Green supply chain initiatives among certified companies in Malaysia and environmental sustainability: Investigating the outcomes

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Abstract

The relationship between green supply chain initiatives and performance outcomes has been subject to numerous studies but the results are not conclusive. This study tries to assess the actual environmental, economic and intangible outcomes resulting from the adoption of green supply chain initiatives. This study used a structured questionnaire derived from the literature and employing a mail survey to collect responses from a group of 569 ISO 14001 certified firms in Malaysia. The results of testing the hypotheses that predicted that green supply chain initiatives have positive effect on the outcomes showed that eco-design have significant positive effect on the four types of outcomes (environmental outcomes, economic outcomes, cost reductions, and intangible outcomes). Reverse logistics was found to have significant positive effect on cost reductions only. However, green purchasing was not found to have significant effect on any of the four types of outcome. Through designing environmentally friendly products and taking back products and packaging, business organizations can generate benefits to the environment, in the form of reduced waste and better resource utilization, in addition to economic benefits and cost reductions to the organizations.

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1. Introduction

Natural environment becomes a challenging issue to business organizations in recent years as a result of global and local environmental problems. Business operations, such as sourcing, manufacturing and logistics, are believed to be responsible for most of these problems (Beamon, 1999). Consequently, business operations are subject to increasing pressures and scrutiny from various stakeholders inside and outside organization such as government agencies, workers, neighbors and not-for-profit groups (Sarkis, 2006). This is over and above growing demand of customers and environmental societies for more environmental friendly products. These challenges and pressures push firms to seriously considering environmental impacts while doing their business. Green becomes a common practice to portray the environmental friendly image of products, processes, systems and technologies, and the way business is conducted (Vachon and Klassen, 2006a, b). However, most of the adopted green solutions, especially in developing countries, remain to be the traditional command-and-control or “end-of-the-pipe” solutions where a firm tries to eliminate or reduce negative environmental impacts, after they are created, rather than adopting a proactive approach to reduce the sources of waste or pollution (Anbumozhi and Kanda, 2005; Walton et al., 1998).

The traditional green initiatives are associated with many weaknesses and problems. The end-of-the-pipe approach does not eliminate pollutants, but merely transforms them from one medium to another (Sarkis, 2006). Moreover, focusing green practices inside organization may expose the organization to negative environmental performance of other organizations in its supply chain. For instance, the poor environmental performance of small suppliers can affect badly the performance and image of buying companies (Christmann and Taylor, 2001; Cousins et al., 2004; Faruk et al., 2002; Darnall and Edwards, 2006; Hall, 2001). In addition, community stakeholders often do not distinguish between an organization’s environmental practices and the practices of its suppliers (Rao, 2002; Sarkis, 2006). In Malaysia, environmental issues have become very important issue of concern for the Malaysian government and the public. The Environmental Quality Act was established in 1974 and has been amended a number of times to encompass 18 sets of regulations to help implement projects relating to clean air, sewage and industrial effluent assessment (Rao, 2004, p. 292). Moreover, numerous pressure groups were formulated to monitor environmental issues. Pressure groups include non-governmental organizations (NGOs) such as Environmental...
Protection Society of Malaysia, in addition to intense media scrutiny of environmental problems (Green Purchasing Network Malaysia GPNM, 2003). However, despite government efforts and growing public awareness of environmental issues, environmental problems continue to persist. In response to environmental issues at global and local levels, firms start to adopt environmental management initiatives that can be categorized in five levels as follows: 


Green supply chain is defined as “the extension of the traditional supply chains to include activities that aims at minimizing environmental impacts of a product throughout its entire life cycle, such as green design, resource saving, harmful material reduction and product recycle or reuse” (Beamon, 1999). The traditional supply chain is typically defined as “a set of three or more entities directly involved in the upstream or downstream flows of products, services, finances, and/or information from a source to a customer.” (Mentzer et al., 2001, p. 4). The definition of traditional supply chain set the boundaries of supply chain to end in the final consumer. Moreover, the traditional supply chains are based on a linear production paradigm which relies on constant input of virgin natural resources and unlimited environmental capacity for assimilation of wastes (Geyer and Jackson, 2004). The objective of green supply chain is to eliminate or minimize negative environmental impacts (air, water, and land pollution) and waste of resources (energy, materials, products) from the extraction or acquisition of raw materials up to final use and disposal of products (Hervani et al., 2005).

The study of the outcomes of green supply chain initiatives is expected to portray the extent to which green supply chain initiatives are effectively adopted. The relationship between green supply chain initiatives and performance outcomes has been subject to numerous studies but the results are not conclusive. While Carter et al. (2000), Rao and Holt (2005), and Zhu and Sarkis (2004) found that green supply chain initiatives have significant positive relationship with environmental and economic performance of organizations, Vachon and Klassen (2006b) and Zhu et al. (2007) found no significant relationships between green supply chain initiatives and such performance outcomes. This inconclusive result raises the question of what are the actual outcomes that can be realized from the adoption of green supply chain initiatives.

