The impact of green supply chain management practices on firm competitiveness

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Abstract: In view of the influence of green supply chain management (GSCM) practices on firm competitiveness, particularly among manufacturing firms, we examined a model linking green production, green purchasing, investment recovery and firm competitiveness. This paper contributes to the emerging body of literature on green supply chains and firm competitiveness in developing countries by examining our research model in the context of Malaysia. Specifically, using a sample of 144 Malaysian manufacturing companies, we propose and find support for the notion that there is a relationship between green supply chain practices and firm competitiveness. Analysis using the partial least squares package reveals that both green production and green purchasing have a direct effect on firm competitiveness. However, investment recovery has no relationship with firm competitiveness. A discussion and suggestions for future research are included.
1 Introduction

There is always a trade-off between a booming economy and environmental protection, in that environmental problems occur simultaneously with economic growth (Moffatt, 2004). It is important to achieve a balance between economic growth and environmental quality. In order to achieve sustainable development, green initiatives have to be urgently adopted across various industries to mitigate and minimise the negative environmental impact. Green supply chain management (GSCM) practices act as a tool for promoting efficiency in the supply chain and help to improve the environmental performance, economic performance and financial performance (Rao and Holt, 2005; Zhu et al., 2005; Yang et al., 2010). Moreover, GSCM is the new way of obtaining better organisational performance in which environmental management and green innovation are expected to be the most important performance indicators in the future (Chiou et al., 2011).

Zhu and Sarkis (2004) defined GSCM as activities ranging from green purchasing to the integrated chains of supply, moving from the supplier, to the manufacturer, customer and continuing in the reverse logistics to close the loop. This definition explicitly indicated that the focus of GSCM is not within the boundary of the integration between the manufacturing process and delivery to customers but also covers the earlier stage of
product design until its end of use or disposal. Hence, GSCM requires a complete product management with full integration along its life cycle (Wooi and Zailani, 2010) involving several key activities, such as procurement, production, material management, distribution, marketing and reverse logistics (De Giovanni and Esposito Vinzi, 2012).

A number of other studies have suggested that firms should adopt the green practices of GSCM in order to become more environmentally responsible. Among the practices mentioned were waste and packaging reduction (Ciliberti et al., 2008), selection of supplier with environmental credibility (Bai and Sarkis, 2010), producing more green products (Chung and Wee, 2008; Kainuma and Tawara, 2006), less pollution during operations and distribution of products (Walker et al., 2008; Ciliberti et al., 2008), educating suppliers to improve their environmental performance (Kainuma and Tawara, 2006), cooperating with suppliers and building the process of reverse supply chains in their organisations (Zhu and Cote, 2004; Ciliberti et al., 2008).

GSCM is gaining popularity in the Asian region through external pressure from the European region. In addition, both customers and the general public’s demand for green have driven Malaysian industries to turn in this direction. GSCM is gaining acceptance among manufacturing firms in Malaysia in their quest to improve their environmental performance in their operations. Although there are many factors that motivate firms to adopt GSCM practices, most involve the ethical (for example, firm’s management value) and also commercial purposes (for example, firm’s competitive advantage by leveraging environmental considerations) (Testa and Iraldo, 2010).

Nevertheless, there is no clear evidence that the transformation from conventional supply chain management to GSCM is stimulated by the opportunities to make a profit in business (Sharfman et al., 2009) as the focus of GSCM is more towards the ecological source rather than pursuing economic goals. This may suggest that the three drivers of coercive, mimetic and normative pressures from the regulations, society and customers could influence firms in their adoption of GSCM practices (DiMaggio and Powell, 1983; Sharfman et al., 1997; Sinding, 2000; Zhu et al., 2010), which were described specifically in the institutional theory. Nonetheless, despite the growth of GSCM practices among firms, there are still many issues pertaining to the implementation that may impede the overall initiatives of firms to improve competitiveness in their organisations.

However, there seems to be a gap between the desirability for GSCM and the implementation for the industries at the aggregate level (Zhu et al., 2005). A similar scenario was found in the Malaysian context where industries are still slow in implementing GSCM practices even though they are aware of the importance of GSCM practices to improve firm performance. Organisations will consider adopting GSCM practices if the financial outcomes and operational benefits are identified (Bowen et al., 2001). Additionally, few researchers have studied the great potential for developing competitive advantage for overall organisational performance through a sustainable green supply chain.

Given the importance of green practices to a firm’s competitive position, a number of studies have tried to identify the possible consequences of greening the supply chain. The extant literature has grouped these GSCM practices into green purchasing, green production, investment recovery, reverse logistics, and supplier and customer collaboration. Greening any phase of the supply chain is claimed to establish a positive relationship with the environmental and financial performance, which comes from cost reduction, increased market share and profit (Chien and Shih, 2007; Zhu et al., 2010).
Against this backdrop, the goal of this study was to examine the effect of GSCM practices (green purchasing, green production, investment recovery, reverse logistics, supplier and customer collaboration) on firm competitiveness among ISO 14001 certified firms within the Malaysian manufacturing industry.

