

THE MEDIATING EFFECT OF GREEN INNOVATION ON THE
RELATIONSHIP BETWEEN GREEN SUPPLY CHAIN MANAGEMENT AND
ENVIRONMENTAL PERFORMANCE IN MALAYSIA MANUFACTURING
INDUSTRIES

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To my beloved husband, daughter, son, *Mak* and *Ayah* and family.

To my supportive supervisor and friends.

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ABSTRACT

Recently, many manufacturing companies in developed countries have recognised the concept of green supply chain management (GSCM). Additionally, the increasing stakeholders' pressures from government, customers, suppliers, buyers and the public have forced manufacturing companies to improve their production processes to become more environmental-friendly, and continually seek ways to innovate their products. However, relatively limited research attention has been devoted to the consideration of the relationship between GSCM, green innovation and environmental performance. Therefore, this study aims to bridge this gap by providing empirical evidence to encourage companies to implement GSCM and green innovation to improve their environmental performance significantly. A conceptual model was constructed to link the above-mentioned constructs. Data were collected using a questionnaire-based survey. Through a census method, 123 ISO 14001 certified manufacturing companies in Malaysia were selected. Data were analysed using Partial Least Squares-Structural Equation Modeling (PLS-SEM). Empirical evidence showed that GSCM practices have positive effect on green innovation and environmental performance. Green innovation has been found to have a positive effect on environmental performance and its role as a mediator between GSCM practices and environmental performance has been confirmed. The results confirmed the complementary effect of GSCM practices on green innovation and environmental performance. This research discussed several theoretical and managerial contributions, and extended research in GSCM and green innovation domains. The findings may help managers and practitioners understand how GSCM practices influence green innovation and environmental performance, as well as assist manufacturers in identifying practices that need improvement. Recommendations for future research include the need to test and expand the conceptual model of GSCM and green innovation using longitudinal designs and multiple dimensions of organisational performance instead of environmental performance only.

ABSTRAK

Baru-baru ini, banyak syarikat pengilangan di negara-negara maju telah mengiktiraf konsep pengurusan rantai bekalan hijau (GSCM). Selain itu, peningkatan tekanan pihak berkepentingan daripada kerajaan, pelanggan, pembekal, pembeli dan orang ramai juga telah mendesak syarikat pengilangan supaya meningkatkan proses pengeluaran mereka untuk menjadi lebih mesra alam dan untuk terus mencari jalan bagi membuat inovasi terhadap produk mereka. Walau bagaimanapun, secara relatifnya perhatian penyelidikan masih lagi terhad ditumpukan terhadap hubungan antara GSCM, inovasi hijau dan prestasi alam sekitar. Oleh itu, kajian ini bertujuan untuk merapatkan jurang tersebut dengan menyediakan bukti empirikal bagi menggalakkan syarikat-syarikat untuk melaksanakan GSCM dan inovasi hijau dalam usaha untuk meningkatkan prestasi alam sekitar mereka dengan signifikan. Model konseptual telah dibina untuk menghubungkan semua konstruk yang dinyatakan di atas. Data dikumpulkan menggunakan tinjauan berdasarkan soal selidik. Melalui kaedah banci, 123 syarikat pengilangan berdaftar ISO 14001 di Malaysia telah dipilih. Data dianalisis dengan menggunakan Model Kuasa Dua Terkecil Separa-Model Persamaan Struktur (PLS-SEM). Bukti empirikal menunjukkan bahawa amalan GSCM mempunyai kesan positif ke atas inovasi hijau dan prestasi alam sekitar. Inovasi hijau turut didapati mempunyai kesan positif ke atas prestasi alam sekitar dan peranannya sebagai pengantara antara amalan GSCM dan prestasi alam sekitar juga telah disahkan. Hasil kajian mengesahkan kesan pelengkap amalan GSCM terhadap inovasi hijau dan prestasi alam sekitar. Kajian ini membincangkan beberapa sumbangan dari segi teori dan pengurusan, dan mengembangkan penyelidikan dalam bidang GSCM dan inovasi hijau. Hasil kajian boleh membantu pengurus dan pengamal memahami bagaimana amalan GSCM mempengaruhi inovasi hijau dan prestasi alam sekitar, di samping membantu pengilang dalam mengenal pasti amalan-amalan yang perlu diperbaiki. Cadangan untuk kajian akan datang termasuk keperluan untuk menguji dan memperluaskan model konseptual GSCM dan inovasi hijau dengan menggunakan reka bentuk longitudinal dan pelbagai dimensi prestasi organisasi dan bukannya hanya pada prestasi alam sekitar sahaja.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENTS	vii
	LIST OF TABLES	xiii
	LIST OF FIGURES	xv
	LIST OF ABBREVIATIONS	xvii
	LIST OF APPENDICES	xix
1	INTRODUCTION	1
	1.1 Background of the Study	1
	1.2 Problem Statement	9
	1.3 Research Questions	23
	1.4 Research Objectives	23
	1.5 Research Scopes	24
	1.6 Significance of the Study	24
	1.7 Conceptual and Operational Definition	28
	1.7.1 Green Supply Chain Management (GSCM)	28
	1.7.2 Green Innovation	30
	1.7.3 Organisational Environmental Performance	31
	1.8 Thesis Outline	32

2	LITERATURE REVIEW	33
2.1	Introduction	33
2.2	Environmental Issues in Manufacturing Industries	34
2.3	An Overview of Supply Chain Management	42
2.4	Green Supply Chain Management: A Brief Background	48
2.5	The Conceptualisation of GSCM Practices	55
2.5.1	Definition of GSCM	57
2.5.2	GSCM Practices	60
	2.5.2.1 Internal Environmental Management	67
	2.5.2.2 Green Purchasing	69
	2.5.2.3 Customer Environmental Cooperation	70
	2.5.2.4 Reverse Logistics	71
	2.5.2.5 Summary of GSCM Practices	73
2.6	The Conceptualisation of Green Innovation	74
2.6.1	Definition of Green Innovation	74
2.6.2	Type of Green Innovation	76
	2.6.2.1 Green Product Innovation	76
	2.6.2.2 Green Process Innovation	77
	2.6.2.3 Green Organisational or Managerial Innovation	78
	2.6.2.4 Green Marketing Innovation	78
2.7	The Conceptualisation of Environmental Performance as an Outcome Variable	79
2.7.1	Measures for Environmental Performance	80
2.7.2	Review on Environmental Performance as an Outcome	85
2.8	Theories and Model Foundations	86
2.8.1	Stakeholder Theory	87
	2.8.1.1 Stakeholders, GSCM, Green Innovation Practices, and Environmental Performance	89
	2.8.1.2 Justification of Utilising Stakeholder Theory	92
2.8.2	Evolutionary Approach	93
2.8.3	Innovation Co-creation Model	95

2.8.4	Continuous Improvement Model	97
2.8.5	Underlying Theory and Model of the research	99
2.9	Hypotheses Development	100
2.9.1	GSCM Practices-Environmental Performance Relationship	101
2.9.2	GSCM Practices-Green Innovation Relationship	102
2.9.3	Green Innovation-Environmental Performance Relationship	106
2.9.4	The Mediating Effect of Green Innovation on the Relationship between GSCM Practices and Environmental Performance	108
2.10	Research Conceptual Model	117
2.11	Chapter Summary	119
3	RESEARCH METHODOLOGY	120
3.1	Introduction	120
3.2	Flow Chart of Research Methodology	120
3.3	Research Design	122
3.4	Survey Methodology	123
3.4.1	Questionnaire Development	123
	3.4.1.1 Development of Research Instrument	123
	3.4.1.2 Questionnaire Design	124
3.4.2	Inter Rater Agreement Analysis	130
	3.4.2.1 Proposed Measurement Items for Green Marketing Innovation	130
	3.4.2.2 Methodology of the Preliminary Study	131
	3.4.2.3 Inter Rater Agreement Process	132
	3.4.2.4 Results of Inter Rater Agreement Analysis	132
3.4.3	Expert Validation	133
3.4.4	Pilot Study	139
3.4.5	Population and Sampling	144

3.4.5.1	Unit of Analysis	144
3.4.5.2	Target Population	145
3.4.5.3	Sampling Frame	145
3.4.5.4	Determining Minimum Sample Size	147
3.4.6	Data Collection Approach	147
3.4.6.1	Treatment for Missing Data	149
3.4.6.2	Test of Response Bias	150
3.4.7	Reliability	152
3.4.8	Validity	153
3.5	Statistical Analysis Technique	155
3.5.1	The PASW	155
3.5.2	The PLS-SEM	155
3.5.2.1	Justification for Selecting PLS-SEM	159
3.5.2.2	Reflective versus Formative Indicators	160
3.5.2.3	Hierarchical Component Models or Higher (eg.Second) Order models Using PLS-SEM	161
3.6	Chapter Summary	162
4	DATA ANALYSIS	163
4.1	Introduction	163
4.2	Respondent General Descriptive Statistic	164
4.2.1	Company's Main Business Activity	164
4.2.2	Number of Employees	165
4.2.3	Type of Ownership	166
4.2.4	Current Position in the Company	167
4.2.5	Environmental Management Representative (EMR) Department Attached	167
4.3	Psychometric Properties of Reflective Measured Constructs	168
4.4	The Analysis of Reflective Measurement Model (Outer Model): Reliability and Validity	172
4.4.1	Internal Consistency Reliability	173

