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# **Promoting Green Manufacturing in Apparel Companies from a Circular Economy Perspective**

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**HAILAN GUO**

**11/11/2020**

**A thesis submitted for the degree of Doctor of Philosophy  
Durham University Business School**

## ABSTRACT

### **Promoting Green Manufacturing in the Apparel Companies based on Circular Economy perspective**

By Hailan Guo

Due to environmental degradation and resource scarcity, the concept of the Circular Economy (CE) has been promoted in many countries, such as China, Japan, Germany, and Sweden, as a way to resolve the conflict between industrial development and environmental protection. The apparel industry makes a significant contribution to many countries' economies. However, with global consumption increasing, most apparel is disposed of in the early stage. Thus, creating a "circular" flow of apparel has significant implications. Manufacturing is an essential factor of many companies' survival in an increasingly competitive market. Nowadays, "Green" Manufacturing is rapidly emerging as a method for companies to reduce their environmental impact. The Global Recycling Council has recommended that apparel companies employ sustainable manufacturing. It recommends that apparel companies should comply with high standards in both the manufacturing and recycling stages to reduce their environmental impacts. Thus, apparel companies promoting Green Manufacturing from a Circular Economy perspective has become urgent and vital.

The so-called Circular Economy—the concept of the "circulation" of materials by using energy more efficiently and maximising the utility of materials and energy —has recently gained momentum. The idea of mediating the inherent conflicts between economic growth and resource dearth gives the concept of the Circular Economy a strong environmental appeal. However, the specific methods for building Circular Economy capability (CECA) at the company level have still not been thoroughly explored. Furthermore, although there have been several studies of Green Manufacturing implementation (GRMA), research attention to apparel companies in this context remains limited. Thus, this study seeks to fill these notable gaps by empirically investigating the implementation of Green Manufacturing as an approach to build Circular Economy Capability at the company level in apparel companies.

This research aims to 1) investigate the implementation of Green Manufacturing as an approach to build apparel companies' Circular Economy capability, 2) analyse the development and implementation of Green Manufacturing in the apparel companies, 3) evaluate the drivers, barriers and outcomes of Green Manufacturing, from both the theoretical perspective and the methodological perspective. First, the Nature-Resource-Based View (NRBV) theory is employed to create the conceptual model highlighting the links between the constructs from a theoretical perspective. Second, this research conducts a literature review to analyse the constructs and sub-constructs of the conceptual model. Third, the Q-sort Pilot Study is undertaken to initially assess the validity and reliability of the measurement items before grouping them into questionnaire survey. Fourth, this study collects 374 samples through a survey distributed among the managerial level employees working in the apparel companies. Last, the Structural Equation Modelling methodology is applied to test the validity and reliability of the measurement items further, to assess the factor analysis of the constructs, and to verify the 7 hypotheses that derive from the proposed conceptual model.

The results show that the Stakeholder Engagement in Environmental Implementation (SEEI) and the Environmental Orientation (ENOR) are two drivers of Green Manufacturing (GRMA), which positively affect apparel companies' Green Manufacturing (GRMA) implementation. Both the Green Manufacturing (GRMA) implementation and building apparel companies' Circular Economy capability (CECA) lead to a positive outcome, which positively affects apparel companies' Organisational Performance (ORPE). Furthermore, this research

verifies three mediation relationships: The Circular Economy capability (CECA) mediates the relationship between Green Manufacturing (GRMA) and Organisational Performance (ORPE); The Green Manufacturing (GRMA) mediates the relationship between Environmental Orientation (ENOR) and Circular Economy capability (CECA); The Environmental Orientation (ENOR) mediates the relationship between Stakeholder engagement for environment implementation (SEEI) and Green Manufacturing (GRMA).

The research contributes to both theory and practice. In terms of theory, the findings contribute to the development of further theoretical models of these concepts: Environmental Orientation, Organisational performance, Stakeholder Engagement in Environmental Implementation, Circular Economy and Green Manufacturing. This research makes a significant contribution to the ongoing research relating to the Green Manufacturing implementation by presenting an integrated conceptual model. It examines the direct relationships, mediation and moderation relationships between above constructs. Practically, the study will be highly useful for policymakers and apparel companies to understand the current barriers, drivers and outcomes of implementing Green Manufacturing and can help them to evaluate the strengths and weaknesses of their current Green Manufacturing and look for improvements. In particular, this research 1) help apparel companies to understand the current barriers; 2) highlight the importance – indeed, the necessity – for apparel companies to develop their own Circular Economy Capability so that they can fully realise the potential gains in performance which can result from applying Green Manufacturing; and 3) guide apparel companies through the stages of implementing green practices. Moreover, the study 4) supports Circular Economy implementation by policymakers and can be used as evidence for them to convince manufacturing companies that still have doubts about the outcomes of implementing Green Manufacturing or building Circular Economy capability at the company level.

# **Promoting Green Manufacturing in the Apparel companies based on Circular Economy perspective**

By: Hailan Guo

Supervisors: Professor Christos Tsinopoulos and Dr Manish Shukla

A thesis submitted for the degree of Doctor of Philosophy

Durham University Business School

University of Durham

November 2020

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## DECLARATION

No part of this thesis has been submitted for a degree in this or any other university. It is all my work unless referenced to the contrary in the text.

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## **DEDICATION**

To My Mother (Yuzhi Qi) And My Father (Tinggang Guo)

To My Sister (Haiyu Guo) And My Brothers (Haifeng Guo; Qunlei Guo)

To My Husband (Yordan Bozhinov) And My Son (Joey GuoQi Yordan)

Thank You for Your Love, Sacrifice, And Support



# CHAPTER 1: INTRODUCTION

## 1.1 Overview

This chapter introduces the research motivation, research gap, research aims, research questions, hypotheses, contributions of the study and the research structure.

## 1.2 Research Motivation

In recent decades, with environmental concerns being integrated in companies, green practices have become an area of interest to numerous researchers. In parallel with this, the concepts of Green Manufacturing and the Circular Economy have been propagated in practice (Rosa et al., 2019; Mendoza et al., 2017; Baldassarre et al., 2019; Genovese et al., 2017; Kazancoglu, Kazancoglu and Sagnak, 2018). The concept of the Circular Economy was first introduced by Boulding in 1966. Nowadays, it functions as a core environmental principle in many countries such as China, Japan, Germany and Sweden with good ecological results (Ghisellini et al., 2016; Zhu et al., 2011). The global apparel industry is a business of 1.3 trillion dollars and represents a significant driver of global GDP (BOF & McKinsey, 2019). The apparel industry makes a significant contribution to many countries' economies and creates jobs worldwide. For example, the UK apparel industry contributes £28bn to the UK economy each year. However, it also produces the same amount of greenhouse gases as UK air travel (Harrabin, 2019). With global consumption increasing, apparel worth around £140 million is disposed of each year in the UK (WRAP, 2019b). The most recent figures show 336,000 tons of apparel being sent to landfill in the UK in 2017 (WRAP, 2019a), compared with 26,000,000 tons in China (CACE, 2019). Apparels degrading in landfills releases greenhouse gas emissions and contributes to groundwater pollution and soil erosion. This brings a severe environmental problem (Yacout and Hassouna, 2016). This presents a challenge in terms of reducing such environmental impacts

(Environmental Audit Committee, 2019). Therefore, creating a 'circular' flow of apparel has significant implications.

Numerous studies on green practices in many sectors have been carried out by academics over the last decade. Nevertheless, the apparel sector is still neglected in the related discussion (Köksal et al., 2017). The primary motivation of this study has arisen from this shortcoming. Hence, this study enriches the discussion by providing a state-of-the-art, which focuses exclusively on Green Manufacturing by considering the apparel sector as the field of application. Furthermore, after reviewing 91 journal papers related to green practices in textile, apparel and fashion industries, Islam, Perry, and Gill (2020) point out there is limited research in the developing country contexts, where most apparel production takes place. China has been the global apparel manufacturing centre for a long time. Most of the international apparel companies have production lines in China, such as Adidas, Zara, Nike, and H&M. Therefore, the target respondents in this study are companies which manufacturing apparel in China, including the local Chinese apparel companies and international apparel companies. China is now the largest developing market in the world and becomes the world's largest manufacturing centre (Bu et al., 2020). As a global manufacturing centre, China has experienced sharply increasing economic growth in recent decades but at the same time suffers from severe resource scarcity and environmental degradation (Yu and Huo, 2019; Zeng et al., 2016; Liu et al., 2017). To strengthen resource productivity and improve environmental sustainability, the Chinese government has promoted the Circular Economy as an official development strategy since 2002 (Yuan et al., 2006; Geng et al., 2009; Liu et al., 2009; Subler and Xin, 2007; Park, Sarkis and Wu, 2010). Furthermore, manufacturing accounted for 68% of total energy consumption and 42.64% of China's GDP in 2013. To keep up with the 'Made in China 2025' campaign, Green Manufacturing has become one of the leading national environmental strategic methods to reduce the adverse effects of high-volume production in China (Kong et al., 2016). However, the value of Green Manufacturing is particularly salient for apparel companies, where environmental performance is increasing in importance in this sector. Furthermore, the Global Recycling Council has recommended that apparel companies employ sustainable production. It recommends that apparel companies should comply with

high standards in both the manufacturing and recycling stages to reduce their environmental impacts (Harrabin, 2019). The international apparel companies have planned to implement green practices to meet such high standards. For example, Adidas aims to only use recycled polyester to manufacture apparel and shoes by 2024, Bottletop plans to collaborate with Mulberry to launch green luxury bags made entirely of upcycled materials (Harrabin, 2019) and Zara, Bershka and Pull & Bear aim to only sell sustainable apparel by 2025 (BBC News, 2019). Therefore, promoting Green Manufacturing in apparel companies has become urgent and vital.

Global trends such as increasing scarcity of resources and growing population are driving forces for change in current practices of manufacturing apparels, as it is increasingly clear that current practices of manufacturing are not sustainable (EEA, 2015; Weetman, 2016; Macchion et al., 2018). This means in order to sustain their business, apparel companies are forced to change current manufacturing models to Green Manufacturing. Due to the high volume of apparel waste produced around the world (Shirvanimoghaddam et al., 2020), use of hazardous materials (Sarmiento, 2004), excessive energy consumption (Nakhate et al., 2020) and water pollution (Periyasamy et al., 2017), the apparel industry becomes one of the most polluting industries (Jia et al., 2020; Macchion et al., 2018). Several pieces of research investigated green practice in apparel industries. For example, Ozturk et al. (2020) studied energy efficiency using clean production techniques in the woollen apparel facility. Tayyab et al. (2020) proposed a sustainable development framework for a cleaner apparel production system. Chen et al. (2017) researched a pollution control performance evaluation tool and process-level water conservation in the apparel industry. However, there is still limited research identified in the apparel sector that evaluates the implementation of Green Manufacturing as an approach to address environmental issues. Furthermore, there has been an increased concern over sustainability issues such as worker rights, sweatshop, and the effects of fast fashion (Goworek, 2011). The focus of the response from apparel companies tends to be on social sustainability strategies as opposed to a systematic approach of the entire life-cycle. Companies are becoming more aware of sustainable apparels but finding it difficult to work within a sustainable framework due to a lack of a systems approach in the apparel industry (Kozlowski et al. 2012). Thus, this study empirically

investigates the implementation of Green Manufacturing as an approach to build Circular Economy Capability in apparel companies in China. With the gradual development of economies, the global environmental situation has become severe. Therefore, more and more governments, companies and researchers have started to pay attention to green practices related to sustainable development. For companies, the most crucial way to improve the environmental situation is to develop a more competitive advantage by improving the efficiency of their resource utilisation and environmental capabilities (Zhou and Li, 2011). Green Manufacturing is an important method for apparel companies to achieve this goal.

Circular economy strongly impacts the economic development of the apparel industry (Gazzola et al., 2020). The apparel companies significantly contribute to resource scarcity and environmental degradation. With the growing population, this has put pressure on natural resources, which are expected to become more scarce (Sandvik and Stubbs, 2019; EEA, 2015). Resource scarcity inevitably affects the apparel supply chain, as the manufacturing of apparels requires raw materials such as cotton (Müller-Christ and Gandenberger, 2006; Sandvik and Stubbs, 2019). The apparel industry uses over 98 million tons of non-renewable resources every year, including fertilizers for cotton plantations, oil to produce synthetic fibres, and chemicals for manufacturing (Gazzola et al., 2020). Hence, in recent years, building environmental capability has been one of the most important trends affecting the apparel companies. The apparel industry is also facing increasing pressure of accumulation of textile waste, as fast manufacturing and consumption of apparels have led to a perception from consumers that apparels are disposable (Andersen, 2017). It is estimated that apparel waste will increase by 60% from 2015 to 2030 globally (GFA and BCG, 2017). Therefore, build a circular economy capability is significantly important for apparel companies to address the above issues (Sandvik and Stubbs, 2019). The concept of the Circular Economy suggests aligning economic activities with the 3R principle: reducing, reusing and recycling in production, consumption and circulation processes. The Circular Economy transforms the traditional one-way linear economic 'resource – product – waste' model into a 'resource – product – waste – renewable resource' model (Zhu et al., 2010, 2011; Huang, 2012; Anderson, 2007; Yong, 2007; Ying and Li-jun, 2012). The concept of the Circular Economy

conforms with the idea of sustainable development, which further strengthens the consciousness of utilising resources and gaining maximum social and economic benefits with a minimum environmental cost, thus promoting the implementation of green practices to a certain extent (Ying and Li-jun, 2012). Therefore, this study analyses the development and implementation of Green Manufacturing in apparel companies and empirically investigates the implementation of Green Manufacturing as an approach to build Circular Economy Capability.

### **1.3 Research Aims**

This research aims to 1) investigate the implementation of Green Manufacturing as an approach to build apparel companies' Circular Economy capability, 2) analyse the development and implementation of Green Manufacturing in apparel companies and 3) evaluate the Drivers, Barriers and Outcomes of Green Manufacturing, from both theoretical and methodological perspectives. Firstly, this research empirically investigated the implementation of GRMA in apparel companies from a Circular Economy perspective. This study innovates the state of the art because it reinforced the evidence for the relationship between CECA and GRMA in apparel companies. Using the strategic response theme of NRBV, this study extends this stream of literature by emphasising the implication of GRMA to build CECA. Overall, this finding addresses this under-researched area by theorising and empirically testing that companies that embarking on Green Manufacturing initiatives help increase employee awareness, invest in environmental systems and ultimately help them build the Circular Economy Capability. In particular, this study suggests that apparel companies could usefully introduce GRMA to improve their ability to implement the Circular Economy. CECA at the company level is represented by capabilities in reduction, reuse and recycling (Zhu, Geng, and Lai 2011). GRMA includes six stages, namely design, procurement, processes, packaging, end of life management and remanufacturing (Melnyk and Smith 1996). Firms' reduction capabilities can be enhanced through green production and distribution. Reuse capabilities aim to extend the life cycle of the product and thus can be improved across all six stages of GRMA. Finally, the capacity to recycle focuses on the proper disposal of products or materials, and this

can be enhanced at the end of life stage. All six stages of GRMA therefore aim to minimise negative environmental impact, which can help companies build and improve their CECA.

Secondly, manufacturing is the principal strategic component that helps companies to build such an advantage (Lele, 2009). This research proposed GRMA as the new approach through which apparel companies can reduce their environmental impact and thus maintain a competitive advantage. Many manufacturing companies today still do not manage their environmental activities systematically and effectively (Huang, 2012). Such companies use the majority of their resources to deal reactively with the negative environmental impact of operations, rather than proactively enhancing the eco-efficiency of the manufacturing system as a whole. Hence, the challenge facing apparel companies is how to enhance the eco-efficiency of their manufacturing process from beginning to end. This study has shed light on this by identifying ways in which companies can reconfigure their resources through implementing GRMA. This study suggests that apparel companies need to broaden their perspectives on the implementation of GRMA and emphasise all stages of the concept. In particular, in the design stage, managers should use sustainable and environmentally friendly materials and technologies (such as recycled or organic textiles and eco-labelling). A rapid prototyping approach should also be used in order to reduce the use of toxic substances, minimise the use of non-renewable resources and produce products which are reusable and recyclable. Additionally, managers should conduct a life cycle analysis for their products to evaluate the environmental impact of the raw materials used and facilitate their reuse and recycling, along with the packaging materials used. Managers may then reconfigure their resources to apply green procurement, which involves activities such as supplier evaluation and cooperation, eco-efficient supply (such as recirculation of packaging and using just-in-time logistics systems) and eco-procurement activities that will facilitate the reduction, reuse and recycling of energy and resources. In the process of the production stage, managers should focus on using resources and energy efficiency and minimising emissions and waste in their production processes and operations. They should address specific activities in order to achieve this goal, such as updating their equipment to reduce energy consumption; minimising air emissions and solid and liquid waste and protecting the safety of workers, consumers and the local community. At the packaging stage, apparel companies

need to focus on minimising the impact of the materials used. Based on current regulatory standards, these should be returnable, reusable and recyclable. The stages of customer use to end of life within the concept of GRMA focus on minimising waste as well as the energy consumption and emissions of the products (Baines et al., 2012; Seliger et al., 2008).

Thirdly, this study unveils the important drivers, barriers, and outcome of implementing GRMA. Most prior study on GRMA has focused on issues, such as advocating the importance of GRMA (Lele, 2009), the performance impacts of GRMA (Choi et al., 2012), and delineating the diffusion of GRMA (Zhou et al., 2017). Relatively limited research has examined the company-level (especially in the apparel sector) drivers, barriers, and outcome of implementing GRMA in a theoretical model. On the basis of a review of the existing research, this study has theorised the concepts of SEEI and ENOR as two key drivers for the implementation of GRMA. It has accordingly reinforced and enriched the exploration of the relationships between GRMA, SEEI and ENOR. In particular, this study examined the positive effect of SEEI on GRMA in apparel companies. Customers demand more green products, governments tighten regulations over the firm's operations, and NGOs expect firms to protect green ecosystems. These pressures lead to an increasing concern that companies should consider environmental issues in their current manufacturing process. Likewise, the increased environmental awareness of stakeholders has led to an increased response from the apparel companies to improve on the ecological impacts of its manufacturing processes (Kozlowski et al., 2012; Chen and Burns 2006). Furthermore, the identified influences of Environmental Orientation (ENOR) on GRMA further corroborate Chan et al. (2012), and Bansal and Roth's (2000) observations that companies are characterised by mixed motivations (e.g., external regulations, internal environmental ethics, competitive considerations) for taking environmental protection activities. The impact of ENOR on GRMA implies the cascading effect of companies' ecological awareness and perceived pressures from stakeholders on the implementing Green Manufacturing. In particular, ENOR can promote the implementation of GRMA by helping the company to understand the importance of ecological practices, engage stakeholders in the product development process and develop appropriate strategies (Chan, 2012; Yu and Huo, 2019; Banerjee, 2002). Moreover, after reviewing more than 30 academic

papers related to barriers to green practises, this study classified four groups of barriers affecting GRMA in apparel companies. This study discussed the importance of identifying the impact of current barriers to implementing GRMA in a company. Apparel companies need to keep monitoring these barriers in order to address their possible impact. Furthermore, this study conceptualised the outcome of GRMA implementation and building CECA as an enhancement of ORPE. ORPE includes two sub-constructs, namely environmental and business performance. The relationship between ORPE and GRMA was empirically tested in this study. Through adopting a set of routines such as green design, procurement, manufacturing, packaging and distribution, companies can make more effective use of resources and energy and minimise the negative environmental impact of their operations (Carter et al., 2000; Ying et al., 2012; Zhu et al., 2005). These measures are likely to help companies to improve both their environmental and business performance (Zhu et al., 2010). The increasing influence of environment-friendly manufacturing can contribute to creating competitive advantage and strong business performance (Genovese et al., 2017; Zeng et al., 2016; Nasir et al., 2017; Sanders, 2012). Green Manufacturing aims to minimise environmental impacts and maximise resource efficiency by focusing on integrating product and process design to identify and assess the flow of waste into the environment. Through applying Green Manufacturing, the negative environmental impacts are minimised, and the resources are effectively utilised. These could help apparel companies to improve their organisational performance.

To achieve the research goal, this study proposes a conceptual model and then empirically tests it. The model links the main constructs, including the Drivers, Barriers, Green Manufacturing, Circular Economy capability and the Outcomes. The study applies an exploratory approach through a mixed-method research design, drawing on the survey with apparel companies managers and the semi-structured interview with both apparel companies managers and academics. Before grouping the measurement items in the survey, the measurement items are improved through conducting the semi-structured interview. Q-sort pilot study is undertaken as an initial evaluation of the validity and reliability of the measurement items, before going on to delineate the validation of the constructs, subconstructs, and measurement items of the conceptual model using Structural Equation Modelling

(SEM). In order to test the proposed conceptual model, this study conducts a large-scale survey and collects data from 374 apparel companies. Using this data, the study empirically investigates: (1) the impact of key Stakeholder Engagement in Environmental Implementation (SEEI) (one of the drivers) on the implementation of Green Manufacturing (GRMA); (2) the impact of the key barriers on the implementation of Green Manufacturing (GRMA); (3) the impact of key Stakeholder Engagement in Environmental Implementation (one of the drivers) on Environmental Orientation (ENOR) (another driver); (4) the impact of Environmental Orientation (ENOR) on implementation of Green Manufacturing (GRMA); (5) the impact of Green Manufacturing (GRMA) on Organisational Performance (ORPE); (6) the impact of Green Manufacturing implementation (GRMA) on building Circular Economy Capability (CECA); (7) the impact of building Circular Economy Capability (CECA) on Organisational Performance (ORPE); (8) the mediating impact of Circular Economy Capability (CECA) on the relationship between Green Manufacturing (GRMA) and Organisational Performance (ORPE); (9) the mediating impact of Green Manufacturing (GRMA) on the relationship between Environmental Orientation (ENOR) and Circular Economy Capability (CECA); (10) the mediating impact of Environmental Orientation (ENOR) on the relationship between key Stakeholder Engagement in Environmental Implementation (SEEI) and Green Manufacturing (GRMA); (11) the moderating impact of the level of Barriers to Green Manufacturing Implementation (BFGI) on the relationship between key Stakeholder Engagement in Environmental Implementation (SEEI) and Green Manufacturing implementation (GRMA) and (12) the moderating impact of the level of Barriers to Green Manufacturing implementation (BFGI) on the relationship between Environmental Orientation (ENOR) and Green Manufacturing implementation (GRMA).

## **1.4 Research Gaps**

This study fills the following research gaps: 1) Although there have been several studies on Green Manufacturing and Circular Economy Capability, research attention to apparel companies in this context remains limited; 2) Many existing studies in the broader literature have examined the Circular Economy at the regional and industry levels but several questions remain to be addressed concerning

how to build Circular Economy Capability at the company level; 3) The specific methods for building Circular Economy Capability at the company level have still not been thoroughly explored. Therefore, this research empirically investigates the implementation of Green Manufacturing as an approach to build Circular Economy Capability at the company level in apparel companies; 4) Green manufacturing implementations are affected by both external and internal drivers. However, these drivers of Green Manufacturing (SEEI and ENOR) in apparel companies have not been explicitly identified; 5) The rate of green transformations is still low. However, Barriers to Green Manufacturing implementation in apparel companies have still not been evaluated; 6) ORPE stemming from Green Manufacturing implementation by apparel companies and the establishment of Circular Economy Capability have not been investigated; 7) In the previous literature, the variables (GRMA, CECA, ORPE, SEEI, ENOR and BFGI) in such a theoretical model are either not assessed for apparel companies or are only separately investigated in other sectors. This research bridges the existing gaps by proposing a conceptual framework to examine these variables.

First, the Global Recycling Council has recommended that apparel companies should employ sustainable production. It has recommended that they should comply with high standards in the manufacturing and recycling stages to reduce their environmental impacts (Harrabin, 2019). For example, Adidas aims to only use recycled polyester to manufacture apparel and shoes by 2024, Bottletop plans to collaborate with Mulberry to launch green luxury bags made entirely of upcycled materials (Harrabin, 2019) and Zara, Bershka and Pull & Bear aim to only sell sustainable apparel by 2025 (BBC News, 2019). Manufacturing is an essential factor in the survival of many companies in an increasingly competitive market (Lele, 2009). Nowadays, Green Manufacturing is rapidly emerging as a method for companies to reduce their environmental impacts. Although there have been several studies on Green Manufacturing implementation, research attention to apparel companies in this context remains limited. This study fills the gap by discussing the implementation of Green Manufacturing by apparel companies.

Second, the Circular Economy has been implemented at three levels, namely in eco-regions at the macro level, eco-industrial parks at the meso level and eco-enterprises at the micro level (Zhu et al.,

2010). At the enterprise/company level, Circular Economy practices involve environmental protection through reduction, reuse and recycling (3Rs) with the aim of achieving both environmental and business performance goals (Zhu et al., 2010). Many existing studies in the broader literature have examined the Circular Economy at the regional and industry levels (Rosa et al., 2019; Ma et al., 2014; Shi et al., 2010; Su et al., 2013). For example, Shi et al. (2010) and Liu et al. (2009) explore the implementation of the Circular Economy in Tianjin city. Park et al. (2010) and Zhu et al. (2010) examine practices to facilitate the implementation of the Circular Economy in manufacturing industries. However, several questions remain to be addressed concerning how to build Circular Economy Capability at the company level. This research fills the gap by empirically investigating the Circular Economy at the company level.

Third, although the concepts of both the Circular Economy and Green Manufacturing focus on reducing environmental impacts (Zhu, Geng and Lai, 2011; Genovese et al., 2017), these two terms take different perspectives. The concept of the Circular Economy focuses on the 'circulation' of materials by using energy more efficiently and maximising the utility of materials and energy in order to improve economic performance while alleviating environmental impacts (Geng et al., 2009). However, Green Manufacturing focuses on reducing environmental impacts across the product lifecycle: from design to end of life, including green design, procurement, processes, packaging, end of life management and remanufacturing (Melnyk and Smith, 1996; Lele, 2009). This is a question of reducing the environmental impact of products rather than improving economic growth (Melnyk and Smith, 1996; Zhou et al., 2017; Sarkis, 2011). Many researchers investigate these two concepts respectively (Rosa et al., 2019; Mendoza et al., 2017; Baldassarre et al., 2019; Genovese et al., 2017; Kazancoglu, Kazancoglu and Sagnak, 2018; Zhou et al., 2017). However, empirical research that examines the two concepts together is still limited. Therefore, this study fills the gap by empirically investigating the implementation of Green Manufacturing as an approach to build Circular Economy Capability at the company level in apparel companies.

In particular, the philosophy of Green Manufacturing is to minimise the use of resources and reduce the environmental impact of products (Melnyk and Smith, 1996; Lele, 2009). Based on this

philosophy, Melnyk and Smith (1996) propose a framework for Green Manufacturing and extend it to all the stages in a products' life cycle from design to end of life: green design, green procurement, green production, green packaging and distribution, green use and remanufacturing. When building their capabilities, companies should allocate and utilise both visible and invisible resources for specific objectives (Eisenhardt and Martin, 2000). Accordingly, to build their Circular Economy capability, apparel companies can configure their resources with the objective of reducing energy consumption and resources, reusing materials and recycling used products and waste. However, specific methods for building Circular Economy Capability at the company level have still not been thoroughly explored. Therefore, this study seeks to fill these notable gaps by empirically investigating the implementation of Green Manufacturing as a means to build Circular Economy Capability at the company level in apparel companies.

Fourth, the green practices of companies are affected by both external and internal factors (Hart, 1995; Ward et al., 1995; Banerjee, 2002; Corbett and Klassen, 2006). Accordingly, Green Manufacturing implementation is affected by both external and internal drivers. However, the drivers of Green Manufacturing in the context of apparel companies have not been explicitly identified. This study suggests that Stakeholder Engagement in Environmental Implementation and Environmental Orientation are the key drivers of Green Manufacturing implementation in apparel companies.

Fifth, many countries, such as China, are striving to enact green transformations to resolve potential trade-offs and diffusion barriers (Lederer, Wallbott and Bauer, 2018). However, the rate of green transformation is still low (Liu et al., 2017). Therefore, it is necessary to identify the critical Barriers to Green Manufacturing implementation (BFGI) in the context of apparel companies. This study fills this gap by analysing current obstacles to Green Manufacturing implementation by apparel companies.

Sixth, previous studies suggest that both ecological development and economic development can be ambidextrously achieved by applying specific green strategies (Park et al., 2010; Zhu et al., 2012; Hajer, 1995; Mol, 1995; Mol and Spaargaren, 1993). Therefore, it is reasonable to argue that companies can apply certain green strategies such as Green Manufacturing to improve their

Organisational Performance. According to Hart (1995), Porter and van der Linde (1995), Ilinitch et al. (1998) and Mol and Spaaragaren (1993), by building their environmental capability, companies can improve their environmental performance and eventually enhance their business outcomes. Accordingly, as one type of environmental capability, building their Circular Economy Capability can improve companies' environmental and business performance. However, outcomes stemming from apparel companies implementing Green Manufacturing and establishing Circular Economy Capability have not been investigated. This study fills this gap by analysing the outcomes of implementing Green Manufacturing and building companies' Circular Economy Capability.

Seventh, Green Manufacturing implementation is crucial for companies to survive in an ever-increasingly competitive market. Green Manufacturing utilises and optimises resources, which is seen as a method to solve increasing environmental degradation and resource scarcity (Kazancoglu, Kazancoglu and Sagnak, 2018). This study proposes a theoretical model to investigate the relationship between Green Manufacturing and the Circular Economy in apparel companies and to analyse the drivers, barriers and outcomes of Green Manufacturing implementation in them. However, in the previous literature the variables in such a theoretical model are either not assessed for the apparel industry or are only investigated separately in other sectors. This study bridges this gap by proposing a conceptual framework to examine these variables. The conceptual model has a three-dimensional hierarchy of constructs, sub-constructs and measurement items. This study proposes and empirically tests this conceptual model and aims to: investigate the implementation of Green Manufacturing as an approach to build Circular Economy Capability at the company level in apparel companies; identify the key drivers and Barriers to Green Manufacturing implementation; examine the outcomes of Green Manufacturing implementation and building companies' Circular Economy Capability. The relevant relationships, constructs, sub-constructs and measurement items are empirically tested after collecting surveys from 374 apparel companies. In order to achieve the research goal and bridge the research gaps, this study seeks to answer the following research questions:

Q1: To what extent can Green Manufacturing implementation enhance companies' Circular Economy Capability?

Q2: To what extent can Stakeholder Engagement in Environmental Implementation affect Green Manufacturing implementation?

Q3: To what extent can Environmental Orientation affect Green Manufacturing implementation?

Q4: To what extent can companies' Organisational Performance be improved through Green Manufacturing implementation?

Q5: What are the key Barriers to Green Manufacturing implementation?

Q6: To what extent can companies' Organisational Performance be improved through developing Circular Economy Capability?

## **1.5 Research Contribution**

The theoretical contribution of this research consists in discovering which GRMA contribute to building the CECA, and the improvement of ORPE in apparel companies, a subject not yet studied, allowing researchers to advance in the relationship between GRMA and each of SEEI, ENOR, CECA and ORPE. On the other hand, when apparel companies' managers know GRMA builds the CECA, improves the ORPE, they will be interested in the implementation of GRMA denoting an important practical contribution. The study makes both academic and practical contributions. From an academic standpoint, it 1) adds to the ongoing research on Environmental Orientation, Stakeholder Engagement in Environmental Implementation, Circular Economy Capability and Green Manufacturing and the performance of apparel firms by employing an empirically tested conceptual model. Therefore, its findings can contribute to further development of the theoretical relationships between these variables. 2) It examines the direct relationships, mediating and moderating relationships between the above main constructs. Practically, the study will be highly useful for policymakers and apparel companies to understand the current barriers, drivers and outcomes of implementing Green Manufacturing and can help them to evaluate the strengths and weaknesses of their current Green Manufacturing and look for improvements. This analytical tool may also be of use to policymakers. This study will: 1) help apparel

companies to understand the current barriers; 2) highlight the importance – indeed, the necessity – for apparel companies to develop their own Circular Economy Capability so that they can fully realise the potential gains in performance which can result from applying Green Manufacturing; and 3) guide apparel companies through the stages of implementing green practices. Moreover, the study 4) supports Circular Economy implementation by policymakers and can be used as evidence for them to convince manufacturing companies that still have doubts about Organisational Performance when building the Circular Economy Capability.

In particular, for the academic community this thesis presents an empirical study with valid measurement instruments which focuses on promoting Green Manufacturing to build Circular Economy Capability at the company level. Furthermore, it develops a conceptual model that fills gaps in the literature to investigate the relationship between Green Manufacturing and the Circular Economy in apparel companies. It analyses the drivers, barriers, and outcomes of Green Manufacturing implementation in apparel companies, thus providing a theoretical foundation for future related research.

For apparel companies, first, the results of this study suggest that Green Manufacturing positively affects Circular Economy Capability. Therefore, in their real practice companies can invest in the six stages of Green Manufacturing to build their Circular Economy Capability: green design, green procurement, green production, green packaging, green end of life management and green remanufacturing. Second, the results indicate that Stakeholder Engagement in Environmental Implementation positively affects the implementation of Green Manufacturing. Environment-protection regulations encourage stakeholders to act more sustainably. Therefore, to improve their implementation of Green Manufacturing, apparel companies should keep track of stakeholder engagement to address possible impacts. Third, the results suggest that Stakeholder Engagement in Environmental Implementation positively affects Environmental Orientation. Therefore, apparel companies may recognise the impact of Stakeholder Engagement in Environmental Implementation and improve their Environmental Orientation to meet the environmental requirements proposed by stakeholders. Fourth, the results suggest that Environmental Orientation

positively affects the implementation of Green Manufacturing. Therefore, in order to facilitate the process of the implementation of Green Manufacturing, apparel companies can increase their environmental awareness, improve their codes of conduct of ecological practice, fully understand the environmental impacts of their operations and meet the environmental requirements of stakeholders (Banerjee, 2002; Banerjee et al., 2003). Fifth, the results suggest that Green Manufacturing positively affects Organisational Performance. By applying Green Manufacturing, companies can minimise their negative environmental impacts and utilise their resources effectively (Anderson, 2007). This will help them improve their Organisational Performance (Zhu et al., 2010; Anderson, 2007). Sixth, the research results suggest Circular Economy Capability positively affects Organisational Performance. In terms of real practice, this result suggests that by building their Circular Economy Capability apparel companies can ultimately improve their Organisational Performance. For example, by building and improving their Circular Economy Capability, the ability of companies to reduce, reuse and recycle materials and energy is improved (Genovese et al., 2017; Zhu, 2010; Zhu, 2011; Mathews and Tan, 2011; Yuan et al., 2006). This will help them improve both their environmental performance and their business performance (Zhu et al., 2010; Anderson, 2007).

Furthermore, this study develops a conceptual model with valid sub-constructs and measurement instruments. These provide a foundation for apparel companies to apply Green Manufacturing from a Circular Economy perspective.

## 1.6 Structure of the thesis

The remainder of this thesis is structured as follows. In the next chapter, the conceptual model linking Circular Economy Capability, Green Manufacturing, Stakeholder Engagement in Environmental Implementation, Environmental Orientation, Barriers to Green Manufacturing implementation and Organisational Performance from a theoretical perspective is presented and hypotheses are developed. This is followed by a literature review which analyses the constructs and subconstructs of the conceptual model. Chapter 3 introduces the research methodology. Chapter 4 reports the data collection. This study uses a Q-sort pilot study to initially assess the validity and reliability of the measurements of the subconstructs deriving from the conceptual model. After generating the measurement items, a large-scale survey is carried out to collect data from apparel companies to test the proposed hypotheses. A link to an online questionnaire is sent in three data collection waves to a total of 1,251 apparel companies which have expressed interest in participating in this research. A total of 374 useful responses were collected. Chapter 5 presents the research analysis. Structural equation modelling (SEM) is used to test the hypotheses derived from the conceptual model. The chapter presents a factor analysis and validity and reliability tests of the constructs at both the first- and second-order levels to assess the outer measurement model. It continues by evaluating multicollinearity, path coefficients, the total effect,  $R^2$  values and  $f^2$  values to assess the inner measurement model. The stability of the bootstrapping procedure, evaluation of the model fit, and tests for common method bias are also discussed in this chapter. This is followed by a discussion of the results of the conceptual model and hypothesis testing. Chapter 6 highlights the implications of the research, its limitations and recommendations for future research. The final chapter concludes.

The following subsections explain the thesis structure in more detail.

### **Literature review**

The theoretical background is first introduced in the literature review and hypotheses are developed. Then the conceptual model is proposed. This is followed by a detailed discussion of the development of the relevant constructs, sub-constructs and measurement items. A conceptual model

(Figure 2.1) linking the drivers, mechanisms, capabilities, outcomes and barriers is developed. The detailed theoretical framework and hypothesis development are described in Section 2.2. At the end of the literature review chapter, Section 2.3 introduces the constructs, sub-constructs and measurement items.

## **Research methodology**

The research philosophy is positivism (how research is conducted in the natural sciences, relying on the scientific method). The research approach is deduction (from general to specific). The deductive approach begins with an abstract logical relationship between concepts and then moves toward concrete empirical evidence (Kothari, 2004; Saunders et al. 2012; Bryman and Bell, 2011). The deductive approach develops hypotheses based on pre-existing theories and then tests them (Silverman, 2013). This study proposes 7 hypotheses and then applies Partial Least Squares Structural Equation Modelling to test them.

## **Data Collection**

This study uses a questionnaire survey to collect data. Dillman (2007) suggests the following four steps to successfully develop valid survey measurement items. The first step is item generation. The measurement items are generated using a literature review. To enhance the content validity of the measurement items, the second step is to pre-test the measurement items. To do this, the study uses semi-structured interviews with managers and academics to confirm the clarity and usability of the measurement instruments. To ensure the discrimination validity of the questionnaire, the third step is to conduct a Q-sort pilot study. To examine the final validity and reliability of the survey, the last step is to perform a large-scale data analysis and validation analysis of the measurement items.

## Research Analysis

Structural equation modelling (SEM), a widely used statistical methodology for data analysis, is applied in this research to analyse the survey data. Partial least square structural equation modelling (PLS-SEM) is used for structural model analysis. Unlike AMOS and LISREL (co-variance-based SEM methods), PLS-SEM is a component-based SEM method which is designed to investigate complex theoretical models and formative constructs, analyse explorative research and perform analyses with small sample sizes (Hsu et al., 2006; Fornell, 1982; Henseler et al., 2009). This study uses 6 second-order constructs, 23 first-order constructs and 58 measurement items in the conceptual model. To test both the reflective and formative constructs, and to deal with a complex model, partial least square modelling is the appropriate technique for this research.

## **CHAPTER 2: LITERATURE REVIEW**

### **2.1 Overview**

This chapter provides a review of the theoretical background literature and develops the hypotheses (Section 2.2). The constructs, sub-constructs and measurement items are then developed (Section 2.3).

### **2.2 Theoretical Background and Hypothesis Development**

The following subsections introduce the theoretical framework (Section 2.2.1) and develop the hypotheses (Section 2.2.2).

#### **2.2.1 Theoretical background**

Apparels constitute an important part of the public's everyday life. However, the apparel manufacturing process creates various environmental (waste generation, water body pollution and air pollution) issues throughout all stages of manufacturing. Environmentalists have been calling forth apparel companies to incorporate environmental principles into their manufacturing (Desore and Narula, 2018; Gazzola et al., 2020). With emerging issues such as scarcity of resources, climate change, strict environmental regulations and demand for sustainable apparels along with increasing consumption, the environmental problems through apparel production must be addressed urgently (Desore and Narula, 2018). The response of companies towards ecological issues show that firms are eager to implement green practices to improve their environmental performance and sustain competitiveness, however, current studies are mainly skewed towards developed countries (Oelze, 2017; Islam, Perry, and Gill, 2020). The global nature of apparel companies requires green practices focus towards the developing countries (Oelze, 2017), such as China, where most apparel production takes place. Thus, building on the NRBV theory, this study empirically validated a conceptual model by means of the PLS-SEM method using data from 374 apparel companies located in China. In this study, Green Manufacturing is proposed as the mechanism or method to develop companies' Circular Economy Capability. Stakeholder Engagement in Environmental Implementation and Environmental

Orientation are proposed as two drivers of Green Manufacturing implementation. The outcomes of implementing Green Manufacturing and building Circular Economy Capability are reflected by a company's Organisational Performance, including both environmental and business performance. Therefore, the conceptual model includes a mechanism (Green Manufacturing implementation (GRMA)), drivers of Green Manufacturing implementation (SEEI and ENOR), Barriers to Green Manufacturing implementation (BFGI), Circular Economy Capability (CECA) and outcomes (ORPE). The following subsection introduces the development of the theoretical model (Figure 2. 1).

### **Nature-Resource-Based View Theory**

Nature-resource-based view (NRBV) theory was first proposed by Hart (1995) on the basis of the earlier theoretical contribution of the resource-based view (RBV). In classic strategic management, RBV suggests firms bundle their resources and capabilities in a unique manner to generate a competitive advantage (Barney, 1991). However, this traditional theory had not yet focused on how the constraints of the natural and social environments affect companies' ability to generate this advantage. NRBV theory was proposed in order to deal with this. It suggests that competitive advantage is likely to be rooted in companies' ability to facilitate environmental performance (Guang Shi et al., 2012; Hart, 1995; 2011). To date, NRBV theory has been applied in many disciplines, such as supply chain management (Schmidt et al., 2016; Guang Shi et al., 2012), ethics (Rousseau, 2016), marketing (Akkucuk, 2015) and general business (Cristina De Stefan et al., 2016) to explain competitive sustainable operations. This study applies NRBV as the main theoretical foundation of the conceptual model (Figure 2. 1).

NRBV theory proposes that firms should look inside themselves to find sources of operational competitive advantage (Barney, 1991). Following the precepts of NRBV theory, Hart (1995) proposes that companies should emphasise product stewardship to reduce the environmental impact across the product lifecycle and, over time, sustainably build their competitive capability. Moreover, relying on prior arguments about the importance of creating opportunities for cost efficiency and product differentiation (Porter and Van der Linde 1995; Hart 1995), Bansal and Roth (2000) hold that operational competitiveness is related to process intensification. Investment in green practices to

reduce environmental impacts requires a redesign of manufacturing processes. The concept of Green Manufacturing combines a heavy emphasis on green practices in all the stages in the product lifecycle from design to end of life: green design, procurement, processes, packaging, end of life management and remanufacturing (Melnyk and Smith, 1996; Lele, 2009). Therefore, when Green Manufacturing is implemented by apparel companies they will become better able to utilise resources in all the stages in their products' life cycles.

NRBV theory articulates a connection among firm resources, capabilities and operational competitive advantages (Hart, 1995). Firm resources are defined by Barney (1991) as all kinds of assets, capabilities, operation processes, attributes, types of information and knowledge etc. that are controlled and owned by the company and can be utilised to improve company efficiency and effectiveness. Firm-based resources include both tangible resources, such as human resources and financial resources, and intangible resources, such as organisational culture, reputation, knowledge, experience and relationships with stakeholders (Lev, 2001). The conceptual model proposes stakeholder engagement and Environmental Orientation as two drivers of the implementation of Green Manufacturing. Stakeholder engagement and Environmental Orientation are both types of intangible resources. Barney (1991) suggests that a company's Environmental Orientation, such as interactions with external stakeholders regarding ecological issues, its code of standards for ethical behaviour and internal values, can be internalised and developed as a company resource over time.

A firm's capabilities are defined by Makadok (2001) as "a special type of resource, specifically an organisationally embedded non-transferable firm-specific resource whose purpose is to improve the productivity of the other resources possessed by the firm." NRBV theory suggests that companies should incorporate environmental practices in their operational activities to maintain sustainable competitiveness and explains how they can utilise their resources to develop their environmental capabilities (Hart, 1995, 2011). Building a company's capability is defined as conducting interrelated routines for business objectives through utilising resources to achieve certain outcomes (Teece et al., 1997; Makadok., 2001). The Green Manufacturing framework can be applied to reflect resource

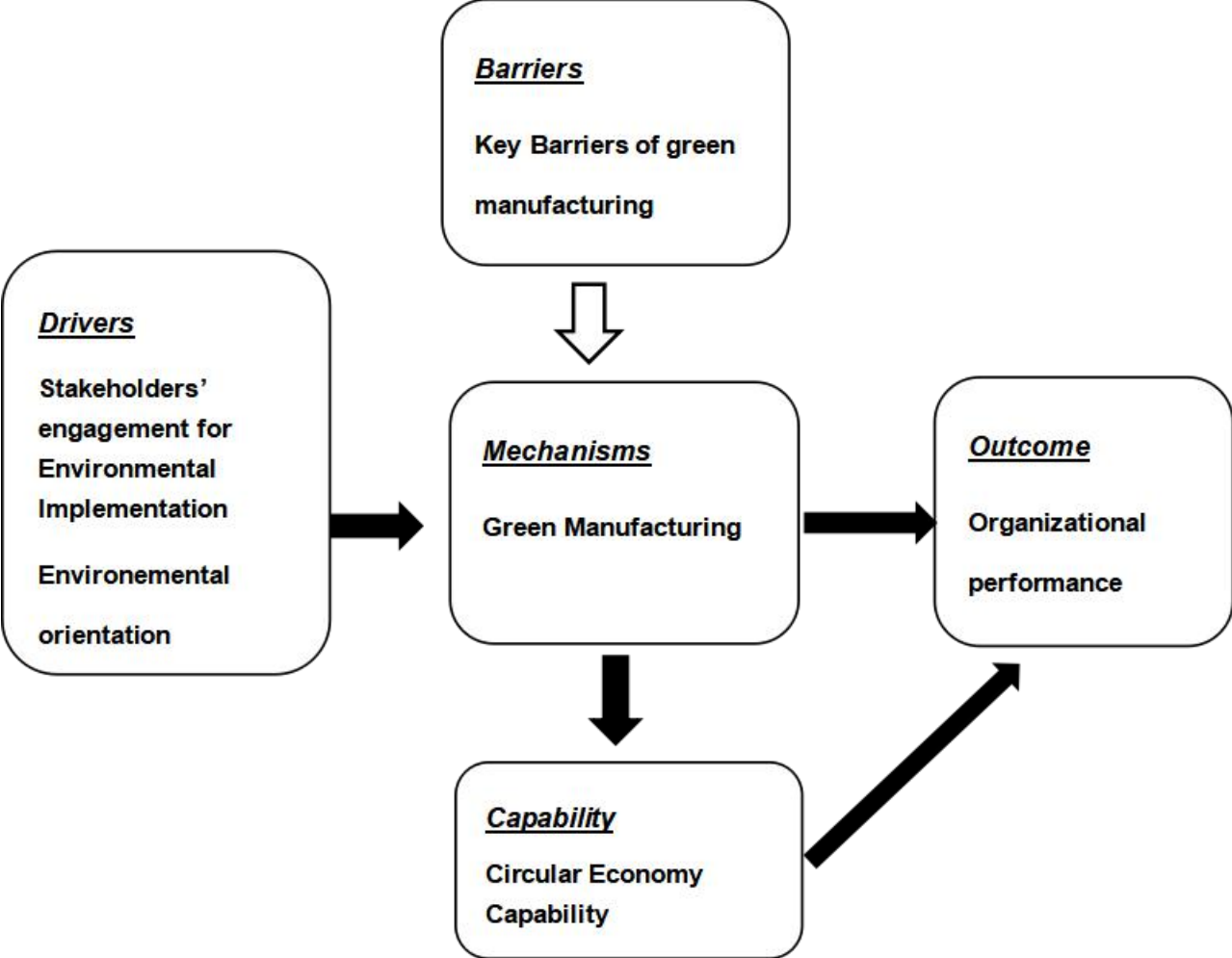
configuration processes. Circular Economy Capability is regarded as a form of environmental capability in this study. Accordingly, based on NRBV theory, companies can utilise their resources efficiently and innovatively to build Circular Economy Capability. Therefore, the conceptual model (Figure 2. 1) proposes that companies can implement Green Manufacturing to build Circular Economy Capability.

Following the precepts of NRBV, Barney (1991) and Hart and Dowell (2011) show the potential of eco-environmental responsiveness to improve long-term profitability. Firms may incorporate environmental concerns in their operational activities to sustain their competitive advantage and ultimately improve operational performance (Hart, 1995). The outcome of implementing Green Manufacturing and developing Circular Economy Capability proposed in the conceptual model (Figure 2. 1) is Organisational Performance, including both environmental and business performance. Environmental performance can be improved after implementing green practices and improving environmental capability (Kong et al., 2016; Anderson, 2007; Yong, 2007; Ilinitch et al., 1998). After implementing Green Manufacturing and building Circular Economy Capability, business performance may be improved by building a good public image and sustaining competitive advantage (Porter and van der Linde, 1995).

The rate of green transformations is still low (Liu et al., 2017). Therefore, it is necessary to identify the factors that inhibit the implementation of Green Manufacturing. In the conceptual model these barriers are grouped into four categories: technologies, knowledge, finance and people's involvement and support. Following the precepts of NRBV, firm resources include information, knowledge, human resources and financial resources (Barney, 2001). Technologies, knowledge, finance and people's involvement and support can be viewed as firm resources. NRBV theory proposes that firms utilise their resources to achieve environmental sustainability (Hart, 1995). Therefore, when an apparel company implements Green Manufacturing, these four groups of barriers should be addressed. The next subsection introduces a detailed description of each construct in the proposed conceptual model.

Based on the above discussion, this study proposes a conceptual model (Figure 2.1). To be specific, Green Manufacturing is proposed as the mechanism that develops companies' Circular

Economy Capability. The drivers of Green Manufacturing implementation are Stakeholder Engagement in Environmental Implementation and Environmental Orientation. Organisational Performance is the outcome of building Circular Economy Capability and implementing Green Manufacturing. There are four groups of barriers that inhibit Green Manufacturing implementation: barriers to stakeholder involvement and support, technology barriers, knowledge barriers and financial constraints. The definitions of these constructs are provided in Table 2.1. Section 2.3 discusses them and develops sub-concepts and measurement items.



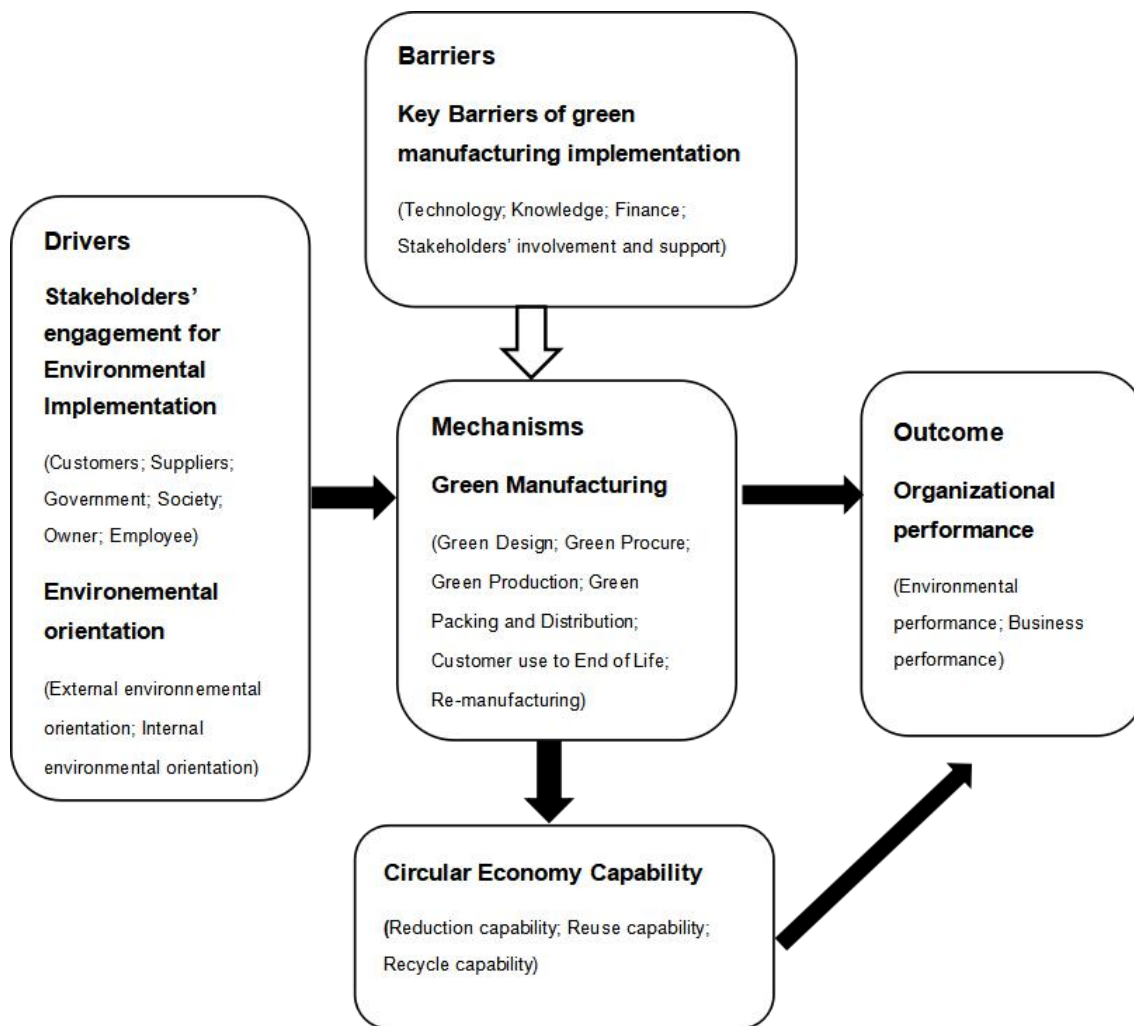


Figure 2. 1 Proposed Conceptual Model

**Table 2. 1 Concepts in the proposed conceptual model**

| <b>Main concepts</b>  | <b>Sub Concepts</b>            | <b>Definition</b>  |
|---|--------------------------------|--|
| <b>Drivers:</b><br><b>Stakeholder</b><br><b>Engagement</b> in<br><b>Environmental</b><br><b>Implementation;</b><br><b>Environmental</b><br><b>Orientation</b> | External                       | External stakeholders include customers, suppliers, the government and society. Stakeholder        |
|   | Stakeholder                    | engagement is “the process of effectively eliciting stakeholders’ views on their relationships     |
|   | Engagement in                  | with the organisation” (Friedman and Miles, 2006).   |
|   | Environmental                  | Environmental  |
|   | Implementation;                | Implementation;  |
|   | External                       | Environmental orientation is managerial recognition of the importance of environmental             |
|   | Environmental                  | problems facing companies (Banerjee, 2001, 2002). External Environmental Orientation is            |
|   | Orientation                    | reflected in managers’ perceptions of interactions with external stakeholders regarding            |
|   | Orientation                    | ecological issues (Banerjee, 2002).  |
|   | Internal                       | An internal stakeholder is an individual or group directly involved in the operational process of  |
|   | Stakeholder                    | the organisation, primarily employees, managers and owners.  |
|   | Engagement in                  | Engagement in  |
|   | Environmental                  | Environmental  |
|   | Implementation;                | Implementation;  |
|   | Internal                       | Company internal Environmental Orientation is a company’s code of standards for ethical            |
|   | Environmental                  | behaviour, internal values and commitments in terms of environment-friendly operational            |
|   | Orientation                    | activities (Banerjee, 2001). According to Banerjee (2002, 2003), most companies’ internal          |
|   | Orientation                    | Environmental Orientation can be tracked in their mission statements, environmental                |
|   | Orientation                    | statements or annual reports.  |
|   | Orientation                    | Orientation  |
| <b>Mechanisms:</b><br><b>Green</b><br><b>Manufacturing</b>  | Green Design                   | Green design requires companies to design according to the environmental principles of rapid       |
|   | Green Procurement              | prototyping, reduction of toxic substances and minimisation of the use of non-renewable            |
|   | Green Production               | resources. Green Procurement involves supplier evaluation and cooperation and eco-efficient supply |
|   | Green Packing and Distribution | (such as recirculating packaging and just-in-time logistics systems) and includes procurement      |
|   | Green End of Life Management   | activities which facilitate reduction, reuse and recycling of energy and resources (Green et al.,  |

2008).

Remanufacturing involves green practices when dealing with reusing products, including the concept of the reverse supply chain (Seuring, 2004; Corbett and Klassen, 2006; Lisney et al., 2003; Rahimifard and Clegg, 2007). It not only reduces the overall carbon footprint but also creates new opportunities for companies to gain new revenue streams by finding secondary markets for materials and products (Nikolaidis, 2013).

|                         |                                     |  |
|-------------------------|-------------------------------------|--|
| <b>Current Barriers</b> | Technology                          | Lack of effective environmental measures; complications in putting positive environmental attitudes into action; complexity of design to reuse/recycle used products; complexity of design to reduce consumption of resources/energy; lack of technology, processes and materials (Wang et al., 2016; Govindan et al., 2014).  |
|                         | Knowledge                           | Lack of awareness about reverse logistics adoption; lack of relevant environmental knowledge about implementing Green Manufacturing; complexity in identifying third parties to collect used products; lack of information on potential environmental improvements (Wang et al., 2016; Govindan et al., 2014).   |
|                         | Finance                             | High investments and lower return on investments; high cost of hazardous waste disposal; cost of switching to new systems (Wang et al., 2016; Govindan et al., 2014).  |
|                         | Stakeholder involvement and support | Lack of training courses/consultancy/institutions to train and monitor/mentor progress specific to the industry; lack of customer awareness and pressure about green practices; poor supplier commitment to Green Manufacturing implementation; lack of inter-departmental co-operation in communication; lack of involvement of top management in adopting green supply chain management; inadequate support by regulatory authorities (Wang et al., 2016; Govindan et al., 2014; Teece, 1996). |

|  |         |  |
|--|---------|--|
| <b>Capabilities: Circular Economy Capability</b> | Reduce  | A set of interrelated routines reducing energy and material usage (Rivera-Becerra and Lin, 1999; Zhu et al., 2005).  |
|  | Reuse   | A set of routines reusing materials, products and packaging, including reusing for the same function and reusing for new functions (French and Laforge, 2006; Anderson, 2007).   |
|  | Recycle | Sets of routines, including collecting waste, used-products, by-products and packaging materials and sorting, reprocessing and utilising them for new purposes (Hicks et al., 2005; Martin et al., 2006; Tam and Tam, 2006; Lee et al., 2007). |

|   |                           |  |
|---|---------------------------|--|
| <b>Outcomes: Organisational Performance</b> | Environmental performance | This study evaluates the following three dimensions of a company's environmental performance: environmental impact, internal environmental management performance and external stakeholder relations.  |
|   | Business performance      | A company's business performance is the effectiveness and efficiency of its business operations (Venkatraman and Ramanujan, 1986; Tracey and Tan, 2001; Tracey et al., 2005; Nahm et al., 2004; McKee et al., 1989; Kristal et al., 2010), which is generally reflected in its financial performance and market performance (Venkatraman and Ramanujan, 1986). |

### 2.2.2 Hypothesis Development

There are many works of literature available in the context of environmental issues in the apparel industry, for example, related to water (Alkaya and Demirer 2014), waste (Powell and Prostko-Bell 2010) and energy management (Zabaniotou and Andreou 2010). A few reviews are also available on the aspects of the green practice of apparel industry (Choi et al., 2012; Kazancoglu et al., 2020; Islam, Perry and Gill, 2020; Köksal et al., 2017; Gazzola et al., 2020). Moreover, previous studies explored the relationships between green practices and Stakeholder Involvement (SEEI) (Liu et al., 2017; Zhou et al., 2017), Environmental Orientation (ENOR) (Chan, 2012; Yu and Huo, 2019), Circular Economy Capability (CECA) (Kazancoglu et al., 2018; Baldassarre et al., 2019) and Organisational Performance (ORPE) (Genovese et al., 2017; Zeng et al., 2016; Nasir et al., 2017; Sanders, 2012) in various sectors, yet, these studies were not as deep as this study and did not correlate all these constructs. Most importantly, none of the researchers has explored all these six constructs (GRMA, CECA, ORPE, SEEI, ENOR and BFGI) in a theoretical model (Figure 2. 2) for apparel companies. Therefore, this study bridges the research gap by proposing a conceptual model to investigate the implementation of Green Manufacturing (GRMA) as an approach to build Circular Economy Capability (CECA) at the company level in apparel companies and to analyse the drivers (SEEI, ENOR), barriers (BFGI) and outcomes (ORPE) of Green Manufacturing implementation (GRMA) in these companies. In particular, this study tests 7 hypotheses to explore the relationships between the constructs in the conceptual model. Based on the discussion of the theoretical framework, the hypotheses (Table 2.2: Hypothesis statements) are H1: Stakeholder Engagement in Environmental Implementation (SEEI) positively affects applying Green Manufacturing (GRMA); H2: The level of Barriers to Green Manufacturing implementation (BFGI) negatively affects Green Manufacturing implementation (GRMA); H3: Stakeholder Engagement in Environmental Implementation (SEEI) positively affects Environmental Orientation(ENOR); H4: Environmental Orientation (ENOR) positively affects the implementation of Green Manufacturing (GRMA); H5: Green Manufacturing (GRMA) positively affects Organisational Performance (ORPE); H6: Applying Green Manufacturing (GRMA) positively affects Circular Economy Capability (CECA); H7: Circular Economy Capability (CECA) positively affects Organisational Performance (ORPE).

**Table 2. 2 Hypothesis statements**

**Hypothesis Statements**

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H1: Stakeholder Engagement in Environmental Implementation positively affects applying Green Manufacturing.

H2: The level of Barriers to Green Manufacturing implementation affects Green Manufacturing implementation.

H3: Stakeholder Engagement in Environmental Implementation positively affects Environmental Orientation.

H4: Environmental Orientation positively affects the implementation of Green Manufacturing.

H5: Green Manufacturing positively affects Organisational Performance.

H6: Applying Green Manufacturing positively affects Circular Economy Capability.

H7: Circular Economy Capability positively affects Organisational Performance.

**Figure 2. 2 Proposed structural hypothesis model**

### 2.2.3.1 The positive effect of Stakeholder Engagement in Environmental Implementation (SEEI) on Green Manufacturing implementation (GRMA)

Firms today are under increasing pressure from stakeholders to adopt green practices. For example, customers demand more green products, governments tighten regulations over the firm's operations, and NGOs expect firms to protect green ecosystems. These pressures lead to an increasing concern that companies should consider environmental issues in their current manufacturing process. Likewise, the increased environmental awareness of stakeholders has led to an increased response from the apparel companies to improve on the ecological impacts of its manufacturing processes (Kozlowski et al., 2012; Chen and Burns 2006). Several studies have examined the impact of stakeholders' engagement on green practices in apparel companies. For example, Kozlowski et al. (2012) conduct a conceptual framework by conflating stakeholders' engagement and life-cycle analysis to develop responses for the apparel companies. Their result shows the stakeholders' engagement can provide a basis for the implementation of environmental practices. Also, Liu et al. (2017) collect data from relevant stakeholders in the National Motor Upgrading Demonstration Project. Based on an analysis of 30 in-depth interviews and 6 focus group discussions, their results suggest that as a key external stakeholder, the government facilitates the implementation of Green Manufacturing among small and medium-sized enterprises. Likewise, Guoyou et al. (2011) report the results of an investigation into the effects of stakeholders on green product innovation and green processes. They show that external stakeholders, such as customers, play an essential role in driving companies to implement green production strategies. And, Zhou et al. (2017) report the results of an investigation into the effects of key stakeholders on energy performance contracts (EPCs). The Chinese government uses EPCs to encourage companies to implement Green Manufacturing technologies voluntarily. Their results reveal a positive effect of stakeholders' perceptions on the diffusion of Green Manufacturing technologies. Hence, previous studies in various sectors have shown that one or more stakeholders' engagement affects companies' green practices. However, limited studies examined the impact of both external stakeholders and internal stakeholders' engagement on the implementation of Green manufacturing (GRMA), especially in apparel companies. In recent years, both external stakeholders (customers, suppliers, government, NGO) and internal stakeholders (employees and managers) have paid increased

attention to encouraging apparel companies to incorporate environmental concerns in their daily operations (Beh et al., 2016). Hence, this study proposes both external stakeholders and internal stakeholders' engagements in environmental implementation (SEEI) as one of the drivers of Green Manufacturing implementation (GRMA).