The rest of this article is organised as follows: The following section briefly reviews the literature. The third section describes the conceptual model and research hypotheses, followed by a description of the methodology and results. The study concludes with a delineation of the significance of the findings, managerial implications, and future research directions.

2 Literature review

2.1 Firm competitiveness

The concept of competitiveness is analysed by cost against profit (Testa, 2010). Competitiveness can be viewed from different perspectives. For instance, the competitiveness at the firm level refers to the ability of a firm to better utilise the resources (efficiency) to meet the objectives (effective) compared to other players. Competitive advantage is achieved by differentiation and cost (Porter, 1990) in order to create uniqueness that excels compared to the others. GSCM practices are used as a tool to create differentiation and low cost strategies across the supply chain in order to be competitive (Tien et al., 2005). Some authors measured manufacturing effectiveness from the dimensions of cost, quality and delivery in connection with supplier management and continuous improvement mediated by environmental programmes. Yang et al. (2010) showed that only cost and quality have a significant relationship towards competitiveness. However, competitiveness goes beyond a quality product delivered on time. Rao and Holt (2005) contended that competitiveness relates to improved quality, efficiency, productivity and cost savings. Nevertheless, quality is the basic parameter that has to be met all the way; thus, the additional cost that is associated with quality is justified as part of the business operation cost.

Wagner and Schaltegger (2004) used environmental competitiveness and the overall firm competitiveness as the measure for economic performance in their study measuring the business perception concerning how environmental management influences economic performance. The dimensions of environmental competitiveness cover market-oriented environmental competitiveness, internal-oriented environmental competitiveness, the profitability-oriented environmental competitiveness and the risk-related environmental competitiveness, which can also relate to market opportunities, employee satisfaction, profitability and risk minimisation. This study demonstrated that environmental practices influence the economic performance of the firm.

Competitiveness interfaces with the environment where the firm operates. ‘Green’ awareness and environmental value are drivers in the product and services that cause the green supply chain to be a dimension for competitiveness (Rao and Holt, 2005). Environmental awareness from publicity has created a demand for ‘green’ products and services. When investigating the relationship between the environmental practices and economic performance, competitiveness should be incorporated with the profitability measurement in relation to the long-term efficiency. The positive linkage between improved environmental performance and competitiveness advantage is further extended
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to economic performance. Environmental competitiveness should consider business performance so firms can have a broader view of competitiveness.

Nation competitiveness depends on the productivity of the economy. Competitiveness at the sector level refers to the ability for better performance realisation in the relevant market while at the country level it is the combined performance across different sectors. It is not restricted to the market perspective but the country’s standard of living and social factors. Potter’s (1990) basic competitiveness indeed compels and covers all aspects of the supply chain, such as supply, demand, rivalry from upstream to downstream value chain. Competitiveness at the firm level refers to the normal profit sustainability and continued existence to maintain the market share. The key indicator is firm productivity (Testa, 2010), which measures ways to maximise firm efficiency through the input output ratio, followed by effectiveness, which is the outcome. All direct and indirect inputs that contribute to the production are taken into account for the purpose of measuring productivity. Therefore, competitiveness is the firm’s capability to provide differentiated products at a competitive price responding to the market demand (Bendavid-Val and Perine, 2003) instead of the traditional competitiveness, which is measured in terms of cheap labour and material cost.

Environmental competitiveness is derived from environmental performance which means, the firms achieve a certain environmental standard that stresses environmental protection, improved use of resources and energy efficiency (Bendavid-Val and Perine, 2003). For the sake of competitiveness, firms are willing to replicate the successful GSCM practices from competitors as result of the mimetic isomorphic forces and drivers (Zhu et al., 2013). On the other hand, there are authors who argued that the competitiveness of a company is generally measured in the context of monetary and services that cover cost, delivery, quality and flexibility (Singh et al., 2008; Rao and Holt, 2005). Manufacturing competitiveness covers three broad categories – cost, quality and delivery (Yang et al., 2010). Cost saving from manufacturing cost is able to reduce end product cost and offer the products at a more competitive price besides increasing profitability. Additionally, the cost saving will be transferred to the customer thereby increasing a firm’s competitiveness in the market place. The present study will discuss firm competitiveness from the dimension of price/cost, delivery and quality based on the most prevalent metric in the previous literature (Singh et al., 2008; Rao and Holt, 2005; Yang et al., 2010; Vachon and Klassen, 2005; Li et al., 2006).