4.4.2	Convergent Validity	174
4.4.3	Discriminant Validity	179
4.5	Estimation of Hierarchical Component Models or Higher Order Models in PLS-SEM	182
4.6	Assessing and Testing the Structural Model (Hypotheses)	187
4.7	Hypothesis Testing (Test of Direct Effects)	195
4.8	Hypothesis Testing (Test of Indirect Effects/Mediation)	195
4.9	Additional Analysis	200
4.9.1	The PLS-SEM Importance-Performance Matrix Analysis (IPMA)	200
4.9.2	The Level of Implementation of GSCM Practices and Green Innovation among Malaysian Manufacturing Industries	202
4.10	Chapter Summary	204
5	DISCUSSION AND IMPLICATIONS	205
5.1	Introduction	205
5.2	Introduction to the Main Findings	206
5.3	Review of the Measurement Model Findings	207
5.3.1	The Findings of GSCM Constructs Measurement Model	207
5.3.2	The Findings of Green Innovation Constructs Measurement Model	213
5.3.3	The Findings of Environmental Performance Constructs Measurement Model	218
5.4	Review of the Structural Model Findings	219
5.4.1	GSCM practices and Environmental Performance	220
5.4.2	GSCM Practices and Green Innovation	224
5.4.3	Green Innovation and Environmental Performance	225

5.4.4	The Mediating Role of Green Innovation on the Relationship between GSCM and Environmental Performance	227
5.5	Discussion on the Level of GSCM and Green Innovation Implementation in Malaysian Manufacturing Companies	229
5.6	Chapter Summary	231
6	CONCLUSION AND RECOMMENDATIONS	232
6.1	Introduction	232
6.2	Research Implications	232
6.2.1	Theoretical Implications	232
6.2.2	Managerial Implications	236
6.3	Fulfillment of Research Objectives	238
6.4	Limitation and Futures Lines of Research	239
6.5	Conclusion	242
	REFERENCES	243
	Appendices A - J	279 - 311

LIST OF TABLES

TABLE NO.	TITLE	PAGE
1.1	Gross Domestic Products (GDP) by Sector (2014-2015)	15
2.1	Pollutant from different industries	36
2.2	Topic focuses in traditional supply chain	45
2.3	Definition of GSCM	57
2.4	Studies on GSCM practices tested in manufacturing industries	65
3.1	GSCM constructs and their measurement items	125
3.2	Green innovation constructs and their measurement items	128
3.3	Organisational environmental performance measures and their measurement items	129
3.4	Measurement items for green marketing innovation	131
3.5	Rules of thumbs kappa's value	132
3.6	Results of agreement of two experts	133
3.7	Summaries of comments and suggestions from experts and practitioners	136
3.8	Types of company ownership	142
3.9	Pilot results of internal consistency analysis for GSCM constructs	144
3.10	Pilot results of internal consistency analysis for green innovation constructs	144
3.11	Pilot results of internal consistency analysis for environmental performance measures	144
3.12	Chi Square test for early versus late responses	151

4.1	Companies' main business activity	164
4.2	Respondents' current position in Malaysian manufacturing Companies	167
4.3	EMR department attached of Malaysian manufacturing companies	168
4.4	Reflective measurement: Internal consistency reliability	173
4.5	Reflective measurement: Convergent validity	176
4.6	Loadings and cross-loading of each item	179
4.7	Fornell-Larcker Criterion analysis for first order construct	182
4.8	Discriminant validity assessment	186
4.9	Result summary for reflective measurement model	186
4.10	Collinearity assessment of set of predictor constructs	188
4.11	Significant testing results of the structural model path coefficients (Direct effects)	191
4.12	Significant testing results of the total effects	191
4.13	Determination Coefficients (R ²) and Predictive Relevance (Q ²) of Endogenous (omission distance=7)	191
4.14	Effect sizes (f ²) of the latent variables	193
4.15	Effect sizes (q ²) of the latent variables	194
4.16	Test of mediation by Sobel's Test	196
4.17	Significance analysis of path coefficients without the mediator	198
4.18	Significance analysis of path coefficients with the mediator	189
4.19	Summary test of mediation by bootstrapping approach	199
4.20	Index values and total effects for the organisational performance	201
5.1	The mediating effect of green innovation	227

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
1.1	Life cycle assessment	3
1.2	CO ₂ emissions trends in Malaysia	11
2.1	Life cycle assessment of manufacturing process	36
2.2	CO ₂ emissions and gross domestic product trends in Malaysia (2000-2011)	40
2.3	The traditional supply chain	43
2.4	Evolution of the green supply chain	53
2.5	Environmental performance measures	84
2.6	GSCM, green innovation, and performance: Stakeholder's perspective	89
2.7	The interaction of evolutionary approach	95
2.8	The continual improvement of GSCM and green innovation from green perspectives	98
2.9	The mediating research model of Eiadat <i>et al.</i> (2008)	112
2.10	The mediating research model of Chang (2011)	113
2.11	The mediating research model of Chiou <i>et al.</i> (2011)	114
2.12	The proposed mediation model of the study through green innovation	115
2.13	The conceptual research model	118
3.1	Flow Chart of Research Methodology	121
3.2	Companies' main business activity	141

3.3	Distribution of companies according to number of employees	142
3.4	Distribution of types of company ownership	143
3.5	A systematic procedure for applying PLS-SEM	158
4.1	Distribution of total of employees among Malaysian manufacturing companies	165
4.2	Ownership statuses of Malaysian manufacturing companies	166
4.3	Conceptual representation of hierarchical component model for GSCM	170
4.4	Conceptual representation of hierarchical component model for green innovation	171
4.5	Outer loading relevance testing	175
4.6	Results of reflective measurement model for first order and second order construct	185
4.7	Mediator analysis procedures in PLS-SEM	197
4.8	IPMA representation of organisational performance	201
4.9	The implementation of GSCM practices of manufacturing companies	203
4.10	The implementation of green innovation of manufacturing companies	204

LIST OF ABBREVIATIONS

AVE	-	Average Variance Extracted
CEC	-	Customer Environmental Cooperation
CO ₂	-	Carbon dioxide
EMR	-	Environmental management representatives
EMS	-	Environmental management system
EP	-	Environmental performance
EU	-	European Union
EuP	-	Eco-design for energy using products
FMM	-	Federation Malaysian Manufacturing
GP	-	Green purchasing
GSCM	-	Green supply chain management
IEM	-	Internal environmental management
IPMA	-	Importance-performance matrix analysis
ISO	-	International organisation for standardisation
LCA	-	Life cycle assessment
MN	-	Managerial innovation
MR	-	Marketing innovation
OECD	-	Organisation for economic co-operation and development
PASW	-	Predictive analytics software
PC	-	Process innovation
PD	-	Product innovation
PLS	-	Partial least square
PLS-SEM	-	Partial least square structural equation modelling
RL	-	Reverse logistics
RoHS	-	Restriction of hazardous substances
SCM	-	Supply chain management
SEM	-	Structural equation modelling

SME	-	Small and medium-sized enterprises
SPSS	-	Statistical Package for Social Sciences
VAF	-	Variance accounted for
VIF	-	Variance inflation factor
WEEE	-	Waste electrical and electronic equipment

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Final questionnaire	259
B	Questionnaire for Expert Validation	268
C	An example letter sent to experts	278
D	Analysis of questionnaire before and after expert validation	279
E	An example of cover letter for pilot study	285
F	An example of cover letter for final study	286
G	Evaluation criteria for PLS-SEM	287
H1	Base model (before remove the items): results of the repeated indicator approach- first stage	288
H2	Base model (after remove the items): results of the repeated indicator approach- first stage	289
I	Full model: results of two-stage approach- second stage	290
J	List of research publications	311

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Increasing environmental and resource depletion problems have become challenging issues to business organisations in recent years. The pattern of economic consumption also leads to the high level of energy and material utilisation among business organisations within their operation. The term ‘business organisation’ here refers to manufacturing companies, which are believed to be the major contributor of those environmental and resource depletion problems (Beamon, 1999; Eltayeb *et al.*, 2011). According to Wisner *et al.* (2012), the business activities along the product development process may create substantial problems to the natural environment including increased carbon monoxide emissions, unnecessary packaging materials, abandoned toxic materials, and other types of industrial pollutions. These issues also have forced the manufacturers to significantly take responsibility to improve their development and production processes to ensure environmental sustainability (Meera & Chitramani, 2014) which, in the long run, can turn their businesses into more ‘green’ business entities.