Moreover, the available studies investigate only the environmental, economic, and operational outcomes of green supply chain initiatives. However, intangible outcomes, such as organizational image and customer loyalty, receive little consideration as an outcome of green supply chain initiatives. Although empirical studies show that intangible outcomes result from the adoption of internal green practices such as Environmental Management Systems (EMS), (Hui et al., 2001; Perry and Singh, 2002; Poksinska et al., 2003; Rao, 2002; Sulaiman and Ahmad, 2002; Tan, 2005; Vastag and Melnyk, 2002), no study found investigating the intangible outcomes of green supply chain initiatives. Therefore, this study tries to find out actual environmental, economic and intangible outcomes resulting from the adoption of green supply chain initiatives. This paper is organized as follows. Next section discusses on the green supply chain initiatives and the outcomes. This is followed by the methodology and analysis. The discussions will end the paper.

2. Literature review

2.1. Green supply chain initiatives

The concept of green supply chain is a multidisciplinary issue that emerges mainly from performing environmental management practices in the context of supply chains (Sarkis, 2006; Walton et al., 1998). Environmental management represents specification of how organizations care about the natural environment and minimize the negative environmental effects of their entire operations (Klassen and McLaughlin, 1996; Welford, 2000). Environmental management principles specify policies, procedures, and audit protocols for controlling operations that create waste materials or emissions (Matthews, 2003). These principles usually take the form of standardized EMS such as British Standard for EMS BS7750 (1994), the EU eco-management and audit scheme (1993), and the international standard ISO 14000 (Bansal and Clelland, 2004). These standards have been developed to provide organizations with a framework to implement EMS (Netherwood, 1996).

While environmental management principles and standards provide powerful tools that have a potential to generate significant improvements to environmental performance of organizations, their focus restricted only on creating and documenting environmental policies and procedures (Curtovic et al., 2005). Such policies and procedures may represent efforts to improve environmental performance only within the organization’s operational boundaries rather than being extended throughout the supply chain (Bansal and Clelland, 2004; Handfield et al., 2005). Firms can market themselves as being environmentally proactive (by virtue of having an EMS) without undertaking the effort of “greening” their supply chains (Darnall and Edwards, 2006). Unlike the traditional environmental management, the concept of green supply chain assumes full responsibility of a firm towards its products from the extraction or acquisition of raw materials up to final use and disposal of products (Hart, 1995). It represents application of environmental management principles to the whole set of activities spanning the entire customer order cycle, including design, procurement, manufacturing and assembly, packaging, logistics, and distribution (Handfield et al., 1997; Zsidisin and Siferd, 2001). This implies that there is a wide range of initiatives that can be performed within green supply chains. As a result, there is a disagreement among scholars regarding what green supply chain initiatives are. The lack of consensus on green supply chain initiatives is due to the fact that green supply chain is a new area of study and practice, and theory in this area is underdeveloped, as pointed out by (Sarkis, 1999). The green supply chain initiatives that have been widely discussed in the literature can be generally classified into the following categories:

1. Eco-design or design for the environment: Includes activities that aim to minimize environmental impacts of products during their entire life cycle (Beamon, 1999; Hervani et al., 2005; Sarkis, 1998; Walton et al., 1998; Zhu et al., 2007).
2. Green purchasing: Includes activities that aim to make sure that purchased items have desirable environmental attributes such as reusability, recyclability, and absence of hazardous materials (Bowen et al., 2001a,b; Carter and Carter, 1998; Hervani et al., 2005; Min and Galle, 2001; Preuss, 2001; Rao, 2002, 2004; Walton et al., 1998; Zhu et al., 2007).
3. Supplier environmental collaboration: Includes activities that aim at improving environmental performance and capabilities of suppliers at undertaking joint projects for developing green products and innovations (Bowen et al., 2001a; Canning and Hamner-Lloyd, 2001; Hall, 2000; Rao, 2002; Vachon and Klassen, 2006a,b; Vachon and Klassen, 2007a,b).
4. Customer environmental collaboration: Includes activities that aim at improving environmental performance and capabilities of customer at undertaking joint projects for developing green products and innovations (Canning and Hamner-Lloyd, 2001; Vachon and Klassen, 2006a,b, 2007a,b).
5. Reverse logistics: Include activities that aim at taking back products or materials for the purposes of reuse or recycling (Alvarez-Gil et al., 2007; Beamon, 1999; Blumberg, 1999; Carter and Ellram, 1998; Hervani et al., 2005; Murphy and Poist, 2003;
2.1. Eco-design

Eco-design (environmental-conscious design), also called design for the environment and green design, refers to actions taken during product development aimed at minimizing a product’s environmental impact throughout its entire lifecycle—from acquiring materials, to manufacturing, use, and ultimately to its final disposal—without compromising other essential quality criteria such as performance and