2.2 GSCM practices

Many studies in the past have identified the drivers that motivate firms into the adoption of GSCM practices. Through thorough interviews with managers in New Zealand food and beverage companies, Frederick and Elting (2013) have uncovered strategic and operational planning, management structure, systems, and decision-making, management of people and company culture, and relationships with supply-chain members as the determinants toward the implementation of GSCM practices. In another study, Srivastava (2007) classified the study of GSCM into three broad categories: the importance of GSCM, green design and green operations. The importance of GSCM was found in the earlier literature concerning GSCM during its implementation stage. In relation to this, several attempts have been made in recent studies to streamline the GSCM practices. According to Eltayeb et al. (2011), GSCM consists of a broad range of activities and no
consensus has been reached so far among scholars regarding the specific activities to represent GSCM. This has occurred as a result of the nature of the underdeveloped theory in GSCM in which the practice and research are still practically emerging (Sarkis, 1999). Nevertheless, although no standardised dimensions for GSCM initiatives have been reached, at present, the basis and general understanding regarding GSCM have been adequately developed theoretically and practiced (Liu et al., 2012). Such a progression of GSCM related studies can be clearly seen from the substantial body of literature that has made use of similar dimensions in measuring GSCM.

For example, several authors have defined GSCM practices as activities relating to the phases of manufacturing, distribution and utilisation, and therefore can be categorised into green procurement, customer co-operation, internal environmental management, eco-design, corporate asset management and recovery (Carter et al., 2000; Walton et al., 1998; Zsidisin and Hendrick, 1998; Zhu et al., 2011). On a similar note, Zhu et al. (2008a) utilised the five practices of GSCM in their study to test the relationships against the closing of the supply chain loops. Among the GSCM practices were internal environmental management, green purchasing, customer cooperation, investment recovery and eco-design.

Another GSCM study by Wu et al. (2012) has reaffirmed on the GSCM practices in their study. By investigating the effect of GSCM drivers and the moderating effects of institutional market, regulatory and competitive pressures on the GSCM practices, the study has used four GSCM practices mentioned in the earlier literatures; green purchasing, cooperation with customers, eco-design and investment recovery. This is again confirmed by Hsu et al. (2013) in their latest study by verifying the vital drivers that affects the three GSCM practices that include green purchasing, eco-design and reverse logistics. In relation to this, GSCM practices exist in compliance with the regulatory and legislation requirements, or as a tool for preserving competitive advantage in the industry (Hsu and Hu, 2008). GSCM has been defined as environmental supply chain management, ecological implications for the supply chain activities including green purchasing and vendor management, total quality management, outbound logistics, eco-design and investment recovery management (Zhu et al., 2008b). Nevertheless, GSCM practices have lack of conformity in the present literature pertaining to their causal and direction of causality between the practices (Mitra and Datta, 2014). For instance, Zhu and Sarkis (2004) discovered no causal association between external GSCM and green design. On the other hand, Zailani et al. (2012) found no causal connection between the eco-purchasing and sustainable eco-packaging.

Green adoption should be applied to the entire supply chain from the upstream to the downstream. Reverse logistics is the critical part (Menzel et al., 2010). Based on the earlier definitions, GSCM practices are aimed at confining the business activities that have a negative impact on the natural environment (Gilbert, 2001). According to Gilbert (2001), conventional supply chains differ from green supply chains in several ways. The main difference is that conventional chains often concentrate on economic objectives and values while green chains are primarily concerned with the ecological causes. GSCM acts as a combination of green purchasing, green manufacturing, and green distribution or marketing as well as reverse logistics by adding ‘green’ components or environmental concepts into the supply chain management (Hervani et al., 2005; Rao and Holt, 2005). In view of this, this study focused on the extent of implementation of green purchasing, green manufacturing and investment recovery (reverse logistics) which represent as the GSCM practices in the study.
2.3 GSCM practices and firm competitiveness

The drivers to adopt GSCM practices maybe ethical or commercial value (Testa, 2010). The economic benefit from good environmental performance is the strongest motivator. Nevertheless, it is widely diffused for companies who are looking for environmental excellence. Competitiveness comes from the reduced risk and cost. Just as the basic competitiveness paradigm, the firm ability to provide competitive goods and services through better resources utilisation (Testa, 2010) compared to other players operating in the same environmental context. Efficiency is incorporated throughout the supply chain just as the 3Rs (reduction, reuse and recycling) concept, which is emphasised in the process of material buying followed by material utilisation on the production floor (Ninlawan et al., 2009; Rao and Holt, 2005). This concept is further extended to the closed loop supply chain (reverse logistics).

In relation to this, the assessment of the outcome of GSCM practices in the literature is primary related to the measures of firm performance and competitiveness. This is due to the fact that the GSCM practices can result in diverse effects to the environment, operations and economics (Lo, 2014) and not limited to certain aspects only. Through the green practices, firms can have the opportunity to improve their company image, enhance market dominancy and enter new market which eventually could increase their financial performance (Klassen and McLaughlin, 1996; Carter, Kale and Grimm, 2000). The operational performance can be translated in the form of processing efficiencies and recycling of the returns, penalties avoidance, waste discarding cost and impending higher compliance cost for the failure of immediate react (Mitra and Datta, 2014). On the other hand, the firm competitiveness signifies on the way on how the present consumers are accepting and aware of the importance of the environment issues in their purchases of goods and services (Rao and Holt, 2005).