The concept of ‘green businesses’ appeared at the end of the 20th century due to pressure from the continually growing community interest about the sustainability of economic development (Čekanavičius *et al.*, 2014). Generally, a green or sustainable business can be defined as any organisation that contributes in environmentally friendly or green actions to guarantee that each process, product, and manufacturing activity sufficiently deal with existing environmental issues

besides retaining its profit. Cekanavicius *et al.* (2014) concludes that the green business refers to any business that is beholden to the standards of environmental sustainability in its management, its attempts to use renewable resources, and its struggles to reduce the negative environmental effects of its actions. In assessing the environmental impacts related to all the stages of a product's life cycle, Life cycle assessment (LCA) has become an important concept for green businesses in designing and transforming their products to more environmentally friendly specifications.

Life-cycle assessment (LCA, also known as life-cycle analysis, eco-balance, and cradle-to-grave analysis) is a systematic method to measure environmental impacts associated with all the stages of a product's life, from cradle to grave which is from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling (US Environmental Protection Agency, 2010). Figure 1.1 shows the Life cycle assessment (LCA) process which is used to assess the environmental aspects related to a product or process. The figure explains the evaluation of environmental impacts from its cradle to grave. It captures the environmental effects to elements such as materials, energy and wastes involved in each phase of the product's life cycle: from raw materials extraction, to manufacturing, to distribution or packaging, to the consumer use of products and finally to post-consumer use which includes recycling or final disposal. LCAs evaluate main environmental effects involving global warming potential, toxicity and resource depletion. The outcomes let organisations recognise sections with the most significant impacts and by comparing LCA results of different products or processes, organisations can decide which has the lower environmental impact.

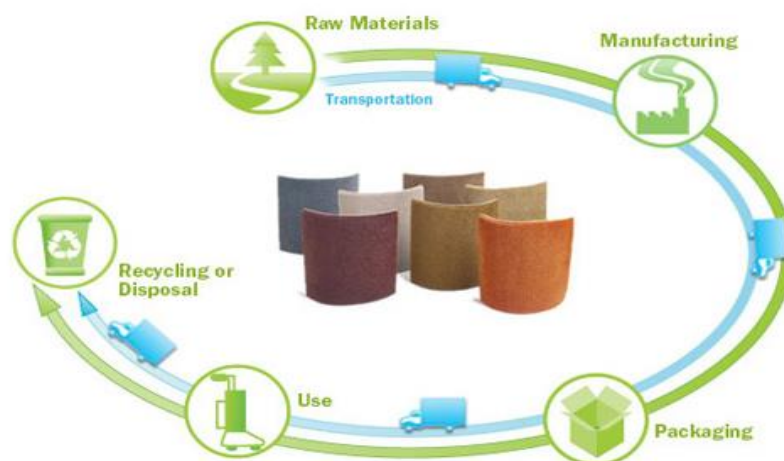


Figure 1.1 Life cycle assessment (Roman, 2013)

There are three major drivers of the green business which includes consumers, governments and the business entity itself, and each of them in its own way contributes to the formation of “green request” or green practices (Čekanavičius *et al.*, 2014). Manufacturers have remained improving several environmental programmes and various “green” business practices namely green brands, green technologies, and eco-design due to the growing attention on environmental problems from consumers, the community or public, and governments’ regulation over the world (Zhu *et al.*, 2008b). There is a mounting need for greening business, from customer, suppliers and management point of view, which necessitates a whole re-evaluation of the activities performed which have impact on the environmental performance. This has led to increased awareness among manufacturers to significantly push their business towards environmentally conscious manufacturing. This is mainly because of the growing demand from worldwide consumers and buyers that require their suppliers to produce more eco-friendly products (Eltayeb *et al.*, 2011). Customers and buyers are also increasingly expecting that the negative impacts of suppliers’ production on the environment can be diminished by reducing the consumption of energy and material throughout the production process (Chiou *et al.*, 2011). As business organisations are believed to be important representatives of society, specifically customers, all their activities may raise the community concern. Meera and Chitramani (2014) claimed that customers are currently more familiar and are increasingly participating in green interests. Through customer loyalty changing

towards environmentally friendly products, companies are gradually attempting to produce greener supply chains by initiating sustainability strategies throughout their organisations and supplier networks. However, it is not just about being environmentally friendly, but also about increasing the image of the organisation which can ultimately lead to higher profits for the organisation. In other words, manufacturers should pay a serious attention on environmental effects while conducting their business.

Since the introduction of current environmental directives for example the Waste Electrical and Electronic Equipment (WEEE), Restriction of Hazardous Substances (RoHS), and Eco-design for Energy using Products (EuP), the European Union (EU) have forced organisations to extend their environmental practices to their suppliers and customers. WEEE directive is founded to promote reuse, recycling and recovery of parts and materials which aimed to reduce the environmental impacts significantly. RoHS is established to minimise the consumption of hazardous substances such as lead, mercury, and cadmium which affect the natural environment. EuP directive seeks to decrease the environmental impact produced throughout the manufacture, use and disposal of a very wide range of products. According to Rao and Holt (2005), these regulations required manufactures to integrate environmental concern into their management practice. Therefore, these environmental regulations are significant to assist manufacturers in recognizing and directly minimising the environmental impacts at every stage of companies' supply chain.

Developed countries have put into place regulations and requirements in promoting the use of environmentally friendly practices or systems and in developing green products. The increase of similar regulations throughout the world especially in developed countries like US, Germany, Portugal, and Italy has also created the emerging issues of green product in Asia. Environmental regulation is the most powerful pressure that may affect the overall activity of a manufacturing company (Zhu *et al.*, 2011). Companies that fail to comply with this pressure will cause a high risk to individual or group action lawsuits which might ruin their public image, customer relations, and external legitimacy (Sarkis *et al.*, 2010; Darnall *et al.*, 2009).

Under such circumstances, manufacturing companies need to utilise an effective environmental management practice as one of the ways to prevent these regulatory threats. Green *et al.* (2012) stated that manufacturing companies should start to implement green supply chain management (GSCM) practices in fulfilling customer demand for environmentally friendly products and services which are designed and produced through environmentally sustainable practices. This environmental management practice can fulfil companies' social responsibility of increasing environmental sustainability conditions as well as ensure their compliance to environment regulations, which will eliminate the threat of imposition of penalty and closure.

Thus, Green Supply Chain Management (GSCM) appears as a novel organized environmental practice to handle with these issues. GSCM is deemed as an environmental innovation which conceptually incorporates environmental thinking into supply chain management (SCM). GSCM have a significant role in affecting the whole environmental effect of any business involved in supply chain activities and subsequently lead to environmental performance improvement (Chin *et al.*, 2015). GSCM is a significant issue on the part of most organisations including those in Asia and South Asian Region (Rao and Holt, 2005). For many organisations in this region it is a way to demonstrate their serious commitment to sustainability (Bacallan, 2000). Still much work and development is needed. Malaysia is one of the countries that are now moving forward to be a developing and industrialised country in the Asia-Pacific region (UNDP Report, 2007; Trading Economics, 2016). Developing and industrialised country deals with many environmental problems and consumption issues as caused by their rising economic growth (Seman *et al.*, 2012a). Therefore, the issue of GSCM is also significant for Malaysian industry, thus serious investigations should be conducted in this particular area.

Similar to other countries, environmental and resource depletion problems have also become a very important issue for the Malaysian Government and the public. Among the initiatives of the Malaysia Government to promote sustainable practices include the Environmental Quality Act 1974 and the 'Malaysian Plan' starts from the 7th Malaysia Plan (1996-2000) until the 10th Malaysia Plan (2011-2015).

For example, the Environmental Quality Act was established in 1974 and has been revised a number of times to encompass 18 sets of regulations to help implement projects related to clean air, sewage, and industrial waste assessment (Rao, 2002). Furthermore, various pressure groups have been established to observe these environmental problems. Pressure groups including non-governmental organisations (NGOs) such as Environmental Protection Society of Malaysia have increased media attention to explore environmental issues (Green Purchasing Network Malaysia, 2003). Even though the attempts made by the Government and public awareness on environmental issues have been improved, it seems that these environmental and resource depletion problems continue to persist. Therefore, five levels of environmental management initiatives have been taken as responses to environmental issues at worldwide and national levels. The initiatives include defensive compliance, waste minimisation or cleaner production, eco-efficiency, design for environment, and green supply chain (Eltayeb *et al.*, 2011). This research will focus on the initiatives of GSCM in Malaysian manufacturing industry.

