor can be condensed and at the same time contribution to Gross Domestic Product (GDP) can be improved.

1.2 PROBLEM STATEMENT

Review of the contemporary literature showed that there are some difficulties viewed from different perspectives. According to Afum et al. (2020), the decisions aligned by managers whether to embrace green advantages such as GM may yield least outcome without the collaboration of critical upstream supply chain partners (e.g. supplier integration) and downstream supply chain partners (customer integration). Some scholars claim that most manufacturing small and medium (SMEs) enterprises in developing countries rarely adopt GM practices due to misunderstanding this concept (Jamian, Ab Rahman, Deros and Ismail (2012)). Furthermore, Zhan, Tan, Ji, Chung, and Chiu (2018) argued that few studies have attempted to link GM practices and focuses on sustainable performance.

Climate change is an undeniable issue for all. Scientists have concluded that human activities due to the burning of coal, oil, and gas, are the causes of the global warming(Ipcc, 2010; Cadez & Czerny, 2016). The third highest carbon emissions are produced by the industries. If carbon emission is not reduced, the risk of global warming will cause the deterioration towards health and environment. Thus, growing numbers of green initiatives are needed to solve the environmental problems. Despite the fact that the green awareness has increased by years, there is still insufficient environmental performance has been achieved by the industries.

Most of the organisations are still not implementing green in their manufacturing processes, causing the reduction of the carbon emission is impossible. This raised the question, why is it hard for the manufacturers to adopt green in their operations. Why do they just sit back and watch? There are only few organisations who have committed to adopt green practices in their processes. Are the pressure and motivations from the

government or other internal and external factors are not effective to boost the adoption of the Green Manufacturing practices?

At the same time, the rejection of implementing green might occur because they are either unaware of their business impact towards environment or they are uncertain about benefit of the cost needed to be invested when implementing the Green Manufacturing. Most manufacturers are restrained to practice green, due to long-term operating cost benefits. Thus, the manufacturer's perception towards the cost-benefit to implement Green Manufacturing which has not yet been studied, needed to be investigated. Hence, the study on the influence of the green cost-benefit awareness of the organisations, towards the implementation of Green Manufacturing is critical. The relationship of the influence needed to be analysed because the integration of Green Manufacturing is expected to boost a change in the environment sustainability.

Besides, to inspire the Green Manufacturing practices to be implemented widely, a study on the financial performance as well as the green performance needed to be performed. The positive result on the financial performance will eliminate any doubt among the manufacturers to pursue green in their operations. Therefore, the carbon emission will consistently reduce by the vigorous attempt of Green Manufacturing practices among manufacturers in Malaysia. In addressing the linkages between GM and sustainability, researchers including Yusliza, Yong, Tanveer, Ramayah, Faezah and Muhammad (2020) claim that few former studies have established the relationship between green intellectual capital and sustainable performance. Chiet, Ching, Huat, Fathi and Tzuu (2019) argued that the addition from current lean manufacturing into lean-green manufacturing could be a cost-operative manner to start green practices and to improve daily actions. Reflecting on sustainability concerns, Ngu, Lee and Osman (2020) discussed that utmost of the manufacturing

practices in Malaysia and other developing nation state are unsustainable since the end of life products are being discarded or landfilled by its end-user deprived of adoption of sustainable manufacturing practice. Remanufacturing which considered among the four components for GM in this study little motivated based on identification of current challenges and future opportunities of Malaysian industries (Ngu, Lee and Osman, 2020).

As such, this study respond to these issues and problems by addressing them in the objectives of the study in the next sub-chapter.

1.3 RESEARCH OBJECTIVES

The objective of the study is to obtain a clear understanding on the influence of the Green Manufacturing (GM) implementation affected by the internal and external factors. Besides, it aims to investigate how the Green Manufacturing implementation affects the Financial Performances and Green Performances. In addressing the study problem, it seeks to achieve the following research objectives:

1. To investigate which green practices are highly adopted in Green Manufacturing among Malaysian industries.
2. To examine the impact of Green Manufacturing implementation towards the Financial Performance and Green Performance.
3. To examine the influence of the green awareness on the Green Manufacturing.
4. To investigate the effects of the Government Regulations, Organisational Culture and Education towards the implementation of Green Manufacturing.
5. To analyse the impact of Government Regulations, Organisational Culture and Education towards the green awareness.