Moreover, collaboration with the supplier and customer enables the firm to compete in terms of a faster response to meet market expectations or even exceed customer expectations. Firms manage to anticipate customer preferences, market trends and movement, and serve the customer better. Just as the ‘green consumerism’ trend towards sustainability development (Testa, 2010), cooperation with business partners for the development of environmental programmes increases the possibility of the success of the programme and improvement of overall performance. Again, better GSCM adoption is proven to be positively related to competitive performance (Zhu and Sarkis, 2004; Rao and Holt, 2005) by ‘greening’ the supply chain for both the upstream and downstream value chain.

However, the effect of the implementation of GSCM practices on the outcome of firm performance in the body of literature up to now has been inconsistent (Carter et al., 2000; Pagell et al., 2004; Zhu et al., 2005, 2012; Hazen et al., 2011; Green et al., 2012a, 2012b; Golicic and Smith, 2013). This is because of the varying result in the previous study. For instance, the inability to provide evidence of the improved financial performance despite the earlier expectation of the environmental practices that could lead to firm competitiveness (Rao, 2002; Rao and Holt, 2005). Besides that, several studies have
discovered that investment in GSCM is merely impacted profitability in short run (Zhu et al., 2005, 2012; Wu and Pagell, 2011) and take longer period to improve the economic and competitive advantage (Zhu and Sarkis, 2004; Krause et al., 2009). Despite this prevailing issue, a review of the above literature signifies mostly positive linkages between GSCM practices and firm competitiveness and this provides a strong support to formulate the following hypotheses.

Hypothesis 1 (H1) GSCM practice (green production) is positively related to firm competitiveness.

Hypothesis 2 (H2) GSCM practice (green purchasing) is positively related to firm competitiveness.

Hypothesis 3 (H3) GSCM practice (investment recovery) is positively related to firm competitiveness.

3 Methodology

3.1 Research design and sampling procedure

This is a quantitative research utilises a cross-sectional research design. The respondents of this study were manufacturing firms that were ISO 14001 certified in Malaysia. This study employed a census method of collecting data, where entire population is taken into account. A total of 541 questionnaires were dispatched based on the list of manufacturing firms in Malaysia that were ISO 14001 certified and listed in the Federation of Malaysian Manufacturers (FMM) directory for 2010, and the Malaysian Certified Online Database. A person holding a managerial position, preferably from the environment, health and safety, operations, quality, production supply chain or engineering department, was requested to respond to the questionnaire. Only 114 useable questionnaires were returned and subsequently analysed, representing a response rate of 21.3%.

3.2 Measuring instruments

Three GSCM practices (green production, green purchasing and investment recovery) were measured using 14 items adapted from various sources (Zhu and Sarkis, 2004; Eltayeb et al., 2010). Meanwhile, firm competitiveness was measured using 14 items obtained from Li et al. (2006). The measuring items were summarized in Table 1. Respondents responded to the items using a five-point Likert-type scale with ‘1’ = strongly disagree to ‘5’ = strongly agree. Since previous studies have shown that firm size correlated with firm competitiveness (Boween, 2002; Shen, 2010), it was treated as a control variable.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Dimension</th>
<th>Items</th>
</tr>
</thead>
</table>
| GSCM practices    | Green production | My organisation utilised environmentally friendly raw materials in its production.  
My organisation implements cleaner technology process for energy, water and waste saving in its production process.  
My organisation takes into consideration environmental design in its production.  
My organisation implements internal recycling of materials in its production.  
My organisation selects their supplier based on environmental criteria.  
My organisation use a questionnaire to collect information about its suppliers' environmental aspects, activities, and/or management system.  
My organisation makes sure that its purchased products must contain green attribute such as recycled or reusable items.  
My organisation makes sure that its purchased products must not contain green environmental undesirable item such as lead or other hazardous or toxic materials.  
My organisation evaluates its suppliers based on specific environmental criteria.  
My organisation evaluates the environmental aspects of its second-tier suppliers.  
My organisation involved in sales of excess inventories/materials.  
My organisation involved in sales of scrap and used materials.  
My organisation involved in sales of excess capital equipment.  
My organisation involved in sales of by-product and waste.  
My organisation offer competitiveness price compared to may competitor.  
My organisation offer price as low or lower than our competitor.  
My organisation direct manufacturing cost/production cost reduced compared to my competitor.  
My organisation total product cost reduced compared to my competitor.  
My organisation raw material cost reduced compared to my competitor.  
My organisation able to compete based on quality.  
My organisation offer products that are highly reliable as compared to my competitor.  
My organisation offer products that durable as compared to my competitor.  
My organisation offer high quality product to our customer as compared to my competitor.  
My organisation offer product which is conformance to design.  
My organisation deliver needed kind of product as compared to my competitor.  
My organisation delivers customer order on time as compared to my competitor.  
My organisation meeting delivery due date as compared to my competitor.  
My organisation order fulfillment speed increased as compared to my competitor. |