Green supply chain adoption within business operation is believed to enhance business performance. The execution of GSCM practices is anticipated to improve environmental performance which can be determined through decreases in air emissions, emission waste, solid waste, and the utilization of toxic materials (Green *et al.*, 2012). There is concern, however, whether GSCM, as an environmental sustainability effort, will finally turn into improved market share and profitability. According to Bowen *et al.* (2001), who stated that companies tend to employ GSCM practices into their business operation if they be able to accomplish both economic and operational profits through the implementation of the green initiatives. Manufacturers will be more motivated to transform their products into green products and they will be more inclined to adopt green technology with the effective and systematic design of environmental practice (Chiou *et al.*, 2011). Hence, companies should apply well-designed environmental principle into their business' supply chain to boost their innovation and creativity in developing green products.

Therefore, the implementation of GSCM is able to create more green innovation activities in developing green products. Green innovation is another concept of environmental management that is now promoted with the intention of eliminating the negative environmental problems (Chen, 2008; Chen & Chang, 2011). To reach companies' growth in the future, green innovation is specifically desired in companies' activities to establish new markets as market forecast show that these fields will encounter above average growth in the next 10 years, which may offer several potential and opportunities (Walz & Eichhammer, 2012). Green innovation concept can promote the implementation of GSCM by offering new ideas and approaches to manufacturers. This is supported by Chen *et al.* (2006) who claimed that green innovation may facilitate increase the implementation of environmental management specifically GSCM, in fulfilling the company's environmental requirement. Green innovation also may present a platform for companies and their suppliers to work together. The cooperation between suppliers and buyers or manufacturers can lead to more green innovation and the improvement of green products (Bergh *et al.*, 2013). However, a constant green innovation is needed in implementing GSCM as to fit current environmental goals.

Traditionally, innovation was categorised into four types of innovations, which are product innovation, process innovation, managerial innovation, and marketing innovation (Porter & Linde, 1995; OECD, 2005). However, from the green perspective, green innovation was usually classified and studied under three main categories including green product innovation, green process innovation, and green managerial innovation (Chen *et al.*, 2006; Chen, 2008; Reid & Miedzinski, 2008). Organisation can improve resource productivity through green innovation besides improving environmental performance. As recommended by Shrivastava (1995), product innovation and process innovation can facilitate manufacturing companies in distinguishing their product, enhancing quality of product, and reducing the amount of production. Manufacturers can also apply the environmental concept into their products' packaging design, manufacturing and managerial aspect (Chiou *et al.*, 2011). As stressed by Porter and Linde (1995), the constant and ongoing innovation is a critical solution to deal with pressures from customers, competitors, and regulators. The organisation would not be fearful or overdramatic

when dealing with these environmental pressures since these pressures might be transformed into motivation that urges them to perform green innovation and generate a competitive advantage and further develop their green environmental performance (Chen *et al.*, 2006). So, the extent of implementation of green supply chain and green innovation within manufacturers' business operation is seen important for top management in improving environmental performance outcomes.

The issue of GSCM and green innovation is still in preliminary level in Malaysia. Many companies in Malaysia are still left behind and they still have not implemented the concept of green supply chain in their business procedures (Wooi & Zailani, 2010). Eltayeb and Zailani (2009) claimed that companies wholly owned by Malaysians have a lower level of acceptance and involvement in green supply chain practices compared with overseas companies and multinational companies (MNC). Some difficulties that delayed the adoption of GSCM in Malaysia consists of size of company (Lee, 2008) and high cost of adopting green supply chain practice (Anbumozhi & Kanada, 2005). The larger manufacturing companies are more likely to involve themselves in green supply chain initiative (Lee, 2008). Wooi and Zailani (2010) claimed a high cost is required in implementing GSCM as it comprises training, learning, technology, and high capabilities. Besides, the concept of green innovation in Malaysia is still less debated and there is a lack of researchers in this field. This indicates that the concept of GSCM and green innovation is still in the preliminary stage among local-based Malaysian manufacturing companies. Certain barriers that interrupt the implementation of GSCM and green innovation in the companies need to be overcome. It is important to develop capabilities of manufacturing companies in adopting GSCM and green innovation in order to broaden the sources of sustainable economic growth.

This research will attempt to examine the level of implementation of GSCM practices and green innovation by Malaysian manufacturers within their business operation. The current research more particularly will try to examine the relationship between GSCM practices and green innovation in Malaysian manufacturers, besides examining whether these variables have direct or indirect impact on environmental performance.

1.2 Problem Statement

There are at least six major issues that drive the researcher to investigate the implementation of GSCM and green innovation in Malaysian manufacturing industries. Firstly, the environmental issues in Malaysia are becoming more complex and challenging (Ibrahim, 2013; Vaghefi *et al.*, 2015). The Department of Environment (2016) and Ibrahim (2013) also highlighted several factors that caused these environmental issues including the development of new types of products, transformations in manufacturing processes, implementations of new technologies for products, level of housekeeping, degree of cleaner technology use, capability in managing environmental issues, old environmental issues yet not appropriately addressed, and regulations have not been revised. These factors directly increased environmental problems such as air pollution, water pollution and waste. In recent years, Malaysia is experiencing high air pollution due to increase in road traffic and rapid economic development. Water pollution from household waste water has also become a big problem that is affecting urban areas. Other environmental problems in Malaysia are haze caused by forest fires, deforestation, and oil pollution of the sea (Vaghefi *et al.*, 2015). Likewise, manufacturing companies have been recognised as one of the largest environmental pollutants (Ho *et al.*, 2015). This is because companies are involved in the whole manufacturing process, from the acquiring of raw materials to fashioning or transforming them into final products which invariably led to the production of waste materials or other substances that can be harmful to the environment (Hassan *et al.*, 2016). These waste and substances cause air and water pollution.

Additionally, among all the sectors, the manufacturing sector has been a major driver of growth for the Malaysian economy. Since early 1980s, Malaysia's manufacturing industry has been experiencing enormous growth. It contributes to almost 80 percent of the overall country's export and Malaysia's manufacturing industry is the 17th largest in the world (FDMAAsia, 2016). Sources from Bank Negara also disclose that the manufacturing sector has a large influence on the country's economy (Ramli & Munisamy, 2010). However, according to the Compendium of Environment Statistics Malaysia 2008 - 2015 (Department of

Statistics Malaysia, 2016), even though the manufacturing sector is the second largest contributor to the Gross Domestic Product (GDP) of Malaysia, it is also one of the main contributors to environmental pollution. Basically, the manufacturing sector is a major cause of environmental pollution especially for water and air pollution. A survey by the Department of Statistics, Malaysia in 2013 discloses that the manufacturing sector was the highest contributor for environmental protection expenditure amounting to RM1, 328.5 million (59.4%). Consequently, all the activities in the manufacturing sector that produce pollutants can contribute to poor environmental performance.

The Malaysian government is devoted to maintain, preserve and enhance its manufacturing sector through various initiatives. However, direct and indirect energy consumption of manufacturing contributes to carbon dioxide (CO₂) emission that harms the environment. In this study, carbon dioxide (CO₂) damage will be discussed as example of pollutant forms of manufacturing industry that can be related with the trend of GDP growth later in Chapter 2. Based on World Bank data, in monetary terms, CO₂ damage is calculated to be about 20 USD per ton of carbon (the unit damage in 1995 USD) multiplied by the number of tons of carbon emitted. CO₂ is the most important anthropogenic greenhouse gases which has the largest contribution from human activities (Safaai *et al.*, 2010). Malaysia usually relies on non-renewable energy such as fossil fuel and coal for its production activities but if the economy is too reliant on this energy, it will cause an increase in CO₂ emission (Chick & Rahim, 2014). Accordingly, the increase in the level of CO₂ emission that is related to the energy supply and consumption are blameable for the global warming. The Intergovernmental Panel on Climate Changes (IPCC) pays most attention to carbon dioxide (CO₂) emission rather than other emissions because of its contribution to the global warming since pre-industrial times (IPCC, 2001). Besides, Malaysia is one of the largest emitters of CO₂ with a total of 193.96 million tonnes or 7.9 metric tons per capita from fuel combustion amongst the South East Asian countries in 2011 (International Energy Agency, 2013; OECD, 2014: 26). CO₂ emission from manufacturing sector contributes about 32.75 million metric tons to the total of CO₂ emission in Malaysia in 2011 (Trading Economics, 2016). Figure 1.2 indicates the increasing trend of CO₂ emission over 11 years in Malaysia. The

problem of CO₂ emission has become an important issue which is affecting the environmental degradation of the country.