In particular, customer engagement facilitates companies' adoption of green practices (Subramanian et al., 2009; Zhu et al., 2010; Zeithaml et al. 1996; Beh et al., 2016). The apparel industry is highly consumer-driven and the perceptions of consumers impact the demand in this industry (Desore and Narula, 2018). The apparel industry is highly complex and competitive, and customers have multiple buying options. As the customers' purchase power increases, they demand greener and better value products for their money. Thus, firms are suggested to implement green practices to satisfy customers' needs (Bu et al., 2020). Furthermore, many studies on consumer behaviour (Gazzola et al., 2020; Hill and Lee 2012; Williams and Page 2011) have pointed out their increasing interest in sustainable apparels. In particular, a recent study shows that young consumers are much more concerned and aware of the negative environmental impacts caused by the apparel manufacturing process (Gazzola et al., 2020). Hence, customer engagement, such as providing real and updated feedback, helps companies to adjust their Green Manufacturing implementation strategies (Subramanian et al., 2009; Zhu et al., 2010; Zeithaml et al. 1996; Beh et al., 2016; Sarkis et al., 2010).

Furthermore, as external stakeholders, suppliers significantly affect apparel companies' operations (Oelze, 2017). A supplier is not only an upstream partner that provides inputs but it also affects companies' environmental performance (Modi and Mabert, 2007; Song and Benedetto, 2008). Therefore, strategically selecting suppliers and supplier collaboration are vital to enhance sustainability (Oelze, 2017). The conventional criteria for evaluating suppliers are price, quality, service and delivery time. To maximise profit, companies may regard price as the primary criterion when selecting a supplier. However, nowadays it has become more common knowledge that to remain competitive in the business environment, companies may need to put the sustainability of their operations in primary position. Therefore, an increasing number of companies are adding an environmental sustainability criterion to select their suppliers (Baskarana et al., 2012). Suppliers' resources and abilities to provide

environment-friendly products significantly affect companies' environmental operations (Min and Galle, 1997; Carter et al., 2000). Therefore, suppliers' willingness to establish an environmental partnership for environmental implementation is considered a critical driver when companies seek to implement green practices.

Nowadays, increasing consumer demand has driven manufacturing activities globally. At the same time, environmental deterioration has become a main concern for many countries. Therefore, governments around the world are implementing means of promoting green practices to increase manufacturing efficiency and reduce negative environmental impacts. Companies currently face increasing pressure on environmental initiatives from both government regulations and global competition (Diabat et al., 2014). Hence, companies are forced to implement green practices to improve their environmental performance. Green manufacturing is a concept which ensures environmentally friendly practices in the manufacturing process. To address public concerns, the government in China has taken Green Manufacturing as one of the leading national environmental strategic methods to reduce the adverse effects of high-volume production in China (Kong et al., 2016). Japan and Germany have also made efforts to develop environmental regulatory frameworks (Triebswetter and Hitchens, 2005; Moriguchi, 2007). Government regulations are enforced in companies to improve environmental performance (Zeng et al., 2016; Zhou et al., 2017). Diabat and Govindan (2011) apply interpretive structural modelling to rank drivers that affect green supply chain management. Their results show that government regulation is the most crucial driver. Since environment-related regulations significantly affect companies' operations, Cavusgil et al. (2004) argue that fully understanding the regulations helps companies to avoid making mistakes and exploit opportunities to achieve high-level operational performance. Moreover, in company decision-making processes, government regulations are the primary criteria determining companies' operational activities (Zhu et al., 2005; Zhu et al., 2007). Thus, the government's engagement in environmental implementation is considered a critical driver when companies seek to implement green implementing.

NGOs play a notable role in forcing companies to develop in environmentally sustainable ways. Relevant literature identifies reasons for this. First, as environmental problems are increasingly

complex, they cannot be solved solely by governments. NGOs and other stakeholders should work together to solve environmental problems (Hartman et al., 1999; Kraft et al., 2013). Since the late 1960s, negative impacts of commercial activities, such as the Cuyahoga River fire, Australian Wildfires, Guatemala Coffee Rust, the Philippines Typhoon and the Chernobyl disaster, have been witnessed and NGOs are involved in cleaning them up (Jakhar, 2015). In response to these negative impacts, NGOs are rapidly generating reports to raise awareness of environmentally sustainable development (Lozano, 2013; Lee and Farzipoor Saen, 2012; Mota et al., 2015). Second, partnerships and cooperation between NGOs and companies have been successful in achieving the goal of environmentally sustainable development (Kong et al., 2002; Jamali and Keshishian, 2009; Reed and Reed, 2009). The use of boycott campaigns and protests by NGOs has been influential as companies do respond to sustainability issues by altering their operations (Kozlowski et al. 2012). In particular, Harangozo and Zilahy (2015) show that, compared with large companies, small and medium-sized companies have the same degree of importance in their cooperation with NGOs. This result indicates that NGOs are non-negligible stakeholders regarding the process of greening businesses. Therefore, NGO engagement in environmental implementation is proposed as one of the drivers of Green Manufacturing implementation.

Employees' ability to deal with new technology or new information affects companies' business models and performance (Zhu and Sarkis, 2004). The increase in the environmental awareness of the employees makes it possible for the managers to be able to implement green practices more robustly and efficiently (Cesar da Silva et al., 2020). Furthermore, in order to build companies' environmental competitive advantages, managers adopt green practices in various industries, including the apparel industry. Managers' knowledge is essential to facilitate green practices. They need to fully understand their employees' skills and have problem-solving ability, technical capabilities and knowledge scanning ability to identify relevant technology and information (Zahra and George, 2002; Tu et al., 2006). To achieve the goal of environment-friendly operation, companies maintain their equipment, resources and production process in pace with the development of technological innovation. At the same time, employees' ability to deal with innovation greatly

influences companies' environmental practices (Klassen and Whybark, 1999; Zhu et al., 2008). Hence, managers' and employees' ability to adopt green practices are considered critical drivers when companies seek to implement green practices. Therefore, in this study hypothesis 1 is that *Stakeholder Engagement in Environmental Implementation (SEEI) positively affects the implementation of Green Manufacturing (GRMA)*.

#### 2.2.3.2 The negative effect of the level of Barriers to Green Manufacturing (BFGI) on Green Manufacturing implementation (GRMA).

In the past, manufacturing companies consumed natural resources in an unsustainable way, which released vast amounts of greenhouse gases. This led to many social and environmental problems ranging from global climate change to local environmental contamination and waste disposal. Nowadays, due to concerns about increased environmental pollution, many manufacturing companies have started to implement Green Manufacturing (Mittal and Sangwan, 2014). However, the rate of green transformations is still low (Liu et al., 2017). Therefore, it is necessary to identify the factors that inhibit the implementation of Green Manufacturing. Previous researchers have developed many models to examine the barriers, such as Mittal and Sangwan's (2014) fuzzy TOPSIS multi-criteria decision model. Their results show that prioritisation of barriers is expected to help effective Green Manufacturing adoption. Mittal, Sindhvani and Kapur (2016) employ a two-way assessment approach to analyse and validate Barriers to Green Manufacturing implementation. Their study reports that identifying high impact barriers helps policymakers to adopt green strategies. Removing these barriers can make Green Manufacturing strategies more implementable. Furthermore, Liu et al. (2017) examine the barriers to green technology implementation in small and medium-sized enterprises and argue that decreasing the level of these barriers can help promote Green Manufacturing. Consequently, in this study hypothesis 2 is that *the level of Barriers to Green Manufacturing (BFGI) negatively affects Green Manufacturing implementation (GRMA)*.

### 2.2.3.3 The positive effect of Stakeholder Engagement in Environmental Implementation (SEEI) on Environmental Orientation (ENOR).

The company is considered as a complex adaptive system involving different Organisational stakeholders, including both external stakeholders (customers, suppliers, the government and society) and internal stakeholders (managers and employees) (Hart, 1995; Matos and Hall, 2007). In recent years, there has been an increasing awareness of sustainable operations and environment-friendly products. Today, external stakeholders have increasing requirements regarding companies' sustainable operations (Ward et al., 1995; Hart, 1995; Corbett and Klassen, 2006; Choi et al., 2001; Matos and Hall, 2007), which increase pressures on internal stakeholders to operate in an environment-friendly manner (Ward et al., 1995; Porter and van der Linde, 1995). Although there are no optimal solutions to address these increased pressures successfully (Choi et al., 2001; Matos and Hall, 2007), Eisenhardt and Martin (2000) suggest companies develop competitive advantages by continually adjusting their resources and strategies under the high pressure.

Environmental Orientation (ENOR) includes both External Environmental Orientation and Internal Environmental Orientation. External Environmental Orientation is reflected in companies responding to the concerns of external stakeholders about ecological issues (Banerjee, 2002). Companies' Internal Environmental Orientation refers to their internal values and codes of standards of ethical behaviour in terms of environmental protection activities (Banerjee, 2001). Based on NRBV, Barney (1991) suggests that companies' interactions with their external stakeholders regarding environmental issues and companies' internal values and codes of standards of ethical behaviour can be internalised as company resources over time.

To help with the continuous adjustments of company's resource, companies need to increase their internal stakeholders' (managers' and employees') abilities to recognise and apply the new knowledge, skills and technology (Zahra & George, 2002; Tu et al., 2006; Zhu and Sarkis, 2004; Klassen & Whybark, 1999; Zhu et al., 2008). In recent years, due to public concerns about environmental pollution and climate change, external stakeholders (customers, suppliers, the government and society) have emphasised promoting Green Manufacturing in manufacturing companies (Beh et al., 2016). Apparel companies need to recognise the impact of Stakeholder Engagement in Environmental

Implementation. Environmental Orientation is referred to as managerial recognition of the importance of environmental problems facing companies (Banerjee, 2001, 2002). To successfully address the impact of Stakeholder Engagement in Environmental Implementation, apparel companies should improve their Environmental Orientation to meet the environmental requirements proposed by stakeholders.

Furthermore, owing to the emergence of increasing stakeholders' concerns about environmental deterioration and tightening environmental regulations of firms' operations, companies today are under heightening pressure to operate in an environmentally oriented manner (Chan et al., 2012; Banerjee et al., 2003). The Stakeholders' engagement dramatically affects the company's recognition of the importance of environmental operation (Beh et al., 2016). Firms must understand the importance of the ecological concerns of their business actions in order to promote environmental policies and procedures (Banerjee, 2002; Banerjee et al., 2003). In other words, a related environmental orientation must be developed. Furthermore, Garces-Ayerbe et al. (2012) examined the stakeholder pressure and environmental issues as the determinants of the Environmental Orientation (ENOR) in hotels. The results reflect that the stakeholder pressure can sequentially drive firms to invest resources and time in collaboration with stakeholders to share environmental knowledge and accomplish environmental goals that cannot be independently achieved (Aboelmaged, 2018; Lee, 2008). Accordingly, this study argues that stakeholder's engagement for environmental implementation (SEEI) remain positively associated with Environmental Orientation (ENOR) in apparel companies. In particular, firms need to consider the ecological effect of their operations; recognise the ecological needs of stakeholders; and develop internal values and ethical standards accordingly (Banerjee, 2002; Banerjee et al., 2003). Hence, a well-established environmental orientation is important to effectively resolve stakeholder's engagement for environmental implementation. Consequently, in this study hypothesis 3 is that *Stakeholder Engagement in Environmental Implementation (SEE) is positively related to Environmental Orientation (ENOR)*.

#### 2.2.3.4 The positive effect of Environmental Orientation (ENOR) on Green Manufacturing (GRMA).

NRBV theory suggests that companies should determine their internal resources and utilise them to achieve environmental sustainability (Hart, 1995). External Environmental Orientation is reflected in companies responding to the concerns of external stakeholders about ecological issues (Banerjee, 2002). Companies' internal Environmental Orientation refers to their internal values and codes of standards of ethical behaviour in terms of environmental protection activities (Banerjee, 2001). Barney (1991) suggests that companies' interactions with their external stakeholders regarding environmental issues and companies' internal values and codes of standards of ethical behaviour can be internalised as company resources over time. Green Manufacturing implementation has been adopted as the leading environmental activity in many companies in recent years. As NRBV theory suggests that companies utilise their resources to improve their environmental impacts (Hart, 1995), this study suggests the positive effect of Environmental Orientation (ENOR) on Green Manufacturing (GRMA).

The apparel sector has been the subject of heavy criticism due to its negative environmental impacts. Recently, increasing attention has been paid to environmental issues by the stakeholders of apparel companies (Gazzola et al., 2020). Prior work on Environmental Orientation (ENOR) has emphasised mainly on determinants (e.g., environmental issues and stakeholder pressure, environmental capability) (Gazzola et al., 2020; Aboelmaged, 2018; Yu et al., 2014; Garcés-Ayerbe et al., 2012) and outcomes (e.g., environmental performance, economic performance) (Akin-Ates et al., 2012) of Environmental Orientation. However, the relationship between Environmental Orientation (ENOR) and Green Manufacturing implementation (GRMA) has yet to be examined empirically in apparel companies, in that context, to mend a significant gap in the current literature. This study adopts the Environmental Orientation as a strategic resource, which has the potential to drive the environmentally sustainable development (Aboelmaged, 2018), and to pursue environmental opportunities (e.g. product stewardship) (Paulraj, 2011). According to NRBV, companies' strategic orientation (e.g., Environmental Orientation) can be conceptualised as its valuable intangible resource that guides green practices (Chan et al., 2012). Prior studies have already provided both theoretical and empirical support for the positive relationships between Environmental Orientation and environmental practices. For instance, based on the responses from 194 foreign-invested companies

operating in China, Chan et al. (2012) showed that the Environmental Orientation exerts a positive influence on the green practices. Chan (2010) also demonstrated that both internal and external environmental orientations serve as important determinants for firms' environmental practices. Likewise, Bu et al. (2020) applied structural equation modelling to analyse the data collected from 247 CEOs from Chinese companies. Their empirical results confirm that the Environmental Orientations (ENOR) are positively related to the green supply chain management. Although there have been several studies on exploring the relationships between ENOR and green practices, the research addresses the impact of ENOR on the GRMA in apparel companies remains limited. This study fills the gap by discussing the relationship between ENOR and GRMA in apparel companies.

In particular, the philosophy of Green Manufacturing is to minimise the use of resources and reduce the environmental impact of products. Based on this philosophy, Green Manufacturing is extended to all the stages in a product's life cycle from the design stage to the end of life management stage (Melnik and Smith, 1996; Lele, 2009). Green management includes six stages: green design, green procurement, green processes, green packaging, customer use to end of life management and remanufacturing (Melnik and Smith, 1996). Green manufacturing emphasises engaging stakeholders and integrating their environmental needs into the product manufacturing process (Zhou et al., 2017; Lele, 2009). In practice, Environmental Orientation can promote the implementation of Green Manufacturing by helping the company understand the importance of ecological practices, engage stakeholders in the product development process, and develop appropriate strategies (Chan, 2012; Yu and Huo, 2019; Banerjee, 2002).

The firms' effective strategy is aligned with the appropriate corresponding orientation (Gabler et al., 2015; Slater, Olson & Hult, 2006), and a green approach is only effective when the firm's culture is reflective of its environmental values (Gabler et al., 2015). The companies' perceptions, behaviours and environmental ideology spread throughout the entire company and become core cultural values. Such core cultural values may motivate companies to develop and implement green practices to address environmental issues (Bu et al., 2020; Kang and He, 2018). Companies' internal Environmental Orientation refers to their internal values and codes of standards of ethical behaviour in terms of

environmental protection activities (Banerjee, 2001). Banerjee et al. (2003) suggest that internal Environmental Orientation helps companies develop a collective consciousness of the importance of environmentally friendly operations, and eventually motivate them to seek approaches to reduce the environmental impacts of their operations. A strong Environmental Orientation (ENOR), for instance, will empower firms to devote more resources to all six stages of Green Manufacturing. With Environmental Orientation, firms could continually refine and enhance these six stages with referring to companies' internal values and codes of standards of ethical behaviour in terms of environmental protection activities. External Environmental Orientation is reflected in companies responding to the concerns of external stakeholders about ecological issues (Banerjee, 2002). During this whole procedure of Green Manufacturing, firms also need to engage with their stakeholders to gain their supports and thereby fulfil their ecological requirements (Zhou et al., 2017). Therefore, hypothesis 4 is that Environmental Orientation (ENOR) *positively affects the implementation of Green Manufacturing (GRMA)*.

#### 2.2.3.5 The positive effect of Green Manufacturing (GRMA) on Organisational Performance (ORPE).

Following the precepts of NRBV theory, Hart (1995) proposes that companies should emphasise product stewardship in order to reduce environmental impacts across the product lifecycle and sustainably build their competitive capability over time. Furthermore, relying on previous arguments about creating opportunities for cost efficiency and product differentiation (Porter and Van der Linde 1995; Hart 1995), Bansal and Roth (2000) propose that operational competitiveness is related to process intensification. Investment in green practices to reduce environmental impacts requires redesigning manufacturing processes. The concept of Green Manufacturing combines a heavy emphasis on green practices in all the stages of the product lifecycle from design to end of life: green design, procurement, processes, packaging, end of life management and remanufacturing (Melnyk and Smith, 1996; Lele, 2009). Therefore, Green Manufacturing can be implemented by apparel companies to utilise their resources in all the stages of their products' life cycles. Companies can adopt the Green Manufacturing framework to reflect resource configuration processes: the green design process, green procurement process, green

production process, green packaging and distribution process, green end of life management process and green remanufacturing process.

It is proposed in this research that a company's implementation of Green Manufacturing could positively affect its Organisational Performance. Following the precepts of the NRBV, Hart and Dowell (2011) point out the potential for eco-environmental responsiveness to improve long-term profitability. The NRBV works on the principle that firms' competitive advantage depends fundamentally on their relationship with the natural environment. It is also likely that such competitive advantage is rooted in companies' environment strategies to facilitate ecological performance (Guang Shi et al., 2012). A particular set of outcomes (ORPE) would be expected to be observed after Green Manufacturing has been implemented.

As NRBV theory holds, companies can incorporate environmental concerns in their operational activities (Hart, 1995), determine their internal resources and utilise them to achieve environmental sustainability and ultimately sustain their competitive advantage (Hart, 1995; 2011). Manufacturing is the principal strategic component that helps companies build a competitive advantage (Lele, 2009). Compared with Green Manufacturing, traditional manufacturing rarely considered resource and energy efficiency and environmental impact (Ying and Li, 2012). The philosophy of Green Manufacturing is to minimise the use of resources and reduce the environmental impact of products. Based on this philosophy, Green Manufacturing is extended to all the stages in a product's life cycle from the design stage to the end of life management stage (Melnyk and Smith, 1996; Lele, 2009). Yuksel (2008) conducted the Kruskal-Wallis confirmative test and addressed that the reduction in the consumption of hazardous materials should be introduced into the product design and manufacturing stage. Leis et al. (2017) carried out the exploratory research employing Life Cycle Assessment to examine the environmental performances of manufacturing cassava starch-based film made from casting. Their results showed that reduced the hazardous materials in the product design stage does not compromise product quality, but minimises the negative environmental impact. Thus, Green Manufacturing can reduce the environmental impact of operational activities without compromising cost, quality, performance, but also ensure overall business performance (Srivastava, 2008; Rehman et

al., 2016). However, the relevant research on the relationship between Green Manufacturing and Organisational Performance in the specific manufacturing sector remains insufficient, especially in the apparel industry.

Green Manufacturing is a pertinent issue in production economics, and it is also an issue relevant to the apparel industry. There are many intermediaries between fibre producers and final customers, which makes the apparel industry with a very long supply chain (Baskarana et al., 2012). This industry has a high uncertainty of demand and high inventory-carrying costs due to fast-changing apparel trends (De Brito et al., 2008; Bonacich and Appelbaum, 2000). Therefore, increasing production efficiency is a critical challenge for apparel companies. Furthermore, traditional apparel manufacturing generates high levels of environmental pollution due to its use of natural resources (land and water) and chemical products (de Brito, 2008). Therefore, it is increasingly essential for apparel companies to consider the implementation of Green Manufacturing. The stakeholder theory suggests companies to enhance corporate social responsibility and understand the expectations of their stakeholders (Sarkis et al., 2011). Companies' engagement in corporate social responsibility positively associates with firm profits (Tang et al., 2012). Nowadays, publics are increasingly concerning green practice and environmental issues, of which the environment - friendly manufacturing has become largely desirable (Tang et al., 2012). Customer awareness of environmental impacts is increasing (Choi et al., 2012). Thus, apparel companies may consider greening their manufacturing processes under the public's pressure. The implementation of Green Manufacturing improves awareness of employees, ensures that they know they work in a respectful environment, convinces customers that this is a reliable and environment-friendly company. The positive attitude of stakeholders, including employees, customers, and society toward implementation of Green Manufacturing has a considerable influence on the green practices of apparel companies. However, companies may reluctantly engage in environmental activities due to the costs of implementing green practices. Consequently, companies may only conform to environmental regulations and transfer environmentally irresponsible activities to other companies. For instance, due to the tightened environmental regulations, such as Canada's National Pollutants Release Inventory and United States'

Toxic Releases Inventory, companies are required to reduce the negative environmental impact of their operations. These regulations lead to several companies outsourcing their polluting activities (Bu et al., 2020; Gavronski et al., 2011). Thus, empirical evidence on how green practices enhances organisational performance in apparel companies would help and convince companies to increase their willingness to invest in green practices.

Some previous studies on the apparel industry confirmed the positive relationship between green practices and organisational performance using case studies. Chen et al. (2017) showed that apparel companies improved environmental and business performance by reducing water consumption in the green production stage. Ozturk et al. (2020) and Ozturk et al. (2014) evaluated the return on investment in terms of economic performance and the percentage reduction of pollution in terms of environmental performance. However, limited studies applied multiple dimensions examined the impact of the implementation of Green manufacturing (GRMA) on the Organisational Performance (environmental and business) (ORPE) of apparel companies using the survey and structural equation modelling (SEM). In specific, this study sets out to evaluate companies' environmental performance using the following dimensions: environmental impact, internal environmental management performance and external stakeholder relations (Ilinitch et al., 1998). This study evaluates the apparel companies' business performance using the financial and non-financial performance (market performance) (Neely et al., 2005, Vickery et al., 2003; Cesar da Silva et al., 2020). Ozturk et al. (2014) showed that the implementation of green practices in the dyeing process and fibre manufacturing reduced costs by 32% and the return on investment (ROI) was 36 months. The implementation of Green Manufacturing in the apparel industry reduces the use of resources, minimises costs and improves the financial performance, also helping to maintain its competitive advantage in the market (Alkaya and Demirer, 2014); the same occurs in other industries, such as in the furniture sector (Souza et al., 2018), and steel and iron sector (Gong et al., 2017). Thus, it is important to examine the business performance of Green Manufacturing implementation through financial and non-financial performance measures (market performance). Financial performance is the efficiency with which a company generates profits, utilises its assets and achieves capital appreciation

(Zeng et al., 2010; Waddock and Graves, 1997; Vickery et al., 2003). Market performance, in turn, is the extent to which a company increases its market share and sales and improves the market competitiveness (Zeng et al., 2010; McKee et al., 1989; Venkatraman and Ramanujan, 1986). Apparel companies implement Green Manufacturing (GRMA) to reduce the consumption of resources and calculate the return on investment for greener equipment and thereby improve financial performance. Also, the implementation of Green Manufacturing (GRMA) supports that apparel companies meet the environmental requirements of the stakeholders, which results in increased market share. However, there was limited research carried out in the apparel companies that confirmed the business performance of implementing Green Manufacturing (GRMA) in a confirmatory manner, contributing to the scientific literature. Apparel companies improve financial performance due to cost reduction with the implementation of Green Manufacturing (GRMA) by minimising the consumption of resources (chemicals and water), use of green technologies that reduce the consumption of energy, electricity and raw materials. A financially healthy apparel company can ultimately improve market performance by investing in hiring staff, expanding market, and maintaining market competitiveness.

Furthermore, Cesar da Silva et al. (2020) pointed out the application of cleaner production practices promote environmental and economic benefits for the textile industry (Cesar da Silva et al., 2020). Severo et al. (2015) examined the relationship between clean production and organisational performance in the metal mechanical sector. Zeng et al. (2010) evaluated the impact of cleaner production on the organisational performance of manufacturing industries and Gong et al. (2017) developed a study in the steel and iron sector which examined the performance of cleaner production considering the use of big data. Furthermore, Rehman et al. (2016) investigate the impact of Green Manufacturing implementation on Organisational Performance in 318 Indian manufacturing companies across different sectors. The results reflect that Green Manufacturing implementation can contribute to overall Organisational Performance. Accordingly, this study argues that Green Manufacturing remain positively associated with Organisational Performance in apparel companies. Therefore, hypothesis 5 is that *Green Manufacturing (GRMA) positively affects Organisational Performance (ORPE)*.

#### 2.2.3.6 The positive effect of Green Manufacturing (GRMA) on Circular Economy Capability (CECA).

Although the concepts of both the Circular Economy and Green Manufacturing focus on reducing environmental impacts (Zhu, Geng and Lai, 2011; Genovese et al., 2017), these two terms take different perspectives. The concept of the Circular Economy focuses on the 'circulation' of materials by using energy more efficiently and maximising the utility of materials and energy in order to improve economic performance while alleviating environmental impacts (Geng et al., 2009). However, Green Manufacturing focuses on reducing environmental impacts across the product lifecycle: from design to end of life, including green design, procurement, processes, packaging, end of life management and remanufacturing (Melnik and Smith, 1996; Lele, 2009). This is a question of reducing the environmental impact of products rather than improving economic growth (Melnik and Smith, 1996; Zhou et al., 2017; Sarkis, 2011). Many researchers investigate these two concepts respectively (Rosa et al., 2019; Mendoza et al., 2017; Baldassarre et al., 2019; Genovese et al., 2017; Kazancoglu, Kazancoglu and Sagnak, 2018; Zhou et al., 2017). However, empirical research that examines the two concepts together is still limited.

The concept of the Circular Economy focuses on continuing economic development and at the same time on sustaining natural systems to reduce, reuse or recycle materials or energy within a company or transferring the company's waste to be a resource for another company. Hence, the Circular Economy focuses on creating self-sustaining manufacturing systems to use materials or products repeatedly (Genovese et al., 2017). Many countries such as China, Japan and Germany promote the Circular Economy. For example, the Chinese government has adopted the Circular Economy as its official development strategy since 2002 to overcome environmental degradation and resource depletion (Zhu, 2010; Zhu, 2011; Mathews and Tan, 2011; Yuan et al., 2006). The NRBV theory articulates the connection between a firm's resources, capabilities, and competitive operational advantages. It suggests companies should incorporate environmental practices in their operational activities to maintain sustainable competitiveness and explains how they can utilise their resources to develop their own environmental capabilities (Hart, 1995; 2011). In order to achieve this outcome,

companies need to allocate and utilise their resources efficiently (Guang Shi et al., 2012). Accordingly, to develop Circular Economy Capability, companies may configure their resources to efficiently reduce energy use, reuse materials, and recycle waste. The green practice is essential for companies to survive in an ever-increasingly competitive market (Schmidt et al., 2016). Green practice, such as green supply chain (Kazancoglu et al., 2018; Zhu et al., 2005), green engineering (O'Connor et al., 2016), eco-design (Mendoza et al., 2017), integrated product development (Baldassarre et al., 2019), and environmental-oriented supply chain (Zhu et al., 2010) is a means of utilising and optimising resources, which is seen as a method to solve environmental problems and improve Circular Economy capability. The apparel companies implement green practices to build environmental capability by reducing the consumption of resources (materials, energy and water) (Ozturk et al., 2016). It is necessary to make the investment in training and technologies in the manufacturing process (Alkaya and Demirer 2014; Barbiroli and Raggi, 2003), establishing changes in the production (Mendoza et al., 2014), adopting equipment to improve efficiency and minimise pollution (Alkaya and Demirer 2014). Ozturk et al. (2014) showed that the implementation of green practices in the dyeing process and fibre manufacturing reduced costs by 32%. The Green Manufacturing has the goal of minimising environmental impact and maximising resource efficiency, which focuses on integrating product and process design to identify and assess the flow of environmental waste (Zhou et al., 2017; Melnyk and Smith, 1996). In this context, the implementation of Green Manufacturing in the apparel industry minimises pollution and improves environmental capability.

Green Manufacturing implementation is crucial for companies' survival in an increasingly competitive market (Zhou et al., 2017). Green Manufacturing is an approach of utilising and optimising resources, which is seen as a method for solving environmental problems (Kazancoglu et al., 2018). The UK Environmental Audit Committee recommends that apparel companies comply with high standards at the manufacturing and recycling stages to reduce their environmental impact (Harrabin, 2019). The Global Recycling Council has already commended apparel companies for sustainable production. For example, apparel retailers such as H&M and Zara have introduced products that use green materials such as organic cotton, and recycled polyester in their manufacturing process. Adidas aims to use only

recycled polyester to manufacture apparel and shoes by 2024; Bottletop plans to collaborate with Mulberry to launch green luxury bags, made entirely with upcycled materials (Harrabin, 2019); and Zara, Bershka, and Pull & Bear aim to sell only sustainable apparel by 2025 (BBC News, 2019). Companies have been embarking on Green Manufacturing initiatives independently and without a view about the Circular Economy view. Yet, this process helps increase employee awareness, invest in environmental systems and such which helps them build a capability relevant to the Circular Economy. A Green Manufacturing framework could be applied to reflect the resource configuration processes. Accordingly, based on the NRBV theory, companies can utilise their resources efficiently and innovatively to build their Circular Economy Capability.

Specifically, Circular Economy Capability at the company level is represented by reduction capability, reuse capability and recycle capability (Zhu et al., 2010; 2011, Anderson, 2007; Yong, 2007). Green Manufacturing is extended to all the stages in the life cycle from design to the end of life: green design, procurement, production, packaging and distribution, end of life management and remanufacturing (Melnyk and Smith, 1996; Lele, 2009). Companies' reduction capabilities can be enhanced through green production and distribution (Zhu et al., 2010; 2011). Their reuse capabilities aim to extend the life cycle of the product can be improved through all six stages of Green Manufacturing (French and Laforge, 2006). Finally, their capacity to recycle focuses on the proper disposal of products or materials and can be enhanced at the end of life stage (Hicks et al., 2005). All six stages of Green Manufacturing aim to minimise the negative environmental impact, which can help companies build and improve their Circular Economy Capability. Accordingly, hypothesis 6 is that *Green Manufacturing (GRMA) positively affects Circular Economy Capability (CECA)*.

#### 2.2.3.7 The positive effect of Circular Economy Capability (CECA) on Organisational Performance (ORPE).

Many studies examined the possible economic or environmental benefits of building environmental capability through experiments or exploratory studies in the pulp and paper mill sector (Avsar and Demirer, 2008; Wang et al., 2011), in the alcohol industry (Guo et al., 2006), in a waste plant (Zhang et al., 2015), and in various sectors (Kliopova and Staniskis, 2006). A few experimental analyses and case

studies only examined the business performance through cost reduction in building the environmental capability, and only mentioned qualitative indications measuring the environmental performance (Ribeiro and Kruglianskas, 2013; Zwetsloot and Ashford, 2003), in the tannery industry (Teodorescu and Gaidau, 2008) and in the coal industry (Mapamba et al., 2017). Furthermore, some experimental analyses and case studies evaluated only the environmental performance of building the environmental capability, in the agrochemical industry (Kulay et al., 2017), in the processing of stones (Bai et al., 2015), in a wastewater treatment plant (Mustapha et al., 2017), in the coopering industry (Song et al., 2017), and in the electroplating (Perez-Torres et al., 2019). This research applies both environmental and business performance as indicators of Organisational Performance (ORPE), and empirically examines the impact of CECA on ORPE in apparel companies using the mixed research methods. The NRBV theory suggests companies incorporate environmental concerns in their operational activities to improve overall outcomes and maintain sustainable competitive advantage (Guang Shi et al., 2012; Hart, 1995; 2011). It also explains how companies utilise resources to develop their environmental capabilities (Guang Shi et al., 2012; Hart, 1995; 2011). Such capabilities could improve overall environmental performance, maintain competitive advantage, and ultimately improve Organisational Performance (Hart, 1995, 2011; Guang Shi et al., 2012; Porter and van der Linde, 1995; Ilinitch et al., 1998). This study accordingly uses a company's Circular Economy Capability to reflect its environmental capability. Several studies have proved the positive impact of the Circular Economy on the environmental performance at the regional and industry levels (Ma et al., 2014; Shi et al., 2010; Su et al., 2013). Furthermore, Kazancoglu et al. (2018) further testified the positive impact of the Circular Economy on both business performance and environmental performance. However, the relevant research on the relationship between the Circular Economy and Organisational Performance within the company level remains insufficient, especially in apparel companies. With the development of globalisation and industrialisation, there has been an increase in the volume of waste apparel. Most is disposed of in the early stages of the lifecycle, which has become a significant source of environmental pollution (Lina, 2015). Thus, creating a circular flow of apparel could be of significant importance.

Building the Circular Economy Capability (CECA) contributes to the improvement of

Organisational Performance (ORPE) by increasing production capacity and flexibility to reduce waste that the circular economy promotes; improving the quality of products; reducing emissions and environmental impact and contributing to the health and safety of workers (Severo et al., 2015). The main objective of the Circular Economy at the company level is to apply sustainable principles to reducing energy and resources, to reuse materials, and to recycle used products (Nasr, 2013; Zhu et al., 2010; 2011). Circular economy capabilities at the company level are represented by the ability to reduce, reuse, and recycle (Zhu et al., 2010, 2011). Specifically, Tayyab et al. (2020), Alkaya and Demirer (2014) and Ozturk et al. (2016) showed that apparel company's economic performance is improved through cost reduction, and environmental performance is improved through reducing pollution. Some studies confirmed the reduction of resource consumption as the action to improve organisational performance in the manufacturing sector (Lim and Park, 2009), in the production of cement (Strazza et al., 2011), in the aluminum industry (Han et al., 2017), and in the chemical industry (Alkaya and Demirer, 2015). Furthermore, Zeng et al. (2010) applied Structural Equation Modelling in the relationship between building environmental capability and organisational performance in manufacturing and pointed out that the reduction in industrial waste through reducing water consumption, electricity and raw materials, generate high environmental performance. Mendoza et al. (2019) conducted the experimental analysis in the manufacturing of disposable diapers by reducing the use of conventional glueing of diaper materials through optimising the novel bonding technologies. The result showed the minimisation of the use of glue reduced 25% of energy and 23% of the consumption of raw materials. Thus, through building the capability to reduce and reuse, companies reduce their spend on resources and their use of energy and can reutilise production materials, all of which could improve business performance (Kazancoglu et al., 2018). Moreover, through building a recycling capability, companies can also attract consumers who prefer eco-friendly products and build a good brand image. These activities allow companies to produce their products in an environmentally sustainable way, increase sales and extend market share in an environmentally conscious market, and ultimately help to improve Organisational Performance and sustain competitive environmental advantage (Ghisellini et al., 2016; Zeng et al., 2017; Porter and van der Linde, 1995; Kazancoglu et al.,

2018). Thus, this study argues that by building Circular Economy Capability, a company can improve its Organisational Performance. On this basis, hypothesis 7 is that *Circular Economy Capability (CECA) positively affects Organisational Performance (ORPE)*.

### **2.3 Definitions of Constructs and Sub-Constructs and Development of Measurement Items**

This section provides a literature review of the constructs (second-order constructs), sub-constructs (first-order constructs) and the measurement items that are employed to develop the conceptual model. Section 2.3.1 discusses two drivers of Green Manufacturing implementation (Stakeholder Engagement in Environmental Implementation and Environmental Orientation). Section 2.3.2 presents the implementation of Green Manufacturing. Section 2.3.3 evaluates Circular Economy Capability in apparel companies. Section 2.3.4 and Section 2.3.5 describe Organisational Performance and Barriers to Green Manufacturing implementation.

#### **2.3.1 Drivers of Green Manufacturing Implementation**

Companies' ecological practice is affected by both external and internal drivers (Ward et al., 1995; Corbett and Klassen, 2006; Hart, 1995; Banerjee, 2002). Accordingly, Green Manufacturing, one type of ecological practice, is also affected by external and internal drivers. This study considers Stakeholder Engagement in Environmental Implementation and Environmental Orientation to be two main drivers of Green Manufacturing implementation in apparel companies. In particular, it considers external Stakeholder Engagement in Environmental Implementation and external Environmental Orientation as the external drivers of Green Manufacturing implementation and internal Stakeholder Engagement in Environmental Implementation and internal Environmental Orientation as the internal drivers of Green Manufacturing implementation.

Numerous researchers have discussed stakeholder theory in the business ethics field and examined how stakeholder engagement can be complemented with approaches to explore organisational dilemmas. Many studies adopt stakeholder theory to develop theoretical frameworks.

For example, Duckworth and Moore (2010, p 10) apply stakeholder theory to build a theoretical framework to study corporate social responsibility methods. Stakeholder engagement involves the process of “effectively eliciting stakeholders’ views on their relationships with organisations” (Friedman and Miles, 2006). Based on stakeholder theory, Guoyou et al. (2011) report the results of an investigation into the effects of stakeholders on green product innovation and green processes. The results show that external stakeholders, such as customers, play an essential role in driving companies to implement green production strategies. Furthermore, Liu et al. (2017) argue that small and medium-sized enterprises (SMEs) are vital to government emission reduction programmes and it is important to improve understanding of the diffusion of green-manufacturing technologies among SMEs. Their study collects data from relevant stakeholders in the National Motor Upgrading Demonstration Project. Based on an analysis of 30 in-depth interviews and 6 focus group discussions, the results suggest that as a key external stakeholder the government facilitates the implementation of Green Manufacturing among SMEs. In addition, Zhou et al. (2017) report the results of an investigation into the effects of key stakeholders on energy performance contracts (EPCs). The Chinese government uses EPCs to encourage companies to implement Green Manufacturing technologies voluntarily. The study first identifies a list of qualified stakeholders and then examines their influence on the implementation of EPCs. The results reveal a positive effect of stakeholders’ perceptions on the diffusion of Green Manufacturing technologies. Therefore, stakeholder engagement is proposed as one of the drivers of Green Manufacturing implementation.

Furthermore, companies are considered to be complex adaptive systems involving different organisational stakeholders, including both external ones (customers, suppliers, the government and society) and internal ones (owners and employees) (Matos and Hall, 2007; Alston and Roberts, 1999; Hart, 1995). In recent years, there has been increasing awareness of sustainable operations and environment-friendly products. Today, external stakeholders have increasing requirements for companies to have sustainable operations (Sarkis et al., 2010; Ward et al., 1995; Hart, 1995; Corbett and Klassen, 2006; Choi et al., 2001; Matos and Hall, 2007), which increase pressures on companies to operate in an environment-friendly manner (Sarkis et al., 2010; Ward et al., 1995; Porter and van der

Linde, 1995). Although there are no optimal solutions to address this increased pressure successfully (Choi et al., 2001; Matos and Hall, 2007), NRBV theory holds that companies can develop competitive advantages by continually reconfiguring their resources and adjusting their strategies to address high environmental pressure (Hart, 2011). To help with the continual adjustments, internal stakeholders may increase their ability to recognise, adjust and apply new knowledge, skills and technology (Cohen and Levinthal, 1990) to establish Environmental Orientation and recognise the environmental impacts of their business conduct (Banerjee, 2002; Banerjee et al., 2003).

Companies' external Environmental Orientation is reflected in their perceptions of interactions with external stakeholders regarding ecological issues (Banerjee, 2002). Companies' internal Environmental Orientation consists of their codes of standards for ethical behaviour, internal values and commitments in terms of environment-friendly operational activities (Banerjee, 2002). In addition, companies' internal Environmental Orientation significantly impacts their environmental performance (Shrivastava, 1995). Companies are suggested by previous studies to purposefully reconfigure their internal and external resource bases to respond to high pressure in rapidly changing environments (Teece et al., 1997; Eisenhardt and Martin, 2000). According to Banerjee (2002, 2003), most companies' internal Environmental Orientation can be tracked in their mission statements, environmental statements or annual reports. Barney (1991) states that a company's Environmental Orientation, such as its interactions with external stakeholders regarding ecological issues, its code of standards for ethical behaviour and internal values can be internalised and developed as company resources over time. Furthermore, NRBV theory explains how companies utilise their resources to achieve environmental sustainability (Hart, 1995). According to NRBV theory, companies incorporate environmental concerns in their operational activities (Hart, 1995). Therefore, resources that are derived from companies' Environmental Orientation can facilitate their environmental activities by providing motivation, leadership commitment and administrative support (Hart, 1995, 1997). This study adopts Green Manufacturing as a reflection of companies' environmental activities. Therefore, it is reasonable to consider companies' Environmental Orientation to be a facilitator of Green Manufacturing implementation.

### 2.3.1.1 External Drivers

This study considers external Stakeholder Engagement in Environmental Implementation and external Environmental Orientation to be the external drivers of Green Manufacturing implementation.

#### **External Stakeholder Engagement in Environmental Implementation and External Environmental Orientation**

In recent years, customers, suppliers, the government and society have paid increased attention to encouraging apparel companies to incorporate environment concerns in their daily operations (Beh et al., 2016).

##### *Customers*

Customer engagement facilitates companies' adoption of green practices (Subramanian et al., 2009; Zhu et al., 2010; Zeithaml et al. 1996; Beh et al., 2016). Customer engagement, such as providing real and updated feedback, helps companies to adjust their Green Manufacturing implementation strategies. Successful cooperation with customers in the green design stage, green production stage, green packaging and distribution stage, product take-back stage and reuse and recycling stage plays a vital role in implementing Green Manufacturing (Zhu et al., 2010, 2011). Furthermore, customer engagement such as protesting and boycotting may force companies to employ green practices. Mohr and Webb (2005) and Hillenbrand et al. (2013) state that companies' environmental behaviour plays an increasing role in consumer choice. Several researchers suggest companies should fulfil their environmental responsibility to meet customers' demands for environmentally friendly products (Utting, 2005; Ghobadian et al., 2015; Christmann and Taylor, 2001; Sweeney and Coughlan, 2008). As customers can access the internet anywhere and at any time, knowledge of company environmentally unfriendly behaviour can spread very fast. It forces companies to adopt Green Manufacturing to decrease risks of protests or boycotts.

##### *Suppliers*

As external stakeholders, suppliers significantly affect companies' operations (Krause, 1999). A supplier is not only an upstream partner that provides inputs but it also affects companies' environmental performance (Modi and Mabert, 2007; Song and Benedetto, 2008). Therefore, strategically selecting suppliers is vital to enhance environmental sustainability. The conventional criteria for evaluating suppliers are price, quality, service and delivery time. To maximise profit, companies may regard price as the primary criterion when selecting a supplier. However, nowadays it has become more common knowledge that to remain competitive in the business environment, companies may need to put sustainability of their operations in primary position. Therefore, an increasing number of companies are adding an environmental sustainability criterion to select their suppliers (Baskarana et al., 2012). Suppliers' resources and abilities to provide environment-friendly products significantly affect companies' environmental operations (Min and Galle, 1997; Carter et al., 2000). Therefore, a supplier's willingness to establish an environmental partnership for environmental implementation is essential to improve companies' environmental practices (Zhu et al., 2010).

### *The Government*

In this study, government engagement in environmental implementation is defined as the perceived uncertainty of specific government environmental regulations. Nowadays, increasing consumer demand has driven manufacturing activities globally. At the same time, environmental deterioration has become a main concern for many countries. Therefore, governments around the world are implementing means of promoting green practices to increase manufacturing efficiency and reduce negative environmental impacts. To address public concerns, the government in China has taken steps to implement environmental regulations to reduce the pressure of the environmental crisis and resource depletion since 2002 (Pan et al., 2015; Zhu et al., 2011; Yuan et al. 2006; Geng and Doberstein, 2008; Zhu, 2008; Zhang et al., 2010). Japan and Germany have also made efforts to develop environmental regulatory frameworks (Triebswetter and Hitchens, 2005; Moriguchi, 2007). Government regulations are enforced in companies to improve environmental performance (Zeng et al., 2016; Zhou et al., 2017). Diabat and Govindan (2011) apply interpretive structural modelling to rank

drivers that affect green supply chain management. Their results show that government regulation is the most crucial driver. Since environment-related regulations significantly affect companies' operations, Cavusgil et al. (2004) argue that fully understanding the regulations helps companies to avoid making mistakes and exploit opportunities to achieve high-level operational performance. Moreover, in company decision-making processes, government regulations are the primary criteria determining companies' operational activities (Zhu et al., 2005; Zhu et al., 2007; Florida, 1996). Government environment regulations apply to all organisations, including both service organisations and manufacturing organisations. More and more environment-related regulations, such as ISO14000, the End of Life Vehicle (ELV) Directive, the Waste Electrical and Electronic Equipment (WEEE) Directive and the Restriction of Hazardous Substances (RoHS) Directive, govern the operations of different industries (Curkovic et al., 2005; Melnyk et al., 2003; Yong, 2007). Specifically, due to the significant level of pollution occurring from production processes and packaging material, the apparel industry has a very high environmental impact. Therefore, government engagement in environmental implementation is vital to guide apparel companies to implement Green Manufacturing following specific government environmental regulations.

#### *Non-governmental organisations (NGOs)*

In this study, NGO engagement in environmental implementation is defined as the perceived uncertainty of NGOs' abilities to promote environment-friendly production and strategies. NGOs play a notable role in forcing companies to develop in environmentally sustainable ways. Relevant literature identifies reasons for this. First, as environmental problems are increasingly complex, they cannot be solved solely by governments. NGOs and other stakeholders should work together to solve environmental problems (Hartman et al., 1999; Kraft et al., 2013). Since the late 1960s, negative impacts of commercial activities, such as the Cuyahoga River fire, Australian Wildfires, Guatemala Coffee Rust, the Philippines Typhoon and the Chernobyl disaster, have been witnessed and NGOs are involved in cleaning them up (Jakhar, 2015). In response to these negative impacts, NGOs are rapidly generating reports to raise awareness of environmentally sustainable development (Lozano, 2013; Lee, 2012; Mota et al., 2015). Second, NGOs point out that companies' operations today will significantly

affect future generations' quality of life (Seuring and Gold, 2013; Corbett and Klassen, 2006; Cruz, 2013). Fassin (2009) argues that NGOs have already taken on a mission to counterbalance the power of large companies, especially transnational companies. NGOs play a role in transnational governance in five ways: by identifying problems, raising their voices, linking different stakeholders together, stressing the importance of issues and public visibility, and keeping track of problem-solving performance (Brown and Timmer, 2006). Third, partnerships and cooperation between NGOs and companies have been successful in achieving the goal of environmentally sustainable development (Kong et al., 2002; Jamali and Keshishian, 2009; Reed and Reed, 2009). In particular, Harangozo and Zilahy (2015) show that, compared with large companies, small and medium-sized companies have the same degree of importance in their cooperation with NGOs. This result indicates that NGOs are non-negligible stakeholders regarding the process of greening businesses. Therefore, NGO engagement in environmental implementation is proposed as one of the drivers of Green Manufacturing implementation.

### **External Environmental Orientation**

Environmental Orientation, including both internal and external Environmental Orientation, is regarded as an essential concept in environmental management studies, reflecting the extent to which companies are involved in reducing negative environmental impacts (Banerjee, 2002; Chan, 2012; Yu and Huo, 2019). Environmental Orientation is the extent to which companies recognise and respond to environmental problems (Banerjee, 2001, 2002). External Environmental Orientation is reflected in companies responding to ecological issues raised by external stakeholders (Banerjee, 2002). To address external stakeholders' environmental concerns, companies should fully understand their requirements and the environmental impacts of their operations (Banerjee, 2002; Banerjee et al., 2003).

#### **2.3.1.2 Internal Drivers**

The internal drivers of Green Manufacturing in this study are internal Stakeholder Engagement in Environmental Implementation and internal Environmental Orientation.

## **Internal Stakeholder Engagement in Environmental Implementation and Internal Environmental Orientation**

Internal stakeholders are individuals or groups who are directly involved in the operational processes of organisations. They are primarily employees and managers. Employees significantly affect companies' strategies and success and have some influence on companies' decisions. Managers determine companies' strategies and are accountable to communicate with stakeholders (Friedman and Miles, 2006). This study uses managers' and employees' engagement in environmental implementation as two variables of internal Stakeholder Engagement in Environmental Implementation.

### *Managers*

The primary responsibility of managers is to make profits over the long term, create competitive advantages, disclose relevant information to other stakeholders and manage stakeholder relationships. Appropriate manager leadership styles and communication styles can facilitate information flows within companies and are also positively associated with companies' environmental performance (Tu et al., 2006; Zahra and George, 2002). Furthermore, managers' capabilities to create competitive advantages significantly affect companies' operations (Choi et al., 2001; Matos & Hall, 2007; Zahra & George, 2002; Tu et al., 2006). In order to build companies' environmental competitive advantages, managers adopt green practices in various industries, including the apparel industry. Managers' knowledge is essential to facilitate green practices. They need to fully understand their employees' skills and have problem-solving ability, technical capabilities and knowledge scanning ability to identify relevant technology and information (Zahra and George, 2002; Cohen and Levinthal, 1990; Tu et al., 2006). Therefore, in this study managers' ability to adopt green practices is considered one of the variables of Stakeholder Engagement in Environmental Implementation.

### *Employees*

Employees' knowledge and abilities to change and deal with new technology and innovation are critical components of business contexts (Phillips, 2002). In particular, employees' ability to deal with new technology or new information affects companies' business models and performance (Zhu and Sarkis, 2004). In order to achieve the goal of environment-friendly operation, companies maintain their equipment, resources and production process in pace with the development of technological innovation. At the same time, employees' ability to deal with innovation greatly influences companies' environmental practices (Klassen and Whybark, 1999; Zhu et al., 2008). Furthermore, Gill and Meyer (2013) argue that employee relations affect companies' operational practices. Good employee relations are more likely to result in high performance. Therefore, in this study employees' engagement in environmental implementation is reflected in their ability to innovate and deal with new technologies.

### **Internal Environmental Orientation**

Companies' internal Environmental Orientation consists of companies' codes of standards for ethical behaviour, internal values and commitments in terms of environment-friendly operational activities (Banerjee, 2001). Like external Environmental Orientation, companies' internal Environmental Orientation also affects their environmental activities (Shrivastava, 1995). According to Banerjee (2002, 2003), most companies' internal Environmental Orientation can be tracked in their mission statements, environmental statements or annual reports. Therefore, this study assesses companies' internal Environmental Orientation by examining their environmental awareness and codes of conduct of ecological practices.

#### **2.3.2 Mechanism: Green Manufacturing**

The philosophy of Green Manufacturing is to minimise the use of resources and reduce the environmental impact of products. Based on this philosophy, Green Manufacturing is extended to all the stages in a product's life cycle from the design stage to the end of life management stage (Melnyk and Smith, 1996; Lele, 2009). Green management includes six stages: green design, green procurement,

green processes, green packaging, customer use and green end of life management and remanufacturing (Melnik and Smith, 1996). As NRBV theory holds, companies can incorporate environmental concerns in their operational activities (Hart, 1995), determine their internal resources and utilise them to achieve environmental sustainability (Barney, 1991; Hart, 1995). On the basis of NRBV theory, Hart (1995) proposes that companies should emphasise product stewardship in order to reduce their environmental impact across the product lifecycle and, over time, sustainably build their competitive capability. The concept of Green Manufacturing requires heavy emphasis on green practices in all the stages of the product lifecycle from the design stage to the end of life management stage (Melnik and Smith, 1996; Lele, 2009). Therefore, when Green Manufacturing is implemented by apparel companies, they become better able to utilise their resources across all the stages in their products' life cycles.

NRBV theory focuses on developing companies' sustainable competitive advantages. Previous studies suggest companies emphasise more competitive survival in rapidly changing environments (Teece et al., 1997; Eisenhardt and Martin, 2000; Ludwig and Pemberton, 2011). It involves the development of strategies for firms to survive in rapidly changing environments. For example, when new technology or knowledge arrive, companies may not be able to adopt this knowledge to improve their traditional manufacturing processes at short notice. In such a situation, companies should adapt their operational activities to make full use of their existing resources and capacities while simultaneously making plans for future changes in their processes (Ludwig and Pemberton, 2011). Therefore, as new knowledge arrives, such as the Circular Economy, companies should develop strategies and adjust their operational activities (for example, by changing from traditional manufacturing to Green Manufacturing) to adapt to rapidly changing environments.

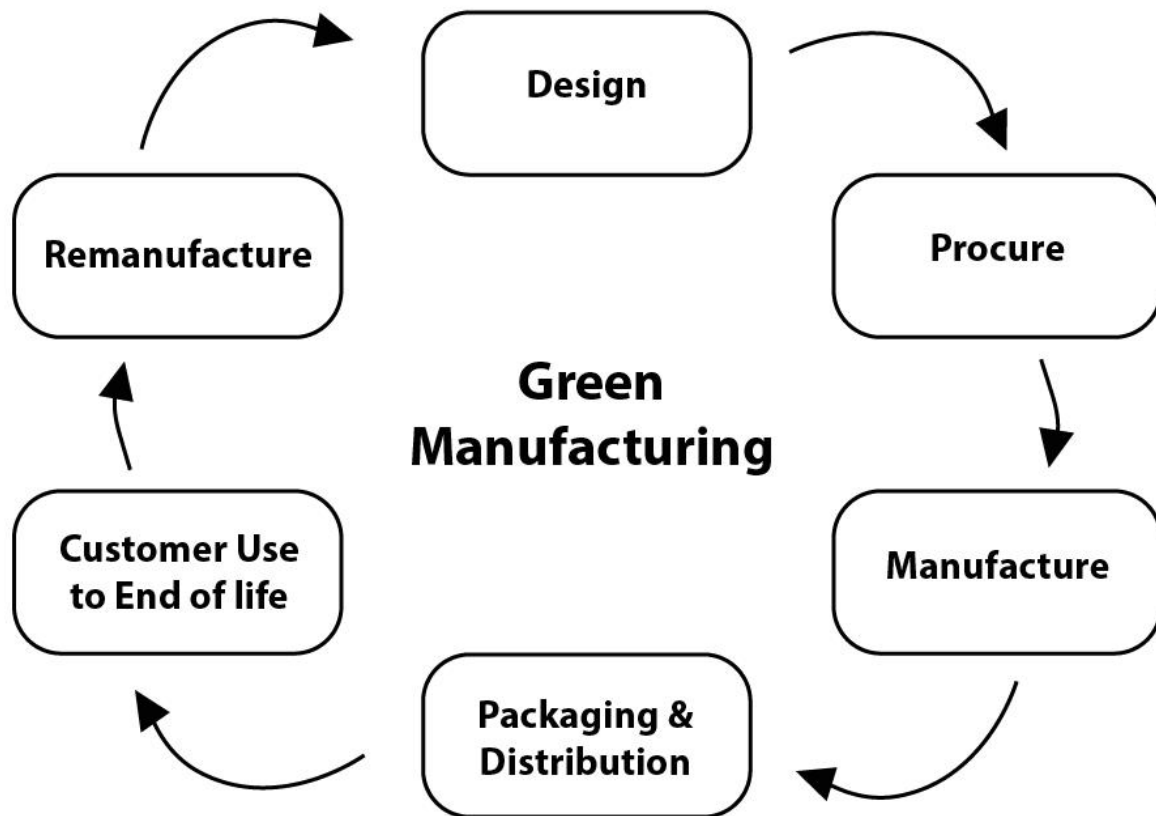
Furthermore, previous studies suggest that companies should continually reconfigure internal and external resources to maintain their competitiveness to deal with high pressure in rapidly changing environments (Teece et al., 1997; Eisenhardt and Martin, 2000). In order to develop this capability, companies can efficiently allocate and utilise their resources (Teece et al., 1997; Eisenhardt and Martin, 2000). Accordingly, to develop Circular Economy Capability, companies may configure their resources

to efficiently reduce energy use, reuse materials and recycle waste. Several researchers argue that eco-design, integrated product development and environment-oriented supply chains can be applied as mechanisms to build companies' Circular Economy Capability (Mendoza et al., 2017; Baldassarre et al., 2019; Zhu et al., 2010; 2011). The concept of Green Manufacturing combined with these mechanisms with the goal of minimising environmental impacts and maximising resource efficiency focuses on integrating product and process design to identify and assess the flow of waste into the environment (Melnik and Smith. 1996). The Green Manufacturing framework can be applied to reflect the resource configuration process. Therefore, Green Manufacturing can be applied in companies to build their Circular Economy Capability. Therefore, based on NRBV theory, Green Manufacturing is proposed as the mechanism to develop companies Circular Economy Capability.

Green Manufacturing focuses on the following three problems: resource and energy optimisation, environmental protection and supply chain management. Compared with Green Manufacturing, traditional manufacturing rarely considered resource and energy efficiency and environmental impact (Ying and Li, 2012). Manufacturing is the principal strategic component that helps companies build a competitive advantage (Lele, 2009). With the development of technology and globalisation, manufacturing is being transformed. In the 1910s, mass production techniques that were widely introduced in the automobile industry revolutionised the process of manufacturing. Between 1970 and 1990, flexible and mass customisation techniques were widely applied in industries to meet individualistic customer demands. New business models encourage design to reduce energy and re-use materials. This represents a departure from the traditional production system (Genovese et al., 2017). Traditional manufacturing rarely considered resource and energy efficiency and environmental impacts (Ying and Li, 2012). With rising awareness in society of environmental impacts, Green Manufacturing was introduced in the 2000s (Lele, 2009). Green Manufacturing focuses on producing products in an environment-friendly way. Nowadays, there is an increasing influence of manufacturing in an environment-friendly way to create a competitive advantage (Genovese et al., 2017; Zeng et al., 2016; Nasir et al., 2017; Sanders, 2012). Therefore, Green Manufacturing is promoted as a critical method for companies seeking to reduce their negative environmental impacts (Genovese et al., 2017).

Green Manufacturing is a pertinent issue in production economics, and it is also an issue relevant to the apparel industry. Although numerous researchers have proposed approaches to address the social, environmental and economic issues associated with manufacturing in the apparel industry, new challenges have emerged. Public's awareness of environmental impacts is increasing (Zhou et al., 2017; Choi et al., 2012), hence, it is time for apparel companies to change their manufacturing processes from traditional production. Furthermore, traditional apparel manufacturing processes generate high levels of pollutants, including high volumes of waste, toxic gases and dyeing chemicals. To produce sustainably, companies should follow regulatory measures (Choi et al., 2012; Zhu et al., 2010; Georgiadis and Besiou, 2008). To protect the environment, governments, such as in China, have already implemented regulatory measures to lessen the impact on the environment caused by apparel manufacturing companies (Choi et al., 2012). Hence, how apparel companies apply Green Manufacturing under the pressure of regulations is becoming an interesting topic to study.

Green Manufacturing is known by different names: environmentally conscious manufacturing, clean manufacturing, environmentally responsible manufacturing and environmentally benign manufacturing (Lele, 2009). Over the years, there have been many variations in the definition of Green Manufacturing. Nevertheless, in general, the principles of the Green Manufacturing concept are mainly aligned with an environment-friendly perspective in which companies are concerned with designing and delivering products with a reduced negative environmental impact in their production, use and disposal (Lele, 2009). Minimising the use of resources and reducing the environmental impacts of products is the main philosophy of Green Manufacturing. According to this philosophy, Melnyk and Smith (1996) propose a Green Manufacturing framework which includes all the stages in a product's life cycle—from design to end of life management: green design, green procurement, green processes, green packaging, green end of life management and remanufacturing (Figure 2.3).



**Figure 2. 3 Green manufacturing stages (Adopted from Melnyk and Smith, 1996)**

There are some concepts which are similar to Green Manufacturing, such as the waste-to-energy (WTE) supply chain (Pan et al., 2015), sustainable supply chain management (SSCM), green supply chain management (GSCM) and reverse supply chains: open-loop, reverse, closed-loop, cleaner production and environmental-oriented supply chain cooperation. These concepts are all related to environmental improvements. However, the core concepts and applications are different. Table 2.3 summarises and outlines the differences and applications of these concepts. Compared with these, Green Manufacturing is more appropriate for application in manufacturing companies as it guides the entire production process from the green design stage to the remanufacturing stage.

**Table 2. 3 Concepts similar to Green Manufacturing**

| Concepts | Definitions | Core concept | Applications |
|----------|-------------|--------------|--------------|
|----------|-------------|--------------|--------------|

|  |   |   |  |
|--|---|---|--|
| Waste-to-energy (WTE) supply chain (Pan et al., 2015)  | “To simultaneously solve the dilemma of energy demand, waste management and greenhouse gas emission for communities globally. Provides a method of simultaneously addressing the problems of energy demand, waste management and GHG emissions to achieve a Circular Economy system (CES).” | 5R practices: reduction, reuse, recycling, recovery (energy) and reclamation (land) | Industrial park level                                |
| Sustainable supply chain management (SSCM) (Zeng et al., 2016; Genovese et al., 2017; Jamali and Keshishian, 2009; Sajjad et al., 2015; Seuring and Muller, 2008; Tay et al., 2015; Walker and Jones, 2012; Wittstruck D, 2011).   | SSCM is “a comprehensive integration of the social, environmental and economic goals of a firm.”  | Social, environmental and economic goals  | Company level, industrial park level, industry level |
| Green supply chain management (GSCM) (Chan, 2012; Diabat and Govindan, 2011; Ebinger et al., 2006; Govindan et al., 2014; Hsu and Hu, 2008; Wu et al., 2011; Luthra et al., 2011; Mathiyazhagan et al., 2013; Sarkis et al., 2011; Stremlau et al., 2016; Toke et al., 2012; Ying and Li, 2012; Zhu and Sarkis, 2004; Zhu et al., 2005 and Zeng et al., 2016). | Like SSCM, GSCM does not explicitly include social factors  | Does not explicitly include social factors  | Company level, industrial park level, industry level |
| Reverse supply chains: open-loop (Gou et al., 2008; Beh et al., 2016; Abraham, 2011; Aurdahl, 2016; Chan, 2007; Dowlatshahi, 2000; Guidini, 1996; Krumwiede and Cheu, 2002; Kumar and Putnam, 2008; Nikolaidis, 2013; Rogers and Tibben-Lembke, 1999; Rogers and Tibben-Lembke, 1999; Schwartz, 2000).   | “The movement of goods from customer to vendor.” “Open-loop supply chains involve materials recovered by parties other than the original producers who are capable of reusing these materials or products.”   | Bringing goods from the customer to a third-party company for reuse.                | Company level, industrial park level, industry level |
| Reverse supply chains: closed-loop (Gou et al., 2008; Beh et al., 2016; Abraham, 2011; Aurdahl, 2016; Chan, 2007; Dowlatshahi, 2000; Guidini, 1996; Krumwiede and Cheu, 2002; Kumar and Putnam, 2008; Nikolaidis, 2013; Rogers and Tibben-Lembke, 1999; Rogers and Tibben-Lembke, 1999; Schwartz, 2000).   | “Closed-loop supply chains deal with the practice of taking back products from customers and returning them to the original manufacturer for recovery of added value by reusing the whole product or part of it.”   | Bringing goods from the customer to the company that produced them.                 | Company level  |
| Cleaner production (Mathews and Tan, 2011).  | “In general, closed-loop initiatives are taken at three levels. Some are confined   | Company-specific environmental  | Company level  |

|  |  |  |               |
|--|--|--|---------------|
|  | to a single enterprise or group of enterprises, enhancing energy and resource efficiency; this kind of initiative is generally recognised as “cleaner production.” | protection initiatives. The aim is to minimise waste and emissions and to maximise product output. |               |
| Environmentally oriented supply chain cooperation (ESCC) (Zhu et al., 2010; Zhu et al., 2011). | “eco-innovation in renovating processes in the supply chain for environmental performance and productivity gains.”   | Utilising cooperation between suppliers and customers in the process of environmental management.  | Company level |

### 2.3.2.1 Green Design

Apparel is particularly sensitive to sustainability due to its inherent characteristics, such as changing fashion trends. Apparel manufacturing generates high levels of environmental pollution due to its use of natural resources (land and water) and chemical products (de Brito, 2008). Therefore, it is increasingly essential for apparel companies to consider environmental issues in the early stages of product development. The focus of green design is to use sustainable and environmentally friendly materials and technologies (such as recycled and organic textiles and eco-labelling) at the design stage to reduce environmental impacts (Blackburn, 2009; Melnyk and Smith, 1996; Rivera-Becerra and Lin, 1999). Some examples of green design are H&M’s organic cotton clothes collection (Baines et al., 2012) and the Global Eco-labelling Network (GEN) (Global Eco labelling, 2017).