Table 1: Measuring instruments pertaining to GSCM practices and firm competitiveness
3.3 Statistical analysis techniques

This study applied partial least squares (PLS) using Smart PLS M3 Version 2.0 (Ringle et al., 2005), specifically due to the PLS ability that allows the latent constructs in the proposed model to be analysed as formative or reflective indicators. PLS places minimal restrictions on measurement scales, sample size, and residual distribution (Chin and Newsted, 1999). In addition, PLS is suitable for identifying the key driver constructs (Hair et al., 2013), which matches the aim of the current study. In addition, Statistic Package for Social Science (SPSS) Version 20.0 was used to analyse the descriptive data.

The results were presented using two steps approach. The first step is to report the measurement model results by employing PLS algorithm approach. The measurement model examines the internal consistency reliability, indicator reliability, convergent validity, and discriminant validity. It provides an evaluation on how reliable the measures are and also their convergent and discriminant validities (Chin, 2010).

After established the appropriate measures, the next step is to test the hypothesis by examining the structure model using the bootstrapping approach. The structural model is assessed based on the significance of the path coefficients and $R^2$ measures.

4 Results

4.1 Sample profile

The majority of the participating manufacturing firms in Malaysia were from the northern region (46.5%), followed by the central region (33.3%), southern region (17.6%) and East Malaysia (2.6%). With regard to the type of industry, in terms of proportion, half of the respondent manufacturing companies were from the electronics/electrical industry (50.0%), followed by basic metal, metals product and machinery (19.3%), rubber and plastics (9.6%), others (7.9%) chemical (6.1%), infrastructure/construction (2.6%), textile and wearing apparel (1.8%), wood based products/furniture (1.8%), and food and beverages (0.9%). In terms of ownership, 66.7% of the respondent companies were 100% foreign owned companies, followed by 100% local owned companies (26.3%), and the remaining 7.0% were joint venture companies.

4.2 Descriptive statistics

The descriptive statistics for the study variables were computed. The level of GSCM practices in terms of green production (M = 3.82, SD = 0.56), and green purchasing (M = 3.75, SD = 0.61) were rather high. The level of GSCM practices in terms of investment recovery (M = 3.43, SD = 0.62) was considered moderate. Firm competitiveness in terms of quality (M = 3.66, SD = 0.44) was considered high, followed by delivery (M = 3.54, SD = 0.67) and price (M = 3.28, SD = 0.63). Given that the participating companies were wide-ranged in terms of number of employees (30 to 8,000), we decided to compute the median for firm size, which was 993 employees with a standard deviation of 1,639.
4.3 Results of measurement model

Firstly, the indicator reliability was checked. Indicator reliability refers to the reliability of each of manifest variable. It is established when an indicator loading has a value of 0.70 and above (Ismail et al., 2012). As shown in Table 2, all the indicators of this study has the loadings value above 0.70. Next, composite reliability (CR) was used to measure the internal consistency reliability of a block of manifest variables. According to Hair et al. (2013), the higher value of CR, the higher levels of reliability. CR values of 0.60 to 0.70 are acceptable in the exploratory research, while in more advanced stages of research which values between 0.70 and 0.90 can only be regarded as satisfactory (Nunally and Bernstein, 1994). In this study, the CR values were ranged from 0.849 to 0.903, which are regarded as good and satisfactory. Convergent validity indicates whether a specific items measures a latent variable that it is supposed to measure (Nils and Frederik, 2010). Average variance extracted (AVE), the grand mean value of the square loadings of the indicators associated with the construct, is used to measure the convergent validity. The AVE of this study ranged from 0.588 to 0.696, which is greater than the minimum value of 0.50 (Barclay et al., 1995).