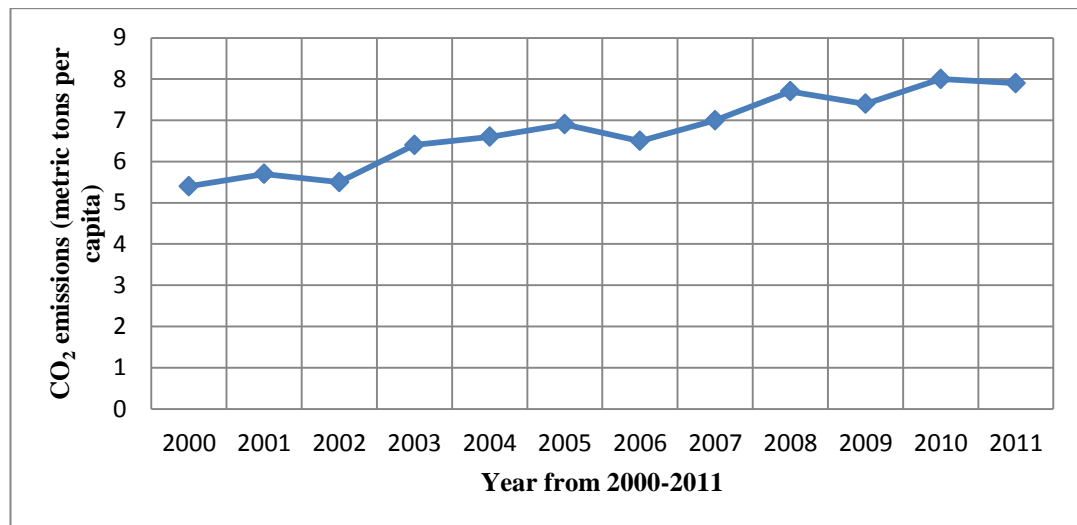


Figure 1.2 CO₂ emissions trends in Malaysia (The World Bank, 2014)

Since the manufacturing industry in Malaysia is still developing, the government has to ensure that its trading policies and regulations are improved in order to guarantee sustainability and protection of the environment. Thus, the Malaysian government promised to reduce carbon emission up to 40 percent by the year 2020 (FDMAAsia, 2016). Malaysia needs to move to a greener economy which takes into account the development of environmental sustainability that will take into consideration not only the economic but also the environment criteria. The evaluation of environmental performance is important to examine and assess firm performance not only in terms of economic efficiency but also environmental efficiency in order to achieve environmental sustainability (Ramli & Munisamy, 2012). The situation definitely provides a ground for debate when it comes to implementation issue especially the implementation of greening concept such GSCM and green innovation.

Secondly, there is limited number of studies on GSCM in developing countries especially in Malaysian countries. Many prior studies in developed countries (Large & Thomsen, 2011; Azevedo *et al.*, 2011; Chiou *et al.*, 2011; Cagno

et al., 2011; Arimura *et al.*, 2011; Zhu *et al.*, 2010; Hsu & Hu, 2008; Shang *et al.*, 2010; Holt & Ghobadian, 2009; Lee, 2008; Raymond *et al.*, 2008; Chien & Shieh, 2007; Simpson *et al.*, 2007; Yang *et al.*, 2013) and developing countries (Zhu *et al.*, 2011; Liu *et al.*, 2011; Li, 2011; Zhu *et al.*, 2008a; Zhu *et al.*, 2008b; Ninlawan *et al.*, 2011; Diabat & Govondan, 2011; Eltayeb & Zailani, 2009; Eltayeb *et al.*, 2011; Diab *et al.*, 2015; Ganeshkumar & Mohan, 2015; Rusli *et al.*, 2011; Wooi & Zailani, 2010; Mahmood *et al.*, 2011) have made significant research progress in green supply chain management. However, in developing countries like Malaysia, GSCM is a relatively new concept either in practice or research (Rao, 2002). Given this issue, there is a future need to understand how Malaysian manufacturing companies deal with GSCM practices.

In Malaysia, based on empirical studies and theoretical backgrounds, several researchers have used different methods such as surveys and case studies by studying similar contexts specifically in manufacturing industries and have proposed different models and frameworks to analyse the implementation of GSCM practices in Malaysia (Eltayeb & Zailani, 2009; Eltayeb *et al.*, 2011; Rusli *et al.*, 2011; Wooi & Zailani, 2010; Mahmood *et al.*, 2011; Conding & Habidin, 2012; Chin *et al.*, 2015; Mahmood *et al.*, 2013; Khairani *et al.*, 2012). Generally, the concept of GSCM is widely studied in Malaysia but to the best of our knowledge very few studies have captured the multidimensional nature of GSCM specifically. According to Malhotra and Grover (1998), more attention is required to be determined on utilising multi-item latent constructs, measuring them for content validity and refining them through field-based testing. In addition, the multidimensional conceptualizations give understanding into the construct of GSCM practices implementation and its relationship with the underlying factors (Zhu *et al.*, 2008b). For example, the items and the factors of the construct may contribute direct and actionable information on GSCM practices implementation. Thus, GSCM practices implementation should be multidimensional, and not restricted to certain practices such as green purchasing or green manufacturing only because these would leave gaps to the full picture of organisational GSCM practices implementation.

Practically, manufacturers have to struggle to develop a multidimensional GSCM practices implementation in order to achieve the overall fulfilment of advantages that may involve increased environmental image and economic benefits (Zhu *et al.*, 2008b). The existing previous studies in Malaysia mostly employed multiple dimensions of GSCM practices include green procurement, green manufacturing, green distribution, green logistics, green purchasing, internal environmental management, customer environmental cooperation, reverse logistics, eco-design, product recycling, environmental compliance, and optimization. This indicates that there is no consistency in recognizing multi-dimension terms of GSCM practices precisely. Basically, the process begins from the acquisition of raw material, manufacturing processes, distribution, end customer usage or end of life disposal, which overall includes all the elements of manufacturing supply chain which can become a cause for pollution, waste and other hazards to the environment (Gupta, Kalia, & Shirvastava, 2010). Henceforth, there is a constantly rising pressure to take effective actions on employing green methods across all these aspects. Given this matter, the current study expand and seek out the potential multidimensional GSCM practices that are actually implemented by manufacturing companies in Malaysia through the review, then confirming and validating them as multidimensional constructs through PLS-SEM analysis. Therefore, this study emphasises to empirically explore the multidimensional nature of GSCM in the context of Malaysia.

Regarding the green innovation field, very few studies have been done on green innovation practices specifically in developing countries like Malaysia. Some previous studies in developed countries such as United States and Sweden (Carrion-Flores & Innes, 2010; Gluch *et al.*, 2009) and developing countries (Alhadid & Abu-Rumman, 2014; Lee *et al.*, 2014; Weng *et al.*, 2015; Chang, 2011; Kucukoglu & Pinar, 2015; Conding & Habidin, 2012; Abdullah *et al.*, 2015; Zailani *et al.*, 2011; Zailani *et al.*, 2015) have done significant research in green innovation. However, some prior studies failed to highlight the multidimensionality of green innovation and only examined the concept of green innovation in general (e.g. Carrion-Flores & Innes, 2010; Gluch *et al.*, 2009; Weng *et al.*, 2015; Lee *et al.*, 2014, Zailani *et al.*, 2011). Meanwhile, other previous studies have underlined the adoption of

multidimensional green innovation practices including green product innovation, green process innovation, and green system or managerial innovation in improving a firm's financial and environmental performance. Yet, the green marketing innovation aspect is still left behind if compared to other types of green innovation in that area. Hence, this study aims to empirically investigate the multidimensional nature of green innovation in the context of Malaysia.

In addition, as reported by UNDP Report (2007) and Trading Economics (2016), Malaysia is now considered as a developing economy in Asia which, in recent years, has successfully been transformed from an exporter of raw materials into a diversified economy. This indicates that Malaysian is now moving forward to be an industrialised economy. Despite the challenging economic environment in 2015, the gross domestic product (GDP) growth in Malaysia was last reported at 5.0% by manufacturing sector which contributed 23.0% of the overall GDP in 2015 (Bank Negara Malaysia, 2016) as shown in Table 1.1. Thus, it indicates manufacturing industry remained to be an important contributor to Malaysian's economy in recent years. The Malaysian economy increased by 5.0 percent year-on-year in 2015, moderating from a 6.0 percent growth in 2014 and in line with market expectations (Trading Economic, 2016). The largest sector of the economy is services, estimating for around 53.5 percent of GDP 2015. Manufacturing sector has been increasing in recent years and now accounts for 23.0 percent of GDP. Mining and quarrying sector represents 8.9 percent of GDP 2015. Although the GDP value has the lowest growth in over two years, the manufacturing sector remains to be an important contributor to the Malaysian economy in recent years.