Rivera-Becerra and Lin (1999) state that experience shows that competitive products cannot be achieved if clear objectives are not set when designing them. In addition, Zhang et al. (1995) show that if emphasis is only put on the functions of a product but not on the design stage negative environmental impacts may appear in subsequent stages of its life cycle. Therefore, putting strong emphasis on the design stage is necessary for companies to reduce negative environmental impacts and the total cost of entire product lines (Melnyk and Smith, 1996; Rivera-Becerra and Lin, 1999). In addition, companies should incorporate environmental performance criteria in the design stage. These can reduce costs and environmental impacts and increase environmentally sound industrial practices

(Whitmer et al., 1995). To identify the impact of the entire life cycle of a product on the environment, companies can conduct life cycle analysis (LCA) in the design stage (Zhang et al., 1995).

The concept of the Circular Economy can be incorporated in the green design stage. Circular Economy Capability at the company level is reflected in reduction capability, reusing capability and recycling capability (Anderson, 2007; Yong, 2007). In the green design stage, when considering reduction capability companies can design products to be energy efficient in the production and use stages. For reuse capability, companies can consider designing products to be reusable. Regarding recycling capability, companies can design products to be recyclable (Lee et al., 2007; Hicks et al., 2005; Martin et al., 2006; Tam and Tam, 2006; Rivera-Becerra and Lin, 1999). In order to achieve these capabilities, companies may need to understand and consider environmental criteria and metrics (Veroutis and Fava, 1996; Mizuki et al., 1996). There are many tools to understand environmental criteria and metrics, such as the Design for Environment Information System (DFEIS) (Allenby, 1992), the Huber Environmental Performance Index (HEPI) (Wells et al., 1994), the Design for Environment Criteria Mapping Matrix (Veroutis and Fava, 1996) and the Higg Index (Sustainable apparel coalition, 2017). However, many of these are limited to single-dimensional metrics or simple checklists so they cannot be fully utilised as diagnostic tools to audit environmental performance.

A similar concept to green design is product stewardship. This is a product-centric approach that is widely used to improve environmental performance (Hart, 1995; Hart, 1997; Hart and Dowell, 2011) which includes two effective practices: eco-design and integrated product development. Eco-design requires companies to design products based on environmental principles and focuses on reducing toxic substances and minimising the use of non-renewable resources. Integrated product development considers the opinions of both internal and external stakeholders in product development. Companies integrate the resources and capabilities of internal stakeholders in different departments in the product design stage and consider the expectations and requirements of external stakeholders, such as suppliers and customers, regarding environmental impacts (Hart, 1995, 1997).

### 2.3.2.2 Green Procurement

Green procurement, or green purchasing, (GP) plays a vital role in improving companies' overall environmental performance when dealing with ecological issues (Zhu et al., 2011). Zhu et al. (2011) conclude that if manufacturing companies seek to improve their economic performance through Circular Economy practices, green procurement is important. This involves supplier evaluation and cooperation, eco-efficient supply (such as recirculation of packaging and the use of just-in-time logistics systems) and eco-procurement activities that facilitate the reduction, reuse and recycling of energy and resources (Green et al., 1996; Melnyk and Smith, 1996; Carter et al., 2000; Zhu et al., 2010; Zeng et al., 2016; Baskarana et al., 2012; Westervelt, 2012; Jakhar, 2015; Min and Galle, 1997).

Companies' green procurement practices are mainly determined by the supply base. A company's supply base is the set of suppliers that it directly cooperates with (Choi and Krause, 2006). To promote green procurement practices, the suppliers in the supply base should have adequate resources and capabilities to cooperate with companies (Handfield et al., 2002; Green et al., 1998; Min and Galle, 1997). Therefore, selecting suppliers to build a green supply base is essential in the green procurement stage. Environmental criteria should be applied in the process of supplier evaluation (Zhu et al., 2010; Carter et al., 2000; Handfield et al., 2002). In particular, Zhu et al. (2010) suggest strategies to evaluate and cooperate with suppliers: providing them with design specifications including environmental requirements; cooperating with them to achieve environmental goals; auditing their environmental performance; checking their ISO14000 certification; evaluating second-tier supplier environment-friendly practices; and cooperating with suppliers to use environment-friendly packaging. In addition to environmental criteria, sustainability criteria in the process of supplier evaluation have gained increasing attention recently (Baskarana et al., 2012; Spangenberg, 2004). Baskarana, Nachiappanb and Rahmanc (2012) suggest the following six criteria to evaluate the sustainability performance of suppliers: discrimination, abuse of human rights, child labour, long working hours, unfair competition and pollution. Considering sustainability criteria in the process of supplier evaluation helps companies gain benefits such as a positive brand image, good customer relations and fairness to suppliers (Rodriguez et al., 2006; Baskarana et al., 2012; Anderson and Skjoett-Larsen, 2009).

Green suppliers are considered to be company assets. However, they may also increase the economic burdens on companies because when suppliers are required to minimise resources and their use of toxic substances the total cost may increase (Zeng et al., 2016). Many researchers suggest that companies should balance economic performance and sustainable production performance in the process of supplier evaluation. Based on an analysis of 278 Indian apparel organisations, Jakhar (2015) concludes that sustainable production performance is more significant than economic performance. Therefore, although working with green suppliers may increase economic burdens, it could be the right decision in the long run.

Numerous researchers have discussed approaches to selecting suppliers. Baskaran et al. (2012) apply a grey approach when evaluating 63 suppliers in the Indian apparel industry using six sustainability criteria. Govindan et al. (2013) use fuzzy techniques referring to sustainability criteria (Fuzzy TOPSIS, Fuzzy AHP, Fuzzy DEMATEL) to select suppliers. Similarly, Shen et al. (2013) apply fuzzy techniques to select suppliers to automobile manufacturing companies considering environmental criteria. Kannan et al. (2014) apply fuzzy techniques when selecting green suppliers for a Brazilian electronics company and Buyukozkan and Cifci (2012) combine fuzzy TOPSIS, fuzzy DEMATEL (Decision Making Trial and Evaluation Laboratory methodology) and fuzzy analytic network processes when selecting green suppliers in a case study of Ford Otosan. The above approaches might not apply to all companies so managers should choose appropriate approaches to rank suppliers in real practice.

### 2.3.2.3 Green Manufacturing

The concept of Green Manufacturing/green production involves production processes and operations that are resource- and energy-efficient and minimise waste and emissions (Baines et al., 2012; Melnyk and Smith, 1996). Green production therefore involves various activities such as: updating equipment to reduce energy use; minimising air emissions; reducing both solid and liquid waste; and protecting the safety of workers, consumers and the local community (Ying et al., 2012; Baines et al., 2012; Ball, Evans, Levers and Ellison, 2009).

Regarding waste minimisation, Aurdahl (2016) states that the growing problem of dealing with waste from manufacturing processes requires companies to choose more green production-oriented approaches to waste management. However, innovations to reduce waste have not kept pace with this (O'Connor et al., 2016). To address these challenges, apparel companies may adopt some or all of the following strategies: designing manufacturing processes so as to be able to use recycled materials; introducing substitute materials; and developing technologies to enable waste recovery, including methods of collection (O'Connor et al., 2016).

As for emission minimisation, governments have imposed various types of regulations to curb greenhouse gas emissions forcing companies to develop greener manufacturing practices which use less energy and other resources (Jakhar, 2015). Table 2.4 shows techniques that have been widely applied in the past to analyse emission reduction in Green Manufacturing processes.

**Table 2. 4 Green Production Techniques**

| <b>Techniques</b>  | <b>Sources</b>  |
|--|---|
| Multi-objective programming of manufacturing processes: implementing constraints on emissions and penalties for exceeding emission limits.   | Radulescu et al. (2009)                                     |
| Grey compromise programming: examining optimal production-planning programmes to decide the environmental costs in an uncertain environment.   | Wu and Chang (2004)   |
| Traditional lot-sizing models: examining how to integrate carbon emission concerns in the processes of procurement and production.   | Benjaafar et al. (2013)                                     |
| Markov decision processes: integrating carbon emission concerns in multi-period production planning.   | Gong and Zhou (2013)  |
| Analytic hierarchy processes (AHP): combining mathematical programming to design a composite sustainable development index for the Shell Group and British Petroleum.                                    | Krajnc and Glavic (2005)                                    |
| Data envelopment analysis (DEA): developing a performance measurement system for the Korean electronics industry   | Lee and Farzipoor Saen (2012)                               |
| Nonlinear integer programming-based models, which are used to decide on pollution control investment.  | Caldentey and Mondschein (2003); Rajaram and Corbett (2002) |
| Oligopoly models: each company uses multiple technologies (differing in emission intensity) to examine over a finite horizon the cost of manufacturing multiple kinds of goods to meet inelastic demand. | Carmona et al. (2010)                                       |
| Interpretive structural modelling: ranking drivers that affect green supply chain management. Government legislation and regulations are the most important drivers.                                     | Diabat and Govindan (2011)                                  |

There are many intermediaries between fibre producers and final customers, which makes the apparel industry the industry with the longest supply chain (Baskaran et al., 2012). This industry has high uncertainty of demand and high inventory-carrying costs (Bonacich and Appelbaum, 2000; Jin, 2004; De Brito et al., 2008). Therefore, increasing production efficiency is a critical challenge for apparel companies. Regarding production efficiency, Huang et al. (2014) find that effective and efficient manufacturing processes require integration of the supplier base. Their result indicates that integrating the supplier base has a significant positive effect on performance (Huang et al., 2014). Knowledge sharing and interdependence become achievable with a high level of integration. Both

positively affect the efficiency of the production process. Furthermore, many researchers have discussed approaches to achieve efficient production, such as lean production and just-in-time production. Nowadays, in particular in the apparel industry, product-life-management-Runtime QT has been promoted to meet fast-changing fashion trends (Infor PLM Runtime QT, 2017). This helps apparel companies to design and produce apparel efficiently. It creates a flexible web-based platform for global collaboration, provides effective collection planning and designs automated workflow processes. Critical information is instantly available for use on a configurable web portal, which helps companies reduce critical lead times in product development.

Furthermore, to some extent, customised production can be efficient. Experience shows that customisation may result in resource and energy waste. However, as a leader in the customised apparel industry, the Red Collar Company has created an online customisation business model which can provide optimised customer experience through mass customisation. The benefits of the company's sophisticated big data information system are that the company can reduce lead time from 7 months to 7 days and make twice the profit compared with traditional apparel players (Red collar, 2017; Bain and Company, 2015). Although the cost of customisation is 10% more than mass production, Red Collar still generated about 2 billion RMB in sales and achieved a zero inventory in 2014. By reducing the lead time, its energy use is less and the zero inventory minimises resource waste (Red collar, 2017). Both help to improve production efficiency.

#### 2.3.2.4 Green Packaging and Distribution

Green packaging focuses on reducing the negative environmental impact of packaging materials. There are packaging material issues mainly in three stages: procurement, production and distribution. In order to achieve the aim of green packaging and distribution, companies may require suppliers and distributors to use environmentally friendly packaging materials in the procurement and distribution stages. Packaging materials used in the production stage should be reusable and recyclable (Lee et al., 2007; Tam and Tam, 2006; Hicks et al., 2005).

Green distribution plays a critical role in facilitating companies' overall environmental performance (Murphy and Poist, 2003; Jakhar, 2015). It aims to reduce the carbon footprint and includes factors such as cleaner transportation, optimised location allocation, effective warehousing systems, environment-friendly packaging and effective inventory management (Rogers and Tibben-Lembke, 1999; Gonzalez and Gonzalez, 2006; Jakhar, 2015). In order to achieve the objectives of green distribution, companies need to consider the following three areas: vehicle routing and transportation speed, mode of transportation (i.e. via water, air, rail or road) and logistics network design (Jakhar, 2015; Rao and Holt, 2005).

Regarding vehicle routing and transportation speed, Palmer (2007) proposes a computer-based vehicle routing model that calculates total CO<sub>2</sub> emissions during road journeys. This helps to reduce CO<sub>2</sub> emissions by 5%. This model is applied by Maden et al. (2010) and Ubeda et al. (2011) in two case studies and is further improved by Bektas and Laporte (2011) after considering fuel costs and travel times. In addition, Dekker et al. (2012) show that the choice of transportation speed affects greenhouse emissions and fuel consumption. This is further confirmed by Cariou (2011), Fagerholt et al. (2010) and Corbett et al. (2009) after analysing the effect of the choice of speed. Furthermore, to optimise vehicle routing, Beltran et al. (2009) apply a genetic algorithm-based approach to optimise the green capacity of public transportation. Faulin et al. (2013) employ an analytic hierarchy process approach to optimise vehicle routing to minimise the environmental impact of transportation activities to cross the Pyrenees between France and Spain.

Regarding the mode of transportation, Cholette and Venkat (2009) show that the choice of transportation mode can have a higher impact on greenhouse gas emissions than storage-related emissions in the California wine industry. Furthermore, input-output analysis shows that CO<sub>2</sub> emissions are reduced if the mode of transportation is changed from truck transportation to rail and marine transportation (Yoshida and Matsubishi, 2009), while Yan et al. (2010) show that electric vehicle truck transportation is the best option to reduce transportation emissions on the basis of an analysis using an interval-parameter intercommunity traffic model. Therefore, in real practice

companies can perform transportation simulations to decide on the best transportation design to minimise their carbon footprints.

Regarding logistics network design, companies can design logistics networks to reduce negative environmental impacts (Murphy and Poist, 2003). After conducting a life cycle analysis and spatial analysis of the freight patterns of major American commodity groups, Vanek and Morlok (2000) suggest that redesigning logistics networks can save energy. Previous researchers have highlighted the impact of logistics network design on the environment. D'Agosto and Ribeiro (2004) propose a structured eco-efficiency management programme to optimise Rio de Janeiro International Airport's road fleet operations and minimise fuel consumption. Sheu et al. (2005) apply a multi-objective linear programming (MOLP)-based logistics model to optimise integrated logistics. This is further applied by Quariguasi Frota Neto et al. (2009) in Germany to examine the eco-efficiency of a recycling logistics network. The MOLP-based logistics model is developed further and combined with DEA by Quariguasi Frota Neto et al. (2008) to design a logistics network which aims to balance environmental impacts and profitability in the European pulp and paper industry. Later, in 2013, to balance financial costs, environmental impacts and customers' needs for a Dutch public transportation operator, Lovric et al. (2013) developed a decision-support tool using a simulation approach and agent-based modelling.

#### 2.3.2.5 Customer Use to End of Life Management

In Green Manufacturing, in the customer use of a product to end of life management stage there is a focus on minimising waste, energy and emissions associated with products when they are in use (Baines et al., 2012; Seliger et al., 2008). The following practices can help apparel companies to achieve this target. First, they can innovate in the design stage to enable products to last longer by using more durable materials such as denim (Abraham, 2011). Long-lasting garments have more reuse options and tend to be seen more in secondary markets such as charity shops, online auction sites, vintage shops and boutiques and consignment stores. Second, and in terms of secondary markets, it is vital to raise customers' awareness of reusing or recycling their apparel to extend its lifecycle. Customers can donate unwanted clothes to charity shops. Some retailers such as TK Maxx and H&M have set up

apparel banks for reusing or recycling purposes. Customer cooperation in donating unwanted garments to these secondary markets can make apparel available at more affordable prices to a broader customer base and ultimately mitigate negative environmental impacts (Meyer, 1999; Brace-Govan and Binay, 2010). Third, a second-life retailing business model may constitute a key opportunity to extend the use of apparel sold by primary retailers. The apparel retailer Urban Outfitters has introduced an Urban Renewal Vintage Customised collection. Designers handpick vintage collections from second-hand shops and rework them for display in the shop or online. Each piece in these vintage collections is therefore unique and limited edition, which is attractive to buyers. Such a second-life business model not only extends the use of apparel in the maturity stage and reduces waste but also democratises consumption for new customers, which represents a significant contribution to sustainability (Beh et al., 2016).

#### 2.3.2.6 Green Remanufacturing

Global environmental problems present new issues in the economic world. There is now worldwide attention to improving the current dominant paradigm. A greener and more sustainable model of business has become the new paradigm (Aurdahl, 2016). This makes it fundamental to create a reverse supply chain for companies. Indeed, reverse supply chains not only reduce the overall carbon footprint but also create new opportunities for companies to gain new revenue streams through finding secondary markets for their materials and products (Nikolaidis, 2013). Nowadays, due to increasing public concerns about environmental pollution, companies are facing pressure to take responsibility for their products' entire life cycles. Remanufacturing has become a leading green practice when dealing with reusing products and it is part of the reverse supply chain concept (Seuring, 2004; Corbett and Klassen, 2006; Lisney et al., 2003; Rahimifard and Clegg, 2007). Reverse supply chains include closed-loop supply chains and open-loop supply chains (Genovese et al., 2017).

Closed-loop supply recovers the value of products from the customer to make a profit through refurbishment, remanufacturing or recycling. It involves returns collection, which is usually done by retailers on behalf of apparel companies. For example, the apparel companies Marks & Spencer and

H&M have set up apparel banks to take back used garments. After collecting products, the manufacturer can strategically integrate supply chain activities to capture their additional value.

An open-loop supply chain reuses, recycles or disposes of products and packaging for all operations. The products collected can be recycled to produce the same type of products or be upcycled for the production of different types of products. For example, used clothes can be recycled in the production of new apparel or toys or upcycled to car upholstery. Therefore, an open-loop supply chain is an environmental protection process of moving goods from their typical final destination to different types of manufacturing to capture their value (Nasir et al., 2017; Gou et al., 2008; Genovese et al., 2015; Abraham, 2011).

The concepts of both closed-loop and the open-loop supply chains focus on taking back products and capturing additional value. There are three main differences between the two concepts. The first is the collection method. Collection in a closed-loop supply chain is usually done by the company but in an open-loop supply chain it is usually done by third parties. The second difference is the use after collection. A closed-loop supply chain aims to move products from customers back to their manufacturer to recover their value or part of it. However, in an open-loop supply chain, products and packaging are moved from customers to different manufactures to be recycled, reused or disposed of. The third difference is the objective. A closed-loop supply chain is for resale and for profit, whereas an open-loop chain is part of corporate social responsibility aiming to reduce environmental impacts.

Products in a reverse supply chain can be categorised into two types: business-to-business (B2B) returns, including commercial returns and manufacturing returns, and business-to-customer (B2C) returns, including warranty returns, product recalls, end-of-use returns, end-of-life returns and service returns (Beh et al., 2016).

Two stages – the collection stage and the selection and sorting stages – are involved in reverse supply chains. These stages have five key components: product acquisition; reverse logistics; inspection and disposition; reconditioning; and distribution and sales. Product acquisition is the process of obtaining used products. Reverse logistics is the process of transporting end of life products to reprocessing companies. Inspection and disposition is the process of inspecting used products (and

deciding whether to reuse, remanufacture or recycle them) (van Hilleberg et al., 2001; Kleindorfer et al., 2005; Corbett and Klassen, 2006). Once it has been decided whether the used products are to be remanufactured or upcycled, they move to reconditioning. Compared with traditional manufacturing, reconditioning is less predictable due to the quality of returned products, variations among them and a large degree of timing uncertainty. Therefore, companies may put efforts into the sorting stage to reduce manufacturing variability. The last stage is distribution and sale. Companies need to decide whether there is a need to create a new market or demand for remanufactured products or upcycled products.

The differences between forward logistics and reverse logistics lie in the following areas: product quality uniformity, product price uniformity, product life cycle and the visibility of the process (Enarsson, 2006; Krumwiede et al., 2002). The traditional logistics systems in most industries are forward logistics (Reinhardt, 1999; Hart, 1995, 1997). Reverse logistics network design has been widely applied in the electronics industry. For example, Xerox proposes an Asset Recycle Management Programme (ARMP) and has developed a remanufacturing process to reuse the parts from leased copiers in new machines. Canon, IBM, Kodak and HP take back used machines and modify the parts for use in new machines.

In the apparel industry, normal reverse logistics activities are reversing products for resale, selling through outlets, donating and reusing (Rogers and Tibben-Lembke, 1999; Guidini, 1996). The purpose of reversed products greatly depends on the condition of the returned products. In the selection and sorting stage, products that cannot be reused or upcycled will be disposed of. Products that can be reused or upcycled are transported to factories for refurbishing, repair or upcycling (Aurdahl, 2016). Regarding transportation, many companies do not have reverse transportation.

Furthermore, due to the complexity of reverse logistics processes, many companies are still unable to efficiently design reverse logistics networks. Therefore, working with third-party reverse providers is an opportunity for companies to enter reverse logistics markets (Aurdahl, 2016). In this case, third-party reverse logistics providers play essential roles in reverse logistics systems. For example, Dongtai is a certified waste management company in north-eastern China with an annual

turnover of around USD 10 million. This company engages in collecting, inspecting and sorting industrial waste products and materials. Although the company has increasingly invested in waste management technologies to deal with an annual 200,000 tons of waste, only 25% of the waste products and materials can be recycled or upcycled, and most electronic waste still needs labour to be disassembled (Park et al., 2010). Nowadays, benefitting from the development of mobile applications, some apparel recycling companies have built mobile applications, such as White Whale and Flying Ants. About 6,000 tons a month of items are collected from customers using online recycling services (Jiuyf, 2018). Customers just need to make an appointment for collection using mobile applications. Delivery men arrive at the scheduled time to collect the items. The collected clothes are either donated or sold to apparel manufacturing companies for remanufacturing (Jiuyf, 2018). Therefore, companies that do not have reverse logistics may work with third-party reverse logistics providers to take back customers' used garments for remanufacturing.

### 2.3.3 Capability: Circular Economy capability

Resource-based view (RBV) theory is an approach to companies' business strategic management which emerged in the 1980s and 1990s. According to this theory, a company possesses various types of resources such as tangible and intangible ones, including skills, assets, information, processes, knowledge and so on. When these resources are reconfigured and combined, they can create 'business capabilities,' which can be viewed as a special type of resource (Makadok, 2001) and which create 'core competencies' that allow companies to maintain sustainable competitiveness (Barney, 1991).

NRBV emerged from the earlier theoretical contribution of RBV. In classic strategic management, RBV suggests firms should bundle their resources and capabilities uniquely to generate competitive advantages (Barney, 1991). Traditional strategic models do not show how the constraints of natural and social environments affect companies' abilities to generate competitive advantages. NRBV was proposed to deal with this aspect and suggests that a competitive advantage is rooted in a companies' ability to facilitate environmental performance (Guang Shi et al., 2012; Hart, 1995, 2011). NRBV theory articulates the connection between companies' resources and capabilities. It suggests

companies should incorporate environmental practices in their operational activities to maintain sustainable competitiveness and explains how they can utilise their resources to develop their environmental capabilities (Hart, 1995). In this study Circular Economy Capability is regarded as a form of environmental capability. Accordingly, based on NRBV theory, companies can utilise their resources efficiently and innovatively to build Circular Economy Capability. In this study, the environmental capability that they aim to build is Circular Economy Capability at the company level, which includes reduction capability, reusing capability and recycling capability (Anderson, 2007; Yong, 2007).

The concept of the Circular Economy focuses on continuing economic development and creating self-sustaining manufacturing systems with which to use materials or products repeatedly (Genovese et al., 2017). Many countries such as China, Japan and Germany promote the Circular Economy as an effective environment-enhancing strategy. The Chinese government adopted the Circular Economy as its official development strategy in 2002 to overcome environmental degradation and resource depletion (Zhu, 2010; Zhu, 2011; Mathews and Tan, 2011; Yuan et al., 2006).

The concept of the Circular Economy was first introduced by Boulding in 1966. He argued that the economy had developed from the traditional “open system” into a new “closed system” (Boulding, 1966). In 1995, Thierry and colleagues proposed the design of circular supply chains. These integrated supply chains enable used products to be returned for recovery operations, including reuse, remanufacture, repair and recycling. After recovery, the products can go back into the forward supply chain. This creates a circular flow of products.

With the development of globalisation and industrialisation, there has been an increase in the volume of waste apparel. Most is disposed of in the early stages of the lifecycle and has become a significant source of environmental pollution (Lina, 2015; WRAP, 2012; Gracey and Moon, 2012; Textiles Circular Economy, 2010). Therefore, creating a circular flow of apparel is of significant importance.

Increasingly, environmental-oriented cooperation among companies’ stakeholders and green supply chains in terms of real practices are considered the approach to achieve the goal of a Circular Economy (Zhu et al., 2010; Georgiadis and Besiou, 2008). Building capabilities is defined as conducting

interrelated routines for business objectives through utilising resources to achieve specific outcomes (Teece et al., 1997). The main objective of the Circular Economy at the company level is to apply sustainable principles to reduce energy and resource use, to reuse materials and to recycle used products (Nasr, 2013; Zhu et al., 2010; 2011). Circular Economy Capability at the company level is represented by the capacity to reduce, reuse and recycle (Zhu et al., 2010; 2011, Anderson, 2007; Yong, 2007). Hence, this study applies the so-called 3Rs as subconstructs of the Circular Economy Capability variable. The 3Rs capabilities (Table 2.5) are reduction capabilities that can be developed in the production, distribution and usage stages in a product’s life cycle; reuse capabilities, which aim to extend the life cycle of a product in the remanufacturing stage; and recycle capabilities, which focus on proper disposal of products or materials in the end of life stage.

**Table 2. 5 Sub-constructs of Circular Economy capability**

| <b>3Rs</b>  | <b>Significance and implications</b>   | <b>Life cycle stage</b>                 |
|---|--|---|
| Reduction capability<br>A set of interrelated routines reducing energy and material usage. (Rivera-Becerra and Lin, 1999; Zhu et al., 2005).  | Energy consumption: a reduction in environmental pollution deriving from the production of energy (electricity, fossil fuels)<br>- maximising energy efficiency during the use stage.<br>- utilising machinery with high efficiency energy utilisation.<br>- employing solar or rechargeable energy or catalytic converters.<br>Materials: elimination of environmentally harmful materials and minimisation of waste (scrap, spills).<br>- avoiding the use of non-renewable resources.<br>- ensuring components can be safely disposed of. | Design, manufacture, distribution, use. |
| Reuse capability<br>A set of interrelated routines utilising production materials (Rivera-Becerra and Lin, 1999; Unob, 2007; Brunori et al., 2005; French and Laforge, 2006).       | Reduction of the quantity of materials or products sent to landfill; recuperation of valuable products or components that are functionally operational.<br>- Including durable products.<br>- Increasing product modularity.<br>- Facilitating access to reusable components   | Design, disposal.                       |
| Recycle capability<br>A set of interrelated routines collecting, reprocessing and reutilising waste and used products for new purposes (Rivera-Becerra and Lin, 1999; Hicks et al., | Reduction of the quantity of materials or products to be sent to landfill, efficiently utilising afterlife materials or products.<br>- combining components with the same materials.<br>- minimising and standardising fasteners.  | Design, disposal.                       |

### 2.3.3.1 Reduction Capability

Zhu et al. (2011) consider that there is a hierarchy among the 3Rs, with waste reduction in first place, then reuse and then recycling. To improve their reduction capabilities, companies may adopt a set of routines to reduce energy and materials, such as investing in energy-efficient equipment, investing in manufacturing methods that use fewer materials and scheduling the working time of employees and equipment to save energy (Zhu et al., 2005; Zhu et al., 2010, 2011; Anderson, 2007; Yong, 2007). These are usually involved in the early stages of the manufacturing process, such as the green design, green procurement, green process and green packaging stages. Reuse and recycling activities are involved in the later stages, such as the green end of life management stage and the remanufacturing stage.

To reduce their use of energy and materials, apparel companies in particular need a set of routines to be adopted, such as investing in energy-efficient equipment, investing in manufacturing methods using fewer materials and scheduling the working time of employee and equipment to save energy (Zhu et al., 2005). Furthermore, to reduce apparel waste, second-life retailing is important. The secondary markets for clothing include charity shops, online auction sites, vintage shops and boutiques and consignment shops. Second-life retailing aims to reduce waste and at the same time democratise consumption (Beh et al., 2016). By reducing the disposal of goods and offering them to a broader consumer base at affordable prices, second-life retailing facilitates companies' sustainability initiatives, improves business performance in secondary markets (Brace-Govan and Binay, 2010; Meyer, 1999) and contributes to the Circular Economy.

### 2.3.3.2 Reusing Capability

Reusing capability is defined as a set of routines for reusing materials, products and packaging. These include reusing for the same and for new functions (French and Laforge, 2006). The proper reuse of apparel can reduce textile waste and ultimately mitigate environmental impacts. For example, apparel companies can reuse scraps or trims of raw materials to make similar products. Numerous researchers have discussed the concept of reusing. Vandermerwe and Oliff (1990) and Cairncross (1992)

demonstrate the environmental value of reusing. Fargher and Smith (1996) further clarify the concept and consider that reusing products should happen when the economic value of doing so is more than the cost of disposing of them. Reuse is advocated by Kumar and Putnam (2008), who recommend the remanufacturing or reuse of used products in different industries.

The proper reuse of used apparel products can reduce textile waste and ultimately reduce environmental impacts. Previous studies (WRAP, 2010; Hansen, 1994; Hansen, 2000; Mhango and Niehm, 2005; Norris, 2010; Abraham, 2011) show that reusing garments is vital in changing consumers' disposal and purchasing behaviour and so it plays an important role in promoting environmental sustainability. Rivoli (2005) studies the apparel supply chain in the economics of global trade by mapping the travels of a T-shirt across continents. Furthermore, the sociologists Kuchler and Miller (2005) link the concept of reusing apparel to material culture. They claim that clothes are vibrant parts of culture rather than superficial adornments. Their results suggest that the proper reuse of used apparel products can reduce textile waste and ultimately reduce environmental impacts. A case study on reusing clothing in Hong Kong shows that reusing used garments is essential in changing consumers' disposal and purchasing behaviour and plays a significant role in promoting environmental sustainability (Wrap, 2012). This is further confirmed by other researchers in other places, such as Zambia (Hansen, 1994; Hansen, 2000); Malawi (Mhango and Niehm, 2005) and India (Norris, 2005; Abraham, 2011). Furthermore, to reuse apparel, some fast-apparel retailers have implemented used garment collection schemes. Consumer surveys indicate that such schemes not only reduce environmental impacts but also help retailers to raise brand awareness and build brand images, which further enhances their market competitiveness (Choi et al., 2015).

#### 2.3.3.3 Recycling Capability

Recycling capability is the process of collecting waste, used products, by-products and packaging materials before sorting, reprocessing and utilising them for new purposes (Hicks et al., 2005). Previous researchers (Kuchler and Miller, 2005; Wang, 2006) have discussed the significant influence of apparel recycling and point out that used clothes can be upcycled or transformed into different items. Kuchler

and Miller (2005) and Hawley (2006) consider that the material value of clothing is not equal to its monetary value, and used clothes can be upcycled or transformed into different items. Hawley (2006) creates a schematic map of a wide variety of apparel recycling markets. She also creates a conceptual model to categorise waste apparel and claims that the volume of goods has an inverse relationship with their value. Furthermore, Koch and Domina (1999) discuss apparel waste in the USA and suggest that it can be reduced by promoting organised apparel recycling programmes.

Recycling used products in the manufacturing sector is possible. Nevertheless, Hawley (2006) and Beh et al. (2016) argue that classic recycling of used apparel is less economical, and it is less common to reverse clothing back to the point of origin to refurbish it and recover value (reverse supply chain) due to technology restrictions. Although the opportunities to transform used apparel into raw material for new apparel are restricted, transforming unusable apparel into other products, such as toys, car upholstery and paper is still possible.

#### 2.3.4 Outcomes: Company performance

The result of implementing Green Manufacturing and building Circular Economy Capability is reflected in Organisational Performance, which includes both environmental and business performance. NRBV theory suggests that companies should incorporate environmental concerns in their operational activities to improve their overall operational performance (Hart, 1995). The outcome after implementing Green Manufacturing and developing Circular Economy Capability is reflected in Organisational Performance, including both environmental performance and business performance. Environmental performance can be improved by implementing green practices and improving environmental capability (Kong et al., 2016; Anderson, 2007; Yong, 2007; Ilinitich et al., 1998; Vachon and Klassen, 2006). In addition, after implementing Green Manufacturing and building Circular Economy Capability, business performance might be improved by building a good public image and sustaining competitive advantages (Porter and van der Linde, 1995).

Hajer (1995) suggests that the economy can benefit from moving to environmentalism. Based on this view, current researchers are now more focused on environmental innovations (Huber, 2004;

Olsthoorn and Wieczorek, 2006; Park et al., 2010; Zhu et al., 2012) which rely on improving product life-cycles and material and energy flows (Braungart and McDonough, 2002). Braungart and McDonough (2002) promote 'cradle to cradle' manufacturing, in contrast with traditional 'cradle to grave' manufacturing (where waste is not taken back into production process). Building on the 'cradle to cradle' concept, Green Manufacturing aims to minimise environmental impacts and maximise resource efficiency by focusing on integrating product and process design to identify and assess the flow of waste into the environment (Melnik and Smith, 1996). Therefore, as both ecological development and economic development can be ambidextrously achieved by applying certain green practices (Park et al., 2010; Zhu et al., 2012; Hajer, 1995; Spaargaren and Mol, 1992; Mol, 1995; Mol and Spaargaren, 1993), companies' overall performance can be improved by implementing Green Manufacturing.

The Circular Economy focuses on improving economic performance while alleviating environmental impacts (Geng et al., 2009). NRBV theory suggests companies should incorporate environmental concerns in their operational activities to improve their overall outcomes (Hart, 1995). They should incorporate environmental practices in their operational activities to maintain sustainable competitiveness and the theory explains how they can utilise their resources to develop their environmental capabilities (Hart, 1995). A company's environmental capability can directly impact its overall environmental performance, facilitate the maintenance of competitive advantages and ultimately improve its Organisational Performance (Hart, 1995; Porter and van der Linde, 1995; Ilinitch et al., 1998; Mol and Spaargaren, 1993). Therefore, as one of companies' environmental capabilities, Circular Economy Capability can help improve Organisational Performance. Circular Economy Capability at the company level is reflected in reduction capability, reusing capability and recycling capability (Anderson, 2007; Yong, 2007). Specifically, by building their reduction capability and reusing capability, companies can reduce expenses on resources and energy use and re-utilise production materials, which can improve their business performance. Through building their recycling capability, companies can attract consumers who prefer eco-friendly products and build good brand images. This will allow them to produce at low cost and in a more environmentally friendly manner and so to

increase their sales and extend their market shares in an environment-oriented market, which eventually will improve their Organisational Performance and sustain their competitive environmental advantages (Yong, 2007; Porter and van der Linde, 1995; Anderson, 2007; Hart, 1995). Therefore, this study adopts companies' Organisational Performance as one of the constructs in its conceptual model. In particular, companies' Organisational Performance is proposed as the outcome of implementing Green Manufacturing and building Circular Economy Capability.

#### 2.3.4.1 Environmental performance

How a company does environmentally plays an increasingly vital role in the evaluation of its overall performance in the current global market (Green et al., 1996; Zhu et al., 2010). This study sets out to evaluate companies' environmental performance using the following dimensions: environmental impact, internal environmental management performance and external stakeholder relations (Wood, 1991; Ilinitich et al., 1998). These are adapted from a four-dimensional theoretical model which was first proposed by Wood (1991) and improved by Ilinitich et al. (1998). This model classifies companies' environmental performance into four sub-sets – environmental impact, internal environmental management performance, regulatory compliance and external stakeholder relations – using two parameters: internal-external and process-outcomes. Regulatory compliance examines the extent to which a company meets the standards in government regulations (Ilinitich et al., 1998; Florida, 1996). External stakeholder relations examine the extent to which a company satisfies external stakeholders' requirements in implementing environmental practices (Ilinitich et al., 1998). As an external stakeholder, the government sets environmental regulations for companies. Therefore, the regulatory compliance variable can be classified in the same group as external stakeholder relations.

Furthermore, internal environmental management performance can be reflected in the extent to which a company can implement environment-enhancing activities (Ilinitich et al., 1998; Hamel and Prahalad, 2005). The environmental impact dimension is measured by changes in a company's negative ecological externalities deriving from its business operations (Ilinitich and Schaltegger, 1995; Ilinitich et al., 1998). As one of the outcomes of this, in this study environmental performance is measured using

the extent a company can meet external stakeholders' requirements, manage internal environment-enhancing activities and reduce negative environmental impacts.

### **Environmental impacts**

Environmental impacts in this study are negative environmental externalities deriving from a company's business operations, including air pollution, water pollution, use of toxic materials and unnecessary or excessive use of natural resources (Ilinitch and Schaltegger, 1995; Zhu et al. 2004).

### **Internal environmental management performance**

Internal environmental management performance is the extent to which a company successfully implements environment-enhancing activities (Ilinitch et al., 1998; Hamel and Prahalad, 2005; Zhu et al. 2004; Zsidisin and Siferd, 2001). The following parameters of this are measured in this study: the implementation of environmental practices, the effectiveness of a company's environmental department, the effectiveness of its environmental training programme and the effectiveness of environmental auditing programmes.

### **External stakeholder relations**

Relationships with external stakeholders, including customers, suppliers, NGOs, local communities and governments, can reflect the success of an organisation's operations (Zhu et al., 2010; Elenkov, 1997). External stakeholder relations regarding environmental issues are viewed as an essential measurement to evaluate environmental performance (Zhu et al., 2010; Ilinitch et al., 1998; Lober, 1996; Wood, 1991). External stakeholder relationships in this study are a company' relationships with external stakeholders regarding environmental issues (Elenkov, 1997; Ilinitch et al., 1998; Zhu et al., 2010).

#### 2.3.4.2 Business Performance

A company's business performance represents the effectiveness and efficiency of its operations (Venkatraman and Ramanujan, 1986; Tracey and Tan, 2001; Tracey et al., 2005; Nahm et al., 2004; McKee et al., 1989; Kristal et al., 2010). This is generally reflected in two things: financial and market performance (Venkatraman and Ramanujan, 1986). In this study, business performance is the extent to which a company improves its business and financial performance (Neely et al., 2005; Venkatraman and Ramanujan, 1986; McKee et al., 1989). To be even more specific, financial performance is the efficiency with which a company generates profits, utilises its assets and achieves capital appreciation (Zeng et al., 2010; Waddock and Graves, 1997; Vickery et al., 2003). Market performance, in turn, is the extent to which a company increases its market share and sales and improves its market competitiveness (Zeng et al., 2010; McKee et al., 1989; Venkatraman and Ramanujan, 1986).

Instead of collecting quantitative objective data, this study collects opinion-based subjective data to analysis business performance. These data are easier to obtain and can directly reflect improvements or declines in business performance in the past two years (Das and Narasimhan, 2001; Venkatraman and Ramanujan, 1986). When respondents answer the survey, they can select the best option to describes changes in their company's performance in the past two years. The options are: increased by over 6%; increased by 1%-5%; no change; decreased by over 6%; decreased by 1%-5%; and not applicable.

#### **Market Performance**

Market performance is a key indicator reflecting a company's overall business performance (McKee et al., 1989; Venkatraman and Ramanujan, 1986). The parameters of market performance are market share growth, sales growth, capital appreciation and competitive position (Tracey and Tan, 2001; Venkatraman and Ramanujan, 1986; Nahm et al., 2004; Kristal et al., 2010; Tracey et al., 2005). When respondents answer the survey, they can select the best option to describe changes in their company's performance in the past two years. The options are: increased by over 6%; increased by 1%-5%; no change; decreased by over 6%; decreased by 1%-5%; and not applicable.

## **Finance Performance**

Financial performance is a primary indication of a company's business performance (Fullerton et al., 2003; Waddock and Graves, 1997; Dehning et al., 2007; Vickery et al., 2003) which reflects the efficiency and effectiveness of operational practices and managers' strategic planning (Neely et al., 2005) and has significant impacts on potential future developments (Fullerton et al., 2003; Waddock and Graves, 1997).

Financial performance in this study is measured using traditional indicators: return on investments (ROI), return on assets (ROA) and return on sales (ROS) (Fullerton et al., 2003; Waddock and Graves, 1997; Vickery et al., 2003). ROI evaluates the efficiency of investments and describes a company's efficiency in converting investments into net income. ROA is the ratio between a company's profitability and its total assets. As an increase in ROA shows increased efficiency of the company's management to use assets to gain profits, ROA is used to compare a company with its competitors. ROS shows the efficiency with which a company turns sales into profits. When respondents answer the survey, they can select the best option to describe changes in their company's performance in the past two years. The options are: increased by over 6%; increased by 1%-5%; no change; decreased by over 6%; decreased by 1%-5%; and not applicable.

### **2.3.4.3 Balancing environmental performance and business performance**

NRBV theory articulates the connection between a firm's resources, capabilities and competitive operational advantages. (Hart, 1995). To sustain competitive advantages, companies may utilise their resources and capabilities to achieve synergy between environmental performance and business performance. As discussed earlier, by implementing Green Manufacturing, companies can improve their environmental performance and business performance. In addition, business intelligence is identified as being useful for companies to achieve synergy between their environmental performance and business performance. It helps companies make right decisions at the right time, and represents a collection of processes, technologies and tools (Elena, 2011; Fink et al., 2017; Martin et al., 2012). It

provides a broad measurement, builds big data analytical capability and lays the foundations for applying integrated management control systems (Elbashir et al., 2013; Peters et al., 2016; Elbashir et al., 2011). Companies may develop a business intelligence model to predict their business performance by employing bankruptcy predictions. Business intelligence enables companies to improve their performance by considerably improving their productivity, services or sales (Martin et al., 2012).

Moreover, big data has emerged as an opportunity for business in recent years (Peters et al., 2016). Big data analytics capability (BDAC) has been applied worldwide to transform how companies do business (Peters et al., 2016; George et al., 2014; Gobble, 2013; Barton and Court, 2012; Strawn, 2012; McAfee and Brynjolfsson, 2012). Table 2.6 shows details of these and other leading suggestions on how to improve business performance: leveraging workforce diversity; integrating supplier management; improving new product development; enhancing knowledge sharing; improving adoption of social media; developing talent intelligence; applying business intelligence; and integrating supplier management.

**Table 2. 6 Suggestions on how to improve business performance**

| Sub-constructs                      | Specific interview questions/ Survey measurement items                         | References  |
|-------------------------------------|--|---|
| Sustainable supply chain management | Sustainable supply chain design<br>Supply chain member relationship management | Zeng et al., 2016; Genovese et al., 2017; Jamali and Keshishian, 2009; Sajjad et al., 2015; Seuring and Muller, 2008; Tay et al., 2015; Walker and Jones, 2012; Wittstruck D, 2011; |
| Applying business intelligence      | Bankruptcy prediction<br>Developing big data analytics capability (BDAC)       | Elena, 2011; Fink et al., 2017; Martin et al., 2012; Akter et al., 2016; Peters et al., 2016;   |

|                                    |   |  |
|------------------------------------|---|--|
| Leveraging workforce diversity     | <p>Building senior management commitment and accountability.</p> <p>Conducting a thorough needs assessment.</p> <p>Developing a well-defined strategy tied to business results.</p> <p>Emphasising team building and group process training.</p> <p>Establishing metrics and evaluating the effectiveness of diversity initiatives.</p> | Jayne et al., 2014;  |
| Integrating supplier management    | <p>Supplier evaluation and selection.</p> <p>Supplier involvement.</p> <p>Supplier management strategy.</p>   | Neumuller, Lasch and Kellner, 2016; Zhu and Geng, 2003; Peltz, Robbins and McGovern, 2012; |
| Improving new product development  | <p>Speed of new product development.</p> <p>Improving supplier new product development performance.</p>   | Lawson, Krause and Potter, 2014  |
| Enhancing knowledge sharing        | <p>Organisational learning and sharing.</p> <p>Open communication.</p> <p>Incentives/rewards.</p>   | Cervellon and Wernerfelt, 2012; Shih et al., 2012;   |
| Improving adoption of social media | <p>Communication performance.</p>   | Wang et al., 2016;   |
| Developing talent intelligence     | <p>Ensuring access to the most critical employee and talent data.</p> <p>Employees' experience before and during employment, career ambitions that can be used in development plans and succession planning, individual performance ratings to help identify future leadership potential.</p>   | Snell, 2011;   |

### 2.3.5 Barriers to Green Manufacturing Implementation

Blind pursuit of fast economic growth and over-exploitation of land creates an increasingly prominent environmental problem in developing countries. Nowadays, developing countries, such as China, are starting to pay much attention to environment issues and put Green Manufacturing on the development schedule. Before 2010, the Chinese government applied a 'command-and-control' model which included an obsolete capacity retirement programme, a mandatory target accountability system and a top-1000 enterprise programme to implement the major energy-efficiency policies (Zhao et al.,

2014). Between 2010 and 2015 (12th five-year plan), as the complexity of green activities which involved decentralised stakeholders increased (Kong et al., 2016), more bottom-up approaches that could mobilise stronger market forces were required to achieve the Chinese government's policy goals (Zhou et al., 2015). Nowadays, the government is striving to apply green transformations to resolve potential trade-offs and diffusion barriers (Lederer, Wallbott and Bauer, 2018). However, the rate of green transformations in China is still low (Liu et al., 2017).

Green Manufacturing has become a topical issue in both research and company practice in recent years. Recent studies show that manufacturers still have a low level of achievement of Green Manufacturing goals (Zhu and Geng, 2013; Zhu et al., 2005; Jui and Ming-Lang Tseng, 2011; Zhu et al., 2012; Diabat and Govindan, 2011). Therefore, it is necessary to identify the factors that inhibit the implementation of Green Manufacturing. However, there is a dearth of empirical research identifying the current barriers to apparel companies implementing Green Manufacturing practices. Therefore, this study fills the existing gap by identifying current Barriers to Green Manufacturing implementation by apparel companies. To identify these barriers, first a literature review of Barriers to Green Manufacturing implementation at the company level is conducted. Then, semi-structured interviews with company managers are conducted to further reveal the latest Barriers to Green Manufacturing implementation in apparel companies.

Researchers have observed various barriers that affect Green Manufacturing implementation in companies, including internal (Zhu and Geng, 2013; Connell, 2010; Walker et al., 2008; Hillary, 2004) and external ones (Walker et al., 2008). This study examines ten barriers (Table 2.8). They fall into the following four categories: technologies, knowledge, finance and people's involvement and support (Wang et al., 2016; Govindan et al., 2014; Sajjad et al., 2015; Walker et al., 2008; Hillary, 2004).

Internal barriers involve: internal stakeholders' behavioural and psychological issues with the organisational workforce; resource and capability constraints; financial constraints and so on (Table 2.7). Numerous researchers have pointed out that management support and commitment can be instrumental in implementing green practices in companies (Sajjad et al., 2015; Zhu and Geng, 2013; Wittstruck and Teuteberg, 2011). Furthermore, from the perspective of resource-based theory,

resource allocation to implement Green Manufacturing requires management support (Zhu and Geng, 2013; D'Amato and Roome, 2009; Ebinger et al., 2006). Hence, a lack of commitment by top or senior managers can reduce company capacity to implement green practices. Specifically, top and senior manager strategic leadership plays a vital role in green procurement (Sajjad et al., 2015; Correia et al. (2013). A study conducted by Walker and Brammer (2009) shows that financial constraints are the most significant barriers to sustainable procurement in public sector procurement practices in the UK. Short-termism in traditional purchasing systems has the result that lower upfront costs encourage buyers to purchase cheaper products (Sajjad et al., 2015). Therefore, decision-makers often struggle to promote Green Manufacturing, considering that the costs of supply chain infrastructure and systems may increase (Ageron et al., 2011). Therefore, a lack of commitment by managers and related financial barriers, such as increasing short-term costs and a lack of clear benefits (Zhu and Geng, 2013; van Hemel and Cramer, 2002; Sarkis et al., 1997) can act as obstacles to implementing Green Manufacturing.

Furthermore, a lack of manager awareness, manager risk-aversion behaviour and legal and administrative complexities can be related barriers inhibiting Green Manufacturing implementation (Sajjad et al., 2015; Correia et al., 2013). Another related internal barrier concerns human resource capabilities (Zhu and Geng, 2013), which for years has been the primary type of barrier in Asian developing countries (Zhu and Geng, 2013; Visvanathan and Kumar, 1999). Although companies recognise the importance of green practices (Vachon and Klassen, 2006; Sajjad et al., 2015; Zhu and Sarkis, 2004), most of them lack the advanced knowledge, essential skills and professional support to implement them.

External barriers involve specific external stakeholder issues, such as external stakeholder corporate ability, awareness and negative perceptions. These includes a lack of supplier awareness, a lack of supplier capability, supplier negative perceptions, inadequate government support and inadequate consumer demand for sustainable products (Table 2.7). In particular, government environmental regulations are the most critical external antecedents of Green Manufacturing implementation (Sajjad et al., 2015; Wittstruck and Teuteberg, 2011). However, some researchers

claim that inflexible and costly regulations restrain green practices (Sajjad et al., 2015; Porter and van der Linde, 1995; Rivera-Becerra and Lin, 1999). Rivera-Becerra and Lin (1999) argue that it is difficult to define environmental performance for the following four reasons: use of qualitative linguistic expressions; use of heterogeneous and non-standardised data; lack of appropriateness; and non-availability of detailed data. Brewer and Speh (2001) and Hervani et al. (2005) agree, arguing that non-standardised performance measures may limit companies' abilities to innovate technology since they are only required to meet minimum regulatory standards.

Furthermore, customers believe that there is a price premium on green products. However, Doonan et al. (2005) argue that this is not true. This decrease in customer demand for green products may be due to lack of time for research or inadequate information on prices (Sajjad et al., 2015; Young et al., 2010; Seuring and Muller, 2008). Table 2.8 (adapted from Wang et al. (2016) and Govindan et al. (2014)) shows barriers to implementing a green supply chain. The specific barriers in Table 2.7 are similar to the barriers in Table 2.8. The difference between the two tables lies in the sources and categories. Table 2.7 is based on a summary of the relevant literature, and these barriers are classified into two groups: internal barriers and external barriers. Table 2.8 is taken from studies by previous researchers, and these barriers are classified into four groups: technologies, knowledge, finance and people's involvement and support.

Furthermore, numerous researchers propose different approaches to identify barriers. Wang (2016) applies DEMATEL to identify critical barriers to green practices in the packaging industry. Sajjad (2015) uses a multiple exploratory case study to explore barriers to sustainable supply chain implementation in four large companies based in New Zealand. Zhu and Geng (2013) apply exploratory factor analysis (EFA) to identify theoretical factors behind green practice implementation barriers in organisations in Shenyang, a typical Chinese industrial city. Toke et al. (2012) and Govindan et al. (2014) use an analytic hierarchy process to analyse barriers to green supply chain implementation in Indian industries. Mudgal et al. (2010), Luthra et al. (2011) and Mathiyazhagan et al., (2013) apply interpretative structural modelling (ISM) to investigate barriers to green supply chain management adoption in Indian industries.

**Table 2. 7 Internal barriers and External barriers**

| <b>Constructs</b>  | <b>Sub-constructs</b>  |
|--|--|
| Internal barriers:   | Benefit.   |
| financial barriers (Zhu and Geng, 2013)  | Lack of clear benefit (van Hemel and Cramer, 2002).<br>Cost.<br>Increasing short-term cost (Sarkis et al., 1997).<br>Higher supplier prices (Sajjad et al., 2015).<br>Customer desire for lower prices (Stremlau et al., 2016).<br>Sunk costs (Govindan et al., 2014).   |
| Internal barriers:   | Resources.   |
| Company resources and capabilities (Zhu and Geng, 2013)  | Efficient resource allocation.<br>Lack of adequate support by top management (Sajjad et al., 2015; Zhu and Geng, 2013; Ebinger et al., 2006; Ageron et al., 2011; Giunipero et al., 2012).<br>Lack of advanced green practice technology (Zhu and Geng, 2013).<br>Improper institutional norms (Govindan et al., 2014).<br>Human resource capabilities.<br>Lack of relevant knowledge and skills (Zhu and Geng, 2013; del Brio et al., 2008; Visvanathan and Kumar, 1999).<br>Lack of adequate training (Wang et al., 2016).<br>Lack of progress monitoring (Wang et al., 2016).<br>Improper communication structures (Govindan et al., 2014). |
| Internal barriers:   | Internal stakeholder awareness.  |
| internal stakeholder behavioural and psychological issues with the organisational workforce (Sajjad et al., 2015). | Top leadership (Ageron et al., 2011; Chan, 2007; Giunipero et al., 2012).<br>Lack of manager awareness and understanding (Sajjad et al., 2015).<br>Manager risk-aversion behaviour (Sajjad et al., 2015).<br>Internal stakeholder commitment.<br>Top management commitment (Stremlau et al., 2016).<br>Internal stakeholder capability.<br>Lack of manager professional environmental knowledge (Muduli et al., 2013; Wu et al., 2012).  |
| External barriers:   | External stakeholder awareness.  |
| External stakeholder issues: society, government, suppliers and customer-specific issues (Sajjad et al., 2015).    | Lack of supplier awareness (Sajjad et al., 2015).<br>Poor customer awareness (Wang et al., 2016) Porter and Kramer (2006).<br>Lack of social pressure for widespread adoption (Wang et al., 2016).<br>Lack of customer demand for more sustainability (Sajjad et al., 2015, Stremlau et al., 2016; Faisal, 2010; Seuring and Müller, 2008; Walker et al., 2008; Brewer and Speh, 2001).<br>Supplier negative perceptions (Sajjad et al., 2015).<br>Lack of influence (Govindan et al., 2014; Kogg, 2003).<br>External stakeholder commitment.<br>Lack of supplier commitment (Stremlau et al., 2016).  |

External stakeholder capability.

Lack of supplier capability (Sajjad et al., 2015).

Inadequate or inappropriate regulations (Sajjad et al., 2015).

Lack of green practice measures (Sajjad et al., 2015).

Improper politics (Govindan et al., 2014).

External stakeholder corporate ability.

Lack of supplier collaboration (Stremlau et al., 2016).

Lack of government support (Sajjad et al., 2015).

Lack of customer support (Sajjad et al., 2015).

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**Table 2. 8 Barriers to green supply chain management (adapted from Wang et al., 2016; Govindan et al., 2014)**

| <b>Barriers</b>   | <b>Description</b>   | <b>Sources</b>  |
|---|--|---|
| <b>Technology</b>   |  |   |
| 1. Complications in putting positive environmental attitudes into action.           | Companies may find it challenging to transform their positive environmental attitudes into real practices.   | Revell and Rutherford (2003); Govindan et al. (2014).   |
| 2. Difficulties in reusing/recycling used products.                                 | Companies may find that designing and recycling used products are complicated.   | Wang et al. (2016); Govindan et al. (2014).   |
| 3. Lack of technology, processes and materials.                                     | Companies may have no appropriate technology or processes to implement Green Manufacturing. The materials used in the manufacturing process are not very eco-friendly. | Govindan et al. (2014); Mathiyazhagan and Haq (2013); Wang et al. (2016).   |
| <b>Knowledge</b>  |  |   |
| 4. Lack of eco-literacy among upstream or downstream supply chain members.          | The upstream or downstream supply chain members may not have adequate knowledge about eco-literacy.  | Ravi and Shankar (2005), Wang et al. (2016); Govindan et al. (2014). Mudgal et al. (2010); Theyel (2000); Revell and Rutherford (2003). |
| 5. Lack of relevant environmental knowledge about implementing Green Manufacturing. | Companies lack awareness of government environmental policies, the environmental impact of company activities and the benefits of implementing Green Manufacturing.    | Wang et al. (2016); Govindan et al. (2014).   |
| 6. Lack of information on potential environmental improvements.                     | Companies may find it is difficult to obtain information to reduce environmental impacts or to receive correct feedback on their current environmental improvements.   | Wang et al. (2016); Govindan et al. (2014); Perron (2005).  |
| <b>Financial</b>  |  |   |

|  |   |  |
|--|---|--|
| 7. High investments and low financial returns. | High investment in implementing Green Manufacturing and low financial returns. Financial constraints are the most significant barrier to sustainable procurement. High investment in human resources. | Govindan et al. (2014; Walker and Brammer (2009); Zhu and Geng (2013); Wang et al. (2016). |
|--|---|--|

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**Involvement and support**

|  |   |   |
|--|---|---|
| 8. Lack of specific company level training and monitoring of progress of Green Manufacturing implementation. | Companies require training to implement Green Manufacturing and to monitor the progress of Green Manufacturing.   | Wang et al. (2016); Govindan et al. (2014).                                       |
| 9. Poor supplier commitment to Green Manufacturing implementation.   | Companies may find their suppliers are not willing to exchange information on environment-related progress.   | Govindan et al. (2014); Hong et al. (2009).                                       |
| 10. Inadequate support by regulatory authorities.  | Companies may find it is difficult to obtain support from the regulatory authorities to maintain a green environment. Companies may find that the relevant Green Manufacturing regulations are inflexible and costly. | Wang et al. (2016); Govindan et al. (2014); Perron (2005); Sajjad, et al. (2015). |

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## CHAPTER 3: RESEARCH METHODOLOGY

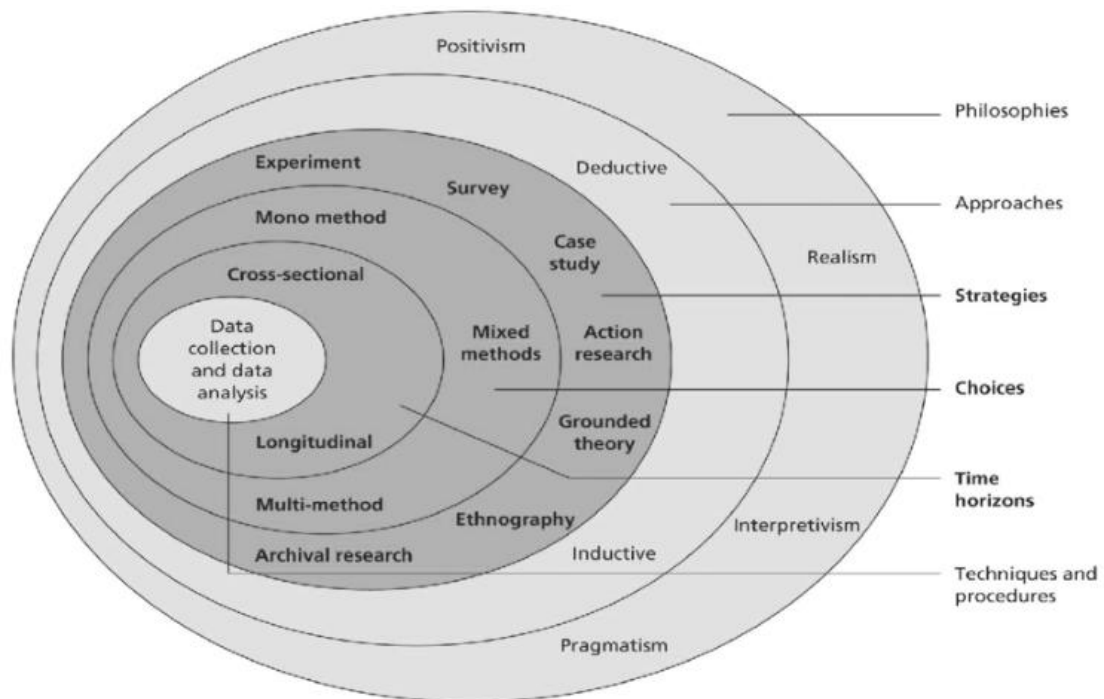
### 3.1 Overview

This chapter introduces the research philosophy (Section 3.2), research approaches (Section 3.3), research strategies, methodological choices, and time horizons (Section 3.4), reviews of the survey method (3.5), survey development process (section 3.6), data collection procedure (section 3.7), the general information of the respondent sample (section 3.8), and the response bias tests (section 3.9).

Saunders et al. (2007) develop the research onion (Figure 3.1) to describe the research stages. The research onion provides a significant progression to design the research methodology, and can be used in a variety of contexts and is useful for almost any type of research methodology (Bryman, 2012). First, to develop an effective research methodology, the research philosophy (Section 3.2) is identified to create the starting point for the research approach. Then, the appropriate research approach (Section 3.3) and the research strategy (Section 3.4) are introduced. The research choice and the time horizon are identified (Section 3.4) before moving to the final layer of data collection and analysis.

Furthermore, the following sections introduce reviews of the survey method (3.5), survey development process (section 3.6), data collection procedure (section 3.7), the general information of the respondent sample (section 3.8), and the response bias tests (section 3.9). One of the critical steps for verifying the proposed conceptual model is to develop the reliable and valid measurement items of the first-order constructs and the second order-constructs for the proposed conceptual model. The successful development process for measurement items suggested by Dillman (2007) includes the following four steps. The first step is to generate the measurement items through the comprehensive literature review. As a result, this research proposes 6 constructs, 23 sub-constructs and 61 measurement items (Table 4. 1), originating the research instrument. Later, this study applied the pilot study procedure to test and validate the variables and make necessary

adjustments before collecting the survey (Forza, 2002). Thus, the second step is to pre-test the measurement items through the pilot study to enhance the content validity of the measurement items. The pilot study applied in this study aimed to seek the pilot validity, which consists of having the "experts" reviewing the variables and examining the appropriateness for application in organisational practice (Cesar da Silva et al., 2020). Four academicians and practitioners were invited to verify which of the variables are actually related to apparel companies. As a result, 58 measurement items are generated based on the feedback of two round Q-sort pilot study. Thus, this study applies the Q-sort pilot study method to examine the appropriateness for application in apparel companies and ensure the convergent and discriminant validity of the measurement items. The final step is to conduct the large-scale data analysis and measurement items validation, to evaluate the final reliability and validity of the measurement items and test the proposed hypotheses using the Partial Least Squares- Structural Equation Modelling (PLS-SEM).



**Figure 3. 1 The Research Onion (Adapted from Saunders et al., 2007)**

The research philosophy of this study is positivism (how research is conducted in the natural sciences, relying on the scientific method). The research approach applied in this study is the deduction (from general to specific). The deductive approach begins with an abstract logical relationship between concepts and then moves toward concrete empirical evidence (Kothari, 2004; Saunders et al. 2012; Bryman and Bell, 2011). The deductive approach develops hypotheses based on pre-existing theories and then tests them (Silverman, 2013). This study proposes 7 hypotheses and then applies Partial Least Squares Structural Equation Modelling to test them. The semi-structured interviews are conducted in the Q-sort pilot study stage (Section 3.6) to improve the conceptual model by clarifying the measurement items and assessing the reliability and validity of the measurement items. As one of the most widely applied statistical methods for testing the complex relationships between variables, the Structural Equation Modelling (SEM) is applied in this research to test the reliability and validate the measurement items and sub-constructs (Section 4.4) and test the hypotheses (Section 4.5) (Byrne, 2010, Anderson

and Gerbing, 1988). Structural Equation Modelling (SEM) is one of the second-generation techniques of multivariate data analysis method, which is generally applied to estimate the multiple regression equations and test the relationships between variables. Due to its convenience to test and estimate the theoretically supported causal models, this statistical technique is widely used in social science research (Hair et al., 2017; Haenlein and Kaplan, 2004).