Table 2  

<table>
<thead>
<tr>
<th>Construct</th>
<th>Items</th>
<th>Loadings</th>
<th>AVE</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green production</td>
<td>GSCM_GP1</td>
<td>0.823</td>
<td>0.695</td>
<td>0.901</td>
</tr>
<tr>
<td></td>
<td>GSCM_GP2</td>
<td>0.905</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GSCM_GP3</td>
<td>0.746</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GSCM_GP4</td>
<td>0.852</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green purchasing</td>
<td>GSCM_PR1</td>
<td>0.823</td>
<td>0.609</td>
<td>0.903</td>
</tr>
<tr>
<td></td>
<td>GSCM_PR2</td>
<td>0.782</td>
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</tr>
<tr>
<td></td>
<td>GSCM_PR3</td>
<td>0.706</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>GSCM_PR4</td>
<td>0.788</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>GSCM_PR5</td>
<td>0.846</td>
<td></td>
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</tr>
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<td></td>
<td>GSCM_PR6</td>
<td>0.730</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment recovery</td>
<td>GSCM_IR1</td>
<td>0.766</td>
<td>0.588</td>
<td>0.849</td>
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<tr>
<td></td>
<td>GSCM_IR2</td>
<td>0.780</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>GSCM_IR3</td>
<td>0.897</td>
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<tr>
<td></td>
<td>GSCM_IR4</td>
<td>0.594</td>
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</tr>
<tr>
<td>Firm competitiveness</td>
<td>Delivery</td>
<td>0.815</td>
<td>0.696</td>
<td>0.873</td>
</tr>
<tr>
<td></td>
<td>Price</td>
<td>0.830</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quality</td>
<td>0.858</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In this study, all the item loadings were above the minimum value, 0.70, as proposed by Chin (1998). The AVE measures the variance captured by the indicators relative to the measurement error (Barclay et al., 1995). The AVE ranged from 0.588 to 0.696, which is greater than the minimum value of 0.50 (Barclay et al., 1995). On the other hand, Fornell and Larcker (1981) specified 0.70 as the minimum value for internal consistency for the latent variables. Hence, it can be concluded that the measurement model of this study is reliable.
Convergent validity refers to the extent to which a measure correlates positively with alternative measures if the same construct (Hair et al., 2013). The mean of the square loadings of the indicators associated with the construct is used to measure the convergent validity. According to Hair et al. (2013), the AVE value should be exceeded 0.50. Discriminant validity refers to the extent to which a construct is truly distinct from other constructs by empirical standards. There are two measures of discriminant validity, namely cross loadings and Fornell-Larcker criterion (Hair et al., 2013). The cross loadings method is an indicators’ outer loadings on a construct should be higher than all its cross loadings with other constructs. The Fornell-Larcker criterion method is the square root of the AVE of each construct should be higher than its highest correlation with any other construct (Hair et al., 2013).

Subsequently, the measurement model was tested for discriminant validity. The discriminant validity of the measures was assessed by examining the correlations between the measures of potentially overlapping constructs. There are two measures of discriminant validity, namely Fornell-Larcker criterion and cross loadings (Hair et al., 2013). The Fornell-Larcker criterion method is the square root of the AVE of each construct should be higher than its highest correlation with any other construct (Hair et al., 2013). Table 3 shows that the square root of the AVE of the latent variable, ranged from 0.767 to 0.834, which exceeded the correlations of the other constructs.

<table>
<thead>
<tr>
<th></th>
<th>Green production</th>
<th>Green purchasing</th>
<th>Investment recovery</th>
<th>Firm competitiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green production</td>
<td>0.834</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green purchasing</td>
<td>0.592</td>
<td>0.780</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment recovery</td>
<td>0.229</td>
<td>0.284</td>
<td>0.767</td>
<td></td>
</tr>
<tr>
<td>Firm competitiveness</td>
<td>0.352</td>
<td>0.425</td>
<td>0.218</td>
<td>0.834</td>
</tr>
</tbody>
</table>

Note: Diagonals represent the square root of the AVE while the other entries represent the correlations

The cross loadings method is an indicators’ outer loadings on a construct should be higher than all its cross loadings with other constructs. Items should load more strongly on their own constructs in the model. Table 4 shows the cross-loading for each item. The results indicated that all items showed sufficient discriminant validity as the loading of each item is greater than all of its cross-loadings (Chin, 1998). Overall, the measurement model demonstrated adequate discriminant validity.

4.4 Results of structural model

The effects of the control variables (firm size) on firm competitiveness were estimated before carrying out the path analysis. As shown in Table 5, firm size did not have a significant effect on the firm competitiveness ($R^2$ value = 0.004). The $R^2$ change was 0.219.
Table 4  Cross-loadings