Table 1.1: Gross Domestic Products (GDP) by Sector (2014-2015)

	2015^p	2014	2015^p	2014	2015^p
	% of GDP	Annual change (%)		Contribution to growth (ppt) ¹	
Services	53.5	6.5	5.1	3.5	2.8
Manufacturing	23.0	6.2	4.9	1.4	1.1
Mining & quarrying	8.9	3.3	4.7	0.3	0.4
Agriculture	8.8	2.1	1.0	0.2	0.1
Construction	4.4	11.8	8.2	0.5	0.3
Real Gross Domestic Product (GDP)	100.0¹	6.0	5.0	6.0	5.0

¹ Figures may not necessarily add up due to rounding and exclusion of import duties component
^p Preliminary

Source: Department of Statistics, Malaysia

Since the manufacturing sector has continuously acted as an important driver to the higher industrialised economy of Malaysia every year, there is an urgent need to give full attention on the monitoring of their business' doings and their impacts on performance, particularly in environmental performance. This is because their activities can cause a substantial risk to the environment in terms of carbon monoxide emissions, unwanted packaging materials, scrapped toxic materials, traffic congestion and other types of industrial pollution (Wisner *et al.*, 2012; Eltayeb & Zailani, 2009; Eltayeb *et al.*, 2011; Beamon, 1999; Chin *et al.*, 2015). In this manner, environmental programmes such as GSCM have been an effective programme for business organisations in handling their operations in a greener manner. GSCM seeks to reduce or eliminate wastages involving hazardous chemicals, emissions, energy and solid waste along the supply chain such as product design, material resourcing and selection, manufacturing process, delivery of final product and end-of-life management of the product (Rao, 2005; Srivastava, 2007). Hereby, GSCM performs as a significant part in affecting the whole environmental effect of any business engaged in supply chain activities and thus contributing to sustainability performance enhancement.

Furthermore, most studies conducted in several other developing Asian countries such as Thailand possibly has similar market or socio-cultural situation with Malaysia. However, it is still different in terms of mode of implementation and

surrounding pressures. Rao (2002) claimed that the level and mode of implementation of GSCM practices vary significantly from a country to another. For example, Ninlawan *et al.* (2010) reported that the GSCM implementation among Thailand manufacturers were at the preliminary level and these manufacturers have adopted several GSCM practices that are mostly concentrated on internal environmental management practice, compared to other GSCM practices. Meanwhile, from the Malaysian context, Wooi and Zailani (2011) said that the level of GSCM implementation is still also at initiation level, starting with the low level green purchasing practice whereby the practice is considered as a very new concept in this country. This indicates that Malaysian manufacturing sector is still in the beginning stage of GSCM implementation by starting with green purchasing practice. Hence, it implies that the implementation of GSCM practices by manufacturers either partly or entirely will lead to the level of GSCM implementation. Therefore, more studies need to be conducted to investigate the current level of adoption and implementation of GSCM practices among Malaysian manufacturers in order to provide the empirical knowledge and evidence in GSCM domain.

Thirdly, there have been many discussions on the importance of several pressures that push companies to implement GSCM and green innovations. The pressures consist of internal and external pressures including the government environmental regulations, legislation, customers, suppliers, buyers, and communities (Clarkson, 1995; Branco & Rodrigues, 2007; Matos & Hall, 2007; Darnall *et al.*, 2010; Darnall *et al.*, 2009; Sarkis *et al.*, 2010; OECD, 2005; Frondel, Horbach, & Rennings, 2007; Horbach, 2008). Christman and Taylor (2001) stressed that different industrial sectors from another countries are confronting with diverse pressures. Each pressure is perceived and managed differently according to the respective countries. For example, the cross-country differences in environmental regulations include the domestic evaluation of environmental quality, ranged of abilities to tolerate, reduce, absorb, or neglect the pollution problems (Christman & Taylor, 2001). Delmas and Toffel (2004) confirmed that these pressures are managed based on the cultural borders such as regulatory conformance, market demand, and social responsibilities. It can be indicated that the manufacturing

industry in Malaysia may be different from the manufacturing industry in other countries due to its different backgrounds and cultures, and may also deal with different pressures.

By the same token, the existence of international environmental regulations such as WEEE, RoHS, and EuP directives also provide high pressures to manufacturing companies in Malaysia to develop environmental practices to their suppliers and customers. For example, WEE directives stressed the manufacturing companies to decrease the quantity of waste that is going to final disposal (Global Legislation Website, 2016). RoHS directives required manufacturers to minimise the use of hazardous substances through their supply chain stages (Global Legislation Website, 2016). Then, EuP directives forced manufacturers to consider the energy utilization from the mining of raw materials right through to recycling at end-of-life (Global Legislation Website, 2016). Hence, all these international legislations influence all manufacturing companies specifically in designing a product; whether by reducing toxic substances from equipment, designing environmentally sustainable products from the beginning, strict controlling of hazardous substances right over to implementing efficient and safe recycling processes at a product's end-of-life.

Furthermore, the International Organisation for Standardisation (ISO) 14001 also requires manufacturing companies in Malaysia to concentrate on environmental aspects not only in their internal operations but also throughout their supply chain (Nawrocka *et al.*, 2009) including customers, suppliers, and logistics aspects. The ISO 14001 certification is the benchmark for the Environmental Management Standard (EMS) and specific minimum requirements for attaining ISO 14000 certification (Beamon, 1999). The ISO 14001 certification helps companies to have better control of their environmental aspect and in that way can lessen their environmental footprints (Yin & Schmeidler, 2007). Moreover, it is important to note that the ISO 14001 certification is internationally linked to supply chains since the certification is a requirement that pre-qualifies the green credentials of companies without the demand for costly environmental assessments (Fenn, 2011). The implementation of GSCM and green innovation can meet the pressures from its external stakeholders such as government regulation, suppliers, and customers.

Similarly, the adoption of ISO 14001 certification by most companies also aimed to comply with legal requirement (Rivera-Camino, 2001), customers' environmental requirement (Hillary, 2004; Poksinska, Dahlgaard, & Eklund, 2003), and public pressure (Rondinelli & Vastag, 2000). Henceforth, this notion directly indicates that the adoption of GSCM, green innovation and ISO 14001 complement each other in fulfilling the requirements from external stakeholders.

In addition, the establishment of the Ministry of Energy, Green Technology and Water on April 9, 2009 by the Prime Minister, YAB Datuk Sri Najib Tun Razak also forced manufacturing companies to embed the green concept into their operation. The formation of this ministry is aimed to confirm that the regulatory mechanisms employed are in line with the requirements of the existing legislation, and continually enhance the organisation's skill to reach the industry and green technology (KeTTHA, 2016). However, the establishment of this ministry is perceived as a holistic approach in encouraging green technology in Malaysia. It is hoped that the establishment of the ministry will also directly assist manufacturing companies in dealing with the current global issues such as pollutions, ozone depletion, global warming, and any other issues related to the environment (Rusli *et al.*, 2011; Bakar *et al.*, 2011). Moreover, as stated in the 10th MALAYSIA Plan, page 49 (2011- 2015), National Green Technology Policy were adopted in 2009 to address the pressing issue of climate change and also to provide direction and motivation for Malaysians to continuously enjoy good quality living and a healthy environment (EPU, 2016:49). Through these policies, Malaysia intends to execute strategies to move towards a low-carbon economy and achieve sustainable development. RM 1.5 billion is also provided to promote Green Technology (EPU, 2016). Yet, the level of willingness to implement green technology among Malaysian manufacturers is still lukewarm due to several barriers such as company size, mode of implementation, and increased several pressures including government environmental regulations, customers, suppliers, buyers, and communities as mentioned earlier. Indeed, Malaysian manufacturing companies' low awareness of green technology inhibits them from comprehending the advantages of green technology (Pawanchik & Sulaiman, 2010). In addition, the Malaysian manufacturing industry is still in its developing stages and has significant negative

environmental impacts (Abdullah *et al.*, 2015). Thus, the barriers to implement green technology such as GSCM and green innovation should be monitored judiciously to adapt to the current environmental situation. The employment of GSCM in Malaysia that started from green purchasing practice is still considered at its infancy level. Although the Malaysian government encourages green activities and gives financial aids and incentives to manufacturers who enter green initiatives, government support remains lacking toward the development of green technology initiatives in Malaysian manufacturing companies (Abdullah *et al.*, 2015). Therefore, based on all the reasons discussed above, the adoption and implementation of GSCM and green innovation among the manufacturing industry in Malaysia needs to be investigated in more depth.

Fourthly, there is limited number of research on the relationships among GSCM practices, green innovation, and organisational environmental performance. Most previous empirical research focus on the relationship between green suppliers and green innovation concepts and their influence on environmental performance and competitive advantage (Lee & Kim, 2011; Chen *et al.*, 2008; Chiou *et al.*, 2011). However, they do not consider the relationship between other GSCM practices with green innovation. Green suppliers or also known as supplier environmental collaboration is a part of GSCM practices (Rao, 2002; Vachon & Klassen, 2006; Shang *et al.*, 2010). The concept of green suppliers is quite similar to the concept of green purchasing (Zhu & Sarkis, 2004; Rao, 2002). As suggested by Chiou *et al.* (2011), other GSCM practices and the relationships among green managerial, green product, and green process innovation should be explored. It is important to note that other GSCM practices including internal environmental management, green purchasing, customer environmental cooperation, and reverse logistics must be examined in this research since they are the main practices in the GSCM implementation and they are closely related with green innovation.