The most widely applied approaches to Structural Equation Modelling (SEM) are the Partial Least Squares- Structural Equation Modelling (PLS-SEM), and the Co-variance based Structural Equation Modelling (CB-SEM). CB-SEM is widely applied to confirm or reject the theories in social science research. One of the requirements to use this approach is the large sample size. Also, the data are required to be normally distributed, and the model should be correctly specified (Hair et al., 2017; Reinartz et al., 2009; Hwang et al., 2010; Henseler et al., 2009). However, in real practice, it is difficult for many researchers to obtain such data set to meet the above requirements (Wong, 2013). Therefore, for the exploratory research having the uncertain relationships existing between the variables, the PLS-SEM can be considered. Differing from the Co-variance based SEM; the PLS-SEM is the components-based method of Structural Equation Modelling (Henseler et al., 2009). The PLS-SEM has the following advantages over co-variance based in terms of the research application. First, the PLS-SEM has no assumptions about the data distribution. Second, the PLS-SEM can be applied in the exploratory research. Third, the PLS-SEM can perform the analysis, even when the sample size is small. Fourth, the PLS-SEM can examine the formative constructs. Fifth, the PLS-SEM can examine the complex theoretical models. Sixth, the predictive accuracy of PLS-SEM analysis is paramount (Venaik et al., 2005; Hwang et al., 2010; Hsu et al., 2006; Wong, 2010; Henseler et al., 2009). However, PLS-SEM has some limitations. For example, if the sample size is very small, the high-valued structural path coefficients are required. The multicollinearity (Section 4.5.1) should be considered and handled well. Despite the limitations, the PLS-SEM is useful and

widely applied in the different kinds of research projects, such as the behavioural sciences (e.g., Wong, 2011; Bass et al., 2003), business strategy, organisation marketing, and management information system (e.g., Hulland, 1999; Henseler et al., 2009; Sosik et al., 2009; Chin et al., 2003). As discussed in the following Section 4.3.1.2.2, this research has three second-order formative constructs, which can only be analysed in the component-based SEM methods, such as PLS-SEM. Furthermore, the sample size of this research is 374, which is not large. Due to the above reasons, the PLS-SEM is chosen as the appropriate method for this research. Thus, to test both the reflective constructs and formative constructs, and dealing with a complex model, Partial Least Square modelling becomes the appropriate technique for this research.

This research applies a mixed-method approach. It combines a survey (See Section 3.7: Data Collection Procedure) and a semi-structured interview (See Section 3.6: The Development of the measurement items) to create a single data set. Before grouping the measurement items in the survey, the measurement items are improved by the semi-structured interview. The cross-sectional time horizon is applied in this research, and the data are collected at a certain point. The following sections show the detailed discussion of research methodology following the research process shown in the research onion (Figure 3.1). In particular, research philosophies, research approaches, research strategies, methodological choices, and the time horizons are discussed in Section 3.2, Section 3.3, and Section 3.4.

### **3.2 Research Philosophy**

This research philosophy of this research is positivism (the way research is conducted in the natural sciences, and it relies on the scientific method (Saunders et al. 2012). This study is engaged in creating knowledge. The primary data are collected and analysed to answer the proposed research questions. These answers can be viewed as the marks of creating new knowledge. The research philosophy refers to dealing with the nature, source,

and the development of knowledge (Bajpai, 2011). In simple terms, the research philosophy is a belief about the nature of the reality being analysed (Bryman, 2012). Generally, the research philosophy has many different branches according to the wide range of disciplines (Saunders et al., 2012). Goddard and Melville (2004) point out that the research philosophy may differ on from research goals and on the methods of achieving the research goals. In particular, Saunders et al. (2012) show that there are four main research philosophies: Pragmatism, Positivism, Realism, and Interpretivism within the scope of business studies. Appropriate research philosophy helps to address researchers' beliefs and assumptions. Hence, this study clarifies the research philosophy by comparing the following four main research philosophies.

### **Pragmatism**

Pragmatic researchers suggest that there are many ways to undertake research and different ways to interpret the real world. It is believed by Saunders et al. (2012) that there is no single point of view could show the entire picture. They state that every method has limitations, and different approaches could be complementary. Therefore, the pragmatic researchers have the freedom to use any of the methods.

### **Positivism**

Positivism studies consider the knowledge as trustworthy only if the knowledge is gained through the observation and measurement. Collins (2010) points out that the knowledge drives from the experience of people and views the world as the observable elements in an observable manner. Also, positivism depends on the observations and statistical analyses. The researchers are independent of the positivism studies and show no provisions for human interests while conducting positivism studies. The researchers' role is limited to data collection and analysis in positivism studies (Wilson, 2010; Collins, 2010). Generally, the deductive approach is chosen for the positivism studies (Crowther and Lancaster, 2008). The deductive approach begins with an abstract, logical relationship

between concepts, then move toward concreting empirical evidence, which is from general to specific. In contrast, the inductive approach is from the specific to the general and usually related to the phenomenology philosophy. Also, positivism focuses on facts, and the phenomenology focuses on the meaning (Kothari, 2004; Saunders et al., 2012).

### **Realism**

There are two types' realism: direct realism (naive realism) and critical realism. The direct realism could be defined as "what you see is what you get", which describes the world based on the personal human senses (Saunders et al., 2012). Critical realism believes that humans experience the sensations of the real world. These sensations may be deceptive and cannot portray the real world (Novikov and Novikov, 2013).

### **Interpretivism**

Interpretivism studies combine the human interests into the study. Myers (2008) believes the interpretive researcher evaluate reality can be only through social constructions such as consciousness, language, instruments, and shared meanings. Also, interpretivism studies focus on the meaning and apply multiple methods to reflect different terms of the issue. In the social sciences, the developments of interpretivism philosophy rely on the critique of positivism; The interpretivism research philosophy values the qualitative analysis over the quantitative analysis (Saunders et al., 2012).

#### **3.2.1 The Choice of Research Philosophy**

The choices between different research philosophies, such as positivist and interpretivism, have represented the primary point of debate. May (2011) suggests that the choice of research philosophy should be defined by the type of knowledge being viewed.

Research is 'something that people undertake to find out things in a systematic way' (Saunders et al., 2012). However, there are different views of what research is and

how research relates to the developed knowledge across disciplines. The paradigm could be used as the guidance to make decisions and carry out the research. Guba (1990) proposes that the paradigms can be classified through their: ontology (what is reality?), epistemology (how do you know something?) and methodology (how do you go about finding out?). These characteristics provide with a holistic view of knowledge. Figure 3.2 presents different types of paradigms associated with each research philosophy. The ontology refers to the underlying assumptions about the nature of reality. The epistemology refers to the basic assumptions about what we can know about reality, and about the relationship between knowledge and reality. The axiology refers to the judgements about the value, which is associated with the assessment of the researcher's role and value on the research (Saunders et al., 2012).

| Research Philosophy (Guba,1990; Saunders et al., 2012) |   |   |  |   |
|--|---|---|--|---|
| Paradigms: How we view knowledge                       | Pragmatism  | Positivism  | Realism  | Interpretivism  |
| Ontology (What is reality?)                            | External, multiple view chosen to best enable the question                              | External, objective and independent of social actors              | Objective, exists independently of human thoughts, but interpreted through social conditioning | Socially constructed, subjective, may change                                |
| Epistemology (How do you know something?)              | Objective and subjective meanings are useful; Focus on practical aspect of the research | Only observable data can provide facts; focus on causality        | Observable data can provide facts; phenomenon can create sensations that are misinterpreted    | Subjective meanings; focus on the details of the situation                  |
| Axiology (What do you value in Research?)              | Values play a large role in interpreting results  | Value free; the researcher is independent of the data             | Research is value laden; the researcher is biased by worldviews                                | Research is value bound, the researcher is part of what is being researched |
| Methodology (How do go about finding out?)             | Mixed or multiple methods (quantitative and qualitative)                                | Highly structured large samples, large focus on quantitative data | Methods are chosen to fit the subject (quantitative and qualitative)                           | Small samples, in depth investigations, qualitative                         |

Figure 3. 2 Research philosophy

### 3.3 Research approaches

The deductive approach and the inductive approach are the two main types of research approaches. The deductive approach begins with an abstract, logical relationship among concepts, then move toward concrete empirical evidence, which is from general to specific, whereas the inductive approach is from the specific to the general (Kothari, 2004; Saunders et al. 2012; Bryman and Bell, 2011).

The deductive approach develops the hypotheses based on the pre-existing theory and then tests it (Silverman, 2013). For example, this research develops the 7 hypotheses from the combined theories and then apply techniques (PLS) to test them. Moreover, Wiles et al. (2011) argue that the deductive approach is appropriate to the research project that associating with assessing whether the observed practice would fit with the expectation from previous research. Therefore, this deductive approach is considered as appropriate to the positivist studies, which first formulates the hypotheses and then relies on the scientific method to test hypotheses (Snieder and Larner, 2009).

However, the inductive approach is from the specific to the general (Kothari, 2004; Saunders et al. 2012; Bryman and Bell, 2011). The observations are the starting point in the inductive approach, and the new theories or existing theories are found after data collection and data analysis (Beiske, 2007; Flick, 2011; Bryman and Bell, 2011).

### **3.4 Research strategies, Methodological choices, and Time horizons**

#### **Research strategies**

The research strategy shows how the researcher plans to carry out the research. Many approaches could be used to carry out the research, such as the survey, interview, action research, experimental research, case study, ethnography, archival research, or the action research (Saunders et al., 2012).

This study uses a questionnaire survey to collect data. The collected samples are used to assess the reliability and validity of the measurement items and sub-constructs (Section 4.4) and to test the proposed hypotheses (Section 4.5). Surveys are usually applied in quantitative research (Bryman and Bell, 2011). Nowadays, a large-scale survey is widely applied in social science research to obtain a large amount of data to explore the relationships between variables (Miller, 1991). Compared with other research methods, such as the focus group interviews or the case study, the large-scale survey is

cost-effective and could help researchers to obtain the extensive information from a large number of target respondents for the specific topics (Alreck and Settle, 2004). Moreover, benefit from the diverse information sources, the outcomes of the large-scale survey is generally considered as having better generalisability (Alreck and Settle, 2004). Most importantly, by applying the statistical methods, the reliability and the validity of the large-scale survey could be assessed (Miller, 1991).

Semi-structured interviews are used in this research to improve the measurement items before grouping the measurement items to the survey in the Q-sort pilot study stage (Section 3.6). Interviews are usually applied in qualitative research, which conducts intensive interviews with respondents to explore their opinions on some particular questions (Boyce and Neale, 2006). There are three different types of interviews: structured interviews, semi-structured interviews, and unstructured interviews (Boyce and Neale, 2006). The difference between the three types of interviews is whether the pre-determined questions are answered in the same order. The structured interview is conducted by asking the series of pre-determined questions. The pre-determined questions are answered in the same order by interviewees. Based on the same pre-determined questions, the researchers could compare different answers, and the data analysis is straightforward. However, there is no question prepared before the unstructured interviews. The data collection of unstructured interviews is completed informally. The semi-structured interview combines the components of structured interviews and unstructured interviews. The interviewers could prepare the same questions before the interviews to be answered by all respondents. At the same time, the additional questions can be asked to clarify specific issues during interviews (Boyce and Neale, 2006).

There are many other approaches to the research strategy. The experimental research creates the research process to assess the results of the experiment against the expected results (Saunders et al., 2012). Action research involves examining the practice to

a specific research problem (Bryman, 2012). Such as teaching, teachers could examine ways in which they could improve the professional teaching methods (Wiles et al., 2011). The case study research provides insights into the specific nature of the example case and draws generalisations (Silverman, 2013; Bryman, 2012). The grounded theory is commonly used in qualitative research in social sciences, which involve constructing the theory from data analysis (May 2011). The ethnography involves observing the people closely and assessing cultural interaction (Bryman, 2012). The archival research is one form of primary research, which involves seeking out evidence from the original archival records (Flick, 2011).

### **Methodological choices**

The methodological choices (Figure 3.1), include the mixed method, the multi-method, and mono method (Saunders et al., 2012). The difference between these approaches is the number of research methods applied in the research to create a single data set. The mono-method refers to applying only one research method for the research. Research using mixed-methods may apply two or more research methods. The mixed-methods involve combining research methods to create one single dataset. The multi-method involves combining research methods to create different single datasets for different separated segments (Bryman, 2012; Flick, 2011; Feilzer, 2010). This research applies mixed methods involving combining surveys and semi-structured interviews to create a single dataset for verifying the proposed conceptual model (Figure 2. 1).

## **Time Horizons**

The time horizon refers to the time framework within which the research is planned to be completed (Saunders et al., 2012). There are two types of time horizons shown in the research onion (Figure 3.1): the cross-sectional and the longitudinal. The cross-sectional time horizon is applied in this research, whereby the data is collected at a certain point (Flick, 2011). It is commonly used to investigate the particular phenomenon at a specific time. The longitudinal time horizon for data collection is commonly used to collect the data repeatedly within the extended period (Goddard and Melville, 2004). It is used to examine the change of the important factor over time.

### **3.5 Reviews of the Survey Method**

Jackson (2011) explains the essence of the survey method as questioning the target respondents on related topics and then describing the responses. As one of the methods for primary data collection, the survey is widely used in the applied social research to test the concepts, assess customer satisfaction, and reflect respondents' behaviours. The main objective of the survey method is to describe the particular characteristics of the target respondents and test the hypotheses of the essence of relationships within the target of respondents. From the point of practicality, the type of surveys includes questionnaires, documentation reviews and interviews (Denscombe, 2010). Compared with other primary data collection methods, such as experiments and observations, surveys can be completed faster and relatively easy to analyse. However, the human bias of respondents, differences in understanding, and target respondents' unwillingness and inability to provide information should be concerned when applying the survey method.

Nowadays, due to the rapid expanding of the internet, the traditional paper-pencil survey is facing the challenge with the online surveys (Griffiths et al., 2014). The online survey becomes popular due to fast data processing, simplified work for the target respondents, and low costs (Beebe et al., 1997). In order to test the hypotheses of the

proposed conceptual model in this research, this study applies the online questionnaire survey.

### **3.6 The Development of the measurement items**

Chapter 3.6 introduces the development of the measurement items, including the Item Generation (3.6.1), Pre-test the measurement items through the semi-structured interviews (3.6.2), and Q-sort Pilot Study (3.6.3).

#### **3.6.1 Item Generation**

Through the previous comprehensive literature review, the 6 second-order constructs, 23 first-order constructs, and 58 measurement items are formulated for this research. The appropriate modification has been taken to adapt most of the constructs and measurement items from the existing research. Appendix 1 (List of references for the survey measurement items) shows the detailed descriptions of the measurement items and relevant references. The main objective of the following validation process is to test these initial measurement items.

#### **3.6.2 Semi-structured interviews**

The second step of the development for measurement items is to pre-test the measurement items through the semi-structured interviews, which is to ensure content validity. Two groups of academic experts and apparel companies' managers are invited to pre-test these initial measurement items. Initially, the first group of academic expert and apparel company manager are required to review the definition of the first-order constructs and second-order constructs, and then to assess the clarity, and the appropriateness of these initial measurement items. Based on their feedback and the discussion of problematic measurement items, the initial measurement items are modified accordingly. Next, the second group of academic expert and apparel company manager are

asked to review the definition of the constructs and sub-constructs, and then to evaluate the modified measurement items. Based on their feedback, the measurement items are improved.

### 3.6.3 Q-sort Pilot Study

This section describes the Q-sort pilot study undertaken as an initial evaluation of the validity and reliability of the measurement items, before going on to delineate the validation of the constructs, subconstructs, and measurement items of the conceptual model using SEM. The results of the pilot study are also discussed in this section.

Although the measurement items were identified after full consideration of the relevant literature (Appendix 1), it cannot be said that all these measurement items are applicable in apparel companies, Hence, this study applies the Q-sort pilot study to verify which of the measurement items are actually related to apparel companies. The Q-sort pilot study applied in this study aimed to seek the pilot validity, which consists of having the "experts" reviewing the variables and examining the appropriateness for application in organisational practice (Cesar da Silva et al., 2020). The Q-sort method is first developed by the William Stephenson in 1953, and then becomes widely applied in the research of social sciences to evaluate individuals' subjectivity. For example, when empirically investigated developing circular economy capability in Chinese manufacturing industry, Huang (2012) conducted Q-sort pilot study for two rounds that involved two participants each (one practitioner and one academician) to pre-test the measurement items. The Q-sort method is the method to assess the validity and reliability of the measurement items, which is applied after the item generation and before grouping the measurement items into the survey (Nahm et al., 2002). The main aim of the Q-sort method is to assess how a certain topic is perceived. In particular, it is used to pre-test the measurement items through the pilot study to enhance the content validity of the measurement items (Stephenson, 1953; Thomas and Watson, 2002). In the present study,

four practitioners and academicians (two apparel company managers and two academics) were invited to verify which of the variables are actually related to apparel companies. One individual from each category is involved in the first round, and the other two individuals enter the process in the second round. The entire Q-sort pilot study follows the instruction provided in Appendix 2 (Q-sort Pilot Study Instruction). Firstly, the Q-sort participants are introduced to this research and given a brief explanation of the conceptual model. Secondly, they are given a table listing all the measurement items. The first column set out the description of the measurement items. Using their judgement, the participants are required to match the measurement items with their associated concepts. They are asked to write the initials of the related concepts in the second column of the table, and to select the option “not applicable” (N/A) only if there is no matching concept.

During the entire process, participants are free to ask questions about the matching process and allowed to discuss with each other. Any unclear measurement items are discussed in the following steps. Based on discussion and feedback, some of the measurement items are reworded, or deleted. Specifically, this research initially proposes 61 measurement items through the comprehensive literature review (Table 3.1). At the end of the first round of Q-sort pilot study, 55 items are agreed upon by both judges (Table 3.2). As suggested by the two judges in the first round, five items are reworded, and one item is deleted (Table 3.1). As a result of the first round, 60 items enter the second round of the Q-sort pilot study. At the end of the second round of the Q-sort pilot study, 56 items are agreed upon by both judges (Table 3.3), two items are reworded, and two items are deleted (Table 3.1). Thus, 58 measurement items are generated based on the feedback of two round Q-sort pilot study.

**Table 3. 1 Summary of Q-sort Pilot study**

| Constructs  | No. | Sub-constructs | Initial Number of Items               | Results of Q-sort Pilot Study |                          | Final Number of Items |
|---|-----|----------------|---------------------------------------|-------------------------------|--------------------------|-----------------------|
|   |     |                |                                       | Round 1                       | Round 2                  |                       |
| Stakeholder Engagement in Environmental Implementation (SEEI) | 1   | SEC            | Customer                              | 2                             |                          | 2                     |
|   | 2   | SES            | Suppliers                             | 2                             |                          | 2                     |
|   | 3   | SEG            | Government                            | 2                             |                          | 2                     |
|   | 4   | SEN            | Non-governmental organisations (NGOs) | 2                             |                          | 2                     |
|   | 5   | SEO            | Owners                                | 3                             |                          | Delete one<br>2       |
|   | 6   | SEE            | Employees                             | 3                             | Delete one<br>Reword two | 2                     |
| Environment orientation (ENOR)                                | 7   | EEO            | External Environmental Orientation    | 2                             |                          | Reword one<br>2       |
|   | 8   | EIO            | Internal Environmental Orientation    | 2                             |                          | 2                     |
| Green Manufacturing (GRMA)                                    | 9   | GMD            | Green Design                          | 2                             |                          | 2                     |
|   | 10  | GMP            | Green Procure                         | 2                             | Reword one               | 2                     |
|   | 11  | GMR            | Green Production                      | 3                             | Reword one               | Delete one<br>2       |

|                                    |    |     |                                       | Reword one |            |   |
|------------------------------------|----|-----|---------------------------------------|------------|------------|---|
|                                    | 12 | GMA | Green Packing and Distribution        | 2          | Reword one | 2 |
|                                    | 13 | GME | Green End of Life Management          | 3          |            | 3 |
|                                    | 14 | GMF | Remanufacturing                       | 2          |            | 2 |
|                                    | 15 | BET | Technology                            |            |            | 3 |
|                                    | 16 | BEK | Knowledge                             | 3          |            | 3 |
| Berries (BFGI)                     | 17 | BEF | Finance                               | 1          |            | 1 |
|                                    | 18 | BES | Stakeholders' involvement and support | 3          | Reword one | 3 |
| Circular Economy capability (CECA) | 19 | CED | Reduce                                | 4          |            | 4 |
|                                    | 20 | CEU | Reuse                                 | 4          |            | 4 |
|                                    | 21 | CEC | Recycle                               | 5          |            | 5 |
| Organisational Performance (ORPE)  | 22 | OEP | Environmental performance             | 3          |            | 3 |
|                                    | 23 | OPB | Business performance                  | 3          |            | 3 |
| Total                              |    |     |                                       | 61         |            |   |

Table 3.2 First round of the Q-sort pilot study

| In the first round of the Q-sort pilot study, 61 items are placed, and 55 are agreed upon by both judges |     |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|--|-----|---------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|---|
|  |     | Judge 1 |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|  |     | 1       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | N/A |   |
| Judge<br>2   | 1   | 2       |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|  | 2   |         | 2 |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|  | 3   |         |   | 2 |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|  | 4   |         |   |   | 2 |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|  | 5   |         |   |   |   | 3 |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|  | 6   |         |   |   |   |   | 2 |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|  | 7   |         |   |   |   |   |   | 2 |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|  | 8   |         |   |   |   |   |   |   | 2 |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|  | 9   |         |   |   |   |   |   |   |   | 2 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|  | 10  |         |   |   |   |   |   |   |   |   | 1  |    |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|  | 11  |         |   |   |   |   |   |   |   |   |    | 1  |    |    |    |    |    |    |    |    |    |    |    |    |     |   |
|  | 12  |         |   |   |   |   |   |   |   |   |    |    | 1  |    |    |    |    |    |    |    |    |    |    |    |     | 1 |
|  | 13  |         |   |   |   |   |   |   |   |   |    |    |    | 3  |    |    |    |    |    |    |    |    |    |    |     |   |
|  | 14  |         |   |   |   |   |   |   |   |   |    |    |    |    | 2  |    |    |    |    |    |    |    |    |    |     |   |
|  | 15  |         |   |   |   |   |   |   |   |   |    |    |    |    |    | 3  |    |    |    |    |    |    |    |    |     |   |
|  | 16  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    | 2  |    |    | 1  |    |    |    |    |     |   |
|  | 17  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    | 1  |    |    |    |    |    |    |     |   |
|  | 18  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    | 3  |    |    |    |    |    |     |   |
|  | 19  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    | 4  |    |    |    |     |   |
|  | 20  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    | 4  |    |    |     |   |
|  | 21  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    | 5  |    |     |   |
|  | 22  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    | 3  |     |   |
|  | 23  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 3   |   |
|  | N/A |         |   |   |   |   | 1 |   |   |   | 1  | 1  | 1  |    |    |    |    |    |    |    |    |    |    |    |     |   |

**Total Number Placement:61 Number of Agreement: 55**

**Table 3. 3 Second round of the Q-sort pilot study**

| In the Second Round of the Q-sort pilot study, 60 items are placed, and 56 are agreed upon by both judges. |     |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
|--|-----|---------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|--|
|  |     | Judge 1 |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
| Judge  |     | 1       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | N/A |  |
| 2  | 1   | 2       |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 2   |         | 2 |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 3   |         |   | 2 |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 4   |         |   |   | 2 |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 5   |         |   |   |   | 2 |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 6   |         |   |   |   |   | 2 |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 7   |         |   |   |   |   |   | 2 |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 8   |         |   |   |   |   |   |   | 2 |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 9   |         |   |   |   |   |   |   |   | 2 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 10  |         |   |   |   |   |   |   |   |   | 2  |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 11  |         |   |   |   |   |   |   |   |   | 1  | 2  |    |    |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 12  |         |   |   |   |   |   |   |   |   |    |    | 2  |    |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 13  |         |   |   |   |   |   |   |   |   |    |    |    | 3  |    |    |    |    |    |    |    |    |    |    |     |  |
|  | 14  |         |   |   |   |   |   |   |   |   |    |    |    |    | 2  |    |    |    |    |    |    |    |    |    |     |  |
|  | 15  |         |   |   |   |   |   |   |   |   |    |    |    |    |    | 3  |    |    |    |    |    |    |    |    |     |  |
|  | 16  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    | 2  |    |    | 1  |    |    |    |    |     |  |
|  | 17  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    | 1  |    |    |    |    |    |    |     |  |
|  | 18  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    | 1  | 2  |    |    |    |    |     |  |
|  | 19  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    | 4  |    |    |    |     |  |
|  | 20  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    | 4  |    |    |     |  |
|  | 21  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    | 5  |    |     |  |
|  | 22  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    | 3  |     |  |
|  | 23  |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 3   |  |
|  | N/A |         |   |   |   | 1 |   |   |   |   |    |    |    |    |    |    |    |    |    | 1  |    |    |    |    |     |  |
|  | A   |         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |  |

**Total Number Placement:60 Number of Agreement: 56**

In order to evaluate the Q-sort pilot study, this study assesses the three statistical measurements, including the Cohen’s Kappa, the Inter-Rater Raw Agreement Score, and the Placement Ratio (Nahm et al., 2002; Moore and Benbasat, 1991). The Inter-Rater Raw Agreement Score equals to the total agreed number of measurement items by two judges divided by the total number of measurement items.

The Placement Ratio is to measure the consistency of the category classifications between the judges’ judgement and the theoretical conclusions. The calculation is  $\sum n$  total number of measurement items agreed upon by Judge i divided by  $n * \text{Total Number of Items}$  (Nahm et al., 2002). For example, in the first round, the number of judge 1 agreed items plus the number of judge 2 agreed items equals to 120. The sum of the total number of items for judge 1 and judge 2 to match is  $2 * 61$ . Therefore, the Placement Ratio of the first round is  $120/122$ , which is 0.984.

**Table 3. 4 Cohen’s Kappa**

| Cohen’s Kappa |     |         |         |
|---------------|-----|---------|---------|
| Round 1       |     | Judge 1 | Judge 1 |
|               |     | Yes     | No      |
| Judge 2       | Yes | 55      | 1       |
| Judge 2       | No  | 1       | 4       |
|               |     |         |         |
| Round 2       |     | Judge 1 | Judge 1 |
|               |     | Yes     | No      |
| Judge 2       | Yes | 56      | 0       |
| Judge 2       | No  | 1       | 3       |

As the statistical measurement of inter-rater agreement, Cohen’s Kappa provides an adequate evaluation of inter-rate reliability and the convergent validity across constructs. Compared with simple percentage agreement calculation, the Cohen’s Kappa is a more robust measure, as it considers the possibility of the agreement occurring by chance (Thomas and Watson, 2002). The calculation is  $(Pr(o) - Pr(e)) / (1 - Pr(e))$ , where  $Pr(o)$  is the relative observed agreement among judges, and  $Pr(e)$  is the hypothetical probability of chance agreement. For example, in the second round (Table 3.4), 56 items are agreed by both judges. 3 items are not agreed by both judges. Overall, judge 1 agrees 57 items (56+1)

and does not agree 3 items (0+3); judge 2 agrees 56 items (56+0) and does not agree 4 items (1+3). The first step of calculating the Cohen's Kappa ( $\kappa$ ) is to calculate the Pr (o), which equals the number in agreement / total =  $(56 + 3) / 60 = 0.983$ .

The second step is to calculate the probability that the judges would randomly both say "Yes" (agreed items). Judge 1 says "Yes" to 57/60, or 0.95. Judge 2 says "Yes" to 56/60, or 0.933. As a result, the total probability of the judges both saying "Yes" randomly is  $0.95 * 0.933 = 0.887$ .

The third step is to calculate the probability that the judges would randomly both say "No". Judge 1 says "No" to 3/60, or 0.050. Judge 2 says "No" to 4/60, or 0.067. As a result, the total probability of the judges, both saying "No" randomly is  $0.050 * 0.067 = 0.003$ .

The fourth step is to calculate the overall probability that the judges would randomly agree by adding the answers from the second step and the third step. As the result, the Pr (e) =  $0.887 + 0.003 = 0.890$

The final step is to insert above answers into the formula and solve  $k = \frac{\text{Pr (o)} - \text{Pr (e)}}{1 - \text{Pr (e)}} = \frac{0.983 - 0.890}{1 - 0.890} = 0.849$ .

If the  $\kappa = 1$ , it means the judges are in complete agreement. If  $\kappa = 0$ , it means the judges are in complete disagreement.  $\kappa$  greater than 0.80, is generally considered as excellent (Landis and Koch, 1977). As a result, in the first round, the  $\kappa$  is 0.782, which means the judges are in substantial agreement. In the second round, the  $\kappa$  is 0.849, which means the judges are in almost perfect agreement.

The result of the Q-sort pilot study is shown in Table 3.5. For the first round, the Inter Rater Raw Agreement Score is 0.902, the Placement Ratio 0.984, and the Cohen's Kappa 0.782 (Table 3.5). As suggested by Landis and Koch (1977), these figures denote the "substantial agreement" level. As a result of the first round Q-sort pilot study, five items are reworded, and one item is deleted based on the feedback of two judges (Table 3.1). 60 items are placed in the second round of the Q-sort pilot study. The Inter Rater Raw Agreement Score for the second round is 0.933, the Placement Ratio 0.992, and the Cohen's Kappa 0.849 (Table 3.5). According to Landis and Koch (1977), these represent "excellent" agreement.

The Q-sort pilot study results in 58 measurement items being generated based on the raters' feedback. The research instrument therefore includes these 58 measurement items as well as 23 first-

and 6 second-order constructs. After generating the measurement items, a large-scale survey is carried out in order to collect data from apparel companies to test the proposed hypotheses. A link to an online questionnaire is sent out to a total of 1,251 apparel companies which have expressed interest in participating in this research, in three data collection waves. A total of 374 useful responses are collected.

**Table 3. 5 Results of Q-sort pilot study**

**Results of Q-sort pilot study**

| Methods                          | Notes   | Round 1  | Round 2  | Reference  |
|----------------------------------|---|--|--|--|
| Inter-Rater Raw Agreement Score  | Total Number of Items Agreed upon by Both Judges divided by Total Number of Items   | 0.902  | 0.933  | Moore and Benbasat, 1991; Nahm et al., 2002; Landis and Koch, 1977; Thomas and Watson, 2002. |
| Placement Ratio                  | $\sum n$ Total Number of Items Agreed upon by Judge i divided by $n * \text{Total Number of Items}$   | 0.984  | 0.992  |  |
| Cohen's Kappa ratio ( $\kappa$ ) | $(Pr(o) - Pr(e))$ divided by $(1 - Pr(e))$<br>$<0$ means No agreement;<br>0-0.19 means Poor agreement;<br>0.20-0.39 means Fair agreement;<br>0.40-0.59 means Moderate agreement;<br>0.60-0.79 means Substantial agreement;<br>0.80-1.00 means Almost perfect agreement; | $Pr(o)=0.968$<br>$Pr(e)=0.850$<br>$\kappa=0.782$ | $Pr(o)=0.983$<br>$Pr(e)=0.890$<br>$\kappa=0.849$ |  |

**3.7 Data Collection Procedure**

Chapter 3.7 describes the data collection procedure. After generating the measurement items, this study conducts a large-scale survey. The main objective of the large-scale survey applied in this research is to collect data from apparel companies to evaluate the final reliability and validity of the variables of the proposed conceptual model and to test the proposed hypotheses.

Nowadays, a large-scale survey is widely applied in social science research to obtain a large amount of data to explore the relationships between variables (Miller, 1991). Compared with other

research methods, such as the focus group interviews or the case study, the large-scale survey is cost-effective and could help researchers to obtain the comprehensive information from a large number of target respondents for the specific topics (Alreck and Settle, 2004). Moreover, benefit from the diverse information sources, the outcomes of the large-scale survey is generally considered as having better generalisability (Alreck and Settle, 2004). Most importantly, by applying the statistical methods, the reliability and the validity of the large-scale survey could be assessed (Miller, 1991).

However, the main drawback of the large-scale survey is the low response rate (Baruch and Holton, 2008; Baruch, 1999). Thus, actions should be taken to overcome this challenge. Eros (1970) suggests that researchers should consider the simple and appealing appearance of the questionnaire in the stage of designing measurement items. Moreover, personalised notice and reasonable incentives are also employed in this research to increase the response rate.

In addition, to avoid the common method variance of a large-scale survey, the procedural remedy is conducted in this research. Standardisation of the scale could make things the same (Conway and Lance, 2010; Yeap et al., 2016; Podsakoff and Organ, 1986). Thus, the questionnaire is designed with the 5-point scale for the measurement items, 7-point scale for some general information items. In addition, the item such as head office location is an open-ended question. Moreover, the survey questions are grouped. The header of the context is designed so that respondents could answer more consistently.

In this research, the self-supported survey is collected from two sources, social media platforms and apparel company websites. In the first two months of data collection, the initial invitation messages are made and sent to apparel companies' managers through the social media platforms, including Weibo, WeChat, and QQ. The links of online surveys are then sent to managers who show interests in participating in this research through social media platforms. Three waves of the large-scale surveys are sent through social media. After one month of the first wave of the large-scale surveys, the message reminder and second wave of large-scale surveys are sent to remind the respondents. The final message reminder and third wave of large-scale surveys are sent after one month of the second wave. In sum, surveys are sent to 586 companies, and 179 useful responses are collected in the first three months.

Furthermore, this study collects samples from apparel companies from the following websites: www.1688.com, www.taobao.com, and www.Tmall.com. These are three main sites of the Alibaba group, which is the biggest online commerce company in China. There are millions of companies selling products in these three main sites, including most of the Chinese apparel companies. The initial invitation messages are made and send through Aliwangwang, the communication software allowing people to contact the sellers. The links of online surveys are sent to the companies which are interested in participating in this research. Three waves of large-scale surveys are sent. After one month of the first wave of the large-scale surveys, the message reminder and second wave of large-scale surveys are sent to remind the respondents. The final message reminder and third wave of large-scale surveys are sent after one month of the second wave. In sum, surveys are sent to 665 companies that show interest to participate in this research, and 195 useful responses are collected in the second three months.

### 3.8 General Information of the Respondent Sample

In the first three months of data collection, a total of 179 usable responses is collected through social media platforms, which accounts for 48% of the total usable responses. During the second three months of data collection, 195 usable responses are collected from online apparel websites, which accounts for 52% of the total usable responses (Table 3.6). The general response rate is 29.8%, where the response rate for social media platforms accounts for 30.5%, and the response rate for online websites accounts for 29.3% (Table 3.6).

**Table 3. 6 Summary of response rates**

| Summary of response rates |              |                             |       |
|---------------------------|--------------|-----------------------------|-------|
| Data sources              | Social media | Apparel companies' websites | Total |
| No. of usable responses   | 179          | 195                         | 374   |
| Percentage                | 48%          | 52%                         | 100%  |
| Data sources              | Social media | Apparel companies' websites | Total |

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|                         |        |        |        |
|-------------------------|--------|--------|--------|
| No. of participants     | 586    | 665    | 1251   |
| No. of usable responses | 179    | 195    | 374    |
| Response Rate           | 30.50% | 29.30% | 29.80% |

Five characteristics variables are applied in this survey to provide the comprehensive understanding of the respondent sample, including respondents' job titles, companies' primary business, companies' annual sales, companies' ownership, and companies headquarter location. The outcome of this survey shows that most of the respondents are from managerial positions. To be specific, 165 respondents (44.59%) are CEOs or the presidents; 139 respondents (37.57%) are senior managers; 48 respondents (12.97%) are managers; 13 respondents (3.51%) are directors, and only 5 respondents (1.35%) are not with managerial titles (Table 3.7). In terms of the companies' primary business, 86.86% (324) of the respondents are from the apparel manufacturing companies, 12.33% (46) of the respondents are from the apparel trading companies, and only 0.8% (3) of the respondents are from other types of apparel companies. In terms of the companies' annual sales, 253 companies (67.83%) have less than 10 million RMB annual sales; 120 companies (32.17%) have more than 10 million RMB annual sales. In terms of companies' ownerships, 265 companies (73.61%) are private enterprises. The rest companies represent the other four types of ownership. In terms of the company's headquarter location, the headquarters of the companies are located in 17 provincial-level districts, including 3 municipalities directly under the central government and 14 provinces.

**Table 3. 7 Summary of respondents' characteristics**

Table: Summary of Respondents' Characteristics

| Respondents' job titles | Frequency | Percentage (%) |
|-------------------------|-----------|----------------|
| CEO/President           | 165       | 44.59%         |
| Senior Manager          | 139       | 37.57%         |
| Manager                 | 48        | 12.97%         |
| Director                | 13        | 3.51%          |
| Other                   | 5         | 1.35%          |
| Total                   | 370       | 100            |

| Respondent companies' primary business | Frequency | Percentage (%) |
|--|-----------|----------------|
| Apparel manufacturers                  | 324       | 86.86%         |
| Apparel trading companies              | 46        | 12.33%         |
| Others                                 | 3         | 0.80%          |
| Total                                  | 373       | 100            |

| Respondent companies' annual sales | Frequency | Percentage (%) |
|------------------------------------|-----------|----------------|
| Less than 500,000                  | 3         | 0.80%          |
| 500,001-1 million                  | 27        | 7.24%          |
| 1million-5 million                 | 58        | 15.55%         |
| 5-10 million                       | 165       | 44.24%         |
| 10-50 million                      | 111       | 29.76%         |
| 50-100million                      | 8         | 2.14%          |
| 101 million+                       | 1         | 0.27%          |
| Total                              | 373       | 100            |

| Respondent companies' ownership | Frequency | Percentage (%) |
|---------------------------------|-----------|----------------|
| Private enterprise              | 265       | 73.61%         |
| Sole proprietorship company     | 62        | 17.22%         |
| Collective owned                | 16        | 4.44%          |

enterprise

|                     |           |                |
|---------------------|-----------|----------------|
| Township enterprise | 13        | 3.61%          |
| Other               | 4         | 1.11%          |
| Total               | 360       | 100            |
| Location            | Frequency | Percentage (%) |
| Anhui               | 11        | 3.22%          |
| Beijing             | 16        | 4.68%          |
| Chongqing           | 13        | 3.80%          |
| Fujian              | 31        | 9.06%          |
| Guangdong           | 45        | 13.16%         |
| Hebei               | 8         | 2.34%          |
| Henan               | 11        | 3.22%          |
| Hubei               | 10        | 2.92%          |
| Hunan               | 8         | 2.34%          |
| Jiangsu             | 42        | 12.28%         |
| Jiangxi             | 6         | 1.75%          |
| Liaoning            | 15        | 4.39%          |
| Shandong            | 22        | 6.43%          |
| Shanghai            | 24        | 7.02%          |
| Sichuan             | 10        | 2.92%          |
| Tianjin             | 24        | 7.02%          |
| Zhejiang            | 46        | 19.01%         |
| Total               | 342       | 100.00%        |

### 3.9 Response Bias Tests

This chapter discusses the response bias tests, including the sample aggregation tests (section 3.9.1) and non-response bias test (section 3.9.2).

#### 3.9.1 Sample Aggregation Tests

As discussed in chapter 3.7, this research collects data from two sources: social media platforms and apparel companies' websites. Thus, to avoid the potential bias of the aggregated data set, this research presents the sample aggregation test (Erdos, 1970). All five characteristics variables are used for the sample aggregation test. The Chi-square test is generally thought to be the appropriate method to deal

with categorical variables (Hair et al., 2006). Therefore, this research uses the Chi-square test to examine the existence of the significant statistical differences of these five characteristics variables across above two sample sources.

As suggested by Carmines and Mciver (1981), it is reasonable to comment that there is no statistical difference among samples, if the value of the adjusted  $\chi^2$  (Chi-square value / Degree of freedom) is less than 3 and the P-value is over 0.05. The results show that (Table 3.8) the value of adjusted  $\chi^2$  is all less than 3, and the associated P-value is all over 0.05. Hence, the results of all Chi-square tests for these five characteristics variables are reasonably good (Table 3.8). Therefore, this research concludes that there is no statistical difference between these two sources of data.

**Table 3. 8 Chi-square test results for sample aggregation test**

Chi-square test results for sample aggregation test

---

| Variable             | Pearson $\chi^2$ | Degree of freedom | Adjusted of (Pearson $\chi^2$ / Degree of freedom) | P-value |
|----------------------|------------------|-------------------|--|---------|
| Position             | 11.83            | 12                | 0.986  | 0.459   |
| Primary Business     | 3.717            | 2                 | 1.859  | 0.156   |
| Annual Sales         | 17.042           | 24                | 0.710  | 0.847   |
| Ownership            | 0.012            | 2                 | 0.006  | 0.994   |
| Headquarter Location | 188.2            | 156               | 1.206  | 0.426   |

### 3.9.2 Non-response bias test

As suggested by Malhotra and Grover (1998), the non-respondent bias test is essential to conduct to ensure the generalisability of the outcomes of the research. The non-respondent bias shows the difference between the target respondents and the non-respondents. It is usually measured by conducting the chi-square test through comparing the non-respondents and the target respondents in terms of the characteristics variables, such as the above five characteristics variables that used for the sample aggregation test (Armstrong and Overton, 1977; Meyer and Collier, 2001). However, to some

extent, obtaining information from non-respondents is almost impossible. Therefore, in some cases, the acceptable substitute method for non-respondent bias test is to consider the later waves of the survey as the non-respondents of the first wave (Armstrong and Overton, 1977).

In this research, two groups of data are selected to conduct the chi-square test, including the first one-third of responses (124) and the last one-third of responses (125). As suggested by Carmines and Mciver (1981), it is reasonable to comment that there is no statistical difference among samples, if the value of the adjusted  $\chi^2$  (Chi-square value / Degree of freedom) is less than 3 and the P-value is over 0.05. The results (Table 3.9) indicate that the value of adjusted  $\chi^2$  is all less than 3, and the associated P-value is all over 0.05. Therefore, the results of the Chi-square test for non-response bias test show that all the five characteristics variables have no statistical difference between later responses and first responses (Carmines and McIver, 1981).

**Table 3. 9 Chi-square test results for Non-response bias test**

Chi-square test results for Non-response bias test

| Variable              | Pearson $\chi^2$ | Degree of Freedom | Adjusted $\chi^2$ (Pearson $\chi^2$ / Degree of freedom) | P-value |
|-----------------------|------------------|-------------------|--|---------|
| Position              | 3.821            | 12                | 0.318  | 0.986   |
| Primary Business      | 5.774            | 2                 | 2.887  | 0.056   |
| Annual Sales          | 4.891            | 9                 | 0.543  | 0.844   |
| Ownership             | 0.017            | 2                 | 0.009  | 0.992   |
| Head quarter Location | 150.475          | 144               | 1.045  | 0.339   |

## **CHAPTER 4: RESEARCH ANALYSIS**

### **4.1 Overview**

As discussed in Chapter 3.0, the successful development process for measurement items/survey questions suggested by Dillman (2007) includes the following four steps. The first step is to generate the measurement items through the comprehensive literature review. The second step is to pre-test the measurement items through the semi-structured interviews with academicians and practitioners to enhance the content validity of the measurement items. The third step is to evaluate the results of the Q-sort pilot study to ensure the convergent and discriminant validity of the measurement items. The first three steps proposed by Dillman (2007) are discussed in Chapter 3.0. The final step is to conduct the large-scale data analysis and measurement items validation, to evaluate the final reliability and validity of the measurement items and test the proposed hypotheses. This is discussed in Chapter 4.0.

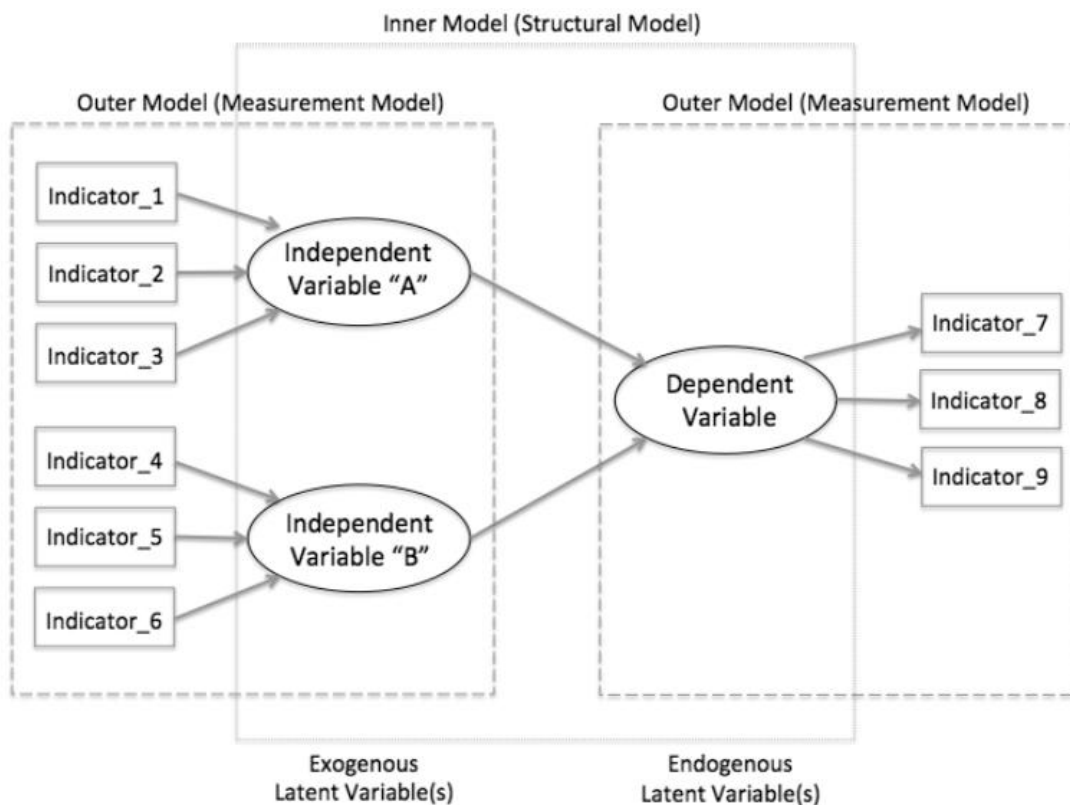
This chapter 4.0 introduces the data analysis and interpretation, including the introduction of the Structural Equation Modelling (SEM) (Section 4.2), the measurement approach, the application of Partial Least Squares PLS-SEM (Section 4.3), assessment of outer measurement model (Section 4.4), assessment of inner structural model (Section 4.5), discussion of hypotheses (Section 4.6), discussion of mediating effect (Section 4.7), and discussion of moderating effect (Section 4.8).

### **4.2 Review of the Structural Equation Modelling (SEM) and PLS Modelling procedure**

#### **Structural Equation Modelling (SEM)**

As one of the most widely applied statistical methods for testing the complex relationships between variables, the Structural Equation Modelling (SEM) is applied in this research to validate the measurement items further and test the hypotheses (Byrne, 2010, Anderson and Gerbing, 1988). Structural Equation Modelling (SEM) is one of the second-generation techniques of multivariate data analysis method, which is generally applied to estimate the multiple regression equations and test the relationships between variables. As a convenient way to test and estimate theoretically supported causal models, SEM is widely used in social science research (Hair et al., 2017; Haenlein and Kaplan, 2004).

SEM connects the multi-item scales into constructs, and then defines the relationships between these constructs. Specifically, there are two models in the SEM, the inner model, and the outer model (Figure 4.1). The outer model, known as the measurement model, specifies the relationships between the constructs (for example the Independent variable "A") and the observed indicators (for example indicator\_1). The inner model, known as the structural model, specifies the relationships between the exogenous latent variables (for example the Independent variable "A") and endogenous latent variables (for example the Dependent Variable). The independent variable is known as the exogenous latent variable, and the dependent variable is known as the endogenous variable. The path arrows point from the exogenous variables to the endogenous variables in SEM (Hair et al., 2017; Wong, 2013; Byrne, 2010).



**Figure 4. 1 Inner Model and Outer Model in a Structural Equation Modelling (SEM) Diagram (Wong, 2013)**

The most widely applied approaches to Structural Equation Modelling (SEM) are the Partial Least Squares- Structural Equation Modelling (PLS-SEM), and the Co-variance based Structural Equation Modelling (CB-SEM). CB-SEM is a covariance-based SEM while PLS-SEM is component-based. The widely used software packages for Partial Least Squares- SEM (PLS-SEM) are SmartPLS, WarpPLS, and VisualPLS. The Covariance-based SEM (CB-SEM) can be carried out using the software packages such as EQS, AMOS, MPlus, and LISREL (Hsu et al., 2006; Reinartz et al., 2009; Hwang et al., 2010; Henseler et al., 2009).

### **Covariance-based SEM (CB-SEM)**

CB-SEM is widely applied to confirm or reject the theories in social science research. One of the requirements to use this approach is the large sample size. Moreover, the data are required to be normally distributed, and the model should be correctly specified (Hair et al., 2017; Reinartz et al., 2009; Hwang et al., 2010; Henseler et al., 2009). However, in real practice, it is difficult for many researchers to

obtain such data set, which meet the above requirements (Wong, 2013). Therefore, for the exploratory research having the uncertain relationships existing between the variables, the PLS-SEM can be considered.

### **Partial Least Squares- SEM (PLS-SEM)**

Compared with CB-SEM, PLS-SEM has the following advantages that are relevant to this study. Firstly, it can be used in exploratory research, and does not require the use of normally distributed data. Secondly, it can be used to analyse a small sample. Thirdly, it can examine both formative constructs and more complex theoretical models. Lastly, and most importantly, it offers greater predictive accuracy (Venaik et al., 2005; Hwang et al., 2010; Hsu et al., 2006; Wong, 2010; Henseler et al., 2009). As discussed in the following chapter 4.3.1.2.2, this research has 3 second-order formative constructs, which could only be analysed using a component-based SEM method such as PLS-SEM. Furthermore, the sample size is small. For these reasons, the PLS-SEM method is used to test the proposed conceptual model. The analysis is performed using the SmartPLS software, the latest version of which can recognise empty cells as missing data. There are 17 missing data values in the final dataset. These values could have been replaced with the midpoint or mean value for the item, but as this could lead to bias, the expectation-maximisation approach is used instead.

However, PLS-SEM has some limitations. For example, if the sample size is very small, the high-valued structural path coefficients are required. The multicollinearity (section 4.5.1) should be considered and handled well. Despite the limitations, the PLS-SEM is useful and widely applied in the applied research projects, such as the behavioural sciences (e.g., Wong, 2011; Bass et al., 2003), business strategy, organisation marketing, and management information system (e.g., Hulland, 1999; Henseler et al., 2009; Sosik et al., 2009; Chin et al., 2003).

### **4.3 The application of PLS-SEM**

The PLS-SEM is first developed in the 1960s (Wold, 1985), and until the 1980s, the first generation of PLS-SEM software, LVPLS 1.8 is created and commonly applied. Nowadays, a newer generation of

PLS-SEM software, such as SmartPLS, adds more features to perform the analysis (Hair et al., 2017). This research applies the new version of SmartPLS (SmartPLS 3) as it provides all features that required for this research's data analysis. Moreover, SmartPLS maintains the active online forum, offering the users an excellent platform for discussion and knowledge sharing. The details of applying SmartPLS 3 are shown in the following sections.

### **Determination of Sample Size in PLS-SEM**

PLS-SEM can deal with small sample sizes, but the minimum sample size is still required. As suggested by Hoyle (1995), the sample size of 100 to 200 is the starting point to carry out path modelling. It also should be noted if the assessed factor has low-value inter-correlations with poor quality of indicators, the sample size should increase (Wong, 2013). The sample size of this research is 374, which meets the requirement.

### **Suggestions to ensure a correct PLS application**

In order to explore the best practices of PLS-SEM, some general guidelines for PLS application should be considered (Table 4.1), including how to set the measurement scale and value for outer weights, how to conduct the bootstrapping, and how to evaluate the inner model and outer model.

In Chapter 2, the proposed conceptual model is explained. As shown in Figure 2.2, this research includes 58 measurement items, 23 first order constructs (sub-constructs), and 6 second order constructs (constructs) (Table 4.2). Before assessing and verifying the proposed conceptual model, this research explains how to prepare data and create a project using SmartPLS in the following section 4.3.1, including identifying the first-order constructs and second-order constructs; Identifying formative and reflective models; Identifying repeated indicators approach and two-stage approach.

**Table 4. 1 General guidelines for PLS application**

| <b>Topics:</b>                      | <b>Suggestions:</b>   | <b>References:</b>  |
|-------------------------------------|---|---|
| Measurement scale                   | Avoid using a categorical scale in endogenous constructs  | Hair et al., 2010   |
| Value for outer weight              | Use a uniform value of 1 as starting weight for the approximation of the latent variable score  | Henseler, 2010  |
| Maximum number of iterations        | 300   | Ringle et al., 2005   |
| Bootstrapping                       | Number of bootstrap "samples" should be 5000;<br>Number of bootstrap "cases" should be the same as the number of valid observations (374 for this research) | Hair et al., 2017   |
| Inner model evaluation              | Report Path Coefficients, Multicollinearity, f <sup>2</sup> effect size, Stability of Bootstrapping Procedure; Report SRMR, NFI for model fit               | Hair et al., 2017; Hu and Bentler, 1999; Henseler et al., 2014; Bentler and Bonett, 1980; Lohmöller, 1989             |
| Outer model evaluation (reflective) | Report indicator loadings, Average variance extracted (AVE) and composite reliability (CR), Cronbach's Alpha, and rho_A                                     | Hair et al., 2017; Hulland, 1999; Fornell and Larcker, 1981; Baqozzi and Yi, 1988; Gefen, et al, 2000; Nunnally, 1978 |
| Outer model evaluation (formative)  | Report indicator weights, variance inflation factor (VIF). To test the outer model's significance, report t-values, p values and standard errors            | Hair et al., 2017;  |

**Table 4. 2 Constructs and Indicator Variables**

| <b>Constructs, Sub-Constructs, and Measurement items</b>         |                                       |       |   |
|--|---------------------------------------|-------|---|
| Construct  | Sub-Construct                         | Item  | Measurement items   |
| Stakeholders’ Engagement for Environmental Implementation (SEEI) | Customer                              | SEC_1 | Customers’ willingness to pay more for environment-friendly products are                    |
|  |                                       | SEC_2 | Customers’ willingness to recycle apparels for remanufacturing                              |
|  | Suppliers                             | SES_1 | Suppliers’ capabilities to provide environment-friendly products is                         |
|  |                                       | SES_2 | Suppliers’ intention to establish an environmental partnership with us is                   |
|  | Government                            | SEG_1 | Government’s willingness for promoting environment-friendly regulations is                  |
|  |                                       | SEG_2 | Government’s willingness for promoting environment-friendly regulations is                  |
|  | Non-governmental organisations (NGOs) | SEN_1 | NGOs’ capabilities for promoting environment-friendly production are                        |
|  |                                       | SEN_2 | NGOs’ power of prompting environment-friendly strategies that will be reinforced shortly is |
|  | Managers                              | SEO_1 | Have adequate knowledge for solving operational problems                                    |
|  |                                       | SEO_2 | Clearly recognises the importance of conducting environment-related R&D activities          |
|  | Employees                             | SEE_1 | Have a high-level of job competence   |
|  |                                       | SEE_2 | Have the ability to deal with new technologies  |
| Organisational Performance (ORPE)                                | Environmental performance             | OEP_1 | The level of emission   |
|  |                                       | OEP_2 | The implementation of our environmental practices   |
|  |                                       | OEP_3 | The relationship with our external stakeholders in terms of environmental issues            |
|  | Business performance                  | OPB_1 | The relationship with our external stakeholders in terms of environmental issues            |
|  |                                       | OPB_2 | Our company’s return on sales   |
|  |                                       | OPB_3 | Our company’s return on investment  |
| Level of Barriers to Green Manufacturing (BFGI)                  | Technology                            | BET_1 | The complication of putting positive environmental attitudes into action                    |
|  |                                       | BET_2 | The difficulties of reusing/recycling used products   |
|  |                                       | BET_3 | Lack of technology, process, and materials  |
|  | Knowledge                             | BEK_1 | Lack of Eco-literacy among the upstream or downstream supply chain members                  |

|                            |                                       |                                |       |   |
|----------------------------|---------------------------------------|--------------------------------|-------|---|
|                            |                                       |                                | BEK_2 | Lack of relevant environmental knowledge of implementing Green Manufacturing  |
|                            |                                       |                                | BEK_3 | Lack of information on potential environmental improvements   |
|                            | Finance                               |                                | BEF   | High investments and low financial returns  |
|                            | Stakeholder's Involvement and support |                                | BES_1 | Lack of training and monitoring the progress of Green Manufacturing implementation specific to the company level      |
|                            |                                       |                                | BES_2 | Poor supplier commitment to Green Manufacturing implementation  |
|                            |                                       |                                | BES_3 | Inadequate support from regulatory authorities  |
| Circular Capability (CECA) | Economy                               | Recycling Capability           | CEC_1 | Ability to implement the used garment collection (UGC) scheme   |
|                            |                                       |                                | CEC_2 | Ability to reprocesses collected used products  |
|                            |                                       |                                | CEC_3 | Ability to reprocesses collected wastes   |
|                            |                                       |                                | CEC_4 | Ability to makes extensive use of reprocessed materials to manufacture products                                       |
|                            |                                       |                                | CEC_5 | Ability to makes extensive use of reprocessed wastes to manufacture products  |
|                            |                                       | Reduction Capability           | CED_1 | Ability to reduce energy consumption  |
|                            |                                       |                                | CED_2 | Ability to reduce raw materials waste   |
|                            |                                       |                                | CED_3 | Ability to improve equipment efficiency   |
|                            |                                       |                                | CED_4 | Ability to improve employees' working efficiency  |
|                            |                                       | Reuse Capability               | CEU_1 | Ability to reutilise the used garment   |
|                            |                                       |                                | CEU_2 | Ability to reutilise extra raw materials  |
|                            |                                       |                                | CEU_3 | Ability to reutilise extra raw materials  |
|                            |                                       |                                | CEU_4 | Ability to reutilise faulty products  |
| Green (GRMA)               | Manufacturing                         | Green Packing and Distribution | GMA_1 | Our company uses environment-friendly packaging   |
|                            |                                       |                                | GMA_2 | Approaches are developed to optimise the logistics network design with consideration of reducing environmental impact |
|                            |                                       | Green Design                   | GMD_1 | Our company fully incorporates the environmental performance criteria into the design phase                           |
|                            |                                       |                                | GMD_2 | Product design teams frequently interact with other departments   |
|                            |                                       | Green End of Life Management   | GME_1 | Our company's products use long-lasting raw materials to extend the products' lifecycle                               |

|                                  |                                    |       |  |
|----------------------------------|------------------------------------|-------|--|
|                                  |                                    | GME_2 | Our company has a program to encourage customers to recycle products in the secondary markets  |
|                                  |                                    | GME_3 | Our company is applying the second-life retailing. (E.g. Urban Outfitters-Vintage collections: first handpicked and then re-worked before displayed in the shop or online) |
|                                  | Remanufacturing                    | GMF_1 | Our company places great emphasis and importance to remanufacturing stage  |
|                                  |                                    | GMF_2 | Our company establishes Eco-efficient remanufacturing centres  |
|                                  | Green Procure                      | GMP_1 | Our company provides design specification including environmental requirements to suppliers  |
|                                  |                                    | GMP_2 | Our company audits the suppliers' environmental performance  |
|                                  | Green Production                   | GMR_1 | Our company's manufacture process could meet the requirements of government legislation and regulation   |
|                                  |                                    | GMR_2 | Our company's manufacture process is harmless to the health of the workers and users   |
| Environmental Orientation (ENOR) | External Environmental Orientation | EEO_1 | Clearly recognises the ecological requirements of external stakeholders  |
|                                  |                                    | EEO_2 | Clearly recognises the importance to cooperate with external stakeholders  |
|                                  | Internal Environmental Orientation | EIO_1 | Has clear codes of standards of ecological practices in all functional area  |
|                                  |                                    | EIO_2 | Regards the protection of the natural environment as the high-priority activity  |

#### 4.3.1 Running the Path-Modelling in SmartPLS

This section introduces how to use SmartPLS 3 for data analysis, including preparing data for SmartPLS, creating the project in SmartPLS, applying PLS Algorithm, applying Bootstrapping, and assessing the output.

#### 4.3.1.1 Data Preparation for SmartPLS

The survey data are exported to the Microsoft Excel and saved as the CSV format. Before conducting the analysis, it is important to state how the missing data are treated. The new version of SmartPLS 3 could recognise the empty cells as the missing data. There are 17 missing data in this research. The missing value could be replaced with midpoint or mean value. However, this might lead to bias. Thus, this research uses the expectation-maximisation (EM) to replace the missing value. It could be done by using Statistical Package for the Social Science (SPSS) (Analysis->missing value analysis->EM). Moreover, to ensure the Excel data can be imported properly, the names of measurement items (e.g., SEC\_1, SEC\_2) are placed in the first row.

#### 4.3.1.2 Project Creation in SmartPLS

After importing the data successfully, the latent variables and the indicators should be placed and connected. In order to build the model correctly, this study examines the following concepts, including identifying the first-order constructs and second-order constructs (section 4.3.1.2.1); identifying the formative and reflective measurement (section 4.3.1.2.2), and identifying the repeated indicators approach and two-staged approach (section 4.3.1.2.3).

4.3.1.2.1 Identify First-order constructs and Second-order constructs

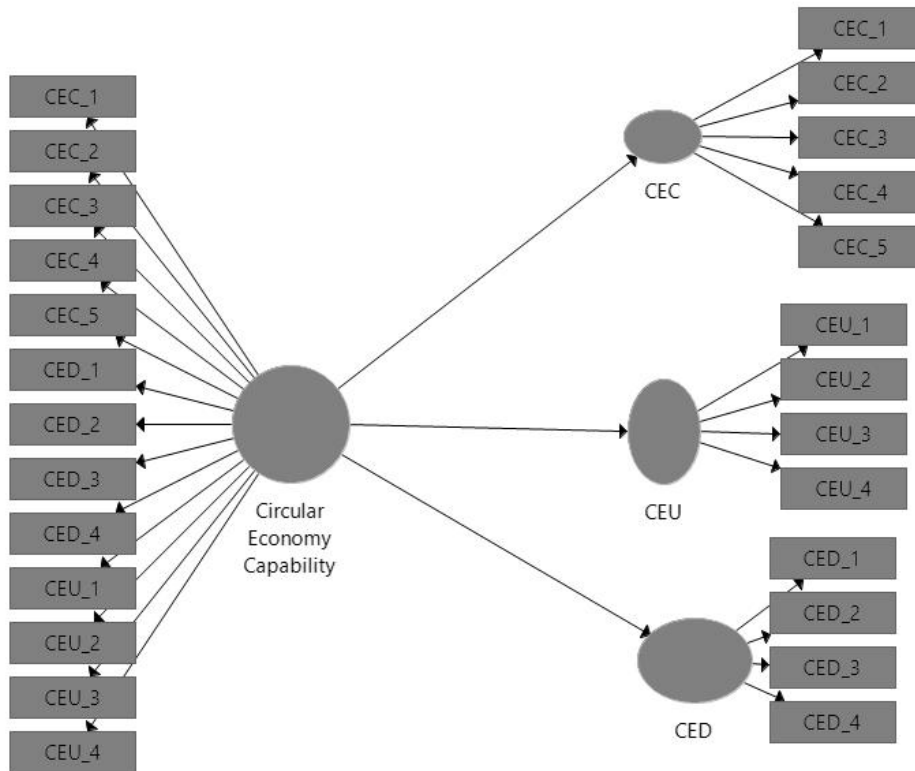


Figure 4. 2 First and second-order constructs

In this research, there are 58 measurement items (also called indicators), 23 first-order constructs (also called low-level constructs or sub-constructs), and 6 high-level constructs/second-order constructs/constructs. For example, in Figure 4.2, Items CEC\_1-CEC\_5, CEU\_1-CEU\_4, and CED\_1-CED\_4 are indicators. Constructs CEC, CEU, and CED are first-order constructs, which are respectively measured by indicators CEC\_1-CEC\_5, CEU\_1-CEU\_4, and CED\_1-CED\_4. The Construct Circular Economy Capability is the second-order construct, which is measured by CEC, CEU, and CED (3 first-order constructs).