<table>
<thead>
<tr>
<th></th>
<th>Green production</th>
<th>Green purchasing</th>
<th>Investment recovery</th>
<th>Delivery</th>
<th>Price</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCD1</td>
<td>0.264</td>
<td>0.275</td>
<td>-0.095</td>
<td>0.710</td>
<td>0.418</td>
<td>0.465</td>
</tr>
<tr>
<td>FCD2</td>
<td>0.208</td>
<td>0.282</td>
<td>0.236</td>
<td>0.885</td>
<td>0.402</td>
<td>0.561</td>
</tr>
<tr>
<td>FCD3</td>
<td>0.111</td>
<td>0.268</td>
<td>0.160</td>
<td>0.779</td>
<td>0.210</td>
<td>0.438</td>
</tr>
<tr>
<td>FCD4</td>
<td>0.170</td>
<td>0.294</td>
<td>0.123</td>
<td>0.784</td>
<td>0.510</td>
<td>0.489</td>
</tr>
<tr>
<td>FCP1</td>
<td>0.398</td>
<td>0.404</td>
<td>0.152</td>
<td>0.462</td>
<td>0.866</td>
<td>0.503</td>
</tr>
<tr>
<td>FCP2</td>
<td>0.354</td>
<td>0.285</td>
<td>0.171</td>
<td>0.439</td>
<td>0.803</td>
<td>0.426</td>
</tr>
<tr>
<td>FCP3</td>
<td>0.345</td>
<td>0.361</td>
<td>0.139</td>
<td>0.391</td>
<td>0.856</td>
<td>0.414</td>
</tr>
<tr>
<td>FCP4</td>
<td>0.331</td>
<td>0.253</td>
<td>0.173</td>
<td>0.387</td>
<td>0.821</td>
<td>0.414</td>
</tr>
<tr>
<td>FCP5</td>
<td>0.240</td>
<td>0.234</td>
<td>0.259</td>
<td>0.360</td>
<td>0.763</td>
<td>0.394</td>
</tr>
<tr>
<td>FCP6</td>
<td>0.185</td>
<td>0.297</td>
<td>0.106</td>
<td>0.394</td>
<td>0.228</td>
<td>0.657</td>
</tr>
<tr>
<td>FCP7</td>
<td>0.205</td>
<td>0.343</td>
<td>0.166</td>
<td>0.545</td>
<td>0.518</td>
<td>0.850</td>
</tr>
<tr>
<td>FCP8</td>
<td>0.162</td>
<td>0.242</td>
<td>0.206</td>
<td>0.561</td>
<td>0.499</td>
<td>0.819</td>
</tr>
<tr>
<td>FCP9</td>
<td>0.227</td>
<td>0.213</td>
<td>0.152</td>
<td>0.490</td>
<td>0.398</td>
<td>0.845</td>
</tr>
<tr>
<td>FCP10</td>
<td>0.139</td>
<td>0.206</td>
<td>0.056</td>
<td>0.410</td>
<td>0.349</td>
<td>0.718</td>
</tr>
<tr>
<td>GSCM_GP1</td>
<td>0.823</td>
<td>0.536</td>
<td>0.149</td>
<td>0.175</td>
<td>0.254</td>
<td>0.173</td>
</tr>
<tr>
<td>GSCM_GP2</td>
<td>0.905</td>
<td>0.634</td>
<td>0.277</td>
<td>0.255</td>
<td>0.371</td>
<td>0.239</td>
</tr>
<tr>
<td>GSCM_GP3</td>
<td>0.746</td>
<td>0.403</td>
<td>-0.080</td>
<td>0.051</td>
<td>0.225</td>
<td>0.052</td>
</tr>
<tr>
<td>GSCM_GP4</td>
<td>0.852</td>
<td>0.388</td>
<td>0.253</td>
<td>0.235</td>
<td>0.436</td>
<td>0.185</td>
</tr>
<tr>
<td>GSCM_IR1</td>
<td>0.062</td>
<td>0.156</td>
<td>0.766</td>
<td>0.062</td>
<td>0.117</td>
<td>0.102</td>
</tr>
<tr>
<td>GSCM_IR2</td>
<td>0.182</td>
<td>0.262</td>
<td>0.780</td>
<td>0.028</td>
<td>0.129</td>
<td>0.119</td>
</tr>
<tr>
<td>GSCM_IR3</td>
<td>0.234</td>
<td>0.224</td>
<td>0.897</td>
<td>0.179</td>
<td>0.255</td>
<td>0.202</td>
</tr>
<tr>
<td>GSCM_IR4</td>
<td>0.200</td>
<td>0.291</td>
<td>0.594</td>
<td>0.085</td>
<td>0.056</td>
<td>0.071</td>
</tr>
<tr>
<td>GSCM_PR1</td>
<td>0.527</td>
<td>0.823</td>
<td>0.222</td>
<td>0.210</td>
<td>0.258</td>
<td>0.241</td>
</tr>
<tr>
<td>GSCM_PR2</td>
<td>0.474</td>
<td>0.782</td>
<td>0.302</td>
<td>0.284</td>
<td>0.275</td>
<td>0.279</td>
</tr>
<tr>
<td>GSCM_PR3</td>
<td>0.402</td>
<td>0.706</td>
<td>0.352</td>
<td>0.294</td>
<td>0.293</td>
<td>0.273</td>
</tr>
<tr>
<td>GSCM_PR4</td>
<td>0.565</td>
<td>0.788</td>
<td>0.095</td>
<td>0.342</td>
<td>0.431</td>
<td>0.277</td>
</tr>
<tr>
<td>GSCM_PR5</td>
<td>0.373</td>
<td>0.846</td>
<td>0.161</td>
<td>0.272</td>
<td>0.225</td>
<td>0.304</td>
</tr>
<tr>
<td>GSCM_PR6</td>
<td>0.386</td>
<td>0.730</td>
<td>0.226</td>
<td>0.197</td>
<td>0.207</td>
<td>0.120</td>
</tr>
</tbody>
</table>

Table 5  Assessment of the control variables

<table>
<thead>
<tr>
<th>Control variable</th>
<th>Firm competitiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beta</td>
</tr>
<tr>
<td>Number of employees</td>
<td>0.060</td>
</tr>
</tbody>
</table>

Note: *p < 0.05; **p < 0.01
Figure 1 Measurement model with firm competitiveness as second order construct (see online version for colours)
We proceeded with the path analysis to test three hypotheses. Firm competitiveness was conceptualised as a second-order construct, which comprises three first-order constructs (price, quality, and delivery). Since firm competitiveness constitutes a second-order construct, items representing each firm competitiveness construct were totalled to provide a score on a composite variable. Figure 1 demonstrates the results of the direct effect hypothesised in this study. The $R^2$ value of firm competitiveness was 0.223 proposing that 22.3% of the variance in firm competitiveness can be explained by price, quality, and delivery.