Besides, the findings on the impact of GSCM practices on environmental performance are also shown as not conclusive by previous researches (e.g. Large & Thomsen, 2011; Li, 2011; Zhu *et al.*, 2010; Chien & Shih, 2007; Eltayeb *et al.*, 2011). Some researchers agreed that GSCM improved environmental performance

significantly, while others do not. For example, the research of Eltayeb *et al.* (2011) in Malaysia found that reverse logistics as GSCM practices only have significant positive effect on cost reduction, while green purchasing does not have significant relationship with the four types of outcomes namely environmental performance, economic performance, cost reductions, and intangible performance. These findings are in line with previous researches that also find no significant relationship between GSCM practices with these four types of performance outcomes (Vachon & Klassen, 2006; Zhu *et al.*, 2007a). On the whole, there is still no clear and conclusive result on the actual performance outcomes that can be recognised from the implementation of green supply chain practices. The current research will focus specifically on the performance of GSCM in terms of environmental outcomes that still indicate unclear findings from past studies.

Fifthly, the current research will try to investigate the mediator variable that possibly affects the relationship between GSCM practices and environmental performance. So, this research proposes that green innovation mediates the relationship between GSCM practices and companies' environmental performance. Based on the literature, the researcher identifies that the model of Evolutionary Approach (Nelson & Winter, 1982) and Innovation through Co-creation Model (Prahalad & Ramaswamy, 2004) support GSCM practices lead to more green innovation activities. To recap from these models, GSCM practices have the potential to lead to green innovation through an interaction between stakeholders and pressures; and green innovation is also significant to increase environmental performance (Chiou *et al.*, 2011; Zailani *et al.*, 2011). Thus, both Evolutionary Approach and Innovation through Co-creation Model are believed to support green innovation which in turn influences the environmental performance of GSCM. Green innovation is considered to deliver constant seeking techniques to innovate in individually platform of supply chain so as to achieve competitive advantage and reduce the ecological burdens in manufacturing (Zailani *et al.*, 2011).

So far, however, there have been limited studies discussing green innovation mediating the relationship between GSCM implementation and environmental performance. To date, little research has focused to consider the green innovation as

mediator variable that affects the relationship between GSCM practices and organisational environmental performance (Chiou *et al.*, 2011; Van den Berg, *et al.*, 2013; Chen, 2014). But, those empirical researches do not take into account the mediating effect of green innovation on the association of multidimensional of GSCM practices and environmental performance. Thus, the mediating effect of green innovation on other GSCM practices namely internal environmental management, green purchasing, customer environmental cooperation, and reverse logistics; which in turn affects environmental performance cannot be explored in detail and with clarity. For these reasons, this research tries to extend the mediation model and to fill this gap.

Next, this research will also extend the green innovation concept by adding green marketing innovation. Marketing innovation is one of the important elements in green innovation (Reid & Miedzinski, 2008) and company's performance (OECD, 2005). Marketing innovation can also fulfil the overall innovation process in the supply chain stage in order to minimise the negative environmental issues. This statement is supported by the report of OECD (2005) that stressed that marketing approach is needed in green innovation background in order to complete the full picture of innovation activities. However, the attention on this element is still lacking in this area although marketing innovation is in fact a type of green innovation (Halila, 2007; Reid & Miedzinski, 2008; OECD, 2005).

Finally, as departure from the previous studies, this study attempts to highlight the value of applying Partial Least Square (PLS); a component based structural equation modelling (SEM) technique in empirical knowledge management research as novelty from the previous studies. PLS-SEM method is one of the robust a multivariate data analysis techniques that had growing popularity as a key multivariate analysis method in numerous research disciplines because of its flexibility on the treatment of different modelling problems and its particular benefits over covariance-based structure equation model procedures (Hair *et al.*, 2013). PLS is mostly appropriate for modelling latent constructs in this study such as GSCM practices, green innovation, and environmental performance, and testing complex models with a small sample. PLS is also a prediction-oriented approach that does not

require strong theory and it can be used for any type of variables; ordinal, categorical or dichotomical. However, a better theory is seemed needed and become beneficial for exploratory research for model building and theory testing (Barroso *et al.*, 2009; Richter *et al.*, 2016). It can validate the measurement model for constructs and has other features such as factor loading, Cronbach's alpha, confirmatory factor analysis and so on. Measurement items also have to be tested or checked for collinearity as well.

Previous studies have generally linked GSCM practices, green innovation and environmental performance by focusing on the first-order dimensions of each (for example green suppliers, green product innovation, green process innovation, green managerial innovation, environmental performance, competitive advantage; Chiou *et al.*, 2011; Van den Berg, *et al.*, 2013; Chen, 2014). In contrast with this, the model proposed in this study illustrate the usefulness of applying PLS-SEM method when modelling a second-order latent construct and testing higher-order mediating effects, which the researcher applies to the concept of GSCM and green innovation because these are better able to reflect such multidimensional constructs (Zhu *et al.*, 2008b). The researcher also reveals how to achieve assurance for a selected measurement specification through the use of a precise theoretical foundation and finally this study has also given a detailed step-by-step procedure on how to apply this approach for other similar studies.

In conclusion, this research is important to explore the relationship among GSCM practices, green innovation, and environmental performance in manufacturing companies. Green innovation acts as a mediator that provides the mechanism through which GSCM practices influence companies' environmental performance. This research also underlines the role of marketing innovation in completing the whole picture of green innovation and fulfils the requirement of supply chain stage. This research also emphasises the significance of utilising PLS-SEM for modelling latent constructs in this study. Enlarging this conversation into the discussion about sustainable practices, it is thus essential to comprehend the association between GSCM practices and green innovation process more closely to well recognise their relationship and influence on environmental performance.

1.3 Research Questions

The research questions are as follows:

1. To what extent Malaysian manufacturing industries implement GSCM practices and green innovation in their business operation?
2. Does GSCM practices implementation contribute to organisational environmental performance in Malaysian manufacturing industries?
3. Does GSCM practices implementation contribute to green innovation adoption in Malaysian manufacturing industries?
4. Does green innovation adoption contribute to organisational environmental performance in Malaysian manufacturing industries?
5. Does the effect of green innovation practices mediate the relationship of GSCM practices on organisational environmental performance in Malaysian manufacturing industries?

1.4 Research Objectives

The aim of this research is to investigate the implementation of green supply chain and green innovation among the Malaysian manufacturing companies in order to increase their business performance includes environmental performance. To achieve this purpose, the following objectives have been formulated:

1. To recognise the level of the implementation of GSCM practices and green innovation among Malaysian manufacturing industries.
2. To examine the effect of GSCM practices (i.e. internal environmental management, green purchasing, customer environmental cooperation, and reverse logistics) on organisational environmental performance among Malaysian manufacturing industries.
3. To examine the effect of GSCM practices on green innovation (i.e. green product innovation, green process innovation, green managerial innovation, and green marketing innovation) among Malaysian manufacturing industries.

4. To examine the effect of green innovation on organisational environmental performance among Malaysian manufacturing industries.
5. To examine the mediating effect of green innovation in the relationship between GSCM practices and organisational environmental performance among Malaysian manufacturing industries.

1.5 Research Scope

There are several issues highlighted in the scope of this study. Firstly, this study is conducted amongst ISO 14001-certified manufacturing companies that possibly represent Malaysia's green companies. The companies are chosen from the list of manufacturing companies that are registered with the Federation of Malaysian Manufacturing (FMM). Second, the method of data collection used for this study is quantitative approach. The questionnaire that is utilised as the research instrument will be distributed and collected only for once a time which is known as cross-sectional study. The questionnaires are distributed among the respondents which is a total of 469 Environmental Management Representatives (EMR) of the involved companies.

1.6 Significance of the Study

To date, there is a lack of empirical studies debating on green innovation which mediates the relationship between GSCM practices and environmental performance. A few studies touched on the subject of green innovation as a mediator variable that influences the relationship between GSCM practices and organisational environmental performance (Chiou *et al.*, 2011; Van den Berg *et al.*, 2013; Chen, 2014). However, none of these studies consider the mediating effect of green innovation on the relationship of multidimensional GSCM practices and environmental performance. Besides, based on Malaysian perspectives as a developing country, studies related to GSCM practices (i.e. Eltayeb *et al.*, 2011;

Rusli *et al.*, 2011; Chin *et al.*, 2015) and green innovation (i.e. Conding & Habidin, 2012; Abdullah *et al.*, 2015; Zailani *et al.*, 2015) is less debated by Malaysian researchers. And surprisingly, it may seem there are only a small numbers of empirically based attempts to examine the significance of green innovation practice as a mediator variable (i.e. Conding & Habidin, 2012).