#### *4.3.1.2.2 Identify Formative and Reflective Models*

The constructs are measured by sub-constructs. The sub-constructs are measured by indicators. There are two models in the Structural Equation Modelling (SEM): formative model and reflective model (Jarvis et al., 2003; Becker, 2012). The direction of arrows (also referred to as implied causality) in the reflective model is from the constructs to the indicators, which means the constructs are reflected by the indicators. The direction of arrows in the formative model is from the indicators/measurement items to the constructs, which means the constructs are formed by the indicators (Jarvis et al., 2003). The differences and the decision rules for formative models and reflective model are summarised in Table 4.3.

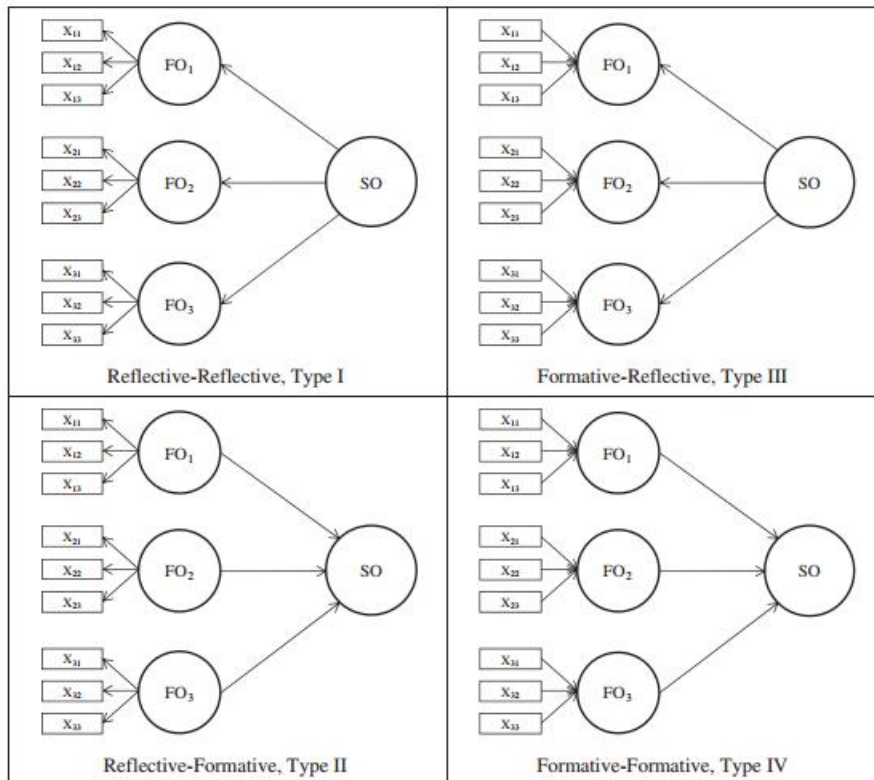
**Table 4. 3 Differences and the decision rules for formative models and reflective model (Jarvis et al., 2003)**

| <b>Differences between reflective and formative model</b>  |  |
|--|--|
| <b>Reflective Model</b>  | <b>Formative Model</b>   |
| Direction of causality is from construct to measurement items.   | Direction of causality is from measurement items to construct.                             |
| Change in the construct conceptualization should impact the measurement items.                                       | Change in the construct conceptualization should not impact the measurement items.         |
| Dropping a measurement item should not alter the conceptual domain of the construct.                                 | Dropping a measurement item may alter the conceptual domain of the construct.              |
| Measurement items are expected to be correlated (Measurement items should possess internal consistency reliability). | Measurement items are not expected to be correlated (Internal consistency is not implied). |
| Takes measurement error into account at the measurement item level.  | Takes measurement error into account at the construct level.                               |

| <b>Decision rules for reflective and formative models</b>  |  |  |
|--|--|--|
| <b>Decision Rules/Questions</b>  | <b>Reflective Model</b>  | <b>Formative Model</b>   |
| Direction of causality from construct to measure implied by the conceptual definition                      | Direction of causality is from construct to measurement items.                       | Direction of causality is from measurement items to construct.                         |
| Are the measurement items defining characteristics or manifestations of the construct?                     | Measurement items are not defining characteristics of the construct.                 | Measurement items are defining characteristics of the construct.                       |
| Would changes in the measurement items cause changes in the construct?                                     | Changes in the measurement items should not cause changes in the construct.          | Changes in the measurement items should cause changes in the construct.                |
| Would changes in the construct cause changes in the measurement items?                                     | Changes in the construct cause changes in the measurement items.                     | Changes in the construct do not cause changes in the measurement items.                |
| Interchangeability of the measurement items  | Measurement items should be interchangeable.   | Measurement items should not be interchangeable.                                       |
| Should the measurement items have the same or similar content, or share a common theme?                    | Measurement items should have the same or similar content or share a common theme.   | Measurement items should not have the same or similar content or share a common theme. |
| Would dropping one of the measurement items alter the conceptual domain of the construct?                  | Dropping a measurement item should not alter the conceptual domain of the construct. | Dropping a measurement item may alter the conceptual domain of the construct.          |
| Co-variation among the measurement items   | Measurement items are expected to co-vary with each other.                           | Not necessary for measurement items to co-vary with each other.                        |
| Should a change in one of the measurement items be associated with changes in the other measurement items? | Necessarily.   | Not necessarily.   |
| Nomological net of the construct measurement items   | Nomological net for the measurement items should not differ.                         | Nomological net for the measurement items may differ.                                  |
| Are the measurement items expected to have the same antecedents and consequences?                          | Measurement items are required to have the same antecedents and consequences.        | Measurement items are not required to have the same antecedents and consequences       |

The hierarchical latent variable models are usually restricted to two levels in the model. This research has two levels of constructs: first-order constructs are the low-level constructs, and

second-order constructs are the high-level constructs. The relationships (reflective or formative) should be identified for each level of constructs (Edwards, 2001; Ringle et al., 2012; Jarvis et al., 2003; Wetzels et al., 2009). There are four types of hierarchical latent variable models. The description of each type of hierarchical latent variable models is shown in Figure 4.3. This research has two types of hierarchical latent variable models: Reflective-reflective type I model, and Reflective-formative type II model (Table 4.4).



**Figure 4. 3 Four types of hierarchical latent variable models**

### The four types of hierarchical latent variable models

| Models                              | Description  | Reference  |
|-------------------------------------|--|--|
| Reflective-reflective type I model  | The first-order constructs are reflectively measured by indicators;<br>The second-order constructs are reflectively measured by first order constructs.<br>Known as the 'hierarchical common factor model'<br>The second order construct represents the common factor of several specific factors.<br>Appropriate for research to find the common factor of several related, yet distinct reflective constructs. | Lohmoller, 1989; Becker, 2012  |
| Reflective-formative type II model  | The first-order constructs are reflectively measured by indicators;<br>The second-order constructs are formatively measured by first order constructs.   | Chin, 1998b; Becker, 2012  |
| Formative-reflective type III model | The first-order constructs are formatively measured by indicators;<br>The second-order constructs are reflectively measured by first order constructs.<br>The second-order construct is the common   | Venkatraman and Ramanunjam, 1986; Jarvis et al., 2003; Petter et al., 2007; Becker, 2012 |
| Formative-formative type IV model   | The first-order constructs are formatively measured by indicators;<br>The second-order constructs are formatively  | Becker, 2012   |

**Table 4. 4 Identify hierarchical latent variable models**

| Identify hierarchical latent variable models                     |   |                   |                                    |       |
|--|---|-------------------|------------------------------------|-------|
| Construct/Second-order construct                                 | Sub-Construct/First-order construct         | Measurement items | Model                              |       |
| Stakeholders' engagement for environmental implementation (SEEI) | Customer (SEC)                              | SEC_1             | Reflective-formative type II model |       |
|  |   | SEC_2             |                                    |       |
|  | Employees (SEE)                             | SEE_1             |                                    |       |
|  |   | SEE_2             |                                    |       |
|  | Government (SEG)                            | SEG_1             |                                    |       |
|  |   | SEG_2             |                                    |       |
|  | NGO (SEN)                                   | SEN_1             |                                    |       |
| SEN_2  |   |                   |                                    |       |
| Owners (SEO)   | SEO_1                                       |                   |                                    |       |
|  | SEO_2                                       |                   |                                    |       |
| Suppliers (SES)  | SES_1                                       |                   |                                    |       |
|  | SES_2                                       |                   |                                    |       |
| Organisational performance (ORPE)                                | Environmental performance (OEP)             | OEP_1             | Reflective-formative type II model |       |
|  |   | OEP_2             |                                    |       |
|  |   | OEP_3             |                                    |       |
| Business performance (OPB)                                       | OPB_1                                       | OPB_1             |                                    |       |
|  |   | OPB_2             |                                    |       |
|  |   | OPB_3             |                                    |       |
| Level of barriers of green manufacturing application (BFGI)      | Finance (BEF)                               | BEF               | Reflective-formative type II model |       |
|  |   | Knowledge (BEK)   |                                    | BEK_1 |
|  |   |                   |                                    | BEK_2 |
|  | BEK_3                                       |                   |                                    |       |
|  | Stakeholders' involvement and support (BES) | BES_1             |                                    | BES_1 |
|  |   |                   |                                    | BES_2 |
|  |   |                   |                                    | BES_3 |
| Technology (BET)   | BET_1                                       | BET_1             |                                    |       |
|  |   | BET_2             |                                    |       |
|  |   | BET_3             |                                    |       |
| Circular Economy Capability (CECA)                               | Recycle (CEC)                               | CEC_1             | Reflective-reflective type I model |       |
|  |   | CEC_2             |                                    |       |
|  |   | CEC_3             |                                    |       |
|  |   | CEC_4             |                                    |       |
|  |   | CEC_5             |                                    |       |
|  | Reduce (CED)                                | CED_1             |                                    | CED_1 |
|  |   |                   |                                    | CED_2 |
|  |   |                   |                                    | CED_3 |
|  |   |                   |                                    | CED_4 |
|  | Reuse (CEU)                                 | CEU_1             |                                    | CEU_1 |
|  |   |                   |                                    | CEU_2 |
|  |   |                   |                                    | CEU_3 |
|  |   | CEU_4             |                                    |       |
| Environment orientation (ENOR)                                   | External environment orientation (EEO)      | EEO_1             | Reflective-reflective type I model |       |
|  |   | EEO_2             |                                    |       |
|  | Internal environment orientation (EIO)      | EIO_1             |                                    |       |
|  |   | EIO_2             |                                    |       |
| Green Manufacturing (GRMA)                                       | Green Packing and Distribution (GMA)        | GMA_1             | Reflective-reflective type I model |       |
|  |   | GMA_2             |                                    |       |
|  | Green Design (GMD)                          | GMD_1             |                                    |       |
|  |   | GMD_2             |                                    |       |
|  | Green End of Life Management (GME)          | GME_1             |                                    | GME_1 |
|  |   |                   |                                    | GME_2 |
|  |   |                   |                                    | GME_3 |
|  | Remanufacturing (GMF)                       | GMF_1             |                                    | GMF_1 |
|  |   |                   |                                    | GMF_2 |
|  | Green Procure (GMP)                         | GMP_1             |                                    | GMP_1 |
| GMP_2  |   |                   |                                    |       |
| Green Production (GMR)   | GMR_1                                       | GMR_1             |                                    |       |
|  |   | GMR_2             |                                    |       |

#### 4.3.1.2.3 Identify Repeated Indicators Approach and Two-Stage Approach

As depicted in Figure 4.4, there are three approaches to estimate hierarchical constructs in the context of PLS path modelling, including the two-stage approach, the repeated indicators approach, and the hybrid approach (Van Riel et al., 2017).

In the repeated indicators approach, the indicators of the first-order constructs are reused for the second-order construct (Wold, 1982). For example, in Figure 4.5, the second-order construct (Circular Economy capability) is made up of 3 first-order constructs (CEC, CEU, and CED). The first-order constructs CEC has five manifest variables/indicators (CEC\_1-CEC\_5). The first-order constructs CEU is with four manifest variables (CEU\_1-CEU\_4). The first-order constructs CED is with four manifest variables (CED\_1-CED\_4). All these 13 variables are reused as the indicators for the second-order construct (Circular Economy capability).

However, Becker et al. (2012) point out that the drawback of this approach is that the indicators reused for the second-order constructs would evoke the artificially correlated residuals. Moreover, Ringle et al. (2012) point out that the severe pitfall of this approach is frequently neglected. In the repeated indicators approach, when the second-order construct is the endogenous construct, most of its variance is explained by the repeated indicators. Therefore, there might be no remaining variance can be explained by other potential constructs. It is easy to make the wrong conclusion that the potential constructs are irrelevant to the endogenous construct (Ringle et al., 2012). To solve the above problem, Ringle et al. (2012) recommend the two-stage approach.

In the two-stage approach, there are two steps to complete this approach. The first stage does not include the second-order constructs. The latent variable scores of the first-order constructs are obtained in the first stage. In the second stage (Figure 4.6), the second-order construct is included, and the latent variable scores of the first-order constructs are used as the indicators for the second-order construct (Tenenhaus et al., 2005; Ringle et al., 2012; Lohmoller, 1989).

Another way to conduct the two-stage approach is to combine it with the repeated indicator approach to obtain the latent variable scores of the first-order constructs for the first step, and then use these latent variable scores of the first-order constructs in the second-stage (Ringle et al., 2012; Wilson, 2010). The measurement of the first-order construct is substantially reduced to the single item (Ringle et

al., 2012). Arnett et al. (2003) indicate that the reduction is useful for both statistical reasons and practical reasons. In terms of the practical reasons, it prevents the “double-counting”. In terms of the statistical reasons, it avoids the multi-collinearity within the indicators. Moreover, the second-order construct can be placed in the endogenous position when using the two-stage approach (Ringle et al., 2012).

Another approach is the hybrid approach. It combines the two-stage approach and the repeated indicators approach. The indicators of the first-order constructs are split in half. In Figure 4.4, half of the indicators of first-order constructs are still applied to measure the first-order constructs, and the rest indicators are employed to measure the second-order construct. This approach could eliminate the issue of artificially correlated residuals. However, in the actual practices, this approach is seldom used, as it does not provide the guidelines for the odd number of indicators. It also lacks suggestions for the specific indicators being assigned to the first-order constructs or the second-order constructs (Van Riel et al., 2017).

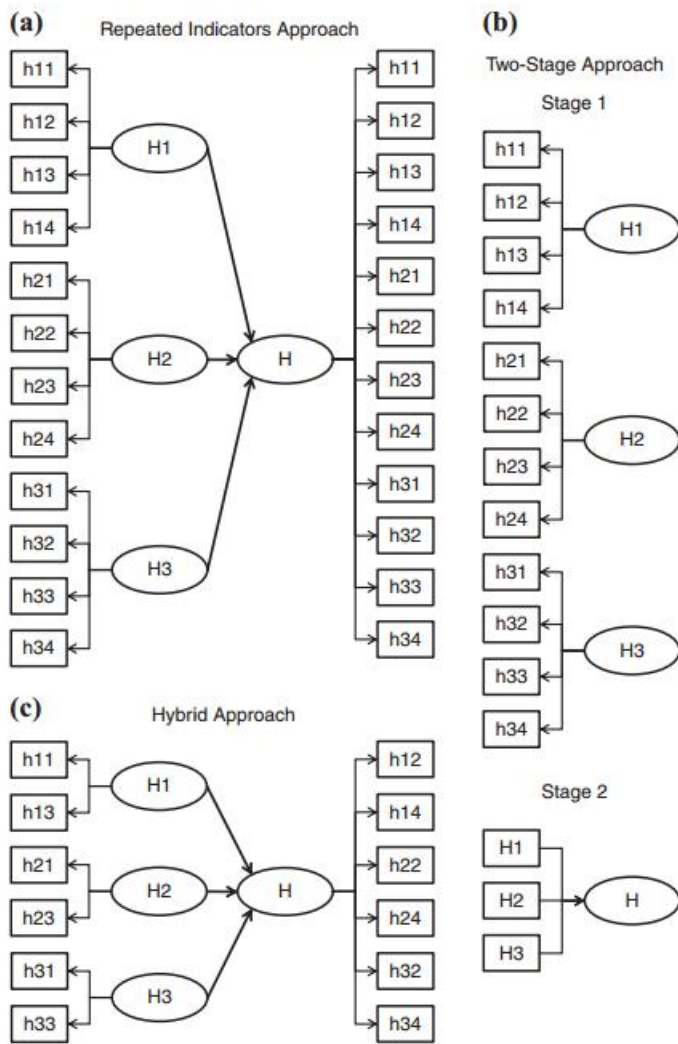
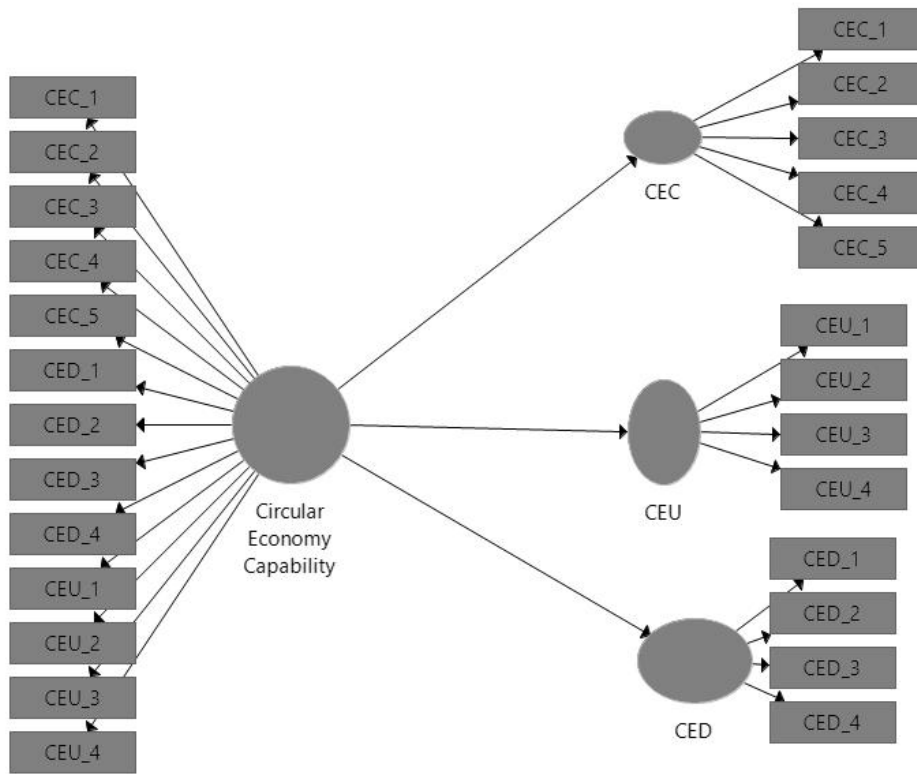
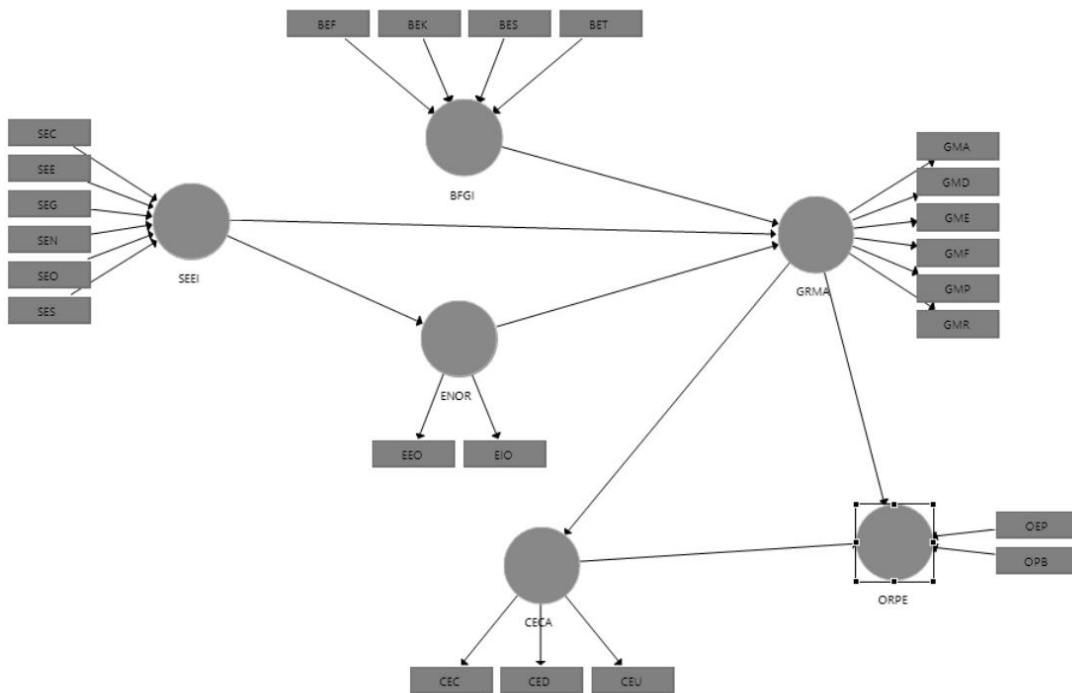


Figure 4. 4 Three approaches to estimate hierarchical constructs (Van Riel et al., 2017).



**Figure 4. 5 Example of Repeated Indicators Approach**



**Figure 4. 6 Example of the two-stage approach (Second stage)**

One of the decision rules to choose the repeated indicators approach or two-stage approach is based on the number of indicators of the first-order constructs. If the number of indicators is the same, the repeated indicators approach should be adopted. If not, the two-stage approach should be used (Wetzels et al., 2009). Moreover, Ringle et al. (2012) show that when the formative second-order construct is placed in the endogenous position, then the two-stage approach should be employed to obtain the valid estimations for  $R^2$  and the path coefficients. In this research, the second-order construct, Organisational Performance (ORPE) is the formative second-order construct that placed in the endogenous position. The number of indicators is not the same. Therefore, the two-stage approach is applied in this research.

#### **4.4 Assessment of the Outer Model**

This section introduces the assessment of outer measurement model, including the outer model assessment methodology (Chapter 4.4.1), the factor analysis, validity and reliability tests for measurement items at first-order constructs level (Chapter 4.4.2), the factor analysis, validity and

reliability tests for constructs at second-order constructs level (Chapter 4.4.3), and the common method variance assessment (Chapter 4.4.4).

#### 4.4.1 Outer Model Assessment Methodology

This study applies the following criteria (Table 4.5) to assess the outer model (also called measurement model), including the indicator reliability, the internal consistency reliability, convergent validity, and the discriminant validity. By running the PLS algorithm and conducting the bootstrapping using the SmartPLS 3 software, the values of the above criteria are generated and can be found in the SmartPLS output report.

**Table 4. 5 Measurement model/outer model assessment criteria (Reflective Model)**

| Assessment/ What to check?              | Criterion/ What to look for in SmartPLS 3?                                     | Where is it in the report?  | Note/Is it OK?  | Reference  |
|---|--|---|---|--|
| <b>Reliability</b>                      |  |   |   |  |
| <b>Indicator Reliability</b>            | Outer loadings   | Reflective Model: PLS Algorithm->Final results->Outer Loadings<br>PLS Algorithm->Quality Criteria->Construct Reliability and Validity | Outer Loadings numbers: 0.70 or higher is preferred. 0.4 or higher is acceptable for exploratory research.  | Hulland, 1999; Hair et al., 2010; Gefen and Straub, 2005; Hair et al., 1995; Hair et al., 2010;        |
| <b>Internal Consistency Reliability</b> | "Reliability" numbers, cronbach's alpha  | PLS Algorithm->Quality Criteria->Construct Reliability and Validity   | Composite reliability number: 0.7 or higher. 0.6 or higher is acceptable for exploratory research.<br><br>Cronbach's alpha >0.7   | Gefen, et al., 2000; Bagozzi and Yi, 1988; Nunnally, 1978;   |
| <b>Validity</b>                         |  |   |   |  |
| <b>Convergent validity</b>              | "AVE" numbers  | PLS Algorithm->Quality Criteria->Construct Reliability and Validity   | AVE: 0.5 or higher  | Fornell and Larcker, 1981; Baqozzi and Yi, 1988;   |
| <b>Discriminant validity</b>            | Fornell-Larcker Criterion; Cross Loadings; Heterotrait-Monotrait Ratio (HTMT); | PLS Algorithm->Quality Criteria->Discriminant Validity  | Fornell-Larcker Criterion: "square root" of AVE of each latent variable should be greater than the correlations among the latent variables.<br><br>Cross Loadings: the number of cross loadings of each latent variable should be greater than the cross loadings among the latent variables.<br><br>HTMT <0.90 | Chin, 2010; Chin, 1998b; Fornell and Larcker, 1981; Hair et al., 2010; Kline, 2011; Gold et al., 2001; |

#### 4.4.2 Tests Conducted at the First-order Construct Level

The factor analysis, validity, and reliability tests for the 58 measurement items are shown in Table 4.6. The 58 measurement items reflectively measure the 23 first-order constructs. After running the PLS algorithm by using the SmartPLS 3 software, the values of the outer loading are generated. All values for the outer loading of these 58 measurement items are over 0.7 (Table 4.6). It suggests excellent measurement of these construct (Hulland, 1999).

The Cronbach's alpha (can be found through the path: PLS Algorithm->Quality Criteria->Construct Reliability and Validity) evaluates the reliability of the measurement items in terms of dimensionality. Cronbach's alpha shows how closely related all variables in the scale are as a group, which can be used as the measure of internal consistency (Nunnally, 1978). However, Hair et al. (2017) argue that the Cronbach's alpha supposes all the measurement items are equally reliable. It assumes all the measurement items have equal outer loadings on the constructs. However, PLS computes the measurement items based on their individual reliability. Due to the limitations of Cronbach's alpha, the Composite Reliability (CR) is a more technically appropriate measure of internal consistency reliability. Composite reliability (CR) value of 0.6 or higher is acceptable for exploratory research (Gefen et al., 2000; Bagozzi and Yi, 1988). All values for the CR in Table 4.6 are over 0.7, demonstrating satisfactory reliability.

The convergent validity could be assessed using the Average Variance Extracted (AVE) (can be found through the path: PLS Algorithm->Quality Criteria->Construct Reliability and Validity). The value of AVE is between 0 and 1. All values of AVE in Table 4.6 are over 0.5, which show that convergent validity has been established (Fornell and Larcker, 1981; Baqozzi and Yi, 1988).

The discriminant validity could be assessed using the Fornell-Larcker Criterion; Cross Loadings, and Heterotrait-Monotrait Ratio (HTMT). All the numbers of the latent variables' square root of AVE are greater than the square root of AVE among the latent variables (See Appendix 3 Discriminant validity testing of the measurement items- Fornell-Larcker Criterion). In addition, all the numbers of cross-loadings of each latent variable are larger than the cross-loadings among the latent variables (Appendix 3 Discriminant validity testing of the measurement items- Cross loadings). Furthermore, all the

HTMT value is below 0.90 (Appendix 3 Discriminant validity testing of the measurement items- HTMT).

The results of these three measures show the discriminant validity has been established.

**Table 4. 6 Results of the factor analysis and validity and reliability tests for the measurement items at the first-order construct level**

Factor analysis, validity, and reliability tests for measurement items at first-order constructs level (Measurement items----> Sub-construct)

| Construct  | Sub-Construct                    | Item  | Scale      | Loadings | AVE   | CR    | Cronbach's Alpha | rho_A |
|--|----------------------------------|-------|------------|----------|-------|-------|------------------|-------|
| Stakeholder Engagement in Environmental Implementation | <b>Customer</b>                  | SEC_1 | Reflective | 0.889    | 0.703 | 0.825 | 0.733            | 0.796 |
|  |                                  | SEC_2 |            | 0.785    |       |       |                  |       |
|  | <b>Employees</b>                 | SEE_1 | Reflective | 0.894    | 0.811 | 0.896 | 0.820            | 0.828 |
|  |                                  | SEE_2 |            | 0.908    |       |       |                  |       |
|  | <b>Government</b>                | SEG_1 | Reflective | 0.958    | 0.921 | 0.959 | 0.924            | 1.108 |
|  |                                  | SEG_2 |            | 0.961    |       |       |                  |       |
|  | <b>NGO</b>                       | SEN_1 | Reflective | 0.814    | 0.769 | 0.869 | 0.767            | 0.872 |
|  |                                  | SEN_2 |            | 0.936    |       |       |                  |       |
|  | <b>Owners</b>                    | SEO_1 | Reflective | 0.926    | 0.851 | 0.919 | 0.814            | 0.816 |
|  |                                  | SEO_2 |            | 0.919    |       |       |                  |       |
|  | <b>Suppliers</b>                 | SES_1 | Reflective | 0.948    | 0.896 | 0.945 | 0.894            | 0.894 |
|  |                                  | SES_2 |            | 0.945    |       |       |                  |       |
| Organisational Performance                             | <b>Environmental performance</b> | OEP_1 | Reflective | 0.696    | 0.627 | 0.833 | 0.698            | 0.705 |
|  |                                  | OEP_2 |            | 0.813    |       |       |                  |       |
|  |                                  | OEP_3 |            | 0.857    |       |       |                  |       |
|  | <b>Business</b>                  | OPB_1 | Reflective | 0.841    | 0.838 | 0.939 | 0.901            | 0.901 |

|  |  |                |              |       |       |       |       |       |  |
|--|--|----------------|--------------|-------|-------|-------|-------|-------|--|
|  | <b>performance</b>                           | <b>OPB_2</b>   |              | 0.951 |       |       |       |       |  |
|  |  | <b>OPB_3</b>   |              | 0.950 |       |       |       |       |  |
| Level of Barriers to Green Manufacturing application | <b>Finance</b>                               | <b>BEF</b>     | Reflective   | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |  |
|  |  | <b>BEK_1</b>   |              | 0.827 |       |       |       |       |  |
|  | <b>Knowledge</b>                             | <b>BEK_2</b>   | Reflective   | 0.856 | 0.711 | 0.880 | 0.796 | 0.797 |  |
|  |  | <b>BEK_3</b>   |              | 0.846 |       |       |       |       |  |
|  | <b>Stakeholders' involvement and support</b> | <b>BES_1</b>   |              | 0.851 |       |       |       |       |  |
|  |  | <b>BES_2</b>   | Reflective   | 0.851 | 0.676 | 0.862 | 0.760 | 0.775 |  |
|  |  | <b>BES_3</b>   |              | 0.761 |       |       |       |       |  |
|  |  | <b>BET_1</b>   |              | 0.700 |       |       |       |       |  |
|  | <b>Technology</b>                            | <b>BET_2</b>   | Reflective   | 0.829 | 0.611 | 0.824 | 0.681 | 0.693 |  |
|  |  | <b>BET_3</b>   |              | 0.811 |       |       |       |       |  |
|  | Circular Economy Capability                  | <b>Recycle</b> | <b>CEC_1</b> |       | 0.857 |       |       |       |  |
|  |  |                | <b>CEC_2</b> |       | 0.901 |       |       |       |  |
|  |  | <b>CEC_3</b>   | Reflective   | 0.930 | 0.821 | 0.958 | 0.945 | 0.946 |  |
|  |  | <b>CEC_4</b>   |              | 0.926 |       |       |       |       |  |
|  |  | <b>CEC_5</b>   |              | 0.916 |       |       |       |       |  |
| <b>Reduce</b>  |  | <b>CED_1</b>   |              | 0.818 |       |       |       |       |  |
|  |  | <b>CED_2</b>   | Reflective   | 0.859 | 0.738 | 0.919 | 0.882 | 0.882 |  |
|  |  | <b>CED_3</b>   |              | 0.868 |       |       |       |       |  |
|  |  | <b>CED_4</b>   |              | 0.890 |       |       |       |       |  |
| <b>Reuse</b>   |  | <b>CEU_1</b>   |              | 0.885 |       |       |       |       |  |
|  |  | <b>CEU_2</b>   | Reflective   | 0.892 | 0.808 | 0.944 | 0.921 | 0.921 |  |
|  |  | <b>CEU_3</b>   |              | 0.912 |       |       |       |       |  |

|                         |   |              |            |       |       |       |       |       |
|-------------------------|---|--------------|------------|-------|-------|-------|-------|-------|
| Environment orientation | <b>External Environmental Orientation</b> | <b>CEU_4</b> |            | 0.906 |       |       |       |       |
|                         |   | <b>EEO_1</b> | Reflective | 0.932 | 0.871 | 0.931 | 0.852 | 0.852 |
|                         |   | <b>EEO_2</b> |            | 0.935 |       |       |       |       |
|                         | <b>Internal Environmental Orientation</b> | <b>EIO_1</b> | Reflective | 0.960 | 0.924 | 0.960 | 0.918 | 0.918 |
|                         |   | <b>EIO_2</b> |            | 0.961 |       |       |       |       |
| Green Manufacturing     | <b>Green Packing and Distribution</b>     | <b>GMA_1</b> | Reflective | 0.897 | 0.780 | 0.876 | 0.718 | 0.725 |
|                         |   | <b>GMA_2</b> |            | 0.869 |       |       |       |       |
|                         | <b>Green Design</b>                       | <b>GMD_1</b> | Reflective | 0.951 | 0.908 | 0.952 | 0.898 | 0.899 |
|                         |   | <b>GMD_2</b> |            | 0.954 |       |       |       |       |
|                         | <b>Green End of Life Management</b>       | <b>GME_1</b> |            | 0.763 |       |       |       |       |
|                         |   | <b>GME_2</b> | Reflective | 0.851 | 0.592 | 0.812 | 0.651 | 0.657 |
|                         |   | <b>GME_3</b> |            | 0.684 |       |       |       |       |
|                         | <b>Remanufacturing</b>                    | <b>GMF_1</b> | Reflective | 0.893 | 0.797 | 0.887 | 0.745 | 0.745 |
|                         |   | <b>GMF_2</b> |            | 0.892 |       |       |       |       |
|                         | <b>Green Procure</b>                      | <b>GMP_1</b> | Reflective | 0.951 | 0.906 | 0.950 | 0.896 | 0.896 |
|                         |   | <b>GMP_2</b> |            | 0.952 |       |       |       |       |
|                         | <b>Green Production</b>                   | <b>GMR_1</b> | Reflective | 0.953 | 0.904 | 0.950 | 0.894 | 0.895 |

**GMR\_2** 0.949

*Notes:*

*A: In exploratory research, item loadings  $\geq 0.4$  are acceptable (Hulland, 1999).*

*B: All AVE scores  $>0.5$  indicates acceptable convergent reliability (Fornell and Larcker, 1981; Baqozzi and Yi, 1988).*

*C: All values for CR  $>0.7$  indicates satisfactory internal consistency (Gefen et al., 2000).*

*D: All values for Cronbach's alpha  $>0.7$  indicates satisfactory indicator Reliability (Nunnally,1978)*



#### 4.4.3 Tests Conducted at the Second-order Construct Level

As discussed in Section 4.3.1.2.3, this research uses the two-stage approach. The critical step of the two-stage approach is to apply the latent variable scores of the first-order constructs as the measurement items of the second-order constructs. Thus, it is necessary to perform factor analysis and validity and reliability tests for the first-order constructs as reported above. To assess the factor analysis, validity, and reliability tests for 23 first-order constructs, the 23 latent variable scores of these 23 first-order constructs are used as the 23 indicators for the 6 second-order constructs (Figure 4.6).

In particular, the second-order constructs, Environmental Orientation (ENOR), Green Manufacturing (GRMA), and Circular Economy capability (CECA) are reflectively measured by the indicators EEO, EIO; GMA, GMD, GME, GMF, GMP, GMR, and CEC, CED, CEU. The second-order constructs, Level of Barriers to the Green Manufacturing application (BFGI), Organisational Performance (ORPE), and Stakeholder engagement for environment implementation (SEEI) are formatively measured by the indicators SEC, SEE, SEG, SEN, SEO, SES; BEF, BEK, BES, BET, and OEP, OPB (Figure 4.6).

As discussed in Section 4.4.2, the measurement criteria for reflective mode are Outer loadings, Composite reliability, Cronbach's alpha, and Average Variance Extracted. According to the above measurement criteria, the result shown in Table 4.7 indicates that indicator reliability, internal consistency reliability, and convergent validity are well established.

Since the formative measurement items are not highly correlated, the Outer loadings, Composite reliability, Cronbach's alpha, and AVE should not be analysed when measuring the formative measurement model. Instead, Outer weights and significance, and the Collinearity of indicators (as denoted by their variance inflation factor (VIF) values) should be evaluated.

The outer weights can be found using the path: Bootstrapping-> Final results->Outer Weights (Mean, STDEV, T-Values). The measurement items with a high value of outer

weights are an important area that should be focused on in real practice (Wong, 2013). Though the indicator can be removed when its outer weight and outer loading are both not significant, the decisive argument should be provided. Because the weights' significance is based on the idiosyncrasies of the sample, the decision to remove one indicator should be carefully made (Cenfetelli and Bassellier, 2009; Hair et al., 2017; Wong, 2013). All formative indicators in this research are meaningful for the second-order construct. Thus, this study keeps all indicators, though some indicators are with insignificant weights.

Furthermore, the multicollinearity of formative second-order constructs may exist (Sarstedt et al., 2016); thus, this research evaluates the collinearity issues of the formative second-order constructs. The value of variance inflation factor (VIF) can be found using the path: PLS Algorithm->Quality Criteria->Collinearity Statistics (VIF). Hair et al. (2006) point out the VIF less than 10 is acceptable. The results (Table 4.7), show that VIF values are all less than 3. It indicates that there are no collinearity issues in this research (Hair et al., 2006).

The discriminant validity could be assessed using the Fornell-Larcker Criterion, and Heterotrait-Monotrait Ratio (HTMT). All numbers of the latent variables' square root of AVE are larger than the square root of AVE among the latent variables (Appendix 4 Discriminant validity testing of the subconstructs- Fornell-Larcker Criterion). Furthermore, all the HTMT value is below 0.90 (Appendix 4 Discriminant validity testing of the subconstructs- HTMT). The results of these three measures show the discriminant validity has been established.

**Table 4. 7 Results of the factor analysis and validity and reliability tests for the second-order construct level**

Factor analysis and validity and reliability test results  
 (Reflective: Construct----> Subconstruct) -Two-stage approach

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Summary of Analysis Results

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| Construct                          | Sub-Construct  | Item  | Scale      | Loadings | AVE  | CR    | Cronbach's Alpha | rho_A |  |
|------------------------------------|----------------|-------|------------|----------|------|-------|------------------|-------|--|
| <b>Circular Economy Capability</b> | <b>Recycle</b> | CEC_1 |            |          |      |       |                  |       |  |
|                                    |                | CEC_2 |            |          |      |       |                  |       |  |
|                                    |                | CEC_3 |            | 0.832    |      |       |                  |       |  |
|                                    |                | CEC_4 |            |          |      |       |                  |       |  |
|                                    |                | CEC_5 |            |          |      |       |                  |       |  |
|                                    | <b>Reduce</b>  | CED_1 |            |          |      |       |                  |       |  |
|                                    |                | CED_2 | Reflective | 0.685    | 0.66 | 0.852 | 0.734            | 0.75  |  |
|                                    |                | CED_3 |            |          |      |       |                  |       |  |
|                                    |                | CED_4 |            |          |      |       |                  |       |  |
|                                    | <b>Reuse</b>   | CEU_1 |            |          |      |       |                  |       |  |
|                                    |                | CEU_2 |            |          |      |       |                  |       |  |
|                                    |                | CEU_3 |            | 0.904    |      |       |                  |       |  |
| CEU_4                              |                |       |            |          |      |       |                  |       |  |

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|                                |   |       |            |       |       |       |      |       |
|--------------------------------|---|-------|------------|-------|-------|-------|------|-------|
| <b>Environment orientation</b> | <b>External Environmental Orientation</b> | EEO_1 |            | 0.926 |       |       |      |       |
|                                |   | EEO_2 | Reflective |       | 0.862 | 0.926 | 0.84 | 0.842 |
|                                | <b>Internal Environmental Orientation</b> | EIO_1 |            | 0.931 |       |       |      |       |
|                                |   | EIO_2 |            |       |       |       |      |       |
| <b>Green Manufacturing</b>     | <b>Green Packing and Distribution</b>     | GMA_1 |            | 0.800 |       |       |      |       |
|                                |   | GMA_2 |            |       |       |       |      |       |
|                                | <b>Green Design</b>                       | GMD_1 |            | 0.774 |       |       |      |       |
|                                |   | GMD_2 |            |       |       |       |      |       |
|                                | <b>Green End of Life Management</b>       | GME_1 |            |       |       |       |      |       |
|                                |   | GME_2 | Reflective | 0.513 | 0.552 | 0.879 | 0.83 | 0.846 |
|                                |   | GME_3 |            |       |       |       |      |       |
|                                | <b>Remanufacturing</b>                    | GMF_1 |            | 0.688 |       |       |      |       |
|                                |   | GMF_2 |            |       |       |       |      |       |
|                                | <b>Green Procure</b>                      | GMP_1 |            | 0.844 |       |       |      |       |
|                                | GMP_2                                     |       |            |       |       |       |      |       |
|                                | <b>Green Production</b>                   | GMR_1 |            | 0.791 |       |       |      |       |
|                                |   | GMR_2 |            |       |       |       |      |       |

*Notes:*

*A: In exploratory research, item loadings  $\geq 0.4$  are acceptable (Hulland, 1999).*

*B: All AVE scores  $>0.5$  indicates acceptable convergent reliability (Fornell and Larcker, 1981; Baqozzi and Yi, 1988).*

*C: All values for CR  $>0.7$  indicates satisfactory internal consistency (Gefen et al., 2000).*

*D: All values for Cronbach's alpha  $>0.7$  indicates satisfactory indicator Reliability (Nunnally,1978)*

Factor analysis and validity and reliability test results  
 (Formative: Sub-Construct----> construct) Two- stage approach

| Summary of Analysis Results                           |                                  |  |           |           |          |       |
|---|----------------------------------|--|-----------|-----------|----------|-------|
| Construct   | Sub-Construct                    | Item   | Scale     | Weights   | T-values | VIF   |
| <b>Barriers of Green Manufacturing Implementation</b> | <b>Finance</b>                   | BEF  |           | 0.089     | 0.680    | 1.471 |
|   |                                  | BEK_1  |           |           |          |       |
|   | <b>Knowledge</b>                 | BEK_2  |           | 0.835     | 1.701+   | 1.707 |
|   |                                  | BEK_3  |           |           |          |       |
|   |                                  | <b>Stakeholders' involvement and support</b> | BES_1     | Formative |          |       |
|   | BES_2                            |  | 0.180     |           | 0.444    | 1.508 |
|   | BES_3                            |  |           |           |          |       |
|   | <b>Technology</b>                | BET_1  |           |           |          |       |
|   |                                  | BET_2  |           | 0.179     | 0.671    | 1.275 |
| BET_3   |                                  |  |           |           |          |       |
| <b>Organisational Performance</b>                     | <b>Environmental performance</b> | OEP_1  |           |           |          |       |
|   |                                  | OEP_2  |           | 0.997     | 11.099** | 1.358 |
|   |                                  | OEP_3  |           |           | *        |       |
|   | <b>Business performance</b>      | OPB_1  | Formative |           |          |       |
|   |                                  | OPB_2  |           | 0.245     | 3.182**  | 1.358 |
|   |                                  | OPB_3  |           |           |          |       |
| <b>Stakeholder Engagement in</b>                      | <b>Customer</b>                  | SEC_1  | Formative |           |          |       |
|   |                                  | SEC_2  |           | 0.073     | 0.119    | 1.178 |

|                                     |                   |       |       |          |       |
|-------------------------------------|-------------------|-------|-------|----------|-------|
| <b>Environmental Implementation</b> | <b>Employees</b>  | SEE_1 | 0.820 | 12.592** | 1.188 |
|                                     |                   | SEE_2 |       | *        |       |
|                                     | <b>Government</b> | SEG_1 | 0.181 | 2.268**  | 1.166 |
|                                     |                   | SEG_2 |       |          |       |
|                                     | <b>NGO</b>        | SEN_1 | 0.054 | 0.914    | 1.097 |
|                                     |                   | SEN_2 |       |          |       |
|                                     | <b>Owners</b>     | SEO_1 | 0.234 | 3.002**  | 1.200 |
|                                     |                   | SEO_2 |       |          |       |
|                                     | <b>Suppliers</b>  | SES_1 | 0.149 | 2.598**  | 1.153 |
|                                     |                   | SES_2 |       |          |       |

Notes:

A: + indicates  $p < 0.1$ ; \* indicates  $p < 0.05$ ; \*\* indicates  $p < 0.01$ ; \*\*\* indicates  $p < 0.001$ ; n/s indicates nonsignificance.

B: 10 is the maximum level of the VIF (Hair et al., 2006)



#### 4.4.4 Common Method Variance Assessment

Conway and Lance (2010) point out that the self-reported bias can cause the common method variance, which results in the inflated relationships between the indicators. Harmon's Single-factor Approach is the appropriate method to estimate the common method variance (CMV) (Williams et al., 1989; Podsakoff and Organ, 1986). According to Williams et al. (1989), if the method factor accounts for more than 25% of the total variance, the existence of CMV is indicated. The results (Appendix 5) show that the general factor accounts for 21.276% of the total variance, which shows the satisfactory in this research.

#### 4.5 Assessment of the Inner Model

This section introduces the assessment of the inner model (also called structural model), including the assessment of multicollinearity (Section 4.5.1), assessment of relevance and significance of the inner model relationships (Section 4.5.2), the assessment of R-square and F-square (Section 4.5.3), the mediating effect (Section 4.5.4), moderating effect (Section 4.5.5), the inner model results (Section 4.5.6), assessment of the stability of bootstrapping procedure (Section 4.5.7), assessment of inner model fit (Section 4.5.8), and common method bias test (Section 4.5.9).

SmartPLS assumes the data is not normal. Thus, it is essential to assess the Univariate and Multivariate Normality for PLS. The assessment of normality uses the standardised scores. The standardised scores can be found using the path: PLS Algorithm-> final results-> latent variables. This normality assessment can be conducted through webpower multivariate kurtosis (<https://webpower.psychstat.org/models/kurtosis/>). The cut off for univariate are that values of skewness are between -1 and 1, and values of kurtosis are between -7 and 7. The cut off for multivariate are that values of skewness are between -1 and 1, and values of kurtosis are between -20 and 20 (Trochim and Donnelly, 2006; Gravetter and Wallnau, 2014; George and Mallery, 2010; Field, 2000). The results (Figure 4.7) show that multivariate is not normal. Thus, this is the reason the bootstrapping can be done for this data set.

## Output of skewness and kurtosis calculation

```

Sample size: 374
Number of variables: 6

Univariate skewness and kurtosis

                                     Skewness  SE_skew
Circular.Economy.Capability          -0.2767462 0.126156
Environment.orientation              0.3347330 0.126156
Green.Manufacturing                   0.7876517 0.126156
Organisational.performance           0.2965612 0.126156
Berriers                             2.4377561 0.126156
Stakeholders...engagement.for.environmental.implementation 0.6566966 0.126156

                                     Kurtosis  SE_kurt
Circular.Economy.Capability          2.146697 0.2516527
Environment.orientation              2.293094 0.2516527
Green.Manufacturing                   4.321747 0.2516527
Organisational.performance           5.202896 0.2516527
Berriers                             16.022980 0.2516527
Stakeholders...engagement.for.environmental.implementation 4.067846 0.2516527

Mardia's multivariate skewness and kurtosis
          b          z p-value
Skewness 34.74232 2165.6046      0
Kurtosis 150.57224 101.2279      0

```

Figure 4. 7 Output of skewness and kurtosis calculation

This study evaluates the inner model by assessing 1) multicollinearity issues, 2) the significance and relevance of the inner model relationships (path coefficients), 3) the predictive power of the inner model (the level of R-square), and 4) the F-square effect size of the hypotheses (Henseler et al., 2009).

### 4.5.1 Multicollinearity

The collinearity issue may exist in both the formative second-order constructs (discussed earlier in section 4.4.3) and the inner model (Hair et al., 2017; Cassel and Westlund, 1999). When using SmartPLS 2, the Variance inflation factors (VIF) have to be calculated manually using SPSS. The collinearity statistics can be directly obtained after running the PLS Algorithm using SmartPLS 3 software. The inner VIF value can be found using the path: PLS Algorithm->Quality Criteria->Collinearity Statistics (VIF) -Inner VIF values. The results (Table

4.8) show that all the VIF scores for the inner model are less than 3, indicating no multicollinearity between the constructs (Hair et al., 2006).

**Table 4. 8 Common Method Bias (CMB) in PLS (partial least squares) -Inner VIF Values**

**Common Method Bias (CMB) in PLS (partial least squares) -Inner VIF Values**

|      | BFGI | CECA  | ENOR  | GRMA  | ORPE  | SEEI |
|------|------|-------|-------|-------|-------|------|
| BFGI |      |       |       | 1.031 |       |      |
| CECA |      |       |       |       | 1.578 |      |
| ENOR |      |       |       | 1.949 |       |      |
| GRMA |      | 1.000 |       |       | 1.578 |      |
| ORPE |      |       |       |       |       |      |
| SEEI |      |       | 1.000 | 1.906 |       |      |

*Note. BFGI: Level of Barriers to Green Manufacturing application (BFGI)*

*CECA: Circular Economy capability (CECA)*

*ENOR: Environmental Orientation (ENOR)*

*GRMA: Green Manufacturing (GRMA)*

*ORPE: Organisational Performance (ORPE)*

*SEEI: Stakeholder engagement for environment implementation (SEEI)*

*\*Factor-level VIFs <3.3, indicates free of common method bias (Kock 2015, p.7)*

#### 4.5.2 Path Coefficients for Inner Model

The values of path coefficients vary between -1 and +1. The higher absolute values indicate the more robust relationships between the constructs (Hair et al., 2017; Peng and Lai, 2012). Before estimating the relationships between the constructs, the following three types of effects should be understood, namely direct effect, indirect effect, and total effect. For example, as shown in Table 4.9, the direct effect is the relationship connecting two constructs (construct 1 and construct 3) with a single arrow and is with the value of 0.2. The indirect effect is the sequence of relationships (construct 1 to construct 2, construct 2 to construct 3) with the values of 0.3. The total effect is the sum of the direct effect and indirect effect with the value of 0.5.

**Table 4. 9 Type of effects and example**

| Type of effects   | Definition   | Example   |
|---|--|---|
| Direct effect   | The relationship linking two constructs with the single arrow between the two constructs | <pre> graph TD     C1((Construct 1)) -- p1=0.5 --&gt; C2((Construct 2))     C1 -- p3=0.2 --&gt; C3((Construct 3))     C2 -- p2=0.6 --&gt; C3             </pre> |
| Indirect effect   | A sequence of relationships with at least one intervening construct involved             |   |
| Total effect  | The sum of the direct effect and all indirect effects linking two constructs             |   |
| Effect of construct 1 on construct 3:<br>Direct effect: 0.2<br>Indirect effect: $0.5 \times 0.6 = 0.3$<br>Total effect: $0.2 + 0.3 = 0.5$ |  |   |

The significance of the effects can be assessed by conducting the bootstrapping using SmartPLS 3 software. The Bootstrapping approach designed in SmartPLS is to estimate the statistical significance of the proposed inner model (Chin, 1998). The related criteria and results can be found in the SmartPLS output report. In this research, the sample number of the Bootstrapping approach is set to 5000 for maximum accuracy of the data analysis. The case number is set to 374 to match the number of useable survey responses.

The direct effect between two constructs can be found using the path: Bootstrapping-> Final results->Path Coefficients (Mean, STDEV, T-Values, and P-Values). The results of Path Coefficients (Table 4.10) show that the direct effect between BFGI and GRMA is not significant. All other direct effects are significant. The detailed discussion of the direct effects and hypotheses are introduced in the following Section 4.6.

**Table 4. 10 Path Coefficients (Two-stage approach)**

Path Coefficients Case: 374, Samples: 5000

| Hypothesis Relationship | Original Sample (O) | Sample Mean (M) | Standard Deviation (STDEV) | T Statistics ( O/STDEV ) | P Values |
|-------------------------|---------------------|-----------------|----------------------------|--------------------------|----------|
| BFGI -> GRMA            | -0.014              | 0.011           | 0.081                      | 0.177 n/s                | 0.860    |
| CECA -> ORPE            | 0.296               | 0.306           | 0.112                      | 2.652**                  | 0.008    |
| ENOR -> GRMA            | 0.649               | 0.638           | 0.055                      | 11.766***                | 0.000    |
| GRMA -> CECA            | 0.605               | 0.605           | 0.045                      | 13.578***                | 0.000    |
| GRMA -> ORPE            | 0.226               | 0.218           | 0.092                      | 2.459*                   | 0.014    |
| SEEI -> ENOR            | 0.689               | 0.692           | 0.042                      | 16.400***                | 0.000    |
| SEEI -> GRMA            | 0.107               | 0.112           | 0.062                      | 1.729+                   | 0.084    |

Note. "+" indicates  $P < 0.1$ ; \* indicates  $P < 0.05$ ; \*\* indicates  $P < 0.01$ ; \*\*\* indicates  $P < 0.001$ ; n/s indicates not significant.

CECA -> ORPE: Circular Economy capability (CECA) -> Organisational Performance (ORPE)

ENOR -> GRMA: Environmental Orientation (ENOR) -> Green Manufacturing (GRMA)

GRMA -> CECA: Green Manufacturing (GRMA) -> Circular Economy capability (CECA)

GRMA -> ORPE: Green Manufacturing (GRMA) -> Organisational Performance (ORPE)

BFGI -> GRMA: Level of Barriers to Green Manufacturing application (BFGI) -> Green Manufacturing (GRMA)

SEEI -> ENOR: Stakeholder engagement for environment implementation (SEEI) -> Environmental Orientation (ENOR)

SEEI -> GRMA: Stakeholder engagement for environment implementation (SEEI) -> Green Manufacturing (GRMA)

#### 4.5.3 R-square and f-square effect size

$R^2$  is the measure of the model's predictive accuracy, which represents the amount of the variance in the depended variables explained by the independent variables linked to it. The value of  $R^2$  is between 0 and 1. The higher value of  $R^2$  shows a higher level of predictive accuracy. The rough guideline for  $R^2$  value is that  $R^2$  is weak at the value of 0.19;  $R^2$  is moderate at the value of 0.33, and  $R^2$  is substantial at the value of 0.67 (Chin, 1998). The effect size  $f^2$  shows how strongly the independent variable contributes to explaining the specific dependent variable in term of  $R^2$ . The rules of thumb of effect size are that  $f^2$ value is small at 0.02;  $f^2$ value is medium at 0.15, and  $f^2$  value is substantial at 0.35 (Cohen, 1988). In this research, the results of  $R^2$  value are either moderate or weak. The results of  $f^2$  are either small or large (Table 4.11).

**Table 4. 11 Results of R<sup>2</sup> value and f<sup>2</sup> effect size (Two-stage approach)**

F-Square effect size

| Hypothesis Relationship | Sample (M) | Mean  | Standard Deviation (STDEV) | T ( O/STDEV ) | Statistics | P Values |
|-------------------------|------------|-------|----------------------------|---------------|------------|----------|
| BFGI -> GRMA            | 0.015 (S)  | 0.020 |                            | 0.021 n/s     |            | 0.983    |
| CECA -> ORPE            | 0.091 (S)  | 0.065 |                            | 1.099 n/s     |            | 0.272    |
| ENOR -> GRMA            | 0.460 (L)  | 0.123 |                            | 3.747 ***     |            | 0        |
| GRMA -> CECA            | 0.594 (L)  | 0.137 |                            | 4.223 ***     |            | 0        |
| GRMA -> ORPE            | 0.047 (S)  | 0.035 |                            | 1.192 n/s     |            | 0.233    |
| SEEI -> ENOR            | 0.950 (L)  | 0.220 |                            | 4.099 ***     |            | 0        |
| SEEI -> GRMA            | 0.018 (S)  | 0.017 |                            | 0.757 n/s     |            | 0.449    |

Note. "+" indicates  $P < 0.1$ ; \* indicates  $P < 0.05$ ; \*\* indicates  $P < 0.01$ ; \*\*\* indicates  $P < 0.001$ ; n/s indicates not significant.

CECA ->ORPE: Circular Economy capability (CECA) -> Organisational Performance (ORPE)

ENOR ->GRMA: Environmental Orientation (ENOR) -> Green Manufacturing (GRMA)

GRMA -> CECA: Green Manufacturing (GRMA) -> Circular Economy capability (CECA)

GRMA -> ORPE: Green Manufacturing (GRMA) -> Organisational Performance (ORPE)

BFGI -> GRMA: Level of Barriers to Green Manufacturing application (BFGI) -> Green Manufacturing (GRMA)

SEEI -> ENOR: Stakeholder engagement for environment implementation (SEEI) -> Environmental Orientation (ENOR)

SEEI -> GRMA: Stakeholder engagement for environment implementation (SEEI) -> Green Manufacturing (GRMA)

f<sup>2</sup> Value displayed for the effect size of the hypothesis. 0.02 is for small (S), 0.15 is for medium (M), and 0.35 is for large (L) effects (Cohen, 1988).

**Hypothesis Testing: Bootstrapping Direct Effect Results Case: 374, Samples: 5000**

| Hypothesis Relationship | Path Std Beta | Path Standard Deviation (STDEV) | Path T-value | Path Values | P | R <sup>2</sup> Value | f <sup>2</sup> Value |
|-------------------------|---------------|---------------------------------|--------------|-------------|---|----------------------|----------------------|
| BFGI -> GRMA            | -0.014        | 0.081                           | 0.177 n/s    | 0.860       |   | 0.542 (M)            | 0.015 (S)            |
| CECA -> ORPE            | 0.296         | 0.112                           | 2.652 **     | 0.008       |   | 0.235 (W)            | 0.091 (S)            |
| ENOR -> GRMA            | 0.649         | 0.055                           | 11.766 ***   | 0.000       |   | 0.542 (M)            | 0.460 (L)            |
| GRMA -> CECA            | 0.605         | 0.045                           | 13.578 ***   | 0.000       |   | 0.368 (M)            | 0.594 (L)            |
| GRMA -> ORPE            | 0.226         | 0.092                           | 2.459 *      | 0.014       |   | 0.235 (W)            | 0.047 (S)            |
| SEEI -> ENOR            | 0.689         | 0.042                           | 16.400 ***   | 0.000       |   | 0.481 (M)            | 0.950 (L)            |
| SEEI -> GRMA            | 0.107         | 0.062                           | 1.729 +      | 0.084       |   | 0.542 (M)            | 0.018 (S)            |

Note. "+" indicates  $P < 0.1$ ; \* indicates  $P < 0.05$ ; \*\* indicates  $P < 0.01$ ; \*\*\* indicates  $P < 0.001$ ; n/s indicates not significant.

CECA -> ORPE: Circular Economy capability (CECA) -> Organisational Performance (ORPE)

ENOR -> GRMA: Environmental Orientation (ENOR) -> Green Manufacturing (GRMA)

GRMA -> CECA: Green Manufacturing (GRMA) -> Circular Economy capability (CECA)

GRMA -> ORPE: Green Manufacturing (GRMA) -> Organisational Performance (ORPE)

BFGI->GRMA: Level of Barriers to Green Manufacturing application (BFGI) -> Green Manufacturing (GRMA)

SEEI -> ENOR: Stakeholder engagement for environment implementation (SEEI) -> Environmental Orientation (ENOR)

SEEI ->GRMA: Stakeholder engagement for environment implementation (SEEI) -> Green Manufacturing (GRMA)

R<sup>2</sup> displayed for the dependent variable in each hypothesis. 0.19 is for the weak (W), 0.33 is for moderate (M), 0.67 is for a substantial explanation (S) (Chin, 1998), and N indicates R<sup>2</sup> value is below the "weak" threshold.

f<sup>2</sup> Value displayed for the effect size of the hypothesis. 0.02 is for small (S), 0.15 is for medium (M), and 0.35 is for large (L) effects (Cohen, 1988).

#### 4.5.4 Inner Model Results

In this research, the path coefficients, the  $R^2$  values,  $f^2$  value, and the total effect between the exogenous construct and the endogenous construct are evaluated before deciding to accept the hypothesis or not (Table 4.12). The results of the proposed structural model (Figure 4.8) show that hypothesis 1 (The Stakeholder Engagement in Environmental Implementation (SEEI) positively affects Green Manufacturing (GRMA)) is supported. Hypothesis 2 (The level of Barriers to Green Manufacturing implementation (BFGI) negatively affects Green Manufacturing implementation (GRMA)) is not supported. Hypothesis 3 (The Stakeholder Engagement in Environmental Implementation (SEEI) positively affects Environmental Orientation (ENOR)) is supported. Hypothesis 4 (The Environmental Orientation (ENOR) positively affects Green Manufacturing (GRMA)) is supported. Hypothesis 5 (Green Manufacturing (GRMA) positively affects Organisational Performance (ORPE)) is supported. Hypothesis 6 (Applying Green Manufacturing (GRMA) positively affects Circular Economy capability (CECA)) is supported. Hypothesis 7 (Circular Economy capability (CECA) positively affects Organisational Performance (ORPE)) is supported. The detailed discussion of all hypotheses is introduced in the following section 4.6.