We ran the bootstrapping procedure with 500 re-samples to test the significance of the regression coefficient. The results showed that both green production ($\beta = 0.220, p < 0.05$) and green purchasing ($\beta = 0.266, p < 0.01$) were positively related to firm competitiveness. Thus, our hypotheses, H1 and H2 were supported. Conversely, investment recovery was not found to be significantly related to firm competitiveness ($\beta = 0.114, p > 0.05$). Therefore, H3 was not supported.

Predictive relevance using blindfolding to obtain cross-validated redundancy measures for each endogenous construct. The predictive capability for the model was tested via the $Q^2$ statistic. A $Q^2$ value greater than zero means that the model has predictive relevance, whereas a $Q^2$ value less than zero means that the model lacks predictive relevance (Fornell and Cha, 1994). There are two types of $Q^2$ statistical estimates, namely, cross-validated communality ($H^2_j$) and cross-validated redundancy ($F^2_j$). Both $H^2_j$ and $F^2_j$ values should be greater than the threshold of zero (Fornell and Cha, 1994). By carrying out blindfolding, our results revealed that $H^2_j = 0.353$ and $F^2_j = 0.115$. Hence, it can be concluded that firm competitiveness was well-explained by green production and green purchasing.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Relationship</th>
<th>Beta</th>
<th>Standard error</th>
<th>t-value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>Green production $\rightarrow$ firm competitiveness</td>
<td>0.220</td>
<td>0.148</td>
<td>1.485*</td>
<td>Supported</td>
</tr>
<tr>
<td>H2</td>
<td>Green purchasing $\rightarrow$ firm competitiveness</td>
<td>0.266</td>
<td>0.137</td>
<td>1.937**</td>
<td>Supported</td>
</tr>
<tr>
<td>H3</td>
<td>Investment recovery $\rightarrow$ firm competitiveness</td>
<td>0.101</td>
<td>0.114</td>
<td>0.888</td>
<td>Not supported</td>
</tr>
</tbody>
</table>

Note: * $p < 0.05$; ** $p < 0.01$

5 Discussion, implications, and limitations

In this study, we examined the effects of three specific GSCM practices (green production, green purchasing, and investment recovery) on firm competitiveness. Generally, the statistical results provided support for most of the hypothesised relationships. The results showed that the higher the level of green production and green purchasing practices in a firm, the higher the level of firm competitiveness. Green production, which is emphasised by ‘reuse, reduce, recycle’ (3Rs), will help the firm in cost saving from direct materials and total product cost. Consequently, the firm’s production will be more efficient, which, in turn, will lead to increased firm
competitiveness. Our finding was consistent with the previous study conducted by Yang et al. (2010).

In the same vein, firms that practice green purchasing will emphasise the balancing among quality, cost, delivery and environmental concept in the purchasing activities. In green purchasing practice, the supplier section and evaluation will be based on the green purchasing criteria to ensure all purchased materials contain green attributes. Green attributed products comprise added advantages for the firms to go towards global competitiveness. This finding concurs with the finding obtained from Yang et al. (2010). On the other hand, investment recovery had no significant relationship with firm competitiveness. One of the possible reasons may be due to the low implementation and monetary restriction. The overall framework for investment recovery is expensive. Firms may not look at the whole value chain and the long run benefit.

Our study offers several implications for the manufacturing industry. Green production and green purchasing have a positive impact on firm competitiveness. These serve as motivation to encourage firms to implement GSCM practices. Firms can further extend the green purchasing elements, such as supplier selection and evaluation, based on environmental criteria. In addition, firms can implement the 3Rs programme in the production lines. This will ensure that the products and services produced by the firms are environmentally friendly. Managers of the firms should view GSCM practices positively and provide full support and cooperation for the implementation of green purchasing and production in the firm. Only the complete implementation of GSCM practices will bring overall efficiency to the monetary cost saving for the firm.

The principal limitations of this study can be viewed from two main aspects. Firstly, limitation in scope as only three GSCM practices was examined. Future research may include other types of GSCM practice. Secondly, the respondents were restricted to the manufacturing sector. Future research should go for a more diverse sample, such as extended to the service industry because manufacturing firms might have different GSCM practices and outcomes compared to service firms.

References
The impact of green supply chain management practices