This study proposes to fill the gap by contributing a basis for future researches on the sustainability management in the Malaysian context, specifically on green supply chain and green innovation in manufacturing industry. This research will lead to the development of research models in the area of GSCM practices, green innovation and environmental performance by providing useful data on the relationships; first, the relationship of GSCM practices, green innovation and organisational environmental performance; second, the mediating role of green innovation on the relationship between GSCM practices and organisational environmental performance.

This study is significant because its empirical evidence will be helpful to Malaysian manufacturing companies as this issue is still quite new in the country. In addition, this research will also offer additional insights to the existing body of knowledge in GSCM and green innovation concept as a novel concept. This study also is beneficial to the academicians and researchers in increasing their understanding on how green innovation concept supports the implementation of GSCM practices. The inclusion of green marketing innovation in green innovation concept will clearly show the overall innovation activities that may be beneficial in each stage of company's supply chain.

Another important factor of this study is that it identifies potential practices of GSCM and green innovation to enhance organisational environmental performance which needs to be studied and understood. A tested and tried conceptual model derived from the study will hopefully help and simplify the GSCM practices and green innovation implementation process for local manufacturers and suppliers. Moreover, the developed research model for this study will also facilitate manufacturers to recognise the gap between their current practice and best practices

compared to their rivals and build up a strategy to reduce the gap. Thus, the findings from this study is essential as a strategic guideline to Malaysian manufacturers in order to perform proper green supply chain and green innovation practices, and at the same time to reach a higher level of global competition.

Findings from this research could also provide additional evidence on the related mechanism needed to strengthen the relationship between GSCM practices and organisational environmental performance through the mediation role of green innovation. The studies on the mediating of green innovation between the relationship of GSCM and environmental performance are less debated. This mechanism is expected to provide manufacturers understanding on the importance of green innovation in improving organisational environmental performance and GSCM practices in their business. From the findings, manufacturing companies can create a new strategy that promotes and focuses on the most important practices of GSCM to enhance their green innovation which will in turn promote organisational environmental performance. The study on green innovation concept as a mediator variable can also help manufacturing companies by offering a lot of new ideas and approaches in mediating the implementation of GSCM practices effectively and by minimising the negative environmental impacts in each stage of supply chain. Both GSCM and green innovation seem to complement each other. Therefore one can conclude that the study gives an overview on what is the best approach to explain the considerable role of GSCM practices, green innovation, and organisational environmental performance in the field of sustainability management.

Additionally, the findings will provide information on the level of GSCM practices and green innovation among manufacturing companies in Malaysia. This information will help manufacturers to recognise which practice will lead to the highest impact of GSCM practices and green innovation implementation, and which practice needs further improvement. Similarly, this research will also facilitate manufactures to identify in detail which indicator items that will become the potential key of implementing the practices successfully, and which indicators need more attention from manufacturers to be improved. Through this analysis, manufacturing companies may be able to focus and make an improvement directly

on the possible practice or item in order to improve GSCM and green innovation effectively.

The findings from the current study could also provide guidelines to government's decision in providing any incentives or specific training to manufacturers in order to enhance their active participation in the GSCM as a part of the green technology within their operations. The research findings will also lead to a better understanding and provide new insights for sustainability management area where GSCM and green innovation practices are important to improve organisational environmental performance, which can directly offer great benefits for both researchers and practitioners.

Finally, several methodological contributions deriving from this study are applicable more generally. It may also provide useful insights on the use of PLS-SEM in management research. This study develops and implements a PLS path modelling application extension for the analysis of constructs at a higher-order level of construct. Additionally, this study follows and extends the key principles of applying best practice analytical process for modelling higher-order structural relationships. The importance of mediator with small sample size to recognise path effects for such models is also established. This is especially relevant for researchers interested in mediator findings within their research. Overall, the current study provides methodological guidance for experts and new researchers involved in PLS structural models with higher-order interaction effects. Analytical procedure follows a multiple method analysis approach which helps to cross-validate the findings and limit any bias that could exist due to subjective analytical choice.

1.7 Conceptual and Operational Definition

The following section explains about the conceptual and operational definition of each variable in the current study.

1.7.1 Green Supply Chain Management Practices (GSCM)

GSCM is defined as involvement of environmental view into supply chain management process, including product design, material sourcing and selection, manufacturing process, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life (Srivastava, 2007). In this research, the researcher defines GSCM as the several potential practices that are believed to minimise and decrease the environmental problems that are possibly occurred during the production process of a final product in an organisation. In this context, the organisation refers to manufacturing companies in Malaysia which is believed to be the potential contributor to the environmental problems. The researcher investigates GSCM practices in terms of four components which are internal environmental management, green purchasing, customer environmental cooperation, and reverse logistics.

1.7.1.1 Internal Environmental Management

Internal environmental management refers to a practice of emerging environmental sustainability as strategic organisational requirement through the impressive commitment and support from senior and mid-level managers (Zhu & Sarkis, 2007). In this present study, the researcher defines internal environmental management as the emphasis on the encouraging support and commitment from top management of the organisation, and the existing of environmental management system or policy in organising the business operation activities in more environmental manner.

1.7.1.2 Green Purchasing

Green purchasing can be defined as an environmentally purchasing practice which ensures that the purchased products or materials conform to environmental objectives developed by the purchasing firm, such as reducing sources of waste, promoting recycling, reuse, resource reduction, and substitution of materials (e.g. Carter *et al.*, 1998). In this research, green purchasing refers to the credential suppliers that comply with environmental management system and supplier collaboration with organisation in purchasing and acquiring process of environmentally friendly raw materials.

1.7.1.3 Customer Environmental Cooperation

Customer environmental cooperation is defined as the collaboration with customers to establish and reach environmental objectives which is to decrease the environmental effect of corresponding activities, besides to fulfil with environmental management systems, conform to customers' environmental requirement regarding to the employment of environmental management systems and notifying customers of compliance their environmental requirements (Theyel, 2001, p. 88). In this study, the researcher defines customer environmental cooperation as the collaboration between customers and organisation in designing and developing environmentally friendly product which meets their environmental requirement and environmental regulation by sharing the idea, knowledge or technical information together.

1.7.1.4 Reverse Logistics

Reverse logistics refer to the movement of products, materials, or packaging from customer or to suppliers (e.g. Carter & Ellram, 1998). In the research, reverse logistics is defined as the process or activities after the final product is delivered to the end customers either collect it back from customers or is returned by customers

in order to maintain the business' effectiveness and maintain natural environmental aspects including includes recycle, reuse, and remanufacturing.

1.7.2 Green Innovation

Green innovation can be defined as a hardware or software innovation that is related to green products or processes, which consists of the innovation in technology such as energy saving, pollution prevention, waste recycling, green product designs, or corporate environmental management (Chen *et al.*, 2006). In this study, the researcher defines green innovation as the several environmental innovation of practices, process, managerial, and marketing which are new or modified that are elicited from the implementation of GSCM practices, in addition to improve environmental performance of the organisation. These innovations include green product innovation, green process innovation, green managerial innovation, and green marketing innovation.

1.7.2.1 Green Product Innovation

Green product innovation refers to a new and significantly improved product or service produced through decreasing its entire environmental impact (Reid & Miedzinski, 2008). In this current study, green product innovation emphasises on the any improved strategy of GSCM practices in minimizing environmental effect throughout a product's entire life cycle starting from its root.

1.7.2.2 Green Process Innovation

Green process innovation can be defined as the change in the production process that leads to the reduction of environmental impacts such as closed loops for solvents, material recycling, or filters (Bernauer *et al.*, 2006). In this study, the

researcher defines green process innovation as the improvement of production process in terms of techniques, equipment or software to increase environmental performance of GSCM practices.

1.7.2.3 Green Managerial Innovation

Green managerial innovation is consists of environmental management systems (EMS) or other specific environmental management tools such as process control tools, environmental audits, and chain management (Reid & Miedzinski, 2008). In this study, green managerial innovation emphasises on the significant changes of organisation system to sustain natural environment. The well managed managerial innovation is potential to facilitate other innovation activities and boost environmental performance of GSCM practices.

1.7.2.4 Green Marketing Innovation

Green marketing innovation defines as a development of environmentally friendly marketing procedure in company (Reid and Miedzinski, 2008). In this study, green marketing innovation emphasises on the improvement of marketing practices of products such as packaging, placing, promotion, and pricing, in addition to increase the environmental performance of GSCM practices.

1.7.3 Organisational Environmental Performance

Environmental performance is referred to an environmental effect that company's activity has made on natural environment (Sharma and Vredenburg, 1998). In the current study, the researcher defines organisational environmental performance as a performance measurement of organisation to evaluate positive

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