**Table 4. 12 Hypothesis Testing: Bootstrapping Direct Effect Results (Two-stage approach)**

Hypothesis Testing: Bootstrapping Direct Effect Results Case: 374, Samples: 5000

| Hypothesis Relationship | Path Std Beta | Path Standard Deviation (STDEV) | Path T-value | Path P Values | R <sup>2</sup> Value | f <sup>2</sup> Value | Total Effect | Total Effect T-value | Total Effect P-value | Decision             |
|-------------------------|---------------|---------------------------------|--------------|---------------|----------------------|----------------------|--------------|----------------------|----------------------|----------------------|
| BFGI -> GRMA            | -0.014        | 0.081                           | 0.177 n/s    | 0.860         | 0.542 (M)            | 0.015 (S)            | 0.011        | 0.177 n/s            | 0.86                 | Not Supported        |
| CECA -> ORPE            | 0.296         | 0.112                           | 2.652 **     | 0.008         | 0.235 (W)            | 0.091 (S)            | 0.306        | 2.652 **             | 0.008                | Moderately Supported |
| ENOR -> GRMA            | 0.649         | 0.055                           | 11.766 ***   | 0.000         | 0.542 (M)            | 0.460 (L)            | 0.638        | 11.766 ***           | 0.000                | Strongly Supported   |
| GRMA -> CECA            | 0.605         | 0.045                           | 13.578 ***   | 0.000         | 0.368(M)             | 0.594 (L)            | 0.605        | 13.578 ***           | 0.000                | Strongly Supported   |
| GRMA -> ORPE            | 0.226         | 0.092                           | 2.459 *      | 0.014         | 0.235 (W)            | 0.047 (S)            | 0.404        | 5.531 ***            | 0.000                | Moderately Supported |
| SEEI -> ENOR            | 0.689         | 0.042                           | 16.400 ***   | 0.000         | 0.481 (M)            | 0.950 (L)            | 0.692        | 16.400 ***           | 0.000                | Strongly Supported   |
| SEEI -> GRMA            | 0.107         | 0.062                           | 1.729 +      | 0.084         | 0.542(M)             | 0.018 (S)            | 0.553        | 9.465 ***            | 0.000                | Moderately Supported |

Notes:

CECA -> ORPE: Circular Economy capability (CECA) -> Organisational Performance (ORPE)

ENOR -> GRMA: Environmental Orientation (ENOR) -> Green Manufacturing (GRMA)

GRMA -> CECA: Green Manufacturing (GRMA) -> Circular Economy capability (CECA)

*GRMA -> ORPE: Green Manufacturing (GRMA) -> Organisational Performance (ORPE)*

*BFGI->GRMA: Level of Barriers to the Green Manufacturing application (BFGI) -> Green Manufacturing (GRMA)*

*SEEI -> ENOR: Stakeholder engagement for environment implementation (SEEI) -> Environmental Orientation (ENOR)*

*SEEI ->GRMA: Stakeholder engagement for environment implementation (SEEI) -> Green Manufacturing (GRMA)*

*+ indicates  $p < 0.1$ ; \* indicates  $p < 0.05$ ; \*\* indicates  $p < 0.01$ ; \*\*\* indicates  $p < 0.001$ ; n/s indicates nonsignificance.*

*R<sup>2</sup> is displayed for the dependent variable in each hypothesis. 0.19 is weak, 0.33 moderate, 0.67 denotes substantial explanation (Chin, 1998); N indicates the R<sup>2</sup> value is below the weak threshold.*

*f<sup>2</sup> denotes the effect size for the hypothesis; 0.02 denotes a small, 0.15 a medium, and 0.35 a large effect (Cohen, 1988).*

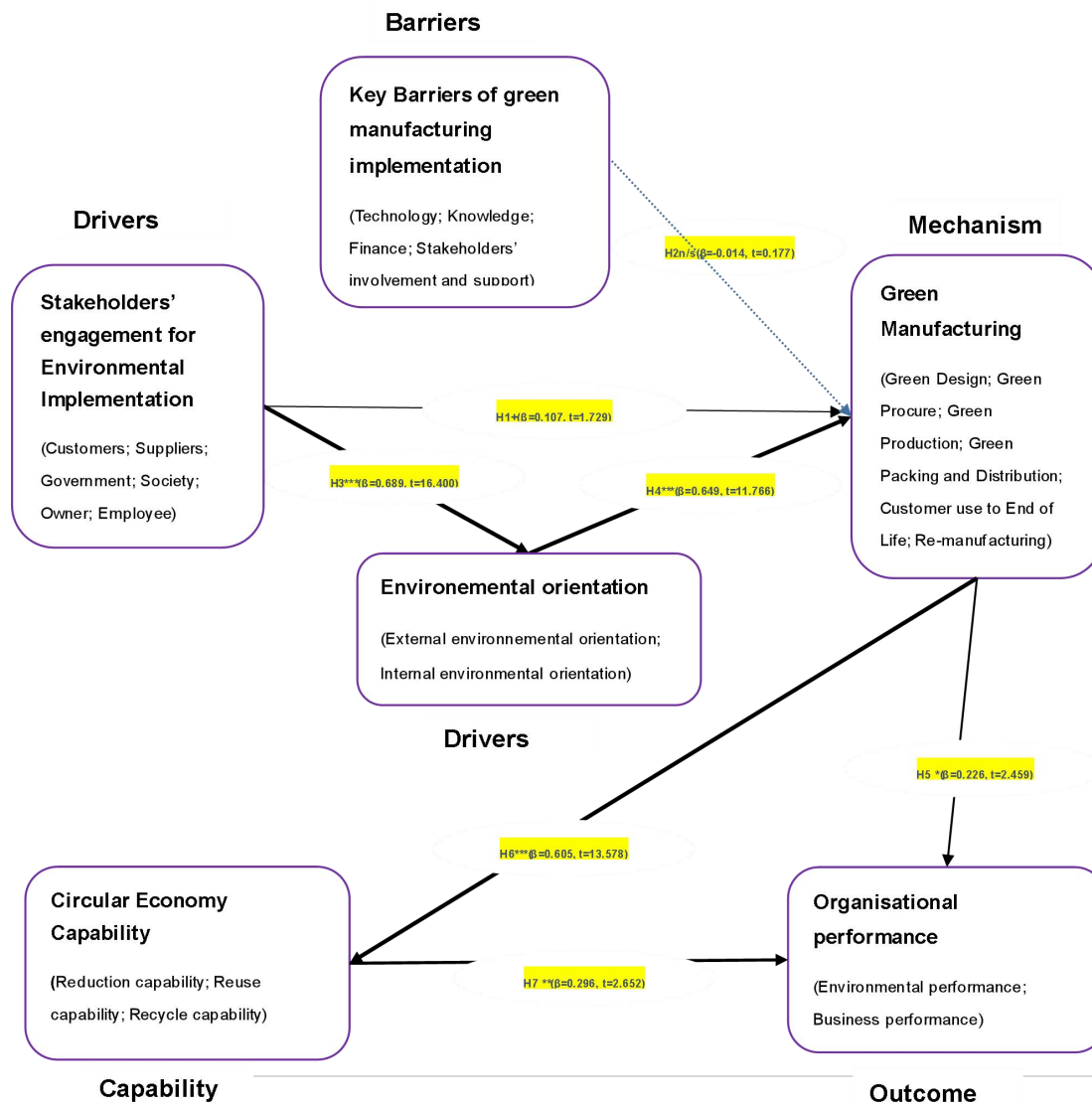


Figure 4. 8 Results of proposed structural model

#### 4.5.5 Assessment of Stability of Bootstrapping Procedure

When assessing the inner model, this study sets the case number to 374, and the sub-samples to 5000 to achieve the maximum accuracy of bootstrapping. However, the results of path coefficients generated by SmartPLS Bootstrapping are sensitive to the number of sub-samples and the cases (Hair et al., 2017). Thus, this research conducts the bootstrapping stability test across different sub-sample numbers and case numbers. First, the inner model conducts three sets of bootstrapping analysing with the case number of 374, 300, and 350. The number of sub-samples is set at 500, 1000, 2000, 2500, and 5000 levels for each set. After conducting 15 times of bootstrapping analysis, the results are consistent across different sub-samples (Table 4.13). Therefore, the reliability and validity of the results generated by conducting bootstrapping are established in this research.

**Table 4. 13 Stability of Bootstrapping (Two-staged approach)**

**Bootstrapping stability test (case: 374)**

|              | Path   | 374/500      |       | 374/1000   |        | 374/2000   |            | 374/2500    |            |             | 374/5000   |             |            |             |
|--------------|--------|--------------|-------|------------|--------|------------|------------|-------------|------------|-------------|------------|-------------|------------|-------------|
|              |        | T            | P     | T          | P      | T          | Statistics | P           | T          | Statistics  | P          | T           | Statistics | P           |
|              |        | Coefficients |       | Statistics | Values | Statistics | Values     | ( O/STDEV ) | Values     | ( O/STDEV ) | Values     | ( O/STDEV ) | Values     | ( O/STDEV ) |
| BFGI -> GRMA | -0.014 | 0.168 n/s    | 0.860 | 0.176 n/s  | 0.860  | 0.175 n/s  |            | 0.861       | 0.175 n/s  | 0.861       | 0.177 n/s  |             | 0.860      |             |
| CECA -> ORPE | 0.296  | 2.523 **     | 0.008 | 2.639 **   | 0.008  | 2.663 **   |            | 0.008       | 2.595 **   | 0.010       | 2.652 **   |             | 0.008      |             |
| ENOR -> GRMA | 0.649  | 12.331 ***   | 0.000 | 11.889 *** | 0.000  | 12.051 *** |            | 0.000       | 12.211 *** | 0.000       | 11.766 *** |             | 0.000      |             |
| GRMA -> CECA | 0.605  | 13.191 ***   | 0.000 | 13.354 *** | 0.000  | 13.380 *** |            | 0.000       | 13.235 *** | 0.000       | 13.578 *** |             | 0.000      |             |
| GRMA -> ORPE | 0.226  | 2.383 *      | 0.014 | 2.515 *    | 0.012  | 2.555 *    |            | 0.011       | 2.487 *    | 0.013       | 2.459 *    |             | 0.014      |             |
| SEEI -> ENOR | 0.689  | 16.384 ***   | 0.000 | 16.651 *** | 0.000  | 15.859 *** |            | 0.000       | 16.602 *** | 0.000       | 16.400 *** |             | 0.000      |             |
| SEEI -> GRMA | 0.107  | 1.807 +      | 0.084 | 1.721 +    | 0.086  | 1.741 +    |            | 0.082       | 1.768 +    | 0.077       | 1.729 +    |             | 0.084      |             |

Note. "+" indicates  $P < 0.1$ ; \* indicates  $P < 0.05$ ; \*\* indicates  $P < 0.01$ ; \*\*\* indicates  $P < 0.001$ ; n/s indicates not significant.

CECA ->ORPE: Circular Economy capability (CECA) -> Organisational Performance (ORPE)

ENOR ->GRMA: Environmental Orientation (ENOR) -> Green Manufacturing (GRMA)

GRMA -> CECA: Green Manufacturing (GRMA) -> Circular Economy capability (CECA)

GRMA -> ORPE: Green Manufacturing (GRMA) -> Organisational Performance (ORPE)

BFGI -> GRMA: Level of Barriers to Green Manufacturing application (BFGI) -> Green Manufacturing (GRMA)

SEEI -> ENOR: Stakeholder engagement for environment implementation (SEEI) -> Environmental Orientation (ENOR)

SEEI -> GRMA: Stakeholder engagement for environment implementation (SEEI) -> Green Manufacturing (GRMA)

**Bootstrapping stability test (case: 300)**

|      |                                     | 300/500      |          | 300/1000     |          | 300/2000                 |          | 300/2500                 |          |                          | 300/5000 |  |  |
|------|-------------------------------------|--------------|----------|--------------|----------|--------------------------|----------|--------------------------|----------|--------------------------|----------|--|--|
|      | Path Coefficients (Original Sample) | T Statistics | P Values | T Statistics | P Values | T Statistics ( O/STDEV ) | P Values | T Statistics ( O/STDEV ) | P Values | T Statistics ( O/STDEV ) | P Values |  |  |
| BFGI | -> -0.014                           | 0.173 n/s    | 0.863    | 0.179 n/s    | 0.858    | 0.178 n/s                | 0.859    | 0.177 n/s                | 0.860    | 0.175 n/s                | 0.861    |  |  |
| GRMA |                                     |              |          |              |          |                          |          |                          |          |                          |          |  |  |
| CECA | -> 0.296                            | 2.773 **     | 0.006    | 2.678 **     | 0.008    | 2.579 **                 | 0.010    | 2.653 **                 | 0.008    | 2.611 **                 | 0.009    |  |  |
| ORPE |                                     |              |          |              |          |                          |          |                          |          |                          |          |  |  |
| ENOR | -> 0.649                            | 11.809 ***   | 0.000    | 11.935 ***   | 0.000    | 11.734 ***               | 0.000    | 12.048 ***               | 0.000    | 11.981 ***               | 0.000    |  |  |
| GRMA |                                     |              |          |              |          |                          |          |                          |          |                          |          |  |  |
| GRMA | -> 0.605                            | 13.774 ***   | 0.000    | 13.298 ***   | 0.000    | 13.207 ***               | 0.000    | 13.792 ***               | 0.000    | 13.665 ***               | 0.000    |  |  |
| CECA |                                     |              |          |              |          |                          |          |                          |          |                          |          |  |  |
| GRMA | -> 0.226                            | 2.694 **     | 0.007    | 2.481 *      | 0.013    | 2.520 *                  | 0.012    | 2.588 **                 | 0.010    | 2.485 *                  | 0.013    |  |  |
| ORPE |                                     |              |          |              |          |                          |          |                          |          |                          |          |  |  |
| SEEI | -> 0.689                            | 16.034 ***   | 0.000    | 16.416 ***   | 0.000    | 16.187 ***               | 0.000    | 16.608 ***               | 0.000    | 16.393 ***               | 0.000    |  |  |
| ENOR |                                     |              |          |              |          |                          |          |                          |          |                          |          |  |  |
| SEEI | -> 0.107                            | 1.721 +      | 0.086    | 1.758 +      | 0.079    | 1.706 +                  | 0.088    | 1.784 +                  | 0.075    | 1.750 +                  | 0.080    |  |  |
| GRMA |                                     |              |          |              |          |                          |          |                          |          |                          |          |  |  |

Note. "+" indicates  $P < 0.1$ ; \* indicates  $P < 0.05$ ; \*\* indicates  $P < 0.01$ ; \*\*\* indicates  $P < 0.001$ ; n/s indicates not significant.

CECA -> ORPE: Circular Economy capability (CECA) -> Organisational Performance (ORPE)

ENOR -> GRMA: Environmental Orientation (ENOR) -> Green Manufacturing (GRMA)

GRMA -> CECA: Green Manufacturing (GRMA) -> Circular Economy capability (CECA)

GRMA -> ORPE: Green Manufacturing (GRMA) -> Organisational Performance (ORPE)

BFGI -> GRMA: Level of Barriers to Green Manufacturing application (BFGI) -> Green Manufacturing (GRMA)

SEEI -> ENOR: Stakeholder engagement for environment implementation (SEEI) -> Environmental Orientation (ENOR)

SEEI -> GRMA: Stakeholder engagement for environment implementation (SEEI) -> Green Manufacturing (GRMA)

### Bootstrapping stability test (case: 350)

|      | Path | Coefficients (Original Sample) | 350/500      |          | 350/1000     |          | 350/2000     |          | 350/2500     |          |              | 350/5000 |  |  |
|------|------|--------------------------------|--------------|----------|--------------|----------|--------------|----------|--------------|----------|--------------|----------|--|--|
|      |      |                                | T Statistics | P Values | T Statistics | P Values | T Statistics | P Values | T Statistics | P Values | T Statistics | P Values |  |  |
| BFGI | ->   | -0.014                         | 0.178 n/s    | 0.859    | 0.174 n/s    | 0.862    | 0.177 n/s    | 0.859    | 0.179 n/s    | 0.858    | 0.176 n/s    | 0.861    |  |  |
| GRMA |      |                                |              |          |              |          |              |          |              |          |              |          |  |  |
| CECA | ->   | 0.296                          | 2.732 **     | 0.007    | 2.646 **     | 0.008    | 2.656 **     | 0.008    | 2.677 **     | 0.007    | 2.651 **     | 0.008    |  |  |
| ORPE |      |                                |              |          |              |          |              |          |              |          |              |          |  |  |
| ENOR | ->   | 0.649                          | 11.168 ***   | 0.000    | 12.087 ***   | 0.000    | 12.052 ***   | 0.000    | 11.302 ***   | 0.000    | 11.986 ***   | 0.000    |  |  |
| GRMA |      |                                |              |          |              |          |              |          |              |          |              |          |  |  |
| GRMA | ->   | 0.605                          | 13.639 ***   | 0.000    | 13.603 ***   | 0.000    | 13.477 ***   | 0.000    | 13.259 ***   | 0.000    | 13.389 ***   | 0.000    |  |  |
| CECA |      |                                |              |          |              |          |              |          |              |          |              |          |  |  |
| GRMA | ->   | 0.226                          | 2.511 **     | 0.012    | 2.433 *      | 0.015    | 2.491 *      | 0.013    | 2.537 **     | 0.011    | 2.485 *      | 0.013    |  |  |
| ORPE |      |                                |              |          |              |          |              |          |              |          |              |          |  |  |
| SEEI | ->   | 0.689                          | 16.623 ***   | 0.000    | 16.310 ***   | 0.000    | 16.372 ***   | 0.000    | 16.375 ***   | 0.000    | 16.134 ***   | 0.000    |  |  |
| ENOR |      |                                |              |          |              |          |              |          |              |          |              |          |  |  |
| SEEI | ->   | 0.107                          | 1.670 +      | 0.096    | 1.739 +      | 0.082    | 1.748 +      | 0.081    | 1.707 +      | 0.088    | 1.723 +      | 0.085    |  |  |
| GRMA |      |                                |              |          |              |          |              |          |              |          |              |          |  |  |

Note. "+" indicates  $P < 0.1$ ; \* indicates  $P < 0.05$ ; \*\* indicates  $P < 0.01$ ; \*\*\* indicates  $P < 0.001$ ; n/s indicates not significant.

CECA -> ORPE: Circular Economy capability (CECA) -> Organisational Performance (ORPE)

*ENOR ->GRMA: Environmental Orientation (ENOR) -> Green Manufacturing (GRMA)*

*GRMA -> CECA: Green Manufacturing (GRMA) -> Circular Economy capability (CECA)*

*GRMA -> ORPE: Green Manufacturing (GRMA) -> Organisational Performance (ORPE)*

*BFGI -> GRMA: Level of Barriers to Green Manufacturing application (BFGI) -> Green Manufacturing (GRMA)*

*SEEI -> ENOR: Stakeholder engagement for environment implementation (SEEI) -> Environmental Orientation (ENOR)*

*SEEI -> GRMA: Stakeholder engagement for environment implementation (SEEI) -> Green Manufacturing (GRMA)*

#### 4.5.6 Model Fit

The standardised Root Mean Residuals (SRMR) is the difference between the model implied correlation matrix and the observed correlation, which assesses the average magnitude of the discrepancies between the expected correlations and the observed correlations as the absolute measure of the model fit criterion (Henseler et al. (2014). Henseler et al. (2014) point out that SRMR can be used as the goodness of fit measure to avoid model misspecification in PLS-SEM. If the value of SRMR is less than 0.1 or 0.08 (Hu and Bentler, 1999), it means the data fits the model.

Bentler and Bonett first propose the Normed Fit Index (NFI) in 1980. First, the  $\chi^2$  value of the proposed model is computed and then is compared against the meaningful benchmark. As the  $\chi^2$  value of the proposed model is insufficient to judge the model fit, the Normed Fit Index (NFI) is used as the yardstick, which views the  $\chi^2$  value of the null model. The NFI is defined as 1 minus the  $\chi^2$  value of the proposed model divided by the  $\chi^2$  values of the null model. Consequently, the NFI results in values between 0 and 1. The closer the NFI is to 1, the better the fit. NFI values above 0.9 usually represent an acceptable fit (Bentler and Bonett, 1980; Lohmoller, 1989). In this research, the SRMR is 0.078 and NFI is 0.931, which indicates the data fits the model.

#### 4.5.7 Common Method Bias Test

##### 4.5.7.1 Structural model controlled for common method bias

Conway and Lance (2010) point out that the self-reported bias can cause the common method variance, which results in the inflated relationships between the indicators. Common method bias (CMB) may exist when uses the large-scale survey method. Common method bias is the situation that the respondents' answers are likely to be more socially desirable. The respondents provide the answer that they think the research want them to provide (Podsakoff et al., 2003: p.888). Manning et al. (2009) developed the Agent's Socially Desirable Responding (ASDR) scale to test whether the respondents are presenting their

companies favourably or not. The Agent's Socially Desirable Responding scale is applied in the final part of the survey in this research. The same analysis procedure introduced in previous sections is employed to provide the Common Method Bias Test (Table 4.14). The results show that all hypotheses of the controlled model remain the same results of the original model.

**Table 4. 14 Common Method Bias Test (Two-stage approach)**

| <b>Table: Summary of structural model controlled for common method bias Case: 374, Samples: 5000</b> |                   |              |              |                  |                   |              |              |                        |
|--|-------------------|--------------|--------------|------------------|-------------------|--------------|--------------|------------------------|
| Hypotheses   | Control Model     |              |              |                  | Original Model    |              |              |                        |
|  | Path Coefficients | Path T-value | Path P-value | R Square Value * | Path Coefficients | Path T-value | Path P-value | R <sup>2</sup> Value * |
| BFGI -> GRMA   | 0.051             | 0.677 n/s    | 0.498        | 0.543 (M)        | -0.014            | 0.177 n/s    | 0.860        | 0.542 (M)              |
| CECA -> ORPE   | 0.290             | 2.657 **     | 0.008        | 0.255 (W)        | 0.296             | 2.652 **     | 0.008        | 0.235 (W)              |
| ENOR -> GRMA   | 0.662             | 11.736 ***   | 0.000        | 0.543 (M)        | 0.649             | 11.766 ***   | 0.000        | 0.542 (M)              |
| GRMA -> CECA   | 0.584             | 12.478 ***   | 0.000        | 0.394 (M)        | 0.605             | 13.578 ***   | 0.000        | 0.368(M)               |
| GRMA -> ORPE   | 0.222             | 2.345 *      | 0.019        | 0.255 (W)        | 0.226             | 2.459 *      | 0.014        | 0.235 (W)              |
| SEEI -> ENOR   | 0.665             | 15.217 ***   | 0.000        | 0.500 (M)        | 0.689             | 16.400 ***   | 0.000        | 0.481 (M)              |
| SEEI -> GRMA   | 0.102             | 1.647 +      | 0.098        | 0.543 (M)        | 0.107             | 1.729 +      | 0.084        | 0.542(M)               |
| SCV-BFGI -> BFGI   | -0.189            | 1.381 n/s    | 0.167        | 0.061 (N)        |                   |              |              |                        |
| SCV-CECA -> CECA   | 0.143             | 2.263 *      | 0.024        | 0.394 (M)        |                   |              |              |                        |
| SCV-ENOR -> ENOR   | 0.136             | 3.082 *      | 0.002        | 0.500 (M)        |                   |              |              |                        |
| SCV-GRMA -> GRMA   | 0.004             | 0.076 n/s    | 0.939        | 0.543 (M)        |                   |              |              |                        |
| SCV-ORPE -> ORPE   | 0.075             | 0.965 n/s    | 0.339        | 0.255 (W)        |                   |              |              |                        |
| SCV-SEEI -> SEEI   | 0.180             | 1.052 n/s    | 0.293        | 0.045 (N)        |                   |              |              |                        |

*Note. (+) indicates P<0.1; \* indicates P<0.05; \*\* indicates P<0.01; \*\*\* indicates P<0.001; n/s indicates not significant. \* R<sup>2</sup> Value displayed for depend variable in each hypothesis. 0.19 is for weak (W), 0.33 is for moderate (M), 0.67 is for substantial explanation (S) (Chin, 1998), and N indicates value is below the "weak" threshold.*

#### 4.5.7.2 Common Method Bias (CMB) using the Inner VIF statistics

There is another way to test the common method bias, the inner Variance inflation factors (VIF). Kock (2015: p.7) shows that the model might be contaminated by the CMB when the factor-level VIFs are greater than 3.3. Therefore, this study conducts the full collinearity test to obtain the values of the factor-level VIFs.

The occurrence of a VIF greater than 3.3 is proposed as an indication of pathological collinearity, and also as the indication that a model may be contaminated by common method bias. Therefore, if all factor-level VIFs resulting from a full collinearity test are equal to or lower than 3.3, the model can be considered free of common method bias. The result of the inner model shows that the VIFs are less than 3.3 (Appendix 6). In particular, when BFGI is used as the dependent variable, and all other five constructs (CECA, ENOR, GRMA,

ORPE, and SEEI) are used as the independent variables, the VIFs are less than 3.3 (Appendix 6). Similarly, when CECA is used as the dependent variable, and all other five constructs (BFGI, ENOR, GRMA, ORPE, and SEEI) are independent variables, the VIFs are less than 3.3 (Appendix 6). When ENOR is used as the dependent variable, and all other five constructs (CECA, BFGI, GRMA, ORPE, and SEEI) are independent variables, the VIFs are less than 3.3 (Appendix 6). When GRMA is used as the dependent variable, and all other five constructs (CECA, ENOR, BFGI, ORPE, and SEEI) are independent variables, the VIFs are less than 3.3 (Appendix 6). When ORPE is used as the dependent variable, and all other five constructs (CECA, ENOR, GRMA, BFGI, and SEEI) are independent variables, the VIFs are less than 3.3 (Appendix 6). When SEEI is used as the dependent variable, and all other five constructs (CECA, ENOR, GRMA, ORPE, and BFGI) are independent variables, the VIFs are less than 3.3 (Appendix 6). All the above results indicate free of common method bias.

## 4.6 Discussion of Hypotheses

This section introduces all the 7 hypotheses and their implications. The results show that hypotheses exclude the moderation hypotheses and hypothesis 2, are supported by the statistical results (Table 4.15). The interpretations of the hypotheses are justified between the statistical results and the theoretical foundations. The possible reasons for the non-supported hypotheses are discussed.

**Table 4. 15 Research results summary: Hypothesis statement**

| Hypothesis Statement   | Decision      |
|--|---------------|
| H1: The Stakeholder Engagement in Environmental Implementation (SEEI) positively affects Green Manufacturing (GRMA).                     | Supported     |
| H2: The level of Barriers for implementation of Green Manufacturing negatively (BFGI) affects Green Manufacturing implementation (GRMA). | Not Supported |
| H3: The Stakeholder Engagement in Environmental Implementation (SEEI) positively affects Environmental Orientation (ENOR).               | Supported     |
| H4: The Environmental Orientation (ENOR) positively affects Green Manufacturing (GRMA).  | Supported     |
| H5: Green Manufacturing positively (GRMA) affects Organisational Performance (ORPE).   | Supported     |
| H6: Applying Green Manufacturing (GRMA) positively affects Circular Economy capability (CECA).   | Supported     |
| H7: Circular Economy capability (CECA) positively affect Organisational Performance (ORPE).  | Supported     |

### **H1. The Stakeholder Engagement in Environmental Implementation (SEEI) positively affects applying Green Manufacturing (GRMA).**

Based on the statistical results ( $\beta=0.107$ , T-value=1.729), the H 1 hypothesis is moderately supported, which implies that the uncertainties of Stakeholder Engagement in Environmental Implementation positively affect companies' Green Manufacturing implementation. As the statistical significance level of the path (SEEI-> GRMA) is not very high (T-value=1.729), the hypothesis is only considered as moderately supported.

There are three possible reasons why H 1 hypothesis is only moderately supported. First, the statistical result shows that only 54.2% ( $R^2$  value) of the variance of GRMA is explained. The effect size ( $f^2 = 0.018$ ) shows that the changes in SEEI may only result in a small variation of GRMA. It indicates the SEEI could affect GRMA, but SEEI is only one of many factors that affecting GRMA. For example, previous studies (Chan, 2012; Anderson and Skjoett-Larsen, 2009; Zhou et al., 2017) show Corporate social responsibility, and Stakeholder Risk and Trust Perceptions could affect GRMA. This study also proves that Environmental Orientation (ENOR) could affect GRMA (H 4). The second reason could be that the indirect relationship between SEEI and GRMA exists. As proposed in this research, the SEEI indirectly affects GRMA through Environmental Orientation (ENOR). This is hypothesis 10 that the Environmental Orientation (ENOR) mediates the relationship between Stakeholder engagement for environment implementation (SEEI) and Green Manufacturing (GRMA). It is introduced in the following section. Third, the method of collecting information for construct SEEI might be one of the reasons that make hypothesis 1 only moderately supported. The questions of the questionnaire for SEEI are designed to examine the uncertainties of Stakeholder engagement in terms of environmental implementation, based on the respondents perceive. It is the perceptive data collection method, which could only obtain the indirect reflections of the phenomena. The results are entirely determined by the respondents' opinions. Thus, the collected information might not adequately reflect the actual phenomena.

The result is largely consistent with some previous studies on exploring the relationships between green practices and stakeholder involvement (Liu et al., 2017; Zhou et al., 2017). This study reinforces the relationships between GRMA and SEEI. This study provides future research with valid and reliable measurement items for these constructs, also enables empirical research in the relevant field. The Stakeholder engagements such as customers' and suppliers' engagements to cooperate for companies' environmental implementation (Subramanian et al., 2009; Zhu et al., 2010; Zeithaml et al. 1996; Beh et al.,

2016); Governments' engagement in enforcing environmental regulations (Diabat and Govindan., 2011); Non-governmental organisations' (NGOs) engagement in monitoring companies for environmental sustainable operating (Lozano, 2013; Lee, 2012; Mota et al., 2015); and both the managers and employees' ability to adopt new knowledge and technology for sustainable environmental operation (Zahra and George, 2002; Cohen and Levinthal, 1990; Tu et al., 2006; Klassen and Whybark, 1999; Zhu et al., 2008), helps companies to improve the process of their green practice. Thus, to improve the process of Green Manufacturing, apparel companies shall keep tracking the Stakeholder engagements to address possible impacts.

## **H2: The level of Barriers to Green Manufacturing implementation (BFGI) negatively affects**

### **Green Manufacturing implementation (GRMA).**

Based on the statistical results ( $\beta=-0.014$ , T-value=0.177), Hypothesis 2 is not supported by the collected data, which implies that the level of barriers for applying Green Manufacturing does not directly impact on companies' Green Manufacturing implementation. There are four sub-constructs (BES, BEK, BEF, and BET) of BFGI considered in this research. BFGI does not have a negative relationship with GRMA. However, based on the statistical results ( $\beta=-0.165$ , T-value=1.966), one of the sub-constructs, BEK still negatively affects Green Manufacturing implementation (GRMA).

Although the barriers were identified after full consideration of the relevant literature, and a pilot study was conducted to improve the associated measurement items, it cannot be said that this research has comprehensively identified all the possible barriers to the implementation of GRMA in apparel companies. There are two possible reasons why H 2 is not supported. First, the sub-constructs of the level of Barriers to Green Manufacturing implementation (BFGI) might not be well established. The weights of some of the sub-constructs: BES, BEF, and BET to BFGI are not statistically significant (Table 4.7) at  $P<0.05$  level or at  $P<0.1$  level, which indicates there is a potential of misspecified measurement for construct BFGI. Second, the way collecting information for construct BFGI might lead to the hypothesis dis-confirmation. The measurement items of BFGI are designed to assess the level of the impact of the current barriers on implementing Green Manufacturing in the company. The results are based on the respondents perceive. The perceptive data collection method is entirely determined by the respondents' opinions and might not adequately reflect the actual phenomena.

This research proposes and validates the sets of measurement items of these four sub-constructs, which provides researchers with a useful measurement tool for empirical research in the field of critical barriers to green practice. Even though three subconstructs

were not well confirmed in this study, it still provides valuable implications. For example, this study discusses the importance of identifying the level of the impact of the current barriers on implementing Green Manufacturing in the company. Although only one group of barriers is supported by statistical results, it is still essential for apparel companies to keep tracking the current barriers in order to address possible impacts.

This research identifies the key Barriers to Green Manufacturing implementation in apparel companies. Blind pursuit of fast economic growth and over-exploitation of the land creates an increasingly prominent environmental problem in developing countries. Nowadays, developing countries, such as China starts to value the environment issue highly and is striving to apply green transformations to resolve the potential trade-offs and diffusion barriers (Lederer, Wallbott, and Bauer, 2018). However, the rate of use for green transformations is still low (Liu et al., 2017). Thus, it is necessary to identify the factors that inhibit the implementation of Green Manufacturing. This research provides empirical research on identifying the current barriers for apparel companies to implement Green Manufacturing practices. This research enhances the understanding of the influence of Barriers to Green Manufacturing implementation in apparel companies. The results are highly useful for the policymakers to understand current barriers and develop potential Green Manufacturing interventions. It also provides valuable insight for apparel companies to deal with the barriers according to their priorities. The findings reveal that the core category: knowledge-related barriers, which include Lack of relevant environmental knowledge about implementing Green Manufacturing, and lack of information on potential environmental improvements are founded to be the most significant barriers to Green Manufacturing implementations in the apparel companies, and therefore need more attention. Thus, apparel companies should accord high priority in dealing with these barriers. The emerging cleaner environmental knowledge plays a vital role in achieving the goal of green manufacturing. There are many related technologies and information that apparel companies could adopt. For example, the best available technology (BAT) focuses on the

eco-efficiency, which aims to reduce the energy and resources. Besides, the rigorous analytical methodologies-based software tools and databases could help to optimise environmental performance, such as MetaFlowScope: Resource flow analysis and optimisation software. In addition, the life cycle assessment methodology helps companies to identify the polluting stages and set up the criteria for the declaration of the environmental products in the apparel companies. Furthermore, the product life-cycle management systematic approach could help companies to manage the series of changes the products go through, from the product's design and development to the products' disposal, which including three stages: Beginning of Life (BOL); Middle of Life (MOL); and End of Life (EOL). The related leading PLM software tools are Aras Innovator, Autodesk PLM 360, Arena PLM, Oracle PLM, Dassault Systems' ENOVIA PLM platform, PTC Windchill, Siemens PLM suite, SAP PLM, and Synergis' Adept PDM.

**H3: The Stakeholder Engagement in Environmental Implementation (SEEI) positively affects Environmental Orientation (ENOR).**

Hypothesis H3 is strongly supported by the statistical results ( $\beta=0.689$ , T-value=16.400), which Stakeholder Engagement in Environmental Implementation (SEEI) is positively related to the Environmental Orientation (ENOR). The statistical result shows that 48.1% ( $R^2$  value) of the variance of ENOR is explained by SEEI. According to Henseler et al. (2009), when the endogenous latent variable is explained by only a few exogenous latent variables in the specific inner model structures, the “moderate” ( $R^2$  value  $>0.33$ ) is acceptable. As ENOR only has one exogenous construct SEEI, and the  $R^2$  value of 0.481 is acceptable. Furthermore, the effect size  $f^2$  value (0.950) shows the changes of SEEI will result in the significant variation of Environmental Orientation (ENOR), which indicates that the SEEI is the important factor that affects companies' Environmental Orientation (ENOR).

The result is largely consistent with some previous study (Beh et al., 2016) on exploring the relationship between Stakeholder engagement and the company's recognition

of the importance of environmental operation. This study reinforces and enriches the exploration of the relationships between Stakeholder Engagement in Environmental Implementation (SEEI) and Environmental Orientation (ENOR). This study develops and validates the subconstructs and the measurement items for these two drivers. Understanding the stakeholders' environmental engagement could help the companies to address the environmental impacts of their operations and adjust their Environmental Orientation. Nowadays, due to stakeholders' increasing concerns on environmental pollution, apparel companies need to recognise the impact of the Stakeholder Engagement in Environmental Implementation (SEEI) and improve their Environmental Orientations (ENOR) to meet the environmental requirements proposed by the stakeholders.

**H4: The Environmental Orientation (ENOR) positively affects Green Manufacturing (GRMA).**

Hypothesis H 4 is strongly supported by the statistical results ( $\beta=0.649$ , T-value=11.766), which indicates the Environmental Orientation (ENOR) is positively related to Green Manufacturing (GRMA). In addition, the statistical result shows that 54.2% ( $R^2$  value) of the variance of GRMA is explained. According to Henseler et al. (2009), when the endogenous latent variable is explained by only a few exogenous latent variables in the specific inner model structures, the "moderate" ( $R^2$  value  $>0.33$ ) is acceptable. As GRMA has three exogenous constructs SEEI, BFGI, and ENOR, thus the  $R^2$  value of 0.542 (greater than 0.33) is acceptable. Furthermore, the effect size  $f^2$  value (0.460) shows the changes of ENOR will result in the significant variation of GRMA, which indicates that the Environmental Orientation is the important factor that influencing company's Green Manufacturing implementation.

The result is largely consistent with some previous studies on exploring the relationships between green practices and the companies environmental orientation (Chan, 2012; Yu and Huo, 2019). This study reinforces the relationships between GRMA and ENOR.

This study provides future research with valid and reliable measurement items for these constructs, also enables empirical research in the relevant field. This study identifies Environmental Orientation (ENOR) is the vital factor that influencing the company's Green Manufacturing implementation. For apparel companies, this finding emphasises the importance of companies' Environmental Orientation. Specifically, this study argues that Environmental Orientation includes two main subconstructs: perceiving stakeholders environment concerns and recognizing the importance of ecological activities. For example, apparel companies' understandings of the values of ecological activities can assist them to reconfigure resources and provide necessary management commitment to incorporate ecological concerns into their implementation of Green Manufacturing. On the other hand, as another component of Environmental Orientation, how apparel companies perceive the external stakeholders' environment concerns can impact their manufacturing processes. Hence, when seeking to improve Green Manufacturing implementation, apparel companies should emphasise Environmental Orientation. The recognition of the importance of the environmental influence of companies' operations significantly affects companies' green practices (Banerjee, 2002; Chan, 2012; Yu and Huo, 2019; Vachon and Klassen, 2006). The results of H4 suggest that when seeking to improve Green Manufacturing implementation, apparel companies should emphasise Environmental Orientation. Apparel companies shall increase companies' environmental awareness, improve companies' codes of conduct of ecological practices, fully understand the environmental impacts of their operations; and meet the environmental requirements of external stakeholders (Banerjee, 2002; Banerjee et al., 2003).

**H5: Green Manufacturing (GRMA) positively affects Organisational Performance (ORPE).**

This hypothesis 5 is moderately supported by the statistical results ( $\beta=0.226$ , T-value=2.459), which implies that companies' Green Manufacturing implementation positively impact the companies' performance. As the statistical significance level of the

path (GRMA → ORPE) is not very high (T-value=2.459), the hypothesis is only considered as moderately supported.

There are two possible reasons why H 5 hypothesis is moderately supported. First, the statistical result shows that only 23.5% ( $R^2$  value) of the variance of ORPE is explained. The effect size  $f^2$  value (0.047) shows that the changes of GRMA may only result in the notable variation of ORPE. Many factors could significantly affect Organisational Performance (ORPE), such as the organisations' multidivisional structures (Al-Tit, 2017); stakeholders' involvement and support (Zhu et al., 2010; Beh et al., 2016; Modi and Mabert, 2007; Song and Benedetto, 2008; Pan et al., 2015; Zeng et al., 2016); green supply chain management practices (Zhu et al., 2010, 2011; Genovese et al., 2017; Zeng et al., 2016); supportive organisational climate, supply chain innovation, human resource practices, knowledge management capacity (Al-Tit, 2017). Thus, GRAM maybe only one of many factors affecting Organisational Performance. It indicates the GRMA could affect ORPE, but GRAM is only one of many factors that affect companies' Organisational Performance. The second reason could be that the indirect relationship between GRMA and ORPE exists. This is discussed in Section 4.7.1 that GRMA indirectly affects ORPE through companies' Circular Economy capability (CECA).

The result is largely consistent with some previous studies on exploring the relationships between green practices and firms' performance (Genovese et al., 2017; Zeng et al., 2016; Nasir et al., 2017; Sanders, 2012). This study reinforces the relationships between GRMA and ORPE. This study provides future research with valid and reliable measurement items for these constructs, also enables empirical research in the relevant field. In terms of research implications, implementation of Green Manufacturing methods is an important aspect of companies' survival in an increasingly competitive market. Through adopting a set of routines such as green design, procurement, manufacturing, packaging, and distribution, companies can make more effective use of resources and energy and minimise negative environmental impact (Carter et al., 2000; Ying et al., 2012; Zhu et al.,

2005). These measures are likely to help companies to improve both their environmental and business performance (Zhu et al., 2010). The confirmation of hypothesis H5 highlights that apparel companies seeking to improve ORPE may find assistance in adopting Green Manufacturing methods. The increasing influence of environment-friendly in manufacturing can be attributed to creating competitive advantage and strong business performance (Genovese et al., 2017; Zeng et al., 2016; Nasir et al., 2017; Sanders, 2012). Green Manufacturing aims to minimise environmental impacts and maximise resource efficiency by focusing on integrating product and process design to identify and assess the flow of waste into the environment. Through applying Green Manufacturing, the negative environmental impacts are minimised, and the resources are effectively utilised. These could help apparel companies to improve their organisational performance.

**H 6: Applying Green Manufacturing (GRMA) positively affects Circular Economy capability (CECA).**

Hypothesis H 6 is strongly supported by the statistical results ( $\beta=0.605$ , T-value=13.578), confirming that GRMA could improve the companies' ability to implement Circular Economy. The findings also show that 36.8% ( $R^2$  value) of the variance of CECA is explained by GRMA. According to Henseler et al. (2009), when an endogenous latent variable is operationalized by only a few exogenous latent variables in a specific inner model structures, a moderate  $R^2$  value ( $>0.33$ ) is acceptable. As CECA has only one exogenous construct, namely GRMA, and the  $R^2$  value of CECA is 0.368 (i.e. above 0.33), this hypothesis is supported. Furthermore, the effect size ( $f^2 =0.594$ ) shows that the changes in GRMA will result in a significant variation of CECA, indicating that the implementation of Green Manufacturing is the important factor affecting company Circular Economy Capability (CECA).

This result is largely consistent with some previous studies (Genovese et al., 2017; Kazancoglu et al., 2018; Baldassarre et al., 2019) on exploring the relationships between Circular Economy capability and green practices. Companies have been embarking on Green Manufacturing initiatives independently and without a view about the Circular Economy view. Yet, this process helps increase companies' ecological awareness, invest in environmental systems and such which helps them build a capability relevant to the Circular Economy. The confirmation of hypothesis H6 reinforces the relationship between Circular Economy capability and Green Manufacturing. This finding suggests that apparel companies could usefully implement Green Manufacturing to improve their ability to implement the Circular Economy. For apparel companies, this study reveals a new avenue to enhance companies' Green Manufacturing implementation from a perspective of Circular Economy. The Circular Economy capabilities at the company level are represented by the reduction capabilities, reuse capabilities and recycle capabilities (Zhu, Geng, and Lai 2011). Green Manufacturing includes six stages, namely, green design, green procurement, green processes, green packaging, green end of life management and remanufacturing (Melnyk and Smith 1996). In real practice, the reduction capabilities could be developed in the green manufacture, green distribution and green use stages by carrying out the set of interrelated environmental routines of reducing energy and materials usage. The reuse capabilities could be developed by carrying out the set of environmental routines of re-utilising production materials in the remanufacturing stage and green design stage that aims to extend the life cycle of a product. The recycle capabilities could be developed by carrying out the set of interrelated environmental routines of focusing on proper disposal of products or materials in the green end of life management stage.

In particular, the reduction capabilities can be improved in the green production, and green distribution stage through using the resource- and energy-efficiently and minimising waste and emissions. Apparel companies may address following issues to achieve this goal: updating equipment to reduce energy use; minimising air emissions; reducing both

solid and liquid waste; and protecting the safety of workers, consumers and the local community. Additionally, apparel companies may require suppliers and distributors to use environmentally friendly packaging materials. Also, in order to reduce the carbon footprint, apparel companies may consider cleaner transportation, optimised location-allocation, effective warehousing systems, environment-friendly packaging and effective inventory management.

The reuse capabilities focus on the ability to extend the life cycle of the product and can be built in the Green Manufacturing process. The following practices can help apparel companies to achieve this target. First, they can innovate in the manufacturing process to enable the ability to reuse the extra raw materials, scrap/trim pieces, faulty products and used garment. Second, and in terms of secondary markets, it is vital to raise customers' awareness of reusing or recycling their apparel to extend its lifecycle. Apparel companies could display contenders for reusing or recycling purposes. Third, a second-life retailing business model may constitute a key opportunity to extend the use of apparel sold by primary retailers. For example, the apparel retailer Urban Outfitters has introduced an Urban Renewal Vintage Customised collection. Designers handpick vintage collections from second-hand shops and rework them for display in the shop or online. Each piece in these vintage collections is therefore unique and limited edition, which is attractive to buyers. Such a second-life business model not only extends the use of apparel in the maturity stage and reduces waste but also democratises consumption for new customers, which represents a significant contribution to sustainability.

The recycle capabilities focus on the ability of proper disposal of products or materials and can be developed in the green remanufacturing stage. This stage focuses on recovering the value of products from the customer to make a profit through refurbishment, remanufacturing or recycling. For example, the apparel companies Marks & Spencer and H&M have set up apparel banks to take back used garments. After collecting products, the manufacturer can strategically integrate supply chain activities to capture their additional

value. The products collected can be recycled to produce the same type of products or be upcycled for the production of different types of products. For example, used clothes can be recycled in the production of new apparel or toys or upcycled to car upholstery. Hence, apparel companies could implement the used garment collection (UGC) scheme, invest facilities to reprocesses collected used products and make extensive use of reprocessed materials to manufacture products. Additionally, due to the complexity of reverse logistics processes, many companies are still unable to efficiently design reverse logistics networks. Therefore, apparel companies may work with third-party reverse providers to enter reverse logistics markets.

**H7: Circular Economy capability (CECA) positively affects Organisational Performance (ORPE).**

This hypothesis H7 is moderately supported by the statistical results ( $\beta=0.296$ , T-value=2.652), implying that companies' Circular Economy capabilities positively affects the companies' Organisational Performance. However, only moderate support is provided for this, as the significance level of the path (CECA -> ORPE) is not very high (T-value = 2.652).

There is one possible reason why H 7 hypothesis is only moderately supported. The statistical result shows that only 23.5% ( $R^2$  value) of the variance of ORPE is explained. The effect size  $f^2$  value (0.091) shows that the changes of CECA may only result in the notable variation of ORPE. It indicates the CECA could affect ORPE, but CECA is only one of many factors that affect companies' Organisational Performance. For example, as discussed earlier, the GRMA could also affect companies' Organisational Performance.

The confirmation of hypothesis H7 suggests that apparel companies' Organisational Performance is improved by enhancing their ability to implement the Circular Economy. The latter involves strengthening the ability to reduce, reuse, and recycle, reducing the negative environmental impact of operations and ensuring effective resource utilisation (Genovese et al., 2017; Zhu, 2010; Zhu, 2011). Such refinements can help companies to improve their

performance (Zhu et al., 2010). Through building and improving the Circular Economy capabilities, apparel companies improve their abilities to reduce, reuse and recycle the materials or energy. These abilities can directly impact its overall environmental performance, facilitate the maintenance of competitive advantages and ultimately improve its Organisational Performance. Specifically, by building their reduction capability and reusing capability, apparel companies can reduce expenses on resources and energy use and re-utilise production materials, which can improve their business performance. Through building their recycling capability, apparel companies can attract consumers who prefer eco-friendly products and build good brand images. This allows them to produce at low cost and in a more environmentally friendly manner and so to increase their sales and extend their market shares in an environment-oriented market, which eventually will improve their Organisational Performance and sustain their competitive environmental advantages.

#### **4.7 Mediating effect**

The mediation is one of the critical methodological concepts and is considered as the important research tool to explain the relationships that underlie empirical phenomena (Baron and Kenny, 1986; Fiedler, 2011; MacKinnon et al., 2002). In order to gain real impact on empirical findings, researchers should not merely explain the straightforward relationship between the dependent variable and independent variable, but also conduct the mediation analysis (Fiedler, 2011).

The mediator must be the causal result of the independent variable/exogenous construct and a causal antecedent of the dependent variable/endogenous construct (Hair et al., 2017; Nitzl et al., 2016; Cepeda et al., 2017). For example, the mediator (Table 4.9: construct 2) is the construct that causes the mediation in the exogenous construct (Table 4.9: construct 1) and the endogenous construct (Table 4.9: construct 3), which explains the relationship between the exogenous construct and the endogenous construct in the PLS path model. As shown in Table 4.9,  $p3$  (0.2) is the direct effect,  $p1$  (0.5) \*  $p2$  (0.6) is the indirect effect (0.3). The total effect (0.5) is the sum of direct effect and indirect effect. The

indirect effect and the direct effect between two constructs can be found using the paths (Bootstrapping-> Final results->Total Indirect Effects (Mean, STDEV, T-Values, P-Values)) and (Bootstrapping-> Final results->Path Coefficients (Mean, STDEV, T-Values, P-Values)). Zhao et al. (2010) suggest the mediator model (Figure 4.9). This mediator model is useful for researchers to decide the types of mediation. When  $p_1$ ,  $p_2$ ,  $p_3$  are all significant, the partial mediation exists. When only  $p_1$  and  $p_2$  are significant, the full mediation exists.

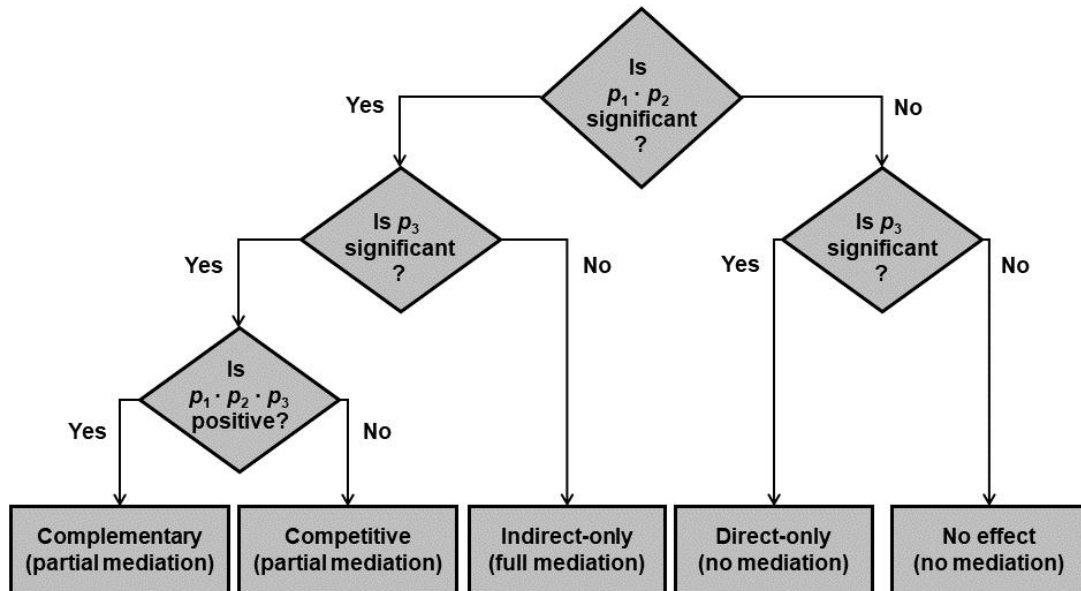


Figure 4. 9 The mediator model (Zhao et al., 2010)

The results (Table 4.16) show that the Circular Economy Capability (CECA) is the mediator, which partially mediates the relationship between Green Manufacturing (GRMA) and Organisational Performance (ORPE). Green Manufacturing (GRMA) is the mediator, which partially mediates the relationship between Environmental Orientation (ENOR) and Circular Economy Capability (CECA). Environmental Orientation (ENOR) is the mediator, which partially mediates the relationship between Stakeholder Engagement in Environmental Implementation (SEEI) and the implementation of Green Manufacturing (GRMA).

**Table 4. 16 Results of Mediation effect (Two-staged approach)**

| <b>Mediation Effect</b>  |                   |                                 |              |               |                   |
|--|-------------------|---------------------------------|--------------|---------------|-------------------|
| <b>Circular Economy Capability (CECA) partially mediates the relationship between green manufacturing (GRMA) and organizational performance (ORPE)</b>               |                   |                                 |              |               |                   |
| Mediation Effect Mediator: Circular Economy Capability (CECA) Independent Variable: Green Manufacturing (GRMA) Dependent Variable: Organisational performance (ORPE) | Path Coefficients | Path Standard Deviation (STDEV) | Path T-value | Path P Values | Decision          |
| Circular Economy Capability (CECA) -> Organisational performance (ORPE)  | 0.296             | 0.112                           | 2.652 **     | 0.008         | Partial Mediation |
| Green Manufacturing (GRMA) -> Circular Economy Capability (CECA)   | 0.605             | 0.045                           | 13.578 ***   | 0.000         |                   |
| Green Manufacturing (GRMA) -> Organisational performance (ORPE)  | 0.226             | 0.092                           | 2.459 *      | 0.014         |                   |

Note. " + " indicates  $P < 0.1$ ; \* indicates  $P < 0.05$ ; \*\* indicates  $P < 0.01$ ; \*\*\* indicates  $P < 0.001$ ; n/s indicates not significant.

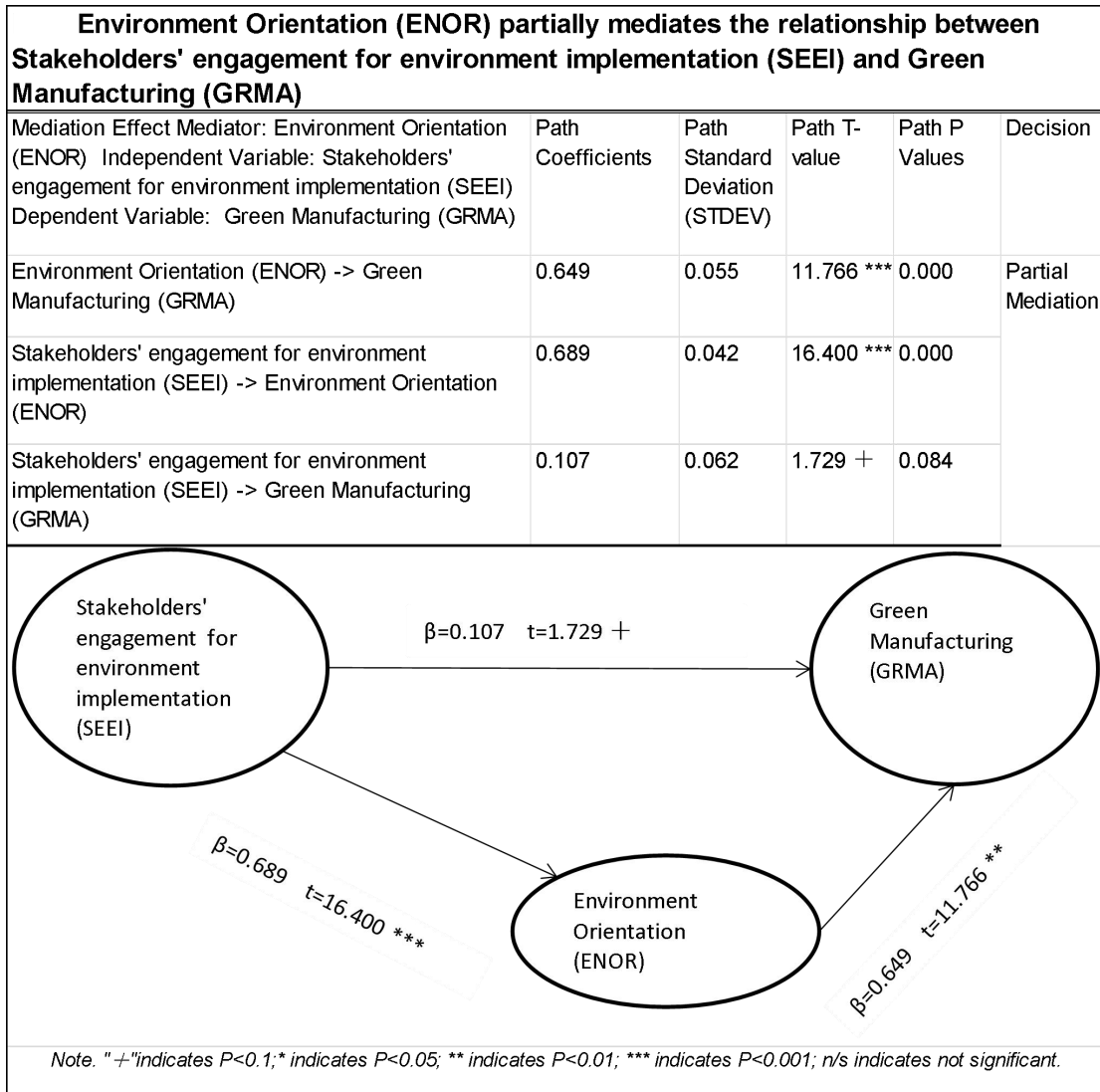
| Green Manufacturing (GRMA) partially mediates the relationship between Environment Orientation (ENOR) and Circular Economy Capability (CECA)                      |                   |                                 |              |               |                   |
|---|-------------------|---------------------------------|--------------|---------------|-------------------|
| Mediation Effect Mediator: Green Manufacturing (GRMA) Independent Variable: Environment Orientation (ENOR) Dependent Variable: Circular Economy Capability (CECA) | Path Coefficients | Path Standard Deviation (STDEV) | Path T-Value | Path P Values | Decision          |
| Environment Orientation (ENOR) -> Circular Economy Capability (CECA)  | 0.386             | 0.044                           | 8.877 ***    | 0.000         | Partial Mediation |
| Environment Orientation (ENOR) -> Green Manufacturing (GRMA)  | 0.638             | 0.055                           | 11.766 ***   | 0.000         |                   |
| Green Manufacturing (GRMA) -> Circular Economy Capability (CECA)  | 0.605             | 0.045                           | 13.578 ***   | 0.000         |                   |

```

graph LR
    ENOR((Environment Orientation (ENOR))) -- "β=0.386 t=8.877*" --> CECA((Circular Economy capability (CECA)))
    ENOR -- "β=0.638 t=11.766***" --> GRMA((Green Manufacturing (GRMA)))
    GRMA -- "β=0.605 t=13.578**" --> CECA
  
```

Note. "+" indicates  $P < 0.1$ ; \* indicates  $P < 0.05$ ; \*\* indicates  $P < 0.01$ ; \*\*\* indicates  $P < 0.001$ ; n/s indicates not significant.



4.7.1 The mediating effect of Circular Economy Capability (CECA) on the relationship between Green Manufacturing implementation (GRMA) and Organisational Performance (ORPE).

To satisfy stakeholders' environmental requirements, firms should implement Green Manufacturing to reduce the use of resources, minimises costs and improves the Eco-efficiency of their production process. Essentially, GRMA helps companies build CECA to address pressures from stakeholders while sustaining a competitive advantage to improve ORPE. This study investigates the influence of GRMA on CECA, which in turn affects ORPE. Implementation of Green Manufacturing (GRMA) may improve companies' environmental capability and ultimately enhance their Organisational Performance (ORPE) (Kazancoglu et

al., 2018). Circular Economy Capability in this study is regarded as a form of environmental capability (Zeng et al., 2017); it may be the variable that explains the relationship between the implementation of Green Manufacturing (GRMA) and Organisational Performance (ORPE). According to the procedures for mediation hypotheses proposed by Baron and Kenny (1986), the critical step is to identify the mediator, the independent variable and the dependent variable. The mediator considered in this study is Circular Economy Capability, the independent variable is Green Manufacturing and the dependent variable is Organisational Performance. Although GRMA can partially improve ORPE on its own, CECA may be a necessary element for achieving such overall improvement.

As discussed above in Section 4.6 (H6), there is also an indirect relationship between GRMA and ORPE. Thus, this research considers the mediation effect of Circular Economy capability (CECA) in the positive relationships between Organisational Performance (ORPE) and Green Manufacturing implementation (GRMA). The mediation is a vital methodological concept that can be used to explain the relationships that underlie empirical phenomena (Baron and Kenny, 1986). In order for empirical findings to have genuine impact, researchers should not just explain the straightforward relationships between the dependent variables and independent variables, but also conduct a mediation analysis (Fiedler, 2011). According to the procedures for constructing mediation hypotheses proposed by Baron and Kenny (1986), the first step is to show that the independent variable is correlated with the dependent variable. As discussed above in relation to H5, the Green Manufacturing (GRMA) is positively related to Organisational Performance (ORPE). Table 4.16 shows that the regression of GRMA (independent variable) and ORPE (dependent variable) is significant at the  $p \leq 0.05$  level. The second step of the procedure outlined by Baron and Kenny (1986) is to show that the independent variable is correlated to the mediator variable. The results set out in Table 4.16 indicate that Green Manufacturing (GRMA) is positively related to Circular Economy capability (CECA) as discussed above in relation to H6. As shown in Table 4.16, the regression coefficient when CECA is the mediator and GRMA the independent variable is

also significant at the  $p \leq 0.001$  level. On this basis, it is reasonable to consider CECA as the mediator. The third step is to show that the mediator variable is correlated with the dependent variable. Again, Hypothesis 7's result shows that the Circular Economy capability (CECA) is positively related to Organisational Performance (ORPE). The regression coefficient when CECA is used as the mediators and ORPE is the dependent variable is also significant at  $p \leq 0.05$  level.

A full mediation effect occurs when the independent variable does not affect the dependent variable when the mediating variable is controlled (Baron and Kenny, 1986). If the independent variable has a lesser effect on the dependent variable, but still significantly affects it when controlled, this is considered to be a partial mediation effect. By comparing the total (0.404) and direct (0.226) effects of the model path (GRMA  $\rightarrow$  ORPE) (see Table 4.16), it may be concluded that CECA is a partial mediator of this relationship. In other words, it explains part of the connection between GRMA and ORPE. Although GRMA can partially improve ORPE on its own, CECA is a necessary element for achieving such overall improvement. This highlights that while apparel companies can enhance their performance through GRMA, they also need to address their ability to implement the Circular Economy in order to achieve the maximum possible improvement. In sum, our analytical results indicate that CECA is the variable that explains the relationship between GRMA and ORPE. Although GRMA can partially improve ORPE, CECA is a necessary element for achieving such improvement. The result highlights that apparel companies can improve Organisational Performance by implementing Green Manufacturing but building the companies' Circular Economy capability is essential to achieve Organisational Performance gains.

#### 4.7.2 The mediating effect of Green Manufacturing (GRMA) on the relationship between Environmental Orientation (ENOR) and Circular Economy Capability (CECA).

Although ENOR can partially improve CECA, GRMA may be a necessary element for achieving such improvement. The first step in Baron and Kenny's procedure is to show the

independent variable (ENOR) is correlated with the dependent variable (CECA). ENOR is regarded as one of the drivers of implementing Green Manufacturing (GRMA) in the proposed conceptual model. In the initial stage, this study did not consider the relationship between ENOR and CECA. However, when developing H4, this study adopts the Environmental Orientation (ENOR) as a strategic resource. Then, ENOR may also be adopted as environmental resources to build the companies' CECA. Natural Resource-Based View (NRBV) theory suggests the environmental resource configuration activities could improve companies' environmental capability (Hart 1995; Makadok 2001). As discussed previously, Barney (1991) suggests that Environmental Orientation, such as a company' interactions with external stakeholders regarding ecological issues, its code of standards of ethical behaviour and internal values can be internalised and developed as company resources over time. Natural Resource-Based View (NRBV) theory holds that companies maintain their competitiveness by continually reconfiguring their resources. Environmental resource configuration activities help to improve companies' environmental capability (Hart, 1995). Circular Economy Capability (CECA) is employed to capture companies' environmental capability (Anderson, 2007). As companies' Environmental Orientation (ENOR) can be configured and developed as a company resource over time, this study expects that companies' Environmental Orientation (ENOR) is positively related to Circular Economy Capability (CECA). According to the NRBV, Environmental Orientation (ENOR) underlines an organisational capability that satisfies firms' environmental needs while meeting their economic goals (Aboelmaged, 2018; Stone and Wakefield, 2000). It is a strategic and proactive approach that has the potential to drive the environmentally sustainable development (Aboelmaged, 2018), and to build the ability to transform cluttered environmental initiatives into strategic actions (Lubin and Esty, 2010). Prior studies on sustainability have also pondered environmental orientation as the resources to build the capability of promoting green practices comprising, eco-design and labelling, and environmental reporting (Aboelmaged, 2018; Yu et al., 2014). Therefore, Environmental

Orientation (ENOR) is expected to correlate with Circular Economy Capability and p3 is expected to be significant.

The second step in Baron and Kenny's procedure is to show that the independent variable (ENOR) is correlated with the mediator variable (GRMA). As discussed earlier, Hypothesis 4 is that Environmental Orientation positively affects the implementation of Green Manufacturing. Therefore, p1 is expected to be significant. The third step in Baron and Kenny's procedure is to show that the mediator variable (GRMA) is correlated with the dependent variable (CECA). Hypothesis 6 is that Green Manufacturing positively affects Circular Economy Capability. Therefore, p2 is expected to be significant.

As the public pays increasing attention to environmental deterioration, governments have tightened environmental regulations for firms' operations (Zhou et al., 2020). As a result, apparel companies face greater challenges in reducing negative environmental impacts than ever before (Gabler et al., 2015; Bu et al., 2020; Macchion et al., 2018). In response to increasing stakeholders' environmental requirements, companies are forced to reconfigure their resources and build their environmental capabilities (Zhou et al., 2020). Environmental Orientation (ENOR) has been deemed an important strategic principle guiding the green practices (Gabler et al., 2015; Bu et al., 2020;), however, how it influences companies' environmental capability, especially the Circular Economy Capability remains unclear in apparel companies. The apparel companies implement green practices to build environmental capability by reducing the consumption of resources (materials, energy and water) (Ozturk et al., 2016); investing in training and technologies in the manufacturing process (Alkaya and Demirer 2014; Barbiroli and Raggi, 2003), establishing changes in the production (Mendoza et al., 2014), adopting equipment to improve efficiency and minimise pollution (Alkaya and Demirer 2014). Hence, this study deems GRMA as a mediator in the relationship between ENOR and CECA. Moreover, one of the most effective approaches to be environmentally oriented is by extending green practices to the supply chain (Bu et al., 2020). Green Manufacturing (GRMA) not only helps companies effectively fulfil stakeholders'

expectations but also develops good brand image and build environmental capability (e.g., Circular Economy Capability (CECA)) that creates a competitive advantage. Thus, Environmental Orientation (ENOR) requires companies to invest increased resources and put efforts into GRMA, which in turn creates CECA and sustains competitive advantage. Hence, p1, p2 and p3 are all expected to be significant. This is supported by the statistical results (Table 4.16), which implies that Green Manufacturing (GRMA) is the mediator that explains the relationship between Environmental Orientation (ENOR) and Circular Economy capability (CECA). In particular, the path coefficients of the paths: Environmental Orientation (ENOR) -> Circular Economy capability (CECA), Environmental Orientation (ENOR) -> Green Manufacturing (GRMA), and Green Manufacturing (GRMA) -> Circular Economy capability (CECA) are 0.386, 0.638, and 0.605. The Path Coefficients T-values are 8.877, 11.766, and 13.578, which show above paths are statistically significant at  $P < 0.001$  level. Thus, Environmental Orientation (ENOR) has a significant impact on Circular Economy capability (CECA), Environmental Orientation (ENOR) has a significant impact on Green Manufacturing (GRMA), and Green Manufacturing (GRMA) has a significant impact on Circular Economy capability (CECA). According to the mediator model proposed by Zhao et al. (2010) (Figure 4.9), the Green Manufacturing (GRMA) is the mediator, which partially mediates the relationship between Environmental Orientation (ENOR) and Circular Economy capability (CECA).

In terms of real practice, the analytical results indicate that Green Manufacturing (GRMA) is the variable that explains the relationship between Environmental Orientation (ENOR) and Circular Economy capability (CECA). Although ENOR can partially improve CECA, GRMA is a necessary element for achieving such improvement. The result highlights that apparel companies can build Circular Economy capability by increasing the level of Environmental Orientation, but implementing Green Manufacturing is an essential method to build the Circular Economy capability.

#### 4.7.3 The mediating effect of Environmental Orientation (ENOR) on the relationship between Stakeholder Engagement in Environmental Implementation (SEEI) and Green Manufacturing (GRMA).

Although SEEI can partially improve GRMA, ENOR may be a necessary variable to achieve such improvement. The first step in Baron and Kenny's procedure is to show that the independent variable (SEEI) is correlated with the dependent variable (GRMA). Hypothesis 1 is that Stakeholder Engagement in Environmental Implementation positively affects the application of Green Manufacturing. Therefore, Stakeholder Engagement in Environmental Implementation is expected to correlate with Green Manufacturing and  $p_3$  is expected to be significant.

The second step in Baron and Kenny's procedure is to show that the independent variable is correlated with the mediator variable. As discussed earlier, Hypothesis 3 is that Stakeholder Engagement in Environmental Implementation positively affects Environmental Orientation. Therefore,  $p_1$  is expected to be significant. The third step in Baron and Kenny's procedure is to show that the mediator variable is correlated with the dependent variable. Hypothesis 4 is that Environmental Orientation positively affects the implementation of Green Manufacturing. Therefore,  $p_2$  is expected to be significant. Hence,  $p_1$ ,  $p_2$  and  $p_3$  are all expected to be significant, this is supported by the statistical results (Table 4.16), which implies that Environmental Orientation (ENOR) is the mediator that explains the relationship between Stakeholder engagement for environment implementation (SEEI) and Green Manufacturing (GRMA). In particular, the path coefficients of the paths: Environmental Orientation (ENOR)  $\rightarrow$  Green Manufacturing (GRMA), Stakeholder engagement for environment implementation (SEEI)  $\rightarrow$  Environmental Orientation (ENOR), and Stakeholder engagement for environment implementation (SEEI)  $\rightarrow$  Green Manufacturing (GRMA) are 0.649, 0.689, and 0.107. The Path Coefficients T-values are 11.766, 16.400, and 1.729, which show above paths are statistically significant at  $P < 0.1$  level. Thus, Environmental Orientation

(ENOR) has a significant impact on Green Manufacturing (GRMA), Stakeholder engagement for environment implementation (SEEI) has a significant impact on Environmental Orientation (ENOR), and Stakeholder engagement for environment implementation (SEEI) has a significant impact on Green Manufacturing (GRMA). Thus, these results indicate the Environmental Orientation (ENOR) is the mediator, which partially mediates the relationship between Stakeholder engagement for environment implementation (SEEI) and Green Manufacturing (GRMA).

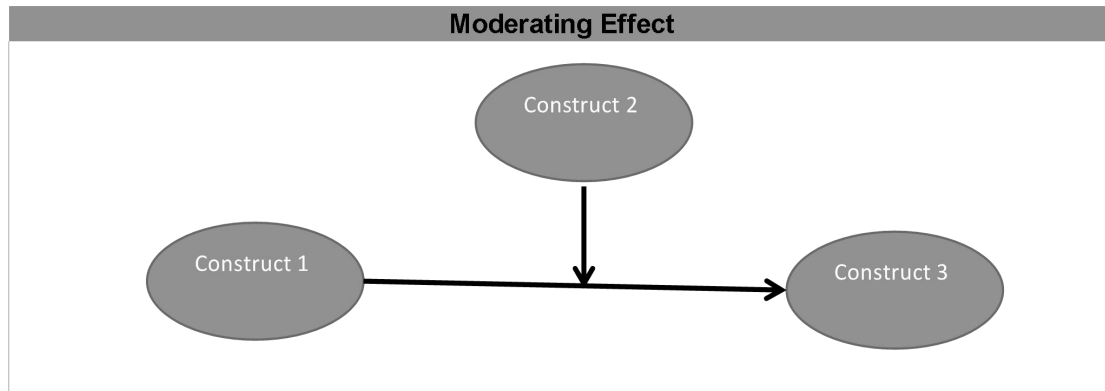
In sum, ENOR is the variable that explains the positive relationship between SEEI and GRMA. Although SEEI can partially improve GRMA, ENOR is a necessary variable to achieve such improvement. The result highlights that apparel companies can improve Green Manufacturing implementation by addressing the issues of Stakeholders' Engagement for Environmental Implementation, however, emphasising on the companies' Environment Orientation is essential to achieve such improvement.

#### **4.8 Moderating Effect**

As discussed earlier, the mediator (Table 4.9: Construct 2) must be the causal result of the exogenous construct (Table 4.9: Construct 1) and a causal antecedent of the endogenous construct (Table 4.9: Construct 3). The main rigid criteria to distinguish between mediator and moderator is that the moderator (Figure 4.10: Construct 2) cannot be the causal result of the exogenous construct (Figure 4.10: Construct 1). In the PLS path model, the moderator construct is the third construct that affects the strength of the relationship between the exogenous construct and endogenous construct (Chin et al., 2003; Hair et al., 2017; Henseler and Chin, 2010; Henseler et al., 2012; Rigdon et al., 2010).

The SmartPLS 3 adds moderation functionality. The results (Table 4.17) show the level of Barriers to Green Manufacturing application (BFGI) is not the moderator between the Green Manufacturing (GRMA) and Stakeholder engagement for environment

implementation (SEEI). The level of Barriers to Green Manufacturing application (BFGI) is also not the moderator between the Green Manufacturing (GRMA) and Environmental Orientation (ENOR). The detailed discussion of hypotheses is discussed in Section 4.8.1 and Section 4.8.2.



**Figure 4. 10** Examples of moderating effect

**Table 4. 17 Results of Moderating effect (Two-staged approach)**

| <b>Moderating Effect</b>  |                                   |       |     |                            |         |        |                      |              |              |              |               |
|---|-----------------------------------|-------|-----|----------------------------|---------|--------|----------------------|--------------|--------------|--------------|---------------|
| The relationship between Stakeholder Engagement in Environmental Implementation (SEEI) AND Green Manufacturing Implementation (GRMA), could be stronger for companies having a lower level of Barriers to Green Manufacturing implementation (BFGI).                          |                                   |       |     |                            |         |        |                      |              |              |              |               |
| The relationship between Stakeholder Engagement in Environmental Implementation (SEEI) AND Green Manufacturing implementation (GRMA), could be less stronger or nonexistent for companies having a higher level of barriers for implementation of Green Manufacturing (BFGI). |                                   |       |     |                            |         |        |                      |              |              |              |               |
| Moderator: Level of Barriers to Green Manufacturing application (BFGI)  |                                   |       |     |                            |         |        |                      |              |              |              |               |
| Dependent Variable: Green Manufacturing (GRMA)  |                                   | Path  | Std | Path                       | Path    | P      | f <sup>2</sup> Value | Total Effect | Total Effect | Total Effect | Decision      |
| Independent Variable: Stakeholder engagement for environment implementation (SEEI)  | Variable: Stakeholder environment | Beta  |     | Standard Deviation (STDEV) | T-value | Values |                      | T-value      | P-value      |              |               |
| Moderating Effect BFGI*SEEI -> Green Manufacturing (GRMA)   |                                   | 0.018 |     | 0.064                      | 0.287   | 0.774  | 0.020 (S)            | 0.001        | 0.287n/s     | 0.774        | Not Supported |
| The relationship between Environmental Orientation (ENOR) AND Green Manufacturing implementation (GRMA), could be stronger for companies having a lower level of Barriers to Green Manufacturing implementation (BFGI).   |                                   |       |     |                            |         |        |                      |              |              |              |               |
| The relationship between Environmental Orientation (ENOR) AND Green Manufacturing implementation (GRMA), could be less stronger or non-existent for companies having a higher level of barriers for implementation of Green Manufacturing (BFGI).                             |                                   |       |     |                            |         |        |                      |              |              |              |               |

Moderator: Level of Barriers to Green Manufacturing application (BFGI)

| Dependent Variable: Green Manufacturing (GRMA)            | Path Beta | Std Standard Deviation (STDEV) | Path T-value | Path Values | P | f <sup>2</sup> Value | Total Effect | Total Effect T-value | Total Effect P-value | Decision      |
|---|-----------|--------------------------------|--------------|-------------|---|----------------------|--------------|----------------------|----------------------|---------------|
| Independent Variable: Environmental Orientation (ENOR)    |           |                                |              |             |   |                      |              |                      |                      |               |
| Moderating Effect BFGI*ENOR -> Green Manufacturing (GRMA) | 0.018     | 0.063                          | 0.290        | 0.772       |   | 0.019 (S)            | 0.019        | 0.290 n/s            | 0.772                | Not Supported |

Note. "+" indicates  $P < 0.1$ ; \* indicates  $P < 0.05$ ; \*\* indicates  $P < 0.01$ ; \*\*\* indicates  $P < 0.001$ ; n/s indicates not significant.

f<sup>2</sup> Value displayed for the effect size of the hypothesis. 0.02 is for small (S), 0.15 is for medium (M), and 0.35 is for large (L) effects (Cohen, 1988).



#### 4.8.1 The moderating effect of the level of Barriers to Green Manufacturing implementation (BFGI) on the relationship between Stakeholder Engagement in Environmental Implementation (SEEI) and Green Manufacturing implementation (GRMA).

As discussed earlier, when confirming that a mediation relationship exists, the mediator (Table 4.9, Construct 2) must be the causal result of an exogenous construct (Table 4.9, construct 1) and a causal antecedent of an endogenous construct (Table 4.9, construct 3). The main rigid criteria to distinguish between a mediator and a moderator is that a moderator (Figure 4.10, construct 2) cannot be the causal result of an exogenous construct (construct 1). The moderator (level of BFGI) affects the extent to which the barriers identified affect Green Manufacturing implementation. Therefore, the moderator cannot be a causal result of the independent variable (SEEI). Furthermore, the moderator construct is the third construct that affects the strength of the relationship between an exogenous construct and an endogenous construct (Chin et al., 2003; Hair et al., 2017; Henseler and Chin, 2010; Henseler et al., 2012; Rigdon et al., 2010). This study expects that the moderator (level of BFGI) affects the strength of the relationship between the exogenous construct (SEEI) and the endogenous construct (GRMA). As discussed earlier, hypothesis 1 is that SEEI positively affects GRMA. Therefore, the path coefficient ( $p_3$ ) between these two constructs (Table 4.9) is expected to be significant. The level of BFGI affects GRMA. Therefore, the path coefficient ( $p_2$ ) between these two constructs is expected to be significant and both  $p_2$  and  $p_3$  are expected to be significant. BFGI includes barriers to stakeholder involvement and support. If a company has a lower level of BFGI, for example, if the company's stakeholders have a high level of involvement and support in terms of GRMA, then the relationship between Stakeholder Engagement in Environmental Implementation and Green Manufacturing implementation (H1) is expected to be stronger. On the contrary, if a company has a higher level of BFGI and the level of stakeholder involvement and support is at a lower level, the relationship between Stakeholder Engagement in Environmental Implementation and Green Manufacturing implementation

may be less strong or inexistent. Surprisingly, this is not supported by the statistical results (Table 4.17), which implies that the level of Barriers to the Green Manufacturing application (BFGI) is not the moderator between the Green Manufacturing (GRMA) and Stakeholder engagement for environment implementation (SEEI). In particular, the path coefficients of the path: Moderating Effect BFGI\*SEEI → Green Manufacturing (GRMA) is 0.018. The path coefficients T-value is 0.287, which means the path is not statistically significant. Thus, BFGI\*SEEI does not have a significant impact on Green Manufacturing (GRMA).

#### 4.8.2 The moderating effect of the level of Barriers to Green Manufacturing implementation (BFGI) on the relationship between Environmental Orientation (ENOR) and Green Manufacturing implementation (GRMA).

Following the same logic as Section 4.8.1, this section investigates the moderation effect of BFGI on the relationship between Environmental Orientation (ENOR) and Green Manufacturing implementation (GRMA). In particular, this study expects the level of BFGI to be the moderator, Environmental Orientation to be the independent variable and Green Manufacturing the dependent variable. The moderator (level of BFGI) affects the extent to which the barriers identified affect Green Manufacturing application (GRMA). Therefore, the moderator cannot be the causal result of the independent variable (ENOR). Hypothesis 4 is that Environmental Orientation (ENOR) positively affects the implementation of Green Manufacturing (GRMA). Therefore, the path coefficient between these two constructs is expected to be significant. Hypothesis 2 is that the level of BFGI negatively affects Green Manufacturing implementation (GRMA). Therefore, the path coefficient between these two constructs is expected to be significant. BFGI includes barriers to stakeholder involvement and support, technology and knowledge barriers. A company' Environmental Orientation (ENOR) is reflected in its perception of interactions with external stakeholders

regarding ecological issues (Banerjee, 2002). Its internal Environmental Orientation is composed of its code of standards for ethical behaviour, internal values and commitments in terms of environment-friendly operational activities (Banerjee, 2002). If the company has a lower level of BFGI, for example it has a better perception of its interactions with external stakeholders regarding ecological issues and better commitments to environmental technology and knowledge, the relationship between Environmental Orientation and Green Manufacturing implementation (H4) will be stronger. On the contrary, if the company has a high level of BFGI then the relationship between Environmental Orientation and Green Manufacturing implementation will be less strong or inexistent. Surprisingly, these are not supported by the statistical results (Table 4.17), which implies that the level of Barriers to the Green Manufacturing application (BFGI) is not the moderator between the Environmental Orientation (ENOR) and Green Manufacturing implementation (GRMA). In particular, the path coefficients of the path: Moderating Effect BFGI\*ENOR → Green Manufacturing (GRMA) is 0.018. The path coefficients T-value is 0.290, which means the path is not statistically significant. Thus, BFGI\*ENOR does not have a significant impact on Green Manufacturing (GRMA).

There are two possible reasons why these arguments (BFGI moderates the relationship between SEEI and GRMA; BFGI moderates the relationship between ENOR and GRMA) are not supported by the data. First, the sub-constructs of the constructs (level of Barriers to Green Manufacturing implementation (BFGI)) might not be well established. The weights of sub-constructs: BES, BEF, and BET to main construct BFGI are not statistically significant (Table 4.7) at  $P < 0.05$  level or at  $P < 0.1$  level, which indicates there is a potential of misspecified measurement for construct BFGI. BFGI has no significant impact on GRMA (Hypothesis H2). Second, the method of collecting information for constructs: BFGI and SEEI, might lead to the hypotheses dis-confirmation. The questions for the questionnaire of BFGI part are designed to assess the impact of the current Barriers to Green Manufacturing in the company. This is based on the respondents perceive. The

questions for the questionnaire of the SEEI part are designed to examine the uncertainties of Stakeholder engagement in terms of environmental implementation, based on the respondents perceive. It is the perceptive data collection method, which could only obtain the indirect reflections of the phenomena. The results are entirely determined by the respondents' opinions. Thus, the collected information might not adequately reflect the actual phenomena.

## **CHAPTER 5: RESEARCH IMPLICATIONS AND LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH**

### **5.1 Overview**

This chapter discusses the implications (5.2) and limitations (5.3) of the study and sets out some directions for future research (5.4).

### **5.2 Research Implications**

This research 1) investigated the implementation of Green Manufacturing (GRMA) as an approach of building apparel companies' Circular Economy capability (CECA); 2) analysed the development and implementation of GRMA in apparel companies located in China and 3) evaluated the drivers of, barriers to and outcomes of GRMA from both a theoretical and methodological perspective. This study represents a significant contribution to the current literature because it investigates the green practices implemented in the apparel sector by not only focusing on specific areas of green practices– previous literature focused only on some areas, such as GRME (e.g. Zhou et al., 2017; Choi et al., 2012; Mittal et al., 2016) or CECA (e.g. Gazzola et al., 2020; Baldassarre et al., 2019; Ghisellini et al., 2016) – but by also offering a more complete perspective that considers the drivers of GRME (SEEI and ENOR), and barriers to GRME, and outcome of GRME (ORPE). As such, it posits that each of these aspects is important for understanding the strategic approaches to implement Green Manufacturing in apparel companies. This study also provides updated academic and managerial knowledge on the green practices in the apparel companies by revealing the GRMA as the strategic approaches to build CECA. This section discusses the implications of the research, both theoretical (5.2.1) and practical (5.2.2).

### 5.2.1 Theoretical implications

Today, the environmental issue has become a relevant challenge in the apparel sector. This perspective reflects the need for apparel companies to transform their production toward Green Manufacturing (GRMA) to benefit their Organisational Performance (ORPE). These trends open interesting research opportunities under the profile of the analysis of the implementation of Green Manufacturing (GRMA) and building Circular Economy Capability (CECA) in this sector, even today barely investigated together by management literature. In this sense, this study aimed to offer a first, innovative contribution to management studies on these topics currently barely investigated in the apparel sector by the literature. Furthermore, this study enriches the stream of literature by offering strong additional evidence, with a unique sample of companies (apparel companies located in China), to the positive effect of GRMA on ORPE. Furthermore, this study unveils the important drivers, barriers, and outcome of implementing GRMA. Most prior study on GRMA has focused on issues, such as advocating the importance of GRMA (Lele, 2009), the performance impacts of GRMA (Choi et al., 2012), and delineating the diffusion of GRMA (Zhou et al., 2017). Relatively limited research has examined the company-level (especially in the apparel sector) drivers, barriers, and outcome of implementing GRMA in a theoretical model. This research has put forward a conceptual model after reviewing, summarising and conceptualising the significant theories and concepts. The relevant relationships, concepts, sub-concepts and measurement items have been empirically tested. The constructs, sub-constructs and measurement items proposed in this research provide future studies with useful measures with which to explore relevant data. Most importantly, this study has empirically tested the relationships between GRMA and other concepts, including Stakeholder Engagement in Environmental Implementation (SEEI), Environmental Orientation (ENOR), Circular Economy Capability (CECA) and Organisational Performance (ORPE). The analysis presented here of the direct, mediating and moderating relationships between these variables contributes to the literature and will also feed into the development of further theoretical models. The

findings of this study indicate positive relationships between the implementation of GRMA and each of SEEI, ENOR, CECA and ORPE. These results are broadly consistent with previous studies exploring the relationships between green practices and stakeholder involvement (Liu et al., 2017; Zhou et al., 2017), environmental orientation (Chan, 2012; Yu and Huo, 2019), Circular Economy Capability (Kazancoglu et al., 2018; Baldassarre et al., 2019) and firm performance (Genovese et al., 2017; Zeng et al., 2016; Nasir et al., 2017; Sanders, 2012). However, these studies were not as deep as this study and did not correlate between the constructs. The theoretical contribution of this research consists in discovering which GRMA contribute to building the CECA, and the improvement of ORPE in apparel companies, a subject not yet studied, allowing researchers to advance in the relationship between GRMA and each of SEEI, ENOR, CECA and ORPE. This study confirms that there are meaningful relationships between GRMA and each of SEEI, ENOR, CECA and ORPE. It has also yielded valid and reliable measurement items for these constructs for use in future research, thus enabling further empirical work to be conducted. The findings of this study also have the following five valuable implications for future work.

Firstly, this research has empirically investigated the implementation of GRMA in apparel companies from a Circular Economy perspective. Although the concepts of both the Circular Economy and GRMA focus on reducing environmental impact (Zhu, Geng and Lai, 2011; Genovese et al., 2017), they do so from different perspectives. The concept of the Circular Economy focuses on the 'circulation' of materials by using energy more efficiently, and maximising the utility of materials and energy, in order to improve economic performance while alleviating environmental impact (Geng et al., 2009). However, GRMA focuses on reducing environmental impact across the product lifecycle from design to end of life, including green design, procurement, processes, packaging, end of life management and remanufacturing (Melnik and Smith, 1996; Lele, 2009). This focuses on reducing the environmental impact of products rather than improving economic growth (Melnik and Smith, 1996; Zhou et al., 2017). Many researchers have investigated each of these concepts

(Rosa et al., 2019; Mendoza et al., 2017; Baldassarre et al., 2019; Genovese et al., 2017; Kazancoglu, Kazancoglu and Sagnak, 2018; Zhou et al., 2017). However, few studies have looked at them both together and studied the apparel companies. Companies have been embarking on GRMA initiatives independently and without taking a view on the Circular Economy. However, this process helps increase companies' ecological awareness and investment in environmental systems, enabling them to build capabilities that are also relevant to the Circular Economy. Thus, this research fills a gap by empirically investigating the development of CECA through the implementation of GRMA.

Specifically, this research provides a new perspective through which to conduct empirical research on green practices in the context of apparel companies. Its findings indicate that GRMA implementation has an impact on CECA. The results are strictly consistent with the literature related to the CECA and GRMA analysed in this study. This result is broadly consistent with previous studies (Genovese et al., 2017; Kazancoglu et al., 2018; Baldassarre et al., 2019) exploring the relationships between CECA and green practices. This study innovates the state of the art because it reinforced the evidence for the relationship between CECA and GRMA in apparel companies. Using the strategic response theme of NRBV, this study extends this stream of literature by emphasising the implication of GRMA to build CECA. Overall, this finding addresses this under-researched area by theorising and empirically testing that companies that embarking on Green Manufacturing initiatives help increase employee awareness, invest in environmental systems and ultimately help them build the Circular Economy Capability. In particular, this study suggests that apparel companies could usefully introduce GRMA to improve their ability to implement the Circular Economy. CECA at the company level is represented by capabilities in reduction, reuse and recycling (Zhu, Geng, and Lai 2011). GRMA includes six stages, namely design, procurement, processes, packaging, end of life management and remanufacturing (Melnyk and Smith 1996). Firms' reduction capabilities can be enhanced through green production and distribution. Reuse capabilities aim to extend the life cycle of the product

and thus can be improved across all six stages of GRMA. Finally, the capacity to recycle focuses on the proper disposal of products or materials, and this can be enhanced at the end of life stage. All six stages of GRMA therefore aim to minimise negative environmental impact, which can help companies build and improve their CECA.

Furthermore, this study has identified a positive relationship between GRMA and ENOR. The identified influences of Environmental Orientation (ENOR) on GRMA further corroborate Chan et al. (2012), and Bansal and Roth's (2000) observations that companies are characterised by mixed motivations (e.g., external regulations, internal environmental ethics, competitive considerations) for taking environmental protection activities. The impact of ENOR on GRMA implies the cascading effect of companies' ecological awareness and perceived pressures from stakeholders on the implementing Green Manufacturing. In particular, ENOR can promote the implementation of GRMA by helping the company to understand the importance of ecological practices, engage stakeholders in the product development process and develop appropriate strategies (Chan, 2012; Yu and Huo, 2019; Banerjee, 2002). Having a strong ENOR can, for instance, empower firms to devote more resources to all six stages of the GRMA process. Companies' internal ENOR refers to their internal values and standards of ethical behaviour in terms of environmental protection activities (Banerjee, 2001). With a strong ENOR, firms can continually refine and enhance their implementation of the six stages of GRMA with reference to their internal values and ethical standards. External ENOR is reflected in companies responding to the concerns of external stakeholders about ecological issues (Banerjee, 2002). During the overall procedure of introducing GRMA, firms also need to engage with their stakeholders to gain their support and meet their ecological expectations (Zhou et al., 2017). Thus, this study has also proposed and confirmed the positive effect of SEEI on the implementation of GRMA. Suppliers' willingness to establish a partnership for environmental implementation (Baskarana et al., 2012); customers, NGOs' and governments' engagement (Subramanian et al., 2009; Beh et al., 2016; Sarkis et al., 2010; Pan et al., 2015; Lozano, 2013; Lee and Farzipoor Saen, 2012;

Mota et al., 2015) and managers' and employees' ability to adopt green practices (Zhu et al., 2008) will all help companies to improve their environmental processes and practices and adjust their GRMA implementation strategies accordingly. Thus, this finding highlights that apparel companies seeking to improve their GRMA processes may find it helpful to track stakeholder engagement to address the possible impact this may have.

Secondly, the Circular Economy can be implemented at three levels, namely, eco-regions at the macro-level, eco-industrial parks at the meso-level, and eco-enterprises at the micro-level (Zhu et al., 2010). Numerous researchers (Ma et al., 2014; Shi et al., 2010; Su et al., 2013) have discussed the Circular Economy at the regional and industry levels. For example, Shi et al. (2010) and Liu et al. (2009) explore its implementation in Tianjin city. Park et al. (2010) and Zhu et al. (2010) examine practices that facilitate the introduction of the Circular Economy in manufacturing industries. However, several questions regarding the Circular Economy at the company level remain to be addressed. This research accordingly fills a gap by empirically investigating the Circular Economy at the company level.

In examining the concept of organisational capability in the context of the Circular Economy, this research has identified some valuable implications. It has tested the relationship between CECA and other constructs, namely ENOR, ORPE and GRMA. The findings suggest that companies' capacity to implement the Circular Economy will enhance their performance. The main objective of the Circular Economy at the company level is to apply sustainability principles to reducing energy and resources, to facilitate the reuse of materials and to recycle used products (Nasr, 2013; Zhu et al., 2010; 2011). Specifically, through building the capability to reduce and reuse materials, companies reduce their spend on resources (including energy costs) and can reutilise production materials, all of which can improve business performance (Kazancoglu et al., 2018). Through building a recycling capability, companies can also attract consumers who prefer eco-friendly products and thus build a good brand image. These activities allow companies to produce their products in an environmentally sustainable way and increase sales and market share in an environmentally

conscious market. This will ultimately help to improve their ORPE and sustain competitive environmental advantage (Ghisellini et al., 2016; Zeng et al., 2017; Porter and van der Linde, 1995; Kazancoglu et al., 2018). Thus, this study suggests that ORPE in apparel companies will be improved by enhancing their ability to implement the Circular Economy. The latter involves strengthening the capacity to reduce, reuse and recycle; reducing the negative environmental impact of operations and ensuring effective resource utilisation (Genovese et al., 2017; Zhu, 2010; Zhu, 2011). Such refinements can help companies to improve their performance (Zhu et al., 2010). Furthermore, the findings of this research also indicate that CECA partially mediates the relationship between GRMA implementation and ORPE. The implementation of GRMA improves companies' environmental capability and thus ultimately enhances their performance (Kazancoglu et al., 2018). CECA in this study is regarded as a form of environmental capability (Zeng et al., 2017); it may accordingly be the variable that explains the relationship between GRMA implementation and ORPE. The results of the analysis conducted for this study indicate that CECA is the variable that explains the relationship between GRMA and ORPE. This highlights that while apparel companies can enhance performance through GRMA implementation, they also need to address their ability to implement the Circular Economy in order to achieve the maximum possible improvement. Thus, this study extends the apparel companies literature by examining the importance of CECA in the relationship between GRMA and ORPE. By integrating the relevant insight from Nature resource-based view, this study developed an important insight that has not yet been investigated by the extant literature, and thus opens a new dimension for empirical work. Moreover, by exploring the relationship between CECA and ENOR as mediated by GRMA, this research has confirmed that ENOR has a positive impact on CECA and GRMA implementation. This is broadly consistent with previous studies (Yu and Huo 2019; Bu et al. 2020) exploring the relationships between ENOR and green management. This study bolsters the evidence based for the relationship between ENOR and GRMA and enriches the exploration of the relationship between ENOR and CECA. Companies with a

high level of ENOR will be more sensitive to the environmental requirements of their stakeholders, which will encourage them to implement green practices such as GRMA, and thus to build their CECA. The results of the analysis reported here indicate that although ENOR can enhance CECA, GRMA is also a useful tool in achieving such improvement.

Thirdly, on the basis of a review of the existing research, this study has theorised the concepts of SEEI and ENOR as two key drivers for the implementation of GRMA. It has accordingly reinforced and enriched the exploration of the relationships between GRMA, SEEI and ENOR. In particular, the findings have shown that SEEI is positively related to ENOR in apparel companies. Stakeholders' engagement dramatically affects companies' recognition of the importance of environmental operations (Beh et al., 2016). Firms must understand the importance of the ecological consequences of their business activities in order to promote environmental policies and procedures (Banerjee, 2002; Banerjee et al., 2003). In other words, the firm must develop an environmental orientation. Specifically, firms need to consider the ecological effect of their operations, recognise the ecological needs of stakeholders and develop their internal values and ethical standards accordingly (Banerjee, 2002; Banerjee et al., 2003). Hence, a well-established environmental orientation is an important means of effectively resolving concerns arising from SEEI. Due to stakeholders' increasing focus on environmental pollution, apparel companies need to recognise the impact of SEEI and improve their ENOR in response so as to address stakeholders' environmental requirements. Also, the findings of this study suggest that ENOR mediates the relationship between SEEI and GRMA implementation. Hence, this study contributes to the stakeholder theory and green practices literature by extending prior work (e.g., Chan, 2012; Yu and Huo, 2019; Danso et al., 2020; Kazancoglu et al., 2020; Garcés-Ayerbe et al., 2012) through examining whether the relationship between SEEI and GRMA is mediated by ENOR. This highlights the need for apparel companies' to emphasise ENOR in order to ultimately realise the potential of stakeholder engagement in improving the implementation of GRMA. Recognising the importance of environmental influences on

companies' operations significantly affects their green practices (Banerjee, 2002; Chan, 2012; Yu and Huo, 2019). This study suggests apparel companies need to keep track of their own ENOR, by addressing SEEI issues, if they seek to enhance the implementation of GRMA. Nowadays, environmental issues have become one of the major concerns of stakeholders. Thus, apparel companies should make an investment in sustaining a high level of ENOR and integrate GRMA into their current operations so as to achieve a competitive advantage.

Fourthly, this study has identified four groups of key barriers to GRMA implementation; stakeholders' involvement and support, technology, knowledge and financial constraints. Surprisingly, the statistical results ( $\beta=-0.014$ , T-value=0.177) implies that BFGI does not directly impact on companies' GRMA. However, based on the statistical results ( $\beta=-0.165$ , T-value=1.966), one of the sub-constructs, BEK negatively affects Green Manufacturing implementation (GRMA). This is largely consistent with the previous study, Kazancoglu et al. (2020) applied the Fuzzy-Decision Making Trial and Evaluation Laboratory (DEMATEL) method to investigate barriers to the circular supply chain in the apparel industry. Their results show that the lack of technical knowledge is the most influencing barrier. As discussed in section 4.6 (H2), even though three of these subconstructs were not strongly confirmed in this study, they still have valuable implications. This study has discussed the importance of identifying the impact of current barriers to implementing GRMA in a company. Apparel companies need to keep monitoring these barriers in order to address their possible impact.

Fifthly, this study has conceptualised the outcome of GRMA implementation and building CECA as an enhancement of ORPE. ORPE includes two sub-constructs, namely environmental and business performance. The relationships between ORPE and the other concepts have been empirically tested in this study. This research highlights the necessity to examine the ORPE by adopting multiple dimensions that consider both business and environmental performance. In particular, it has been shown that the implementation of GRMA is an important aspect of companies' survival in an increasingly competitive market.

Through adopting a set of routines such as green design, procurement, manufacturing, packaging and distribution, companies can make more effective use of resources and energy and minimise the negative environmental impact of their operations (Carter et al., 2000; Ying et al., 2012; Zhu et al., 2005). These measures are likely to help firms to improve both their environmental and business performance (Zhu et al., 2010). The confirmation of hypothesis 5 in particular highlights that apparel companies seeking to improve their ORPE may find it of assistance to adopt GRMA practices.

### 5.2.2 Practical implications

Managerial issues have been completely ignored by previous studies in the context of implementing Green Manufacturing (GRMA) and building Circular Economy Capability (CECA) in the apparel companies. The stakeholder's engagement for environmental implementation (SEEI) plays a role in determining the extent to which Green manufacturing (GRMA) is adopted, and a fundamental shift in companies Environmental Orientation (ENOR) is needed to achieve GRMA. The findings of the study are useful for managers and policymakers to advance their understanding of implementing Green Manufacturing and the drivers, barriers and outcomes for implementation of Green Manufacturing, and building Circular Economy Capability at the firm level. Based on responses from 374 apparel manufacturing companies located in China, this study has generated the following significant practical implications. The section below summarises the implications of the findings for apparel companies and policymakers, respectively.

#### 5.2.2.1 Practical implications for apparel companies

GRMA was introduced in the 2000s as social awareness of the environmental impact of manufacturing increased (Lele, 2009). Its focus is on environmentally friendly production. This has now become one of the most critical concerns of companies (Sanders, 2012; Genovese et al., 2017). However, many manufacturing companies still do not manage their environmental activities in a systematic and effective manner (Huang, 2012). Such

companies use the majority of their resources to deal reactively with the negative environmental impact of operations, rather than proactively enhancing the eco-efficiency of the manufacturing system as a whole. Hence, the challenge facing apparel companies is how to enhance the eco-efficiency of their manufacturing process from beginning to end. This study has shed light on this by identifying ways in which companies can reconfigure their resources through implementing GRMA. A comprehensive explanation of the GRMA process has also been provided, which sets out how its implementation can improve ORPE.

Accordingly, this research has firstly proposed GRMA as the new approach through which apparel companies can reduce their environmental impact and thus maintain a competitive advantage. Manufacturing is the principal strategic component that helps companies to build such an advantage (Lele, 2009). This research has shown GRMA to be positively related to ORPE. The increasing influence of environmentally friendly practices in manufacturing can be attributed to the desire to create competitive advantage and ensure strong business performance (Genovese et al., 2017; Zeng et al., 2016; Nasir et al., 2017; Sanders, 2012). GRMA aims to minimise environmental impact and maximise resource efficiency by focusing on integrating product and process design so as to identify and assess the flow of waste into the environment. Through applying GRMA principles, firms can minimise negative environmental impact and use resources effectively. This approach can help apparel companies to improve their ORPE. Hence, the framework for GRMA that has been identified and confirmed in this study can be used to guide apparel companies to adjust their manufacturing configurations so as to achieve ecological excellence.

To be more specific, this finding suggests that apparel companies need to broaden their perspectives on the implementation of GRMA and emphasise all stages of the concept. In particular, in the design stage, managers should use sustainable and environmentally friendly materials and technologies (such as recycled or organic textiles and eco-labelling). A rapid prototyping approach should also be used in order to reduce the use of toxic substances, minimise the use of non-renewable resources and produce products which are

reusable and recyclable. Additionally, managers should conduct a life cycle analysis for their products to evaluate the environmental impact of the raw materials used and facilitate their reuse and recycling, along with the packaging materials used. Managers may then reconfigure their resources to apply green procurement, which involves activities such as supplier evaluation and cooperation, eco-efficient supply (such as recirculation of packaging and using just-in-time logistics systems) and eco-procurement activities that will facilitate the reduction, reuse and recycling of energy and resources. In the process of production stage, managers should focus on using resources and energy efficiently and minimising emissions and waste in their production processes and operations. They should address specific activities in order to achieve this goal, such as updating their equipment to reduce energy consumption; minimising air emissions and solid and liquid waste and protecting the safety of workers, consumers and the local community. At the packaging stage, apparel companies need to focus on minimising the impact of the materials used. Based on current regulatory standards, these should be returnable, reusable and recyclable. The stages of customer use to end of life within the concept of GRMA focus on minimising waste as well as the energy consumption and emissions of the products (Baines et al., 2012; Seliger et al., 2008). Managers may achieve this goal by addressing the following. Firstly, they can improve product design to enable their products to last longer by using materials with a longer life cycle. Long-lasting apparel has more reuse options and tends to be seen more in secondary markets such as charity shops, online auction sites, vintage shops and boutiques and consignment stores. Secondly, in terms of these secondary markets, companies can raise customers' awareness of reusing or recycling apparel to extend its use. For example, customers could donate unwanted apparel to charity shops. Companies may also set up banks for reusing or recycling apparel. Customer cooperation in donating and recycling unwanted garments can also help to make products available at affordable prices across a broader customer base, ultimately minimising their negative environmental impact.

Additionally, apparel companies could adjust their manufacturing processes to enable the use of recycled and reprocessed materials.

Secondly, this research has examined the outcome of building firms' CECA. Although the concepts of both the Circular Economy and GRMA focus on reducing environmental impact (Zhu, Geng and Lai, 2011; Genovese et al., 2017), as noted above, they do so from different perspectives. GRMA focuses on reducing the environmental impact of products rather than improving economic growth (Melnik and Smith, 1996; Zhou et al., 2017) while the Circular Economy focuses how to enhance economic performance while reducing environmental impact (Geng et al., 2009). The positive relationship between the implementation of GRMA and ORPE has been discussed above. However, this study has also identified a positive relationship between CECA and ORPE. This finding suggests that ORPE for apparel companies is improved by enhancing their ability to implement the Circular Economy. This means strengthening the ability to reduce, reuse and recycle, thus minimising the negative environmental impact of their operations and ensuring effective resource utilisation (Genovese et al., 2017; Zhu, 2010; Zhu, 2011). Such refinements can help companies to improve their performance (Zhu et al., 2010). Through building and improving their CECA, managers can improve their companies' ability to reduce, reuse and recycle materials and/or energy. This can have a direct impact on overall environmental performance, facilitate the maintenance of competitive advantage and ultimately improve the firm's ORPE. In particular, by building the capability to reduce and reuse, managers can cut expenditure on resources and energy and reuse production materials, both of which can further enhance business performance. Through building their recycling capability, apparel companies can also attract consumers who prefer eco-friendly products and build a good brand image. This allows them to produce garments at lower cost and in a more environmentally friendly manner and so increase their sales and extend their market share in an environment-oriented marketplace. Again, this will ultimately improve their ORPE and help sustain a competitive advantage. Furthermore, this study has provided managers with

an overview of Chinese apparel companies in terms of both business performance and environmental operations. The survey reported here collected biographical information about respondents, which can be used by firms as a reference for developing operational strategies.

Thirdly, this research has investigated how apparel companies have used the implementation of GRMA to build their CECA. Specific methods for building CECA at the company level in apparel companies have not been thoroughly explored before this study. Therefore, this research set out to empirically investigate the implementation of GRMA as an approach to build CECA in apparel companies. The findings suggest that GRMA implementation is the critical factor which affects apparel companies' CECA. Accordingly, this study has identified a new avenue through which companies can enhance the implementation of GRMA from the perspective of the Circular Economy. As mentioned above, CECA at the company level is represented by capabilities in reduction, reuse and recycling (Zhu, Geng, and Lai 2011). GRMA includes six stages, namely design, procurement, processes, packaging, end of life management and remanufacturing (Melnyk and Smith 1996). In practice, reduction capabilities could be developed through the distribution and use stages of GRMA by carrying out a set of interrelated environmental routines which reduce the consumption of energy and materials. Reuse capabilities could be developed by taking steps to use production materials again in the remanufacturing and design stages, with the aim of extending the product life cycle. Recycling capabilities could be developed by implementing processes which focus on the proper disposal of products or materials at the end of life management stage.

Fourthly, this research has also identified two critical drivers for GRMA implementation, namely SEEI and ENOR. SEEI significantly affects a company's recognition of the importance of environmental operations (Beh et al., 2016). Stakeholder engagement refers to issues such as companies cooperating with customers and suppliers to implement environmental solutions (Subramanian et al., 2009; Zhu et al., 2010; Zeithaml et al. 1996;

Beh et al., 2016), government enforcement of environmental regulations (Diabat and Govindan., 2011), NGOs' involvement in monitoring environmentally sustainable operations (Lozano, 2013; Lee and Farzipoor Saen, 2012; Mota et al., 2015) and the ability of both managers and employees to acquire new knowledge and technology to implement sustainable working practices (Zahra & George, 2002; Tu et al., 2006; Klassen & Whybark, 1999; Zhu et al., 2008). All of these forms of engagement can help companies to improve their green processes and practices. Thus, to enhance the process of implementing GRMA, apparel companies must keep tracking SEEI to address the possible impact of change. Furthermore, understanding SEEI can help a company to address the environmental impact of its operations and adjust its ENOR to meet the requirements of stakeholders (Banerjee, 2002; Banerjee et al., 2003). For apparel companies in particular, these findings have highlighted the importance of these two drivers in their environmental operations. This study has also identified ENOR as the vital factor that influences a company's GRMA implementation. For apparel companies, this underlines the importance of developing and monitoring their ENOR. Specifically, this study has proposed that ENOR includes two main sub-constructs: perceiving stakeholders' environmental concerns and recognising the importance of ecological activities. Apparel companies' understanding of the value of the latter can help them to reconfigure resources and provide the necessary management commitment to incorporate ecological concerns into their GRMA implementation. On the other hand, firms' perception of external stakeholders' environmental concerns can also have an impact on their manufacturing processes. Hence, when seeking to improve GRMA implementation, apparel companies should place emphasis on their ENOR. Apparel companies need to increase their environmental awareness, develop and improve a code of conduct for ecological practices, fully understand the environmental impact of their operations and address the environmental requirements of external stakeholders. Furthermore, this finding reminds managers of the importance to nurture their Environmental Orientation (ENOR) well as to improve companies' sensitivity to stakeholders'

environmental demands for achieving greener practices. Managers should realise the highly essential role the Environmental Orientation (ENOR) plays in further fine-tuning their GRMA practices. Hence, managers are advised to facilitate the infusion of their ENOR. For instance, they can be involved in related environmental management initiatives, such as providing employees environmental training, establishing channels to encourage communication of green practices, designing reward systems by taking the environmental contribution in consideration (Chan et al.(2012). Such environmental management activities would help employees to internalise environmental ethics and to visualise companies' environmental sustainable corporate growth (Banerjee et al., 2003).

#### 5.2.2.2 Practical implications for policymakers

Based on the analysis of data collected from 374 apparel companies, this research has suggested that companies' CECA could be improved by implementing GRMA. Many countries, such as China, Japan and Germany, now promote the Circular Economy as an effective strategy for enhancing the environment. For example, the Chinese government adopted the Circular Economy as its official development strategy in 2002 to address the issues of environmental degradation and resource depletion (Zhu, 2010; Zhu, 2011; Mathews and Tan, 2011; Yuan et al., 2006). Despite this, many companies still have concerns about the outcomes of building their CECA (Aurdahl, 2016; Huang, 2012; Liu et al., 2009). The findings of this study have suggested that CECA is positively associated with companies' ORPE. Thus, policymakers can use this study as evidence to help influence manufacturing companies that remain unconvinced about the positive effect of building their CECA on firm performance.

This research has also provided apparel companies with a comprehensive explanation of the impact of implementing GRMA. Despite the fact that most organisations recognise the significance of their ecological impact, they may not have as clear a picture of how their environmental activities can work together as an effective system. They may instead conduct environmental activities simply to meet the minimum requirements of the

government (Huang, 2012; Liu et al., 2009). The results of this study have provided apparel companies and policymakers with an overview of the entire process of implementing GRMA. Applying the findings of this study, apparel companies can therefore systematically enhance their operations to improve their eco-efficiency. Furthermore, although many countries are now striving to implement green practices (Genovese et al., 2017; Zeng et al., 2016; Nasir et al., 2017; Sanders, 2012), rates of implementation remain low (Liu et al., 2017). The findings of this study indicate that the implementation of GRMA is positively associated with companies' ORPE; as noted above, it accordingly forms part of the evidence base to assist policymakers in working with manufacturing companies to encourage adoption of green approaches.

### **5.3 Research Limitations**

The results and contributions of this research must be understood in the context of its limitations. The first such limitation is the proposed concepts of drivers of and barriers to GRMA. Although the drivers and barriers were identified after full consideration of the relevant literature, and a pilot study conducted to improve the associated measurement items, it cannot be said that this research has comprehensively identified all the possible influences on the implementation of GRMA.

The second limitation of this research lies in the nature of the data collection process. All 374 respondents worked in apparel companies located in China, so caution must be exercised when generalising the findings to companies in other sectors or countries. Furthermore, the examination of GRMA implementation and building CECA at the company level was based on data collected from only one respondent from each participating company. Such an approach may not fully represent the phenomena under study or provide full and accurate information about each company. Moreover, given the time constraints on this study, a cross-sectional approach was taken, which means that data on the respondents'

perceptions was collected in a single survey. The findings can therefore only reflect the respondent apparel companies' operations at that particular point in time.

Thirdly, the measurement items for the construct Barriers to GRMA implementation (BFGI) were not well established. Based on the statistical results ( $\beta=-0.165$ , T-value=1.966), only one of the sub-constructs, Knowledge barrier (BEK), was shown to negatively affect GRMA implementation. Thus, future studies should focus on improving the measurement items for the other three sub-constructs proposed (barriers of People's involvement and support (BES), Finance barrier (BEF) and Technology barrier (BET)).

#### **5.4 Future research**

The findings of this study suggest some directions for future research. Firstly, as noted above, care should be taken when generalising the results to different types of company, or firms in other countries. Future research could test whether the model set out here applies to other types of companies and in other geographical settings. Secondly, future work could develop more valid and reliable measurement items to measure the sub-constructs of the BFGI variable. Thirdly, the conceptual research model developed and studied here consists of six second-order constructs, 23 first-order constructs and 58 measurement items; as such, it is relatively complex. This creates the opportunity for future studies to decompose the conceptual model and investigate some of the relationships between the sub-constructs and measurement items. Finally, as a cross-sectional survey can only reflect the position at a particular point, future studies could use a longitudinal approach to track changes over time.

## CHAPTER 6: CONCLUSION

This research has 1) investigated the implementation of Green Manufacturing (GRMA) as an approach of building apparel companies' Circular Economy capability (CECA); 2) analysed the development and implementation of GRMA in apparel companies and 3) evaluated the drivers of, barriers to and outcomes of GRMA implementation from both a theoretical and methodological perspective. Firstly, the Nature Resource Based View Theory (NRBV) was used to build a conceptual model highlighting the links between the constructs from a theoretical perspective. Secondly, a literature review was conducted to analyse the constructs and sub-constructs of the conceptual model. Thirdly, a Q-sort Pilot Study was carried out to assess the initial validity and reliability of the measurement items before grouping them into the main survey instrument. Fourthly, a dataset of 374 responses was obtained by distributing the survey among managerial-level employees working in the apparel companies. Finally, SEM was applied to further test the validity and reliability of the measurement items, to conduct a factor analysis of the constructs and to verify the 7 hypotheses derived from the proposed conceptual model. The results show that Stakeholder Engagement in Environmental Implementation (SEEI) and Environmental Orientation (ENOR) are two of the drivers of GRMA implementation, and as such positively affect its success in apparel companies. Both GRMA implementation and building CECA in apparel companies positively affect apparel companies' Organisational Performance (ORPE).

Furthermore, this study has verified the existence of three mediating relationships. Firstly, CECA mediates the relationship between GRMA and ORPE. This highlights that apparel companies seeking to improve their ORPE may find it helpful to adopt GRMA methods. Secondly, GRMA mediates the relationship between ENOR and CECA. This indicates that GRMA is the variable that explains the relationship between ENOR and CECA. Although ENOR can partially improve CECA on its own, GRMA is a necessary element in achieving overall enhancement. This highlights that apparel companies can build their CECA by increasing the level of their ENOR, but implementing GRMA is an essential element of

doing so. Thirdly, ENOR mediates the relationship between SEEI and GRMA. This result shows that apparel companies can improve their GRMA implementation by addressing stakeholders' environmental concerns; however, they must also place emphasis on the firm's own ENOR to achieve an overall improvement.

This research makes both academic and practical contributions. From an academic standpoint, it adds to the existing research base looking at ENOR, SEEI, CECA, GRMA and ORPE in apparel firms by employing an empirically tested conceptual model. Its findings can therefore contribute to further development of the theoretical relationships between these variables. Secondly, it has also examined the direct, mediating and moderating relationships between these constructs. In particular, it has confirmed and reinforced the positive impact of GRMA implementation on building CECA. This is consistent with previous studies (Genovese et al., 2017; Kazancoglu et al., 2018; Baldassarre et al., 2019) that have explored the relationships between CECA and green practices. This finding suggests that apparel companies could usefully apply GRMA approaches to improve their ability to implement the Circular Economy. Furthermore, the findings of this study have identified positive relationships between GRMA and each of SEEI, ENOR and ORPE. Again, this is broadly consistent with previous studies exploring the relationships between green practices and stakeholder involvement (Liu et al., 2017; Zhou et al., 2017), companies' environmental orientation (Chan, 2012; Yu and Huo, 2019) and firm performance (Genovese et al., 2017; Zeng et al., 2016; Nasir et al., 2017; Sanders, 2012). Accordingly, this study has generated valid and reliable measurement items for these constructs that will facilitate further empirical research in this field.

On a practical level, the study will be very useful for policymakers and apparel companies seeking to understand the current barriers to, drivers for and outcomes of implementing GRMA. It can also help them to evaluate the strengths and weaknesses of their current GRMA practices and look for improvements. As such, it provides an analytical tool that may also be of use to policymakers. This study will help apparel companies to

understand the current barriers and highlight the importance – indeed, the necessity – of developing their own CECA so that they can fully realise the potential gains in performance which can result from applying GRMA; it can also guide apparel companies through the practical stages of implementing green practices. Moreover, the study also provides support for policies encouraging firms to implement the Circular Economy and thus can be used by policymakers as part of the evidence base both to develop such policies and to persuade manufacturing companies of the benefits of implementing GRMA and building their CECA.

In terms of practical steps, this study firstly suggests that apparel companies need to broaden their perspective on the implementation of GRMA and emphasise all the stages of this concept in order to realise the potential improvements in ORPE. Hence, the GRMA framework identified and confirmed in this study can be used as a framework to guide apparel companies through the process of adjusting their manufacturing configurations to achieve ecological excellence. Secondly, the findings also highlight the importance of the two drivers, SEEI and ENOR, to firms' implementation of GRMA. Stakeholders' increasing interest in environmental issues means that apparel companies need to recognise the impact of SEEI and improve their ENOR in response to the requirements likely to be proposed by stakeholders. Thus, to enhance the GRMA process, apparel companies should track their stakeholders' engagement in order to address the possible impact of these concerns. Thirdly, the findings show that the core category of knowledge-related barriers, which includes a lack of relevant knowledge about implementing GRMA and a lack of information on potential environmental improvements, is the most significant impediment to the implementation of GRMA in apparel companies. These barriers require attention and overcoming them should be a top priority for companies in this sector. Fourthly, this research has examined the outcome of GRMA implementation and building CECA. Applying GRMA enables negative environmental impact to be minimised and resources used effectively, helping apparel companies to improve their ORPE. Furthermore, the findings also suggest that apparel companies that are able to improve their CECA will ultimately see

improved ORPE. Through building and improving their CECA, apparel companies will improve their ability to reduce, reuse and recycle materials and/or energy. These capacities can have a direct impact on overall environmental performance, facilitate the maintenance of competitive advantage and ultimately improve the firm's ORPE. Furthermore, this study has showed that CECA partially mediates the relationship between GRMA implementation and ORPE. This suggests that while apparel companies can enhance their performance through GRMA implementation, they also need to address their ability to implement the Circular Economy in order to achieve the maximum possible improvement. Fifthly, although many countries are now striving to implement green practices to overcome environmental degradation and resource depletion (Genovese et al., 2017; Zeng et al., 2016; Nasir et al., 2017; Sanders, 2012), the rate of uptake is still low (Liu et al., 2017). The finding that the implementation of GRMA is positively associated with companies' ORPE may be highlighted by policymakers to demonstrate the advantages of GRMA to manufacturing companies that still have doubts about the impact on ORPE. Furthermore, although the Circular Economy has been promoted as a development strategy in several countries, many firms still have concerns about the outcomes of building their CECA (Liu et al., 2009; Aurdahl, 2016; Huang, 2012). This study has indicated that CECA is positively associated with companies' ORPE, which should provide further evidence for the benefits to firms of focusing on this area of operations.

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## APPENDIX

### Appendix 1: Survey

#### List of reference of the survey measurement items

| Sections   | Survey measurement items               | Reference   |
|--|--|---|
| Section 1: External Stakeholder Engagement in Environmental Implementation | Customer                               | Zhu et al., 2010; Zhu et al., 2011; Huang, 2012; Beh et al., 2016.  |
|  | Suppliers                              | Zhu et al. 2010; Zhu et al., 2005;  |
|  | Government                             | Huang, 2012; Zhu et al., 2005;  |
|  | Non-governmental organisations (NGOs)  | Lozano, 2013; Lee, 2012; Mota et al., 2015; Brown and Timmer, 2006;   |
| Section 2: Internal Stakeholder Engagement in Environmental Implementation | Managers                               | Tu et al. 2006; Zahra and George, 2002;   |
|  | Employees                              | Phillips, 2002; Gill and Meyer, 2013;   |
| Section 3: Environmental Orientation                                       | External Environmental Orientation     | Huang, 2012; Banerjee, 2002; Banerjee et al., 2003;   |
|  | Internal Environmental Orientation     | Huang, 2012; Banerjee, 2002; Banerjee et al., 2003;   |
| Section 4: Green Manufacturing Design                                      | Design stage                           | Blackburn, 2009; Melnyk and Smith, 1996; Rivera-Becerra and Lin, 1999; Melnyk and Smith, 1996; Rivera-Becerra and Lin, 1999; Zhang et al., 1995; Veroutis and Fava, 1996; Fiskel and Wapman, 1994; Mizuki et al., 1996; Hart, 1995; |
|  | Procure stage                          | Green et al., 1996; Melnyk and Smith, 1996; Carter et al., 2000; Zhu et al., 2010; Zeng et al., 2016; Baskarana et al., 2012; Westervelt, 2012; Jakhar, 2015; Min and Galle, 1997.  |
|  | Manufacture stage                      | Baines et al., 2012; Melnyk and Smith, 1996; O'Connor et al., 2016;   |
|  | Packaging and Distribution stage       | Melnyk and Smith, 1996; Lee et al., 2007; Tam and Tam, 2006; Hicks et al., 2005; Murphy and Poist, 2003; Jakhar, 2015; Rao and Holt, 2005;  |
|  | Customer used to the end of life stage | Abraham, 2011; Meyer, 1999; Brace-Govan and Binay, 2010; Beh et al., 2016;  |

|  |             |   |   |
|--|-------------|---|---|
|  |             | Remanufacturing stage   | Seuring, 2004; Corbett and Klassen, 2006; Lisney et al., 2003; Rahimifard and Clegg, 2007; Beh et al., 2016;  |
| Section 5: Circular Economy Capability |             | Reduction Capability  | Huang, 2012, Anderson, 2007; Yong, 2007;  |
|  |             | Reuse Capability  | Huang, 2012; French and Laforge, 2006, Anderson, 2007;  |
|  |             | Recycling Capability  | Huang, 2012; Lee et al., 2007; Hicks et al., 2005; Martin et al., 2006; Tam and Tam, 2006;  |
| Section 6: Environmental Performance   |             | Environmental Impact  | Lober, 1996; Ilinitich et al., 1998; Florida, 1996 Zhu and Sarkis, 2004; Huang, 2012;   |
|  |             | Internal Environmental Management Performance                       | Lober, 1996; Ilinitich et al., 1998; Hamel and Prahalad, 2005; Zhu et al. 2004; Zsidisin and Siferd, 2001; Zhu and Sarkis, 2004; Huang, 2012;   |
|  |             | External Stakeholders Relationship in terms of environmental issues | Lober, 1996; Ilinitich and Schaltegger, 1995; Huang, 2012;  |
| Section 7: Business Performance        |             | Market Performance  | Nahm et al., 2004; Huang, 2012; McKee et al., 1989; Venkatraman and Ramanujan, 1986; Tracey et al., 2005; Huang, 2012; Tracey and Tan, 2001;  |
|  |             | Financial Performance   | Fullerton et al., 2003; Huang, 2012; Fullerton et al., 2003; Waddock and Graves, 1997; Dehning et al., 2007; Vickery et al., 2003; McKee et al., 1989; Venkatraman and Ramanujan, 1986; |
| Section 8: Barriers                    | Current     | Technology Barriers   | Wang et al, 2016; Govindan et al., 2014   |
|  |             | Knowledge Barriers  | Wang et al, 2016; Govindan et al., 2014   |
|  |             | Finance Barriers  | Wang et al, 2016; Govindan et al., 2014   |
|  |             | People's Involvement and support Barriers                           | Wang et al, 2016; Govindan et al., 2014   |
| Section 9: Questions                   | General     |   |   |
| Section 10: Control Questions          | Statistical |   | Manning et al., 2009; Huang, 2012   |

**A Survey of Promoting Green Manufacturing in apparel companies based on the Circular Economy perspective 循环经济理论下绿色制造在服饰企业的应用调查**

Business School, Durham University, UK 英国，杜伦大学，商学院

You are invited to participate in a Durham University doctoral dissertation research survey. 诚挚地邀请您参与本项调查！  
本调查是英国杜伦大学博士生毕业研究的重要组成部分。非常感谢您的参与！

**Research Aim:** 研究目的:

The main objective of this research is to shed light on promoting Green Manufacturing in the apparel companies to build their Circular Economy capabilities. Specifically, this research intends to investigate, as the mechanisms, how the Green Manufacturing practices applied to build Circular Economy capability; the external and internal drivers of the mechanisms, the critical barriers of promoting Green Manufacturing, and the outcomes of developing Circular Economy capability. 本项调查旨在探索循环经济理论下，绿色制造在服饰企业的应用。本调查将具体研究（1）服饰企业如何利用绿色制造建立其循环经济的能力，（2）影响绿色制造的内外助力和阻力，以及（3）建立循环经济能力可能为企业带来如何的环境效益和经济效益。

**Research Processes:** 研究过程:

To participate in this research, complete and submit the paper or web-based questionnaire.

This questionnaire takes about 15 minutes to complete. Participates' knowledge and experiences are valued to answer this questionnaire. We only value the participants' own opinions. There are no correct and wrong answers. 如果您决定参与本调查，请您完成并提交纸质或电子版调查问卷。整个回答的过程将持续大约 15 分钟。您的回答没有对错之分，我们仅仅关注于您的个人观点。请基于您自身对所在企业的了解进行回答。

**Potential Benefits:** 潜在益处:

This questionnaire may offer the opportunity to reflect on your experiences as the apparel company's member, which may improve your companies' performance and enhance self-understanding. 参与调查问卷可能会让您加深自身对所在企业的了解以及改善公司业绩。

**Potential Risks:** 潜在风险:

There might be some specific questions that you are uncomfortable responding or to which you would simply prefer not to answer. Participating in this research is strictly voluntary, and you can choose not to answer any specific questions that you are uncomfortable responding. 问卷中可能包含让您感到不舒服的问题以及您不愿回答的问题。温馨提示：本研究的参与是完全自愿的。针对让您不舒服的问题，您可以不必回答。

**Voluntary Participation:** 自愿参与:

Participating in this research is strictly voluntary. You may decide not to participate in or complete the questionnaire at any time for any reason without the consequence of any kind. Your decision will not affect your future relationship with the research team and Durham University. 本研究的参与是完全自愿的。您可以拒绝参与或在参与的过程中放弃而不必做出任何通知。您的任何决定将不会影响到您和研究团队以及杜伦大学的关系。

如果您对本调查的内容以及过程有任何疑问，请随时联系：

**Confidentiality:** 隐私保护:

**The questionnaire is anonymous.** The collected data will be treated as confidential and only used for this research and related research. The data will be analysed at an aggregate level. Thus, any participants' opinions will not be identified by readers. 本调查问卷是为学术研究而设计，以匿名方式进行，研究团队将竭尽全力地保护您的隐私和信息安全。本调查所采集的信息将只会被作为一个整体进行分析，参与调查问卷的个人的观点将不会被读者识别。

**Questions:** 疑问求助:

If you have any questions or concerns about this research, please do not hesitate to contact: Hailan Guo (<https://www.dur.ac.uk/research/directory/staff/?mode=staffandid=16125>) Email: [hailan.guo@durham.ac.uk](mailto:hailan.guo@durham.ac.uk) Phone: 00447511508356 (UK); 008613917767039 (China); 如果您对本调查的内容以及过程有任何疑问，请随时联系：郭

海 兰 (https://www.dur.ac.uk/research/directory/staff/?mode=staffandid=16125) 邮 箱 : hailan.guo@durham.ac.uk 手机: 00447511508356 (英国); 008613917767039 (中国);

**Thanks for your cooperation and helps! 再次诚挚感谢您的合作与帮助!**

**Section 1: External Stakeholder Engagement in Environmental Implementation**

**第一部分：外部利益相关者环保参与的可预测性**

The statements in section 1 describe the perceived uncertainty of the company's External Stakeholder Engagement in Environmental Implementation. Please use the scale provided and place a tick in the column that best describes the predictability of your company's External Stakeholder Engagement in Environmental Implementation. 以下的问题描述了外部利益相关者环保参与的可预测性。请根据您所在企业的实际状况，勾选最为合适的选项。

|                                   |                            |   |                              |                                     |                              |
|-----------------------------------|----------------------------|---|------------------------------|-------------------------------------|------------------------------|
| <b>Very Predictable</b><br>完全可以预测 | <b>Predictable</b><br>可以预测 | <b>Slightly Unpredictable</b><br>轻微不可预测 | <b>Unpredictable</b><br>不可预测 | <b>Very Unpredictable</b><br>完全不可预测 | <b>Not Applicable</b><br>不了解 |
|-----------------------------------|----------------------------|---|------------------------------|-------------------------------------|------------------------------|

|                    |          |          |          |          |                      |
|--------------------|----------|----------|----------|----------|----------------------|
| <b>1</b>           | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>N/A</b>           |
| <b>Customer 顾客</b> |          |          |          |          | <b>1 2 3 4 5 N/A</b> |

Customers' willingness to pay more for environment-friendly products are 顾客为环保产品支付更高费用的意愿

Customers' willingness to recycle apparels for remanufacturing 顾客配合衣物回收的意愿

|                      |          |          |          |          |          |            |
|----------------------|----------|----------|----------|----------|----------|------------|
| <b>Suppliers 供应商</b> | <b>1</b> | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>N/A</b> |
|----------------------|----------|----------|----------|----------|----------|------------|

Suppliers' capabilities to provide environment-friendly products is 供应商提供环保产品的能力

Suppliers' intention to establish an environmental partnership with us is 供应商对于和我们建立环境保护战略合作的意向

|                      |          |          |          |          |          |            |
|----------------------|----------|----------|----------|----------|----------|------------|
| <b>Government 政府</b> | <b>1</b> | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>N/A</b> |
|----------------------|----------|----------|----------|----------|----------|------------|

Government's willingness for promoting environment-friendly regulations is 政府促进环境保护的意愿

Government's environmental regulations that will be promoted shortly are 政府在不远的将来有可能颁布的政策法规

|  |          |          |          |          |          |            |
|--|----------|----------|----------|----------|----------|------------|
| <b>Non-governmental organisations (NGOs) 非政府组织</b> | <b>1</b> | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>N/A</b> |
|--|----------|----------|----------|----------|----------|------------|

NGOs' capabilities for promoting environment-friendly production are 非政府组织促进环境保护的能力

NGOs' power of prompting environment-friendly strategies that will be reinforced shortly is 非政府组织促进环境保护的能力将来有可能加强

**Section 2: Internal Stakeholder Engagement in Environmental Implementation**

**第二部分：内部利益相关者环保参与的可预测性**

The statements in section 2 describe the perceived uncertainty of the company's Internal Stakeholder Engagement in Environmental Implementation. Please use the scale provided and place a tick in the column that best describes the predictability of your company's Internal Stakeholder Engagement in Environmental

Implementation. 以下的问题描述了内部利益相关者环保参与的可预测性。请根据您所在企业的实际状况，勾选最为合适的选项。

| <b>Strongly Disagree</b><br>完全不同意 | <b>Disagree</b><br>不同意 | <b>Neutral</b><br>中立 | <b>Agree</b><br>同意 | <b>Strongly Agree</b><br>完全同意 | <b>Not Applicable</b><br>不了解 |
|-----------------------------------|------------------------|----------------------|--------------------|-------------------------------|------------------------------|
| 1                                 | 2                      | 3                    | 4                  | 5                             | N/A                          |
| <b>Our Managers: 我们的管理层</b>       |                        |                      |                    |                               | 1 2 3 4 5 N/A                |

Have adequate knowledge for solving operational problems. 具有足够的知识做出运营决策。

Clearly recognises the importance of conducting environment related RandD activities. 清楚地认识到与环境相关的研发的重要性。

**Our Employees: 我们的员工** 1 2 3 4 5 N/A

Have a high-level of job competence. 具有高水平的工作能力。

Have the ability to deal with new technologies. 有能力使用新技术。

### Section 3: Environmental Orientation 第三部分：环境保护的导向

The statements in section 3 describe the degree to which the company recognises the importance of Green Manufacturing from both external and internal perspectives. Please use the scale provided and place tick whichever best describes your current agreement with each statement. 以下的问题从内外两个方面描述了企业对于环境保护重要性的认知程度。请根据您所在企业的实际状况，勾选最为合适的选项。

| <b>Strongly Disagree</b><br>完全不同意   | <b>Disagree</b><br>不同意 | <b>Neutral</b><br>中立 | <b>Agree</b><br>同意 | <b>Strongly Agree</b><br>完全同意 | <b>Not Applicable</b><br>不了解 |
|---|------------------------|----------------------|--------------------|-------------------------------|------------------------------|
| 1   | 2                      | 3                    | 4                  | 5                             | N/A                          |
| <b>External Environmental Orientation: Our company: 外部环境保护的导向：我所在的企业：</b> |                        |                      |                    |                               | 1 2 3 4 5 N/A                |

Clearly recognises the ecological requirements of external stakeholders 清楚地认识到其外部利益相关者对于环境保护方面的要求。

Clearly recognises the importance to cooperate with external stakeholders 意识到满足其外部利益相关者对于环境保护的要求的重要性。

**Internal Environmental Orientation: Our company: 内部环境保护的导向：我所在的企业：** 1 2 3 4 5 N/A

Has clear codes of standards of ecological practices in all functional area 所有职能部门有清楚的，与环境保护相关的规章制度。

Regards the protection of the natural environment as the high-priority activity 把环境保护当作重要的运营活动。

### Section 4: Green Manufacturing Implementation 第四部分：绿色制造的应用

The statements in section 4 describe the process by which the company integrates the environmental concerns into the manufacturing design. Please use the scale provided and place tick whichever best describes your

current agreement with each statement. 以下的问题分步描述了绿色制造在企业运营中的应用。请根据您所在企业的实际状况，勾选最为合适的选项。

| <b>Strongly Disagree</b><br>完全不同意   | <b>Disagree</b><br>不同意 | <b>Neutral</b><br>中立 | <b>Agree</b><br>同意 | <b>Strongly Agree</b><br>完全同意 | <b>Not Applicable</b><br>不了解 |
|---|------------------------|----------------------|--------------------|-------------------------------|------------------------------|
| <b>1</b>  | <b>2</b>               | <b>3</b>             | <b>4</b>           | <b>5</b>                      | <b>N/A</b>                   |
| <b>Design stage 产品设计阶段</b>  |                        |                      |                    |                               |                              |
| Our company fully incorporates the environmental performance criteria into the design phase. 我所在企业在设计阶段充分参考环保性能标准。                                    |                        |                      |                    |                               |                              |
| Product design teams frequently interact with other departments. 产品研发部门与不同职能部门经常进行沟通和交流。  |                        |                      |                    |                               |                              |
| <b>Procure stage 采购阶段</b>   |                        |                      |                    |                               |                              |
| Our company provides design specification including environmental requirements to suppliers. 我所在企业提供给供应商包含具体环保要求的设计参数                                 |                        |                      |                    |                               |                              |
| Our company audits the suppliers' environmental performance. 审核供应商的环境表现   |                        |                      |                    |                               |                              |
| <b>Manufacture stage 生产阶段</b>   |                        |                      |                    |                               |                              |
| Our company's manufacture process could meet the requirements of government legislation and regulation. 我所在企业的生产流程符合政府法规要求                            |                        |                      |                    |                               |                              |
| Our company's manufacture process is harmless to the health of the workers and users. 我所在企业的生产过程对工人和顾客的健康是无害的。  |                        |                      |                    |                               |                              |
| <b>Packaging and Distribution stage 包装和分配阶段</b>   |                        |                      |                    |                               |                              |
| Our company uses environment-friendly packaging. 我所在企业采用环保包装。   |                        |                      |                    |                               |                              |
| Approaches are developed to optimise the logistics network design with consideration of reducing environmental impact. 在考虑减少环境影响的情况下，我所在企业设计了优化物流的方案。 |                        |                      |                    |                               |                              |
| <b>Customer use to end of life stage 客户使用到产品生命周期结束阶段</b>  |                        |                      |                    |                               |                              |
| Our company's products use long-lasting raw materials to extend the products' lifecycle. 我所在企业的产品使用长持久性的原材料来延长产品的生命周期。                                |                        |                      |                    |                               |                              |
| Our company has a program to encourage customers to recycle products in the secondary markets. 我所在企业有鼓励客户在二手市场回收产品的计划。                                |                        |                      |                    |                               |                              |
| Our company is applying the second-life retailing. (E.g. Urban  |                        |                      |                    |                               |                              |

Outfitters-Vintage collections: first handpicked and then re-worked before displayed in the shop or online). 我所在企业有二次零售业务。(例如: 英国服装公司 Urban Outfitters 的古着系列: 先人工有针对性挑选回收衣物, 然后对所选衣物二次改造, 最后在商店或网上展示)。

**Remanufacturing stage 再制造阶段** 1 2 3 4 5 N/A

Our company places great emphasis and importance to remanufacturing stage. 我所在企业非常重视回收衣物的再制造阶段。

Our company establishes Eco-efficient remanufacturing centres. 我所在企业拥有高效节能环保的再制造中心。

**Section 5: Circular Economy Capability 循环经济能力**

The statements in section 5 describe the company's Circular Economy capability. Please use the scale provided and place tick whichever best describes your current agreement with each statement. 以下的问题描述了企业实施循环经济的能力。请根据您所在企业的实际状况, 在最为合适的选项上打勾。

|                                   |                        |                      |                    |                               |                              |
|-----------------------------------|------------------------|----------------------|--------------------|-------------------------------|------------------------------|
| <b>Strongly Disagree</b><br>完全不同意 | <b>Disagree</b><br>不同意 | <b>Neutral</b><br>中立 | <b>Agree</b><br>同意 | <b>Strongly Agree</b><br>完全同意 | <b>Not Applicable</b><br>不了解 |
| <b>1</b>                          | <b>2</b>               | <b>3</b>             | <b>4</b>           | <b>5</b>                      | <b>N/A</b>                   |

**Reduction Capability 减少原材料/能源消耗** 1 2 3 4 5 N/A

**Our company:** 我所在的企业:

Ability to reduce energy consumption. 致力于减少能源的消耗。

Ability to reduce raw materials waste. 致力于减少原材料的浪费。

Ability to improve equipment efficiency. 致力于提高生产设备的使用效率。

Ability to improve employees' working efficiency. 致力于提高员工的生产效率。

**Reuse Capability 重复利用零部件/原材料** 1 2 3 4 5 N/A

**Our company:** 我所在的企业:

Ability to reutilise the used garment. 重复利用回收的衣物。

Ability to reutilise extra raw materials. 重复利用剩余原材料。

Ability to reutilise scrap/trim pieces. 重复利用边角料。

Ability to reutilise faulty products. 重复利用瑕疵品。

**Recycling Capability 循环再利用废旧产品** 1 2 3 4 5 N/A

**Our company:** 我所在的企业:

Ability to implement the used garment collection (UGC) scheme. 向顾客回收衣物。

Ability to reprocesses collected used products 再加工回收的衣物。

Ability to reprocesses collected wastes 回收生产制造过程中产生的边角料。

Ability to makes extensive use of reprocessed materials to manufacture products. 使用经过再加工处理的废旧衣物生产新的产品

Ability to makes extensive use of reprocessed wastes to manufacture products. 使用经过再加工处理的边角料生产新的产品。

### Section 6: Organisational Performance 公司绩效

The statements in section 6 describe the company's Environmental Performance and Business Performance. Please use the scale provided and place tick whichever best describes the change of your company's performance *in the past two years*. 以下的问题描述了您所在企业的公司绩效，包括了环保绩效和商业绩效。请根据您所在企业在过去两年内的经营状况，在最为合适的选项上打勾，各个选项的含义如下图所示：

|                         |              |                  |                      |                |                       |
|-------------------------|--------------|------------------|----------------------|----------------|-----------------------|
| <b>Increased by</b> 增加了 |              | <b>No change</b> | <b>Decreased</b> 减少了 |                | <b>Not</b>            |
| <b>over 6%</b>          | <b>1%-5%</b> | 没有变化             | <b>1%-5%</b>         | <b>over 6%</b> | <b>Applicable</b> 不了解 |
| <b>1</b>                | <b>2</b>     | <b>3</b>         | <b>4</b>             | <b>5</b>       | <b>N/A</b>            |

**Environmental Performance:** 环保绩效: 1 2 3 4 5 N/A

The level of emission. 污染物的排放水平:

The implementation of our environmental practices 环境保护相关的措施的执行力度

The relationship with our external stakeholders in terms of environmental issues 与利益相关者在环境保护方面的关系

**Business Performance:** 商业绩效 1 2 3 4 5 N/A

Our company's sales 我所在企业的销售额:

Our company's return on sales 我所在企业的销售回报率:

Our company's return on investment 我所在企业的投资回报率:

### Section 8: Current Barriers 环保阻力

The statements in section 8 indicate the level of the impact of the current barriers on implementing Green Manufacturing in the company. Please use the scale provided and place tick whichever best describes your current agreement with each statement. 以下的问题描述了您所在企业的在落实环保问题方面的障碍。请根据您所在企业的经营状况，在最为合适的选项上打勾，各个选项的含义如下图所示：

|                 |                 |                |              |                 |                   |
|-----------------|-----------------|----------------|--------------|-----------------|-------------------|
| <b>Strongly</b> | <b>Disagree</b> | <b>Neutral</b> | <b>Agree</b> | <b>Strongly</b> | <b>Not</b>        |
| <b>Disagree</b> | 不同意             | 中立             | 同意           | <b>Agree</b>    | <b>Applicable</b> |
| 完全不同意           |                 |                |              | 完全同意            | 不了解               |
| <b>1</b>        | <b>2</b>        | <b>3</b>       | <b>4</b>     | <b>5</b>        | <b>N/A</b>        |

**Technology** 科技方面阻力 1 2 3 4 5 N/A

The complication of putting positive environmental attitudes into

action. 很难将积极的环保态度转化成具体行动。

The complexity of design to reuse/recycle used products. 重复利用和回收产品的过程的复杂性

Lack of technology, process, and materials. 缺乏新科技, 新环保材料和新加工过程

**Knowledge 知识方面阻力**

1 2 3 4 5 N/A

Lack of Eco-literacy among the upstream or downstream supply chain members. 公司的供应链成员普遍缺乏环保意识

Lack of relevant environmental knowledge of implementing Green Manufacturing. 缺乏环保知识

Lack of information on potential environmental improvements. 很难获得如何提高环保绩效的信息。

**Finance 金融阻力**

1 2 3 4 5 N/A

High investments and low financial returns. 高投资, 低投资回报

**People's Involvement and support 人员参与和支持的阻力**

1 2 3 4 5 N/A

Lack of training and monitoring the progress of Green Manufacturing implementation specific to the company level. 缺乏针对公司环保进度评估的环保顾问/培训/机构

Poor supplier commitment to Green Manufacturing implementation. 供应商不愿承担环保责任/交换环保信息

Inadequate support from regulatory authorities. 缺乏权力机构的支持和引导

**Section 9: General Questions**

The questions in section 10 describe the general information of the company and the participants. Please use the scale provided and place tick whichever best describes you and your company. (Please estimate if necessary). 以下的问题涉及到您以及您所在企业的基本信息。请选择最符合您和您所在企业情况的选项(如果您没有掌握精确信息,您可以根据您的了解和经验进行估计)。

1. What is your current job title? 您现在的职位是什么?

CEO/President 总裁/总经理  Senior Manager 副总裁/副总经理  Manager 经理  Director 主管  Group Leader 团队领导  other (Please indicate): 其他(请指明)

2. Please indicate the category that best describes your company's primary business: 您所在的企业主要从事什么行业?

Apparel trading companies 服装贸易公司  Apparel manufacturers 服装制造公司  Others (Please indicate): 其他(请指明)

3. The average annual sales (RMB) of your company is (for the last five years): 您所在的企业在过去五年内,年平均销售额是多少(人民币)?

Less than 500,000 少于 50 万  500,001-1 million 51-100 万  1million-5 million 100-500 万  5-10 million 500-1000 万  10-50 million 1000-5000 万  50-100million 5000 万-1 亿  101 million+ 多于 1 亿

4. The ownership type of your company is 您所在的企业的所有制是:

State-owned enterprise 国有企业  Township enterprise 乡镇企业  Sole proprietorship company 个人独资企业  Private enterprise 民营企业  Collective owned enterprise 集体所有制企业  Foreign-owned enterprises 外资企业  Joint-stock company 股份制企业  Sino-foreign joint ventures 中外合资企业  Other (Please indicate):其他 (请指明) : \_\_\_\_\_

5. Please indicate the location of your company's headquarters (Province-City): 请指出您所在的企业在中国总部的地理位置 (省/直辖市/自治区) : \_\_\_\_\_

6. If you would like to receive a summary of results from this research, please provide your e-mail address here: 如果您想收到最后的研究报告, 请您提供您的电子邮件地址:  
\_\_\_\_\_

**Section 10: Statistical Control Questions**

The questions in section 11 are designed for statistical control, which is significantly important for statistically validating this research. Your answers are anonymous and will not be released. Please use the scale provided and place tick whichever best describes your agreement with each statement. 以下的问题仅仅是用于控制统计分析的过程。这些问题对于保证统计分析的质量非常重要。您的答案是匿名的。请根据您所在企业的实际情况, 选择最为合适的选项上。各个选项的含义如下图所示:

|                          |                 |                |              |                       |                       |
|--------------------------|-----------------|----------------|--------------|-----------------------|-----------------------|
| <b>Strongly Disagree</b> | <b>Disagree</b> | <b>Neutral</b> | <b>Agree</b> | <b>Strongly Agree</b> | <b>Not Applicable</b> |
| 完全不同意                    | 不同意             | 中立             | 同意           | 完全同意                  | 不了解                   |
| <b>1</b>                 | <b>2</b>        | <b>3</b>       | <b>4</b>     | <b>5</b>              | <b>N/A</b>            |

**Statistical Control Questions** 统计控制问题 1 2 3 4 5 N/A

**In our company:** 在我所在的企业:

All managers feel satisfied with their jobs. 所有的管理者对他们的工作都非常满意。

We always exercise good judgement. 管理层总是能够做出正确的判断。

Employees are always trustworthy. 所有的员工都是值得信赖的。

Hiring decisions have always been based only on qualifications. 所有雇佣的决定仅仅取决于申请者的能力。

**Thank you very much for your participation in this research! 非常感谢您的参与!**

## **Appendix 2: Q-sort Pilot Study Instruction**

### **General Introduction:**

Thanks very much for participating in this research. The main objective of this research is to shed light on promoting Green Manufacturing in the apparel companies to build their Circular Economy capabilities. Specifically, this research intends to investigate, as the mechanisms, how the Green Manufacturing practices applied to build Circular Economy capability, the drivers and barriers of implementing Green Manufacturing to develop the Circular Economy capability, the outcomes of developing Circular Economy capability. In order to achieve the research goal, this research develops the conceptual model, including constructs, sub-constructs, and measurement items. The Q-sort method pilot study is to validate the measurement items/ questionnaire questions.

The Q-sort method pilot study is a process of matching the measurement items to the appropriate sub-constructs. First, please read the brief introduction of this research and the conceptual model with specific definitions. Then, please read the measurement items/questionnaire questions relevant to the concepts of the conceptual model. The next step is to match these measurement items/questionnaire questions with the given concepts.

### **Specific Instructions:**

1: Please read the definitions of these concepts and understand all the given concepts (Each concept is allocated with the initials: the first letter of each word of the concept. e.g. OEP is the initial of Environmental performance).

2: Please understand all the measurement items/questionnaire questions (All of the measurement items are randomly listed in the first column of one table) and match them with the relevant concept based on your judgements (Please write the initials of the concept in the second column. E.g., you believe some measurement items are associated with environmental performance, and then please write the OEP in the second column. Please write N/A if you believe there is no matched concept).

3: Please write down the unclear measurement items or concepts for later discussion.

4: Before submitting it to the researcher, please review your judgement.

NOTE: If you have any questions about the matching process during the entire process, please do not hesitate to ask the researcher.

Thank you again for participating in this research!

### Appendix 3: Discriminant validity testing of the measurement items

| Table-Discriminant validity (Fomell-larcker criterion) |                      |              |              |                           |                                  |              |              |              |                              |                                |               |                  |                                  |              |              |              |              |              |                 |              |                                       |              |              |
|--|----------------------|--------------|--------------|---------------------------|----------------------------------|--------------|--------------|--------------|------------------------------|--------------------------------|---------------|------------------|----------------------------------|--------------|--------------|--------------|--------------|--------------|-----------------|--------------|---------------------------------------|--------------|--------------|
|  | Business performance | Customer     | Employees    | Environmental performance | External environment orientation | Finance      | Government   | Green Design | Green End of Life Management | Green Packing and Distribution | Green Procure | Green Production | Internal environment orientation | Knowledge    | NGO          | Owners       | Recycle      | Reduce       | Remanufacturing | Reuse        | Stakeholders' involvement and support | Suppliers    | Technology   |
| Business performance                                   | <b>0.915</b>         |              |              |                           |                                  |              |              |              |                              |                                |               |                  |                                  |              |              |              |              |              |                 |              |                                       |              |              |
| Customer   | 0.002                | <b>0.886</b> |              |                           |                                  |              |              |              |                              |                                |               |                  |                                  |              |              |              |              |              |                 |              |                                       |              |              |
| Employees  | 0.031                | 0.035        | <b>0.920</b> |                           |                                  |              |              |              |                              |                                |               |                  |                                  |              |              |              |              |              |                 |              |                                       |              |              |
| Environmental performance                              | 0.517                | 0.188        | 0.186        | <b>0.791</b>              |                                  |              |              |              |                              |                                |               |                  |                                  |              |              |              |              |              |                 |              |                                       |              |              |
| External environment orientation                       | 0.156                | 0.031        | 0.632        | 0.309                     | <b>0.933</b>                     |              |              |              |                              |                                |               |                  |                                  |              |              |              |              |              |                 |              |                                       |              |              |
| Finance  | 0.169                | 0.157        | -0.130       | 0.176                     | -0.060                           | <b>1.000</b> |              |              |                              |                                |               |                  |                                  |              |              |              |              |              |                 |              |                                       |              |              |
| Government   | 0.085                | 0.299        | -0.046       | 0.027                     | -0.044                           | 0.194        | <b>0.930</b> |              |                              |                                |               |                  |                                  |              |              |              |              |              |                 |              |                                       |              |              |
| Green Design   | 0.089                | 0.136        | 0.527        | 0.249                     | 0.588                            | -0.043       | -0.028       | <b>0.953</b> |                              |                                |               |                  |                                  |              |              |              |              |              |                 |              |                                       |              |              |
| Green End of Life Management                           | 0.336                | 0.102        | 0.175        | 0.441                     | 0.246                            | 0.200        | 0.229        | 0.226        | <b>0.769</b>                 |                                |               |                  |                                  |              |              |              |              |              |                 |              |                                       |              |              |
| Green Packing and Distribution                         | 0.023                | 0.037        | 0.414        | 0.266                     | 0.508                            | -0.053       | -0.037       | 0.527        | 0.284                        | <b>0.883</b>                   |               |                  |                                  |              |              |              |              |              |                 |              |                                       |              |              |
| Green Procure  | 0.078                | 0.109        | 0.441        | 0.280                     | 0.535                            | -0.042       | -0.019       | 0.629        | 0.284                        | 0.659                          | <b>0.952</b>  |                  |                                  |              |              |              |              |              |                 |              |                                       |              |              |
| Green Production                                       | 0.045                | 0.145        | 0.469        | 0.287                     | 0.538                            | -0.078       | -0.022       | 0.607        | 0.150                        | 0.632                          | 0.691         | <b>0.951</b>     |                                  |              |              |              |              |              |                 |              |                                       |              |              |
| Internal environment orientation                       | 0.054                | 0.023        | 0.657        | 0.183                     | 0.725                            | -0.177       | 0.007        | 0.718        | 0.188                        | 0.551                          | 0.546         | 0.578            | <b>0.961</b>                     |              |              |              |              |              |                 |              |                                       |              |              |
| Knowledge  | 0.179                | 0.286        | -0.123       | 0.185                     | -0.145                           | 0.500        | 0.248        | -0.080       | 0.117                        | -0.106                         | -0.180        | -0.114           | -0.228                           | <b>0.843</b> |              |              |              |              |                 |              |                                       |              |              |
| NGO  | -0.062               | 0.078        | 0.113        | -0.099                    | 0.134                            | -0.045       | -0.018       | 0.169        | -0.075                       | 0.048                          | 0.116         | 0.070            | 0.107                            | 0.020        | <b>0.897</b> |              |              |              |                 |              |                                       |              |              |
| Owners   | 0.069                | 0.036        | 0.487        | 0.108                     | 0.394                            | 0.008        | -0.008       | 0.375        | 0.096                        | 0.243                          | 0.189         | 0.306            | 0.403                            | -0.068       | 0.073        | <b>0.918</b> |              |              |                 |              |                                       |              |              |
| Recycle  | 0.276                | -0.033       | 0.274        | 0.389                     | 0.307                            | -0.040       | 0.109        | 0.305        | 0.494                        | 0.329                          | 0.281         | 0.282            | 0.384                            | -0.093       | -0.082       | 0.169        | <b>0.906</b> |              |                 |              |                                       |              |              |
| Reduce   | 0.103                | 0.125        | 0.306        | 0.302                     | 0.363                            | -0.109       | -0.109       | 0.329        | 0.192                        | 0.297                          | 0.366         | 0.417            | 0.362                            | -0.093       | 0.144        | 0.200        | 0.282        | <b>0.859</b> |                 |              |                                       |              |              |
| Remanufacturing  | 0.188                | -0.026       | 0.377        | 0.328                     | 0.411                            | -0.055       | 0.047        | 0.353        | 0.474                        | 0.429                          | 0.436         | 0.380            | 0.439                            | -0.147       | 0.010        | 0.185        | 0.486        | 0.357        | <b>0.893</b>    |              |                                       |              |              |
| Reuse  | 0.232                | 0.010        | 0.382        | 0.370                     | 0.392                            | -0.076       | 0.047        | 0.387        | 0.454                        | 0.345                          | 0.376         | 0.322            | 0.438                            | -0.139       | 0.032        | 0.204        | 0.701        | 0.455        | 0.550           | <b>0.899</b> |                                       |              |              |
| Stakeholders' involvement and support                  | 0.164                | 0.243        | -0.018       | 0.194                     | -0.055                           | 0.479        | 0.279        | -0.080       | 0.209                        | -0.052                         | -0.071        | -0.046           | -0.092                           | 0.518        | -0.033       | -0.006       | -0.035       | -0.050       | -0.086          | -0.110       | <b>0.822</b>                          |              |              |
| Suppliers  | -0.010               | 0.347        | -0.028       | -0.034                    | -0.081                           | 0.136        | 0.245        | 0.014        | 0.035                        | -0.075                         | -0.004        | -0.027           | -0.032                           | 0.210        | 0.231        | 0.076        | -0.015       | 0.090        | 0.006           | -0.009       | 0.152                                 | <b>0.951</b> |              |
| Technology   | 0.113                | 0.114        | -0.100       | 0.164                     | -0.092                           | 0.308        | 0.233        | -0.081       | 0.142                        | -0.012                         | -0.028        | -0.014           | -0.152                           | 0.450        | 0.064        | -0.042       | -0.052       | -0.082       | -0.049          | -0.079       | 0.310                                 | 0.160        | <b>0.782</b> |

| Table-Discriminant validity (Heterotrait-Monotrait Ratio (HTMT)) |          |           |                           |                                  |         |            |              |                              |                                |               |                  |                                  |           |       |        |         |        |                 |       |                                       |           |            |
|--|----------|-----------|---------------------------|----------------------------------|---------|------------|--------------|------------------------------|--------------------------------|---------------|------------------|----------------------------------|-----------|-------|--------|---------|--------|-----------------|-------|---------------------------------------|-----------|------------|
| Business performance   | Customer | Employees | Environmental performance | External environment orientation | Finance | Government | Green Design | Green End of Life Management | Green Packing and Distribution | Green Procure | Green Production | Internal environment orientation | Knowledge | NGO   | Owners | Recycle | Reduce | Remanufacturing | Reuse | Stakeholders' involvement and support | Suppliers | Technology |
| Business performance   |          |           |                           |                                  |         |            |              |                              |                                |               |                  |                                  |           |       |        |         |        |                 |       |                                       |           |            |
| Customer   | 0.076    |           |                           |                                  |         |            |              |                              |                                |               |                  |                                  |           |       |        |         |        |                 |       |                                       |           |            |
| Employees  | 0.082    | 0.045     |                           |                                  |         |            |              |                              |                                |               |                  |                                  |           |       |        |         |        |                 |       |                                       |           |            |
| Environmental performance  | 0.648    | 0.242     | 0.221                     |                                  |         |            |              |                              |                                |               |                  |                                  |           |       |        |         |        |                 |       |                                       |           |            |
| External environment orientation                                 | 0.177    | 0.037     | 0.756                     | 0.400                            |         |            |              |                              |                                |               |                  |                                  |           |       |        |         |        |                 |       |                                       |           |            |
| Finance  | 0.178    | 0.185     | 0.143                     | 0.215                            | 0.065   |            |              |                              |                                |               |                  |                                  |           |       |        |         |        |                 |       |                                       |           |            |
| Government   | 0.105    | 0.409     | 0.073                     | 0.067                            | 0.080   | 0.232      |              |                              |                                |               |                  |                                  |           |       |        |         |        |                 |       |                                       |           |            |
| Green Design   | 0.096    | 0.164     | 0.613                     | 0.312                            | 0.684   | 0.046      | 0.052        |                              |                                |               |                  |                                  |           |       |        |         |        |                 |       |                                       |           |            |
| Green End of Life Management                                     | 0.432    | 0.152     | 0.249                     | 0.640                            | 0.326   | 0.245      | 0.301        | 0.299                        |                                |               |                  |                                  |           |       |        |         |        |                 |       |                                       |           |            |
| Green Packing and Distribution                                   | 0.039    | 0.080     | 0.533                     | 0.371                            | 0.647   | 0.062      | 0.085        | 0.651                        | 0.418                          |               |                  |                                  |           |       |        |         |        |                 |       |                                       |           |            |
| Green Procure  | 0.085    | 0.130     | 0.512                     | 0.354                            | 0.612   | 0.045      | 0.021        | 0.701                        | 0.368                          | 0.819         |                  |                                  |           |       |        |         |        |                 |       |                                       |           |            |
| Green Production   | 0.086    | 0.174     | 0.544                     | 0.361                            | 0.617   | 0.083      | 0.055        | 0.677                        | 0.190                          | 0.781         | 0.772            |                                  |           |       |        |         |        |                 |       |                                       |           |            |
| Internal environment orientation                                 | 0.058    | 0.043     | 0.756                     | 0.228                            | 0.819   | 0.185      | 0.038        | 0.792                        | 0.250                          | 0.676         | 0.602            | 0.638                            |           |       |        |         |        |                 |       |                                       |           |            |
| Knowledge  | 0.209    | 0.353     | 0.147                     | 0.247                            | 0.177   | 0.557      | 0.319        | 0.095                        | 0.165                          | 0.144         | 0.190            | 0.135                            | 0.266     |       |        |         |        |                 |       |                                       |           |            |
| NGO  | 0.077    | 0.118     | 0.132                     | 0.158                            | 0.153   | 0.061      | 0.106        | 0.185                        | 0.141                          | 0.081         | 0.127            | 0.095                            | 0.118     | 0.065 |        |         |        |                 |       |                                       |           |            |
| Owners   | 0.102    | 0.079     | 0.591                     | 0.146                            | 0.474   | 0.040      | 0.057        | 0.437                        | 0.139                          | 0.313         | 0.222            | 0.368                            | 0.465     | 0.088 | 0.102  |         |        |                 |       |                                       |           |            |
| Recycle  | 0.289    | 0.106     | 0.312                     | 0.481                            | 0.342   | 0.042      | 0.090        | 0.332                        | 0.627                          | 0.401         | 0.305            | 0.285                            | 0.413     | 0.107 | 0.121  | 0.190   |        |                 |       |                                       |           |            |
| Reduce   | 0.113    | 0.158     | 0.357                     | 0.385                            | 0.418   | 0.117      | 0.149        | 0.368                        | 0.244                          | 0.368         | 0.411            | 0.468                            | 0.401     | 0.112 | 0.152  | 0.234   | 0.307  |                 |       |                                       |           |            |
| Remanufacturing  | 0.228    | 0.053     | 0.481                     | 0.452                            | 0.516   | 0.063      | 0.091        | 0.432                        | 0.682                          | 0.585         | 0.534            | 0.441                            | 0.531     | 0.191 | 0.052  | 0.237   | 0.580  | 0.439           |       |                                       |           |            |
| Reuse  | 0.255    | 0.099     | 0.440                     | 0.466                            | 0.443   | 0.080      | 0.039        | 0.426                        | 0.581                          | 0.426         | 0.415            | 0.366                            | 0.477     | 0.161 | 0.106  | 0.235   | 0.751  | 0.503           | 0.665 |                                       |           |            |
| Stakeholders' involvement and support                            | 0.206    | 0.340     | 0.067                     | 0.268                            | 0.078   | 0.543      | 0.373        | 0.094                        | 0.300                          | 0.079         | 0.094            | 0.053                            | 0.105     | 0.652 | 0.065  | 0.043   | 0.087  | 0.058           | 0.113 | 0.129                                 |           |            |
| Suppliers  | 0.021    | 0.427     | 0.083                     | 0.060                            | 0.093   | 0.144      | 0.270        | 0.034                        | 0.103                          | 0.097         | 0.031            | 0.034                            | 0.039     | 0.247 | 0.284  | 0.088   | 0.035  | 0.101           | 0.049 | 0.038                                 | 0.181     |            |
| Technology   | 0.140    | 0.184     | 0.129                     | 0.247                            | 0.114   | 0.372      | 0.300        | 0.089                        | 0.252                          | 0.079         | 0.075            | 0.113                            | 0.185     | 0.598 | 0.090  | 0.071   | 0.084  | 0.106           | 0.095 | 0.104                                 | 0.422     | 0.206      |

| Discriminant Validity-Cross Loadings |                      |          |           |                           |                                  |         |            |              |                              |                                |               |                  |                                  |           |        |        |         |        |                 |        |                                       |           |            |       |
|--------------------------------------|----------------------|----------|-----------|---------------------------|----------------------------------|---------|------------|--------------|------------------------------|--------------------------------|---------------|------------------|----------------------------------|-----------|--------|--------|---------|--------|-----------------|--------|---------------------------------------|-----------|------------|-------|
|                                      | Business performance | Customer | Employees | Environmental performance | External environment orientation | Finance | Government | Green Design | Green End of Life Management | Green Packing and Distribution | Green Procure | Green Production | Internal environment orientation | Knowledge | NGO    | Owners | Recycle | Reduce | Remanufacturing | Reuse  | Stakeholders' involvement and support | Suppliers | Technology |       |
| BEF                                  | 0.169                | 0.157    | -0.130    | 0.176                     | -0.090                           | 1.000   | 0.194      | -0.043       | 0.200                        | -0.063                         | 0.090         | -0.042           | -0.078                           | -0.177    | 0.500  | -0.046 | 0.008   | -0.040 | -0.109          | -0.056 | -0.076                                | 0.479     | 0.138      | 0.308 |
| BEK_1                                | 0.150                | 0.248    | -0.105    | 0.180                     | -0.108                           | 0.478   | 0.240      | -0.052       | 0.090                        | -0.067                         | -0.132        | -0.098           | -0.197                           | 0.830     | 0.042  | -0.022 | -0.096  | -0.060 | -0.109          | -0.135 | 0.405                                 | 0.242     | 0.427      |       |
| BEK_2                                | 0.101                | 0.200    | -0.082    | 0.068                     | -0.127                           | 0.351   | 0.196      | -0.076       | 0.034                        | -0.108                         | -0.155        | -0.102           | -0.181                           | 0.853     | 0.036  | -0.070 | -0.077  | -0.107 | -0.117          | -0.104 | 0.415                                 | 0.133     | 0.312      |       |
| BEK_3                                | 0.196                | 0.223    | -0.139    | 0.184                     | -0.132                           | 0.429   | 0.188      | -0.075       | 0.166                        | -0.095                         | -0.119        | -0.088           | -0.197                           | 0.845     | -0.026 | -0.081 | -0.081  | -0.071 | -0.145          | -0.110 | 0.488                                 | 0.154     | 0.391      |       |
| BES_1                                | 0.133                | 0.228    | 0.009     | 0.152                     | -0.027                           | 0.465   | 0.239      | -0.093       | 0.170                        | -0.107                         | -0.099        | -0.060           | -0.112                           | 0.517     | -0.047 | 0.011  | -0.049  | -0.068 | -0.086          | -0.097 | 0.853                                 | 0.156     | 0.282      |       |
| BES_2                                | 0.069                | 0.261    | -0.050    | 0.161                     | -0.087                           | 0.372   | 0.243      | -0.069       | 0.142                        | -0.017                         | -0.087        | -0.030           | -0.097                           | 0.430     | -0.017 | -0.048 | -0.078  | -0.043 | -0.110          | -0.118 | 0.850                                 | 0.115     | 0.243      |       |
| BES_3                                | 0.216                | 0.093    | -0.004    | 0.168                     | -0.021                           | 0.331   | 0.204      | 0.031        | 0.211                        | 0.012                          | 0.003         | -0.018           | -0.003                           | 0.308     | -0.013 | 0.025  | 0.055   | -0.004 | -0.006          | -0.052 | 0.760                                 | 0.097     | 0.236      |       |
| BET_1                                | 0.089                | 0.114    | -0.005    | 0.218                     | -0.015                           | 0.225   | 0.174      | -0.018       | 0.057                        | 0.000                          | 0.043         | 0.098            | -0.055                           | 0.302     | 0.024  | -0.022 | -0.093  | -0.018 | 0.000           | -0.015 | 0.188                                 | 0.137     | 0.700      |       |
| BET_2                                | 0.023                | 0.079    | -0.068    | 0.072                     | -0.078                           | 0.227   | 0.195      | -0.070       | 0.080                        | -0.011                         | -0.033        | -0.006           | -0.117                           | 0.297     | 0.090  | -0.013 | -0.085  | -0.051 | -0.074          | -0.101 | 0.234                                 | 0.108     | 0.830      |       |
| BET_3                                | 0.144                | 0.080    | -0.143    | 0.108                     | -0.111                           | 0.267   | 0.180      | -0.093       | 0.197                        | -0.051                         | -0.081        | -0.099           | -0.171                           | 0.440     | 0.037  | -0.058 | 0.008   | -0.111 | -0.038          | -0.064 | 0.293                                 | 0.132     | 0.808      |       |
| CEC_1                                | 0.282                | -0.110   | 0.293     | 0.305                     | 0.310                            | -0.063  | 0.061      | 0.283        | 0.429                        | 0.317                          | 0.252         | 0.273            | 0.393                            | -0.136    | -0.100 | 0.162  | 0.857   | 0.241  | 0.496           | 0.662  | -0.038                                | -0.060    | -0.056     |       |
| CEC_2                                | 0.251                | -0.037   | 0.262     | 0.307                     | 0.294                            | -0.058  | 0.078      | 0.261        | 0.457                        | 0.291                          | 0.290         | 0.209            | 0.328                            | -0.085    | -0.059 | 0.182  | 0.901   | 0.244  | 0.431           | 0.642  | -0.022                                | -0.010    | -0.050     |       |
| CEC_3                                | 0.244                | -0.009   | 0.226     | 0.375                     | 0.282                            | -0.063  | 0.144      | 0.284        | 0.472                        | 0.279                          | 0.245         | 0.223            | 0.312                            | -0.051    | -0.046 | 0.147  | 0.930   | 0.270  | 0.495           | 0.654  | -0.009                                | -0.014    | -0.016     |       |
| CEC_4                                | 0.197                | 0.001    | 0.240     | 0.298                     | 0.270                            | -0.005  | 0.117      | 0.265        | 0.439                        | 0.311                          | 0.234         | 0.226            | 0.352                            | -0.050    | -0.044 | 0.137  | 0.926   | 0.245  | 0.441           | 0.606  | -0.035                                | -0.002    | -0.043     |       |
| CEC_5                                | 0.276                | 0.004    | 0.248     | 0.358                     | 0.285                            | -0.044  | 0.101      | 0.299        | 0.440                        | 0.322                          | 0.283         | 0.257            | 0.355                            | -0.100    | -0.034 | 0.137  | 0.916   | 0.275  | 0.430           | 0.641  | -0.054                                | 0.016     | -0.087     |       |
| CED_1                                | 0.112                | 0.067    | 0.330     | 0.269                     | 0.382                            | -0.046  | -0.068     | 0.361        | 0.202                        | 0.304                          | 0.318         | 0.383            | 0.388                            | -0.051    | 0.134  | 0.322  | 0.293   | 0.818  | 0.371           | 0.403  | -0.045                                | 0.057     | -0.046     |       |
| CED_2                                | 0.091                | 0.112    | 0.220     | 0.239                     | 0.337                            | -0.109  | -0.113     | 0.287        | 0.158                        | 0.283                          | 0.318         | 0.332            | 0.307                            | -0.085    | 0.101  | 0.133  | 0.216   | 0.859  | 0.278           | 0.363  | -0.019                                | 0.078     | -0.092     |       |
| CED_3                                | 0.099                | 0.118    | 0.259     | 0.256                     | 0.279                            | -0.121  | -0.070     | 0.257        | 0.170                        | 0.236                          | 0.329         | 0.363            | 0.292                            | -0.117    | 0.120  | 0.178  | 0.247   | 0.868  | 0.289           | 0.419  | -0.071                                | 0.096     | -0.112     |       |
| CEU_4                                | 0.049                | 0.134    | 0.237     | 0.270                     | 0.247                            | -0.102  | -0.107     | 0.229        | 0.125                        | 0.224                          | 0.289         | 0.349            | 0.252                            | -0.086    | 0.138  | 0.140  | 0.207   | 0.890  | 0.284           | 0.382  | -0.033                                | 0.079     | -0.031     |       |
| CEU_1                                | 0.238                | -0.008   | 0.389     | 0.318                     | 0.392                            | -0.110  | 0.036      | 0.382        | 0.390                        | 0.324                          | 0.378         | 0.329            | 0.472                            | -0.157    | 0.063  | 0.225  | 0.602   | 0.459  | 0.553           | 0.885  | -0.119                                | 0.041     | -0.108     |       |
| CEU_2                                | 0.282                | 0.020    | 0.321     | 0.367                     | 0.370                            | -0.074  | 0.036      | 0.324        | 0.410                        | 0.329                          | 0.337         | 0.311            | 0.356                            | -0.095    | 0.010  | 0.162  | 0.587   | 0.395  | 0.494           | 0.892  | -0.100                                | -0.018    | -0.055     |       |
| CEU_3                                | 0.159                | 0.003    | 0.316     | 0.334                     | 0.318                            | -0.040  | 0.047      | 0.308        | 0.401                        | 0.282                          | 0.300         | 0.250            | 0.357                            | -0.108    | 0.001  | 0.166  | 0.680   | 0.429  | 0.454           | 0.912  | -0.092                                | -0.016    | -0.083     |       |
| CEU_4                                | 0.177                | 0.020    | 0.346     | 0.315                     | 0.333                            | -0.061  | 0.046      | 0.368        | 0.432                        | 0.307                          | 0.340         | 0.269            | 0.390                            | -0.139    | 0.043  | 0.181  | 0.668   | 0.353  | 0.479           | 0.906  | -0.084                                | -0.040    | -0.038     |       |
| EEO_1                                | 0.200                | 0.011    | 0.590     | 0.274                     | 0.931                            | -0.064  | -0.033     | 0.542        | 0.207                        | 0.451                          | 0.489         | 0.513            | 0.658                            | -0.144    | 0.100  | 0.399  | 0.291   | 0.333  | 0.382           | 0.362  | -0.094                                | -0.095    | -0.086     |       |
| EEO_2                                | 0.093                | 0.047    | 0.591     | 0.302                     | 0.935                            | -0.049  | -0.049     | 0.575        | 0.252                        | 0.496                          | 0.509         | 0.492            | 0.694                            | -0.127    | 0.150  | 0.337  | 0.282   | 0.345  | 0.385           | 0.370  | -0.010                                | -0.056    | -0.105     |       |
| EEO_3                                | 0.035                | 0.010    | 0.638     | 0.186                     | 0.692                            | -0.174  | 0.008      | 0.677        | 0.191                        | 0.516                          | 0.533         | 0.534            | 0.961                            | -0.243    | 0.111  | 0.398  | 0.381   | 0.358  | 0.436           | 0.427  | -0.104                                | -0.028    | -0.146     |       |
| EEO_4                                | 0.068                | 0.033    | 0.625     | 0.167                     | 0.701                            | -0.167  | 0.006      | 0.704        | 0.170                        | 0.543                          | 0.516         | 0.577            | 0.961                            | -0.195    | 0.096  | 0.378  | 0.350   | 0.338  | 0.408           | 0.415  | -0.073                                | -0.033    | -0.146     |       |
| GMA_1                                | 0.023                | 0.030    | 0.403     | 0.253                     | 0.494                            | -0.061  | -0.074     | 0.523        | 0.211                        | 0.897                          | 0.806         | 0.834            | 0.523                            | -0.067    | 0.058  | 0.266  | 0.266   | 0.313  | 0.384           | 0.292  | -0.024                                | -0.025    | -0.006     |       |
| GMA_2                                | 0.017                | 0.038    | 0.324     | 0.212                     | 0.431                            | -0.041  | 0.013      | 0.401        | 0.298                        | 0.869                          | 0.565         | 0.474            | 0.447                            | -0.124    | 0.025  | 0.155  | 0.318   | 0.208  | 0.373           | 0.319  | -0.070                                | -0.113    | 0.016      |       |
| GMD_1                                | 0.064                | 0.093    | 0.550     | 0.246                     | 0.581                            | -0.038  | -0.025     | 0.951        | 0.181                        | 0.496                          | 0.580         | 0.562            | 0.727                            | -0.074    | 0.143  | 0.402  | 0.308   | 0.341  | 0.359           | 0.370  | -0.055                                | 0.022     | -0.081     |       |
| GMD_2                                | 0.105                | 0.164    | 0.455     | 0.228                     | 0.559                            | -0.045  | -0.028     | 0.954        | 0.248                        | 0.509                          | 0.619         | 0.594            | 0.643                            | -0.079    | 0.159  | 0.314  | 0.275   | 0.288  | 0.315           | 0.368  | -0.059                                | 0.005     | -0.073     |       |
| GME1                                 | 0.318                | 0.038    | 0.108     | 0.623                     | 0.280                            | 0.124   | 0.108      | 0.144        | 0.763                        | 0.246                          | 0.284         | 0.178            | 0.116                            | 0.054     | -0.101 | 0.099  | 0.412   | 0.239  | 0.373           | 0.425  | 0.169                                 | -0.044    | 0.039      |       |
| GME_2                                | 0.279                | 0.072    | 0.103     | 0.317                     | 0.156                            | 0.247   | 0.205      | 0.164        | 0.851                        | 0.205                          | 0.206         | 0.116            | 0.092                            | 0.178     | -0.082 | 0.039  | 0.388   | 0.115  | 0.358           | 0.339  | 0.181                                 | 0.044     | 0.177      |       |
| GME_3                                | 0.164                | 0.137    | 0.201     | 0.146                     | 0.144                            | 0.085   | 0.226      | 0.220        | 0.685                        | 0.201                          | 0.177         | 0.041            | 0.236                            | 0.036     | 0.021  | 0.082  | 0.333   | 0.074  | 0.362           | 0.270  | 0.128                                 | 0.093     | 0.116      |       |
| GMP1                                 | 0.187                | -0.027   | 0.315     | 0.363                     | 0.382                            | -0.080  | -0.008     | 0.322        | 0.422                        | 0.399                          | 0.396         | 0.326            | 0.412                            | -0.151    | 0.021  | 0.192  | 0.465   | 0.408  | 0.893           | 0.516  | -0.111                                | 0.032     | -0.088     |       |
| GMP_2                                | 0.148                | -0.020   | 0.358     | 0.283                     | 0.352                            | -0.018  | 0.091      | 0.309        | 0.425                        | 0.386                          | 0.413         | 0.318            | 0.371                            | -0.112    | -0.003 | 0.138  | 0.402   | 0.330  | 0.892           | 0.466  | -0.042                                | -0.021    | 0.000      |       |
| GMP_1                                | 0.083                | 0.092    | 0.431     | 0.281                     | 0.538                            | -0.042  | -0.027     | 0.597        | 0.244                        | 0.639                          | 0.951         | 0.669            | 0.508                            | -0.129    | 0.098  | 0.197  | 0.241   | 0.330  | 0.381           | 0.334  | -0.050                                | -0.017    | 0.009      |       |
| GMP_2                                | 0.066                | 0.115    | 0.409     | 0.252                     | 0.480                            | -0.038  | -0.009     | 0.601        | 0.296                        | 0.614                          | 0.952         | 0.646            | 0.531                            | -0.174    | 0.124  | 0.163  | 0.294   | 0.366  | 0.449           | 0.382  | -0.046                                | 0.010     | -0.081     |       |
| GMR_1                                | 0.024                | 0.144    | 0.467     | 0.277                     | 0.622                            | -0.073  | -0.020     | 0.589        | 0.151                        | 0.633                          | 0.669         | 0.953            | 0.565                            | -0.106    | 0.055  | 0.320  | 0.253   | 0.399  | 0.347           | 0.295  | -0.032                                | -0.024    | -0.016     |       |
| GMR_2                                | 0.063                | 0.132    | 0.424     | 0.269                     | 0.501                            | -0.076  | -0.022     | 0.566        | 0.134                        | 0.568                          | 0.644         | 0.949            | 0.534                            | -0.111    | 0.078  | 0.261  | 0.245   | 0.394  | 0.338           | 0.317  | -0.055                                | -0.028    | -0.009     |       |
| GMP_1                                | 0.365                | 0.207    | 0.216     | 0.717                     | 0.276                            | 0.162   | 0.073      | 0.264        | 0.338                        | 0.242                          | 0.321         | 0.283            | 0.184                            | 0.162     | -0.065 | 0.105  | 0.359   | 0.302  | 0.306           | 0.112  | 0.010                                 | 0.116     | 0.110      |       |
| OEP_2                                | 0.400                | 0.107    | 0.045     | 0.801                     | 0.190                            | 0.192   | 0.022      | 0.078        | 0.408                        | 0.148                          | 0.083         | 0.118            | 0.081                            | 0.146     | -0.083 | 0.081  | 0.273   | 0.178  | 0.254           | 0.294  | 0.203                                 | -0.029    | 0.144      |       |
| OEP_3                                | 0.457                | 0.091    | 0.134     | 0.850                     | 0.286                            | 0.071   | -0.024     | 0.244        | 0.308                        | 0.236                          | 0.259         | 0.276            | 0.169                            | 0.133     | -0.087 | 0.072  | 0.295   | 0.238  | 0.316           | 0.256  | 0.145                                 | -0.058    | 0.129      |       |
| OPB_1                                | 0.850                | 0.078    | 0.063     | 0.596                     | 0.236                            | 0.121   | -0.004     | 0.149        | 0.298                        | 0.070                          | 0.148         | 0.156            | 0.078                            | 0.129     | -0.052 | 0.154  | 0.250   | 0.158  | 0.202           | 0.216  | 0.098                                 | -0.017    | 0.099      |       |
| OPB_2                                | 0.946                | -0.039   | 0.007     | 0.452                     | 0.090                            | 0.192   | 0.122      | 0.052        | 0.312                        | 0.001                          | 0.030         | -0.009           | 0.036                            | 0.206     | -0.067 | 0.022  | 0.251   | 0.058  | 0.149           | 0.205  | 0.177                                 | -0.014    | 0.111      |       |
| OPB_3                                | 0.945                | -0.039   | -0.018    | 0.423                     | 0.096                            | 0.151   | 0.118      | 0.088        | 0.321                        | -0.011                         | 0.031         | -0.029           | 0.032                            | 0.196     | -0.051 | 0.009  | 0.295   | 0.065  | 0.161           | 0.212  | 0.178                                 | 0.005     | 0.099      |       |
| SEC_1                                | -0.009               | 0.844    | 0.021     | 0.161                     | 0.016                            | 0.147   | 0.332      | 0.020        | 0.080                        | -0.015                         | 0.076         | 0.101            | -0.016                           | 0.255     | 0.057  | -0.015 | -0.103  | 0.118  | -0.051          | -0.076 | 0.315                                 | 0.292     | 0.178      |       |
| SEC_2                                | 0.008                | 0.926    | 0.038     | 0.142                     | 0.036                            | 0.135   | 0.220      | 0.192        | 0.099                        | 0.067                          | 0.112         | 0.150            | 0.046                            | 0.225     | 0.079  | 0.066  | 0.023   | 0.107  | -0.005          | 0.088  | 0.148                                 | 0.322     | 0.048      |       |
| SEE_1                                | -0.004               | 0.049    | 0.930     | 0.143                     | 0.591                            | -0.132  | -0.079     | 0.506        | 0.121                        | 0.418                          | 0.444         | 0.475            | 0.633                            | -0.146    | 0.132  | 0.495  | 0.239   | 0.295  | 0.359           | 0.349  | -0.059                                | 0.035     | -0.127     |       |
| SEE_2                                | 0.066                | 0.014    | 0.911     | 0.164                     | 0.572                            | -0.106  | 0.000      | 0.461        | 0.205                        | 0.340                          | 0.363         | 0.383            | 0.574                            | -0.076    | 0.073  | 0.396  | 0.267   |        |                 |        |                                       |           |            |       |

#### Appendix 4: Discriminant validity testing of the subconstructs

Discriminant validity (Fornell-larcker criterion)

|  | Barries of Green Manufacturing Implementation | Circular Economy Capability | Environment orientation | Green Manufacturing | Organisational Performance | Stakeholder Engagement in Environmental Implementation |
|--|---|-----------------------------|-------------------------|---------------------|----------------------------|--|
| Barries of Green Manufacturing Implementation          | <b>0.59</b>                                   |                             |                         |                     |                            |  |
| Circular Economy Capability                            | -0.143  | <b>0.705</b>                |                         |                     |                            |  |
| Environment orientation                                | -0.209  | 0.532                       | <b>0.836</b>            |                     |                            |  |
| Green Manufacturing                                    | -0.095  | 0.629                       | 0.806                   | <b>0.633</b>        |                            |  |
| Organisational Performance                             | 0.29  | 0.424                       | 0.218                   | 0.314               | <b>0.692</b>               |  |
| Stakeholder Engagement in Environmental Implementation | -0.122  | 0.418                       | 0.785                   | 0.617               | 0.112                      | <b>0.414</b>   |

Discriminant validity (Heterotrait-Monotrait Ratio (HTMT))

|  | Barriers of Green Manufacturing Implementation | Circular Economy Capability | Environment orientation | Green Manufacturing | Organisational Performance | Stakeholder Engagement in Environmental Implementation |
|--|--|-----------------------------|-------------------------|---------------------|----------------------------|--|
| Barriers of Green Manufacturing Implementation         |  |                             |                         |                     |                            |  |
| Circular Economy Capability                            | 0.157  |                             |                         |                     |                            |  |
| Environment orientation                                | 0.206  | 0.542                       |                         |                     |                            |  |
| Green Manufacturing                                    | 0.21   | 0.68                        | 0.792                   |                     |                            |  |
| Organisational Performance                             | 0.303  | 0.45                        | 0.24                    | 0.4                 |                            |  |
| Stakeholder Engagement in Environmental Implementation | 0.438  | 0.383                       | 0.521                   | 0.489               | 0.232                      |  |



## Appendix 5: Common Method Variance Assessment

### Harmon's Single-factor Approach-Total Variance Explained

| Factor | Initial Eigenvalues |               |              | Extraction Sums of Squared Loadings |               |              |
|--------|---------------------|---------------|--------------|-------------------------------------|---------------|--------------|
|        | Total               | % of Variance | Cumulative % | Total                               | % of Variance | Cumulative % |
| 1      | 12.974              | 22.369        | 22.369       | 12.34                               | 21.276        | 21.276       |
| 2      | 5.949               | 10.256        | 32.626       |                                     |               |              |
| 3      | 3.965               | 6.836         | 39.461       |                                     |               |              |
| 4      | 2.855               | 4.922         | 44.383       |                                     |               |              |
| 5      | 2.652               | 4.573         | 48.957       |                                     |               |              |
| 6      | 2.409               | 4.153         | 53.11        |                                     |               |              |
| 7      | 1.818               | 3.134         | 56.244       |                                     |               |              |
| 8      | 1.675               | 2.887         | 59.131       |                                     |               |              |
| 9      | 1.419               | 2.447         | 61.579       |                                     |               |              |
| 10     | 1.36                | 2.345         | 63.923       |                                     |               |              |
| 11     | 1.293               | 2.23          | 66.153       |                                     |               |              |
| 12     | 1.146               | 1.976         | 68.129       |                                     |               |              |
| 13     | 1.102               | 1.899         | 70.028       |                                     |               |              |
| 14     | 1.046               | 1.803         | 71.832       |                                     |               |              |
| 15     | 1.011               | 1.744         | 73.576       |                                     |               |              |
| 16     | 0.912               | 1.572         | 75.147       |                                     |               |              |
| 17     | 0.861               | 1.484         | 76.631       |                                     |               |              |
| 18     | 0.794               | 1.369         | 78           |                                     |               |              |
| 19     | 0.744               | 1.283         | 79.283       |                                     |               |              |
| 20     | 0.708               | 1.221         | 80.504       |                                     |               |              |
| 21     | 0.684               | 1.18          | 81.683       |                                     |               |              |
| 22     | 0.659               | 1.136         | 82.819       |                                     |               |              |
| 23     | 0.624               | 1.075         | 83.895       |                                     |               |              |
| 24     | 0.573               | 0.988         | 84.883       |                                     |               |              |
| 25     | 0.53                | 0.914         | 85.797       |                                     |               |              |
| 26     | 0.502               | 0.866         | 86.663       |                                     |               |              |
| 27     | 0.481               | 0.83          | 87.493       |                                     |               |              |
| 28     | 0.459               | 0.791         | 88.284       |                                     |               |              |
| 29     | 0.43                | 0.742         | 89.026       |                                     |               |              |
| 30     | 0.426               | 0.734         | 89.76        |                                     |               |              |
| 31     | 0.412               | 0.71          | 90.47        |                                     |               |              |
| 32     | 0.384               | 0.661         | 91.131       |                                     |               |              |
| 33     | 0.363               | 0.625         | 91.756       |                                     |               |              |
| 34     | 0.351               | 0.605         | 92.361       |                                     |               |              |
| 35     | 0.338               | 0.582         | 92.943       |                                     |               |              |
| 36     | 0.326               | 0.563         | 93.506       |                                     |               |              |
| 37     | 0.293               | 0.505         | 94.01        |                                     |               |              |

|    |       |       |        |
|----|-------|-------|--------|
| 38 | 0.285 | 0.492 | 94.503 |
| 39 | 0.281 | 0.485 | 94.987 |
| 40 | 0.257 | 0.443 | 95.431 |
| 41 | 0.242 | 0.416 | 95.847 |
| 42 | 0.226 | 0.39  | 96.238 |
| 43 | 0.208 | 0.359 | 96.597 |
| 44 | 0.198 | 0.342 | 96.939 |
| 45 | 0.195 | 0.336 | 97.274 |
| 46 | 0.186 | 0.321 | 97.596 |
| 47 | 0.174 | 0.301 | 97.896 |
| 48 | 0.172 | 0.297 | 98.193 |
| 49 | 0.15  | 0.259 | 98.452 |
| 50 | 0.139 | 0.24  | 98.692 |
| 51 | 0.126 | 0.217 | 98.909 |
| 52 | 0.118 | 0.204 | 99.113 |
| 53 | 0.111 | 0.191 | 99.303 |
| 54 | 0.109 | 0.187 | 99.491 |
| 55 | 0.097 | 0.167 | 99.658 |
| 56 | 0.084 | 0.145 | 99.803 |
| 57 | 0.075 | 0.129 | 99.932 |
| 58 | 0.04  | 0.068 | 100    |

Extraction Method: Principal Axis Factoring.



## Appendix 6: Common Method Bias (CMB) in PLS-SEM – Values for Inner VIF

Common Method Bias (CMB) in PLS (partial least squares)-Inner VIF Values

|      | BFGI | CECA | ENOR | GRMA  | ORPE  | SEEI |
|------|------|------|------|-------|-------|------|
| BFGI |      |      |      | 1.031 |       |      |
| CECA |      |      |      |       | 1.578 |      |
| ENOR |      |      |      | 1.949 |       |      |
| GRMA |      | 1    |      |       | 1.578 |      |
| ORPE |      |      |      |       |       |      |
| SEEI |      |      | 1    | 1.906 |       |      |

*Note. BFGI: Level of Barriers to Green Manufacturing application (BFGI)*

*CECA: Circular Economy capability (CECA)*

*ENOR: Environmental Orientation (ENOR)*

*GRMA: Green Manufacturing (GRMA)*

*ORPE: Organisational Performance (ORPE)*

*SEEI: Stakeholder engagement for environment implementation (SEEI)*

*\*Factor-level VIFs <3.3, indicates free of common method bias (Kock 2015, p.7)*

Common Method Bias (CMB) in PLS (partial least squares)-Inner VIF Values- (BFGI as the dependent variable)

|      | BFGI  | CECA | ENOR | GRMA | ORPE | SEEI |
|------|-------|------|------|------|------|------|
| BFGI |       |      |      |      |      |      |
| CECA | 1.556 |      |      |      |      |      |
| ENOR | 2.073 |      |      |      |      |      |
| GRMA | 1.766 |      |      |      |      |      |
| ORPE | 1.218 |      |      |      |      |      |
| SEEI | 1.081 |      |      |      |      |      |

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*ORPE: Organisational Performance (ORPE)*

*SEEI: Stakeholder engagement for environment implementation (SEEI)*

*\*Factor-level VIFs <3.3, indicates free of common method bias (Kock 2015, p.7)*

Common Method Bias (CMB) in PLS (partial least squares)-Inner VIF Values- (CECA as the dependent variable)

|      | BFGI | CECA  | ENOR | GRMA | ORPE | SEEI |
|------|------|-------|------|------|------|------|
| BFGI |      | 1.144 |      |      |      |      |
| CECA |      |       |      |      |      |      |
| ENOR |      | 2.754 |      |      |      |      |
| GRMA |      | 2.306 |      |      |      |      |
| ORPE |      | 1.332 |      |      |      |      |
| SEEI |      | 1.863 |      |      |      |      |

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*\*Factor-level VIFs <3.3, indicates free of common method bias (Kock 2015, p.7)*

Common Method Bias (CMB) in PLS (partial least squares)-Inner VIF Values- (ENOR as the dependent variable)

|      | BFGI | CECA | ENOR  | GRMA | ORPE | SEEI |
|------|------|------|-------|------|------|------|
| BFGI |      |      | 1.106 |      |      |      |
| CECA |      |      | 1.678 |      |      |      |
| ENOR |      |      |       |      |      |      |
| GRMA |      |      | 1.958 |      |      |      |
| ORPE |      |      | 1.369 |      |      |      |
| SEEI |      |      | 1.489 |      |      |      |

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*ORPE: Organisational Performance (ORPE)*

*SEEI: Stakeholder engagement for environment implementation (SEEI)*

*\*Factor-level VIFs <3.3, indicates free of common method bias (Kock 2015, p.7)*

Common Method Bias (CMB) in PLS (partial least squares)-Inner VIF Values- (GRMA as the dependent variable)

|      | BFGI | CECA | ENOR | GRMA  | ORPE | SEEI |
|------|------|------|------|-------|------|------|
| BFGI |      |      |      | 1.068 |      |      |
| CECA |      |      |      | 1.535 |      |      |
| ENOR |      |      |      | 2.204 |      |      |
| GRMA |      |      |      |       |      |      |
| ORPE |      |      |      | 1.260 |      |      |
| SEEI |      |      |      | 1.905 |      |      |

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*GRMA: Green Manufacturing (GRMA)*

*ORPE: Organisational Performance (ORPE)*

*SEEI: Stakeholder engagement for environment implementation (SEEI)*

*\*Factor-level VIFs <3.3, indicates free of common method bias (Kock 2015, p.7)*

Common Method Bias (CMB) in PLS (partial least squares)-Inner VIF Values- (SEEI as the dependent variable)

|      | BFGI | CECA | ENOR | GRMA | ORPE | SEEI  |
|------|------|------|------|------|------|-------|
| BFGI |      |      |      |      |      | 1.072 |
| CECA |      |      |      |      |      | 1.643 |
| ENOR |      |      |      |      |      | 2.326 |
| GRMA |      |      |      |      |      | 2.649 |
| ORPE |      |      |      |      |      | 1.283 |
| SEEI |      |      |      |      |      |       |

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*GRMA: Green Manufacturing (GRMA)*

*ORPE: Organisational Performance (ORPE)*

*SEEI: Stakeholder engagement for environment implementation (SEEI)*

*\*Factor-level VIFs <3.3, indicates free of common method bias (Kock 2015, p.7)*

Common Method Bias (CMB) in PLS (partial least squares)-Inner VIF Values- (ORPE as the dependent variable)

|      | BFGI | CECA | ENOR | GRMA | ORPE | SEEI  |
|------|------|------|------|------|------|-------|
| BFGI |      |      |      |      |      | 1.067 |
| CECA |      |      |      |      |      | 1.724 |
| ENOR |      |      |      |      |      | 2.200 |
| GRMA |      |      |      |      |      | 2.456 |
| ORPE |      |      |      |      |      |       |
| SEEI |      |      |      |      |      | 1.348 |

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*ORPE: Organisational Performance (ORPE)*

*SEEI: Stakeholder engagement for environment implementation (SEEI)*

*\*Factor-level VIFs <3.3, indicates free of common method bias (Kock 2015, p.7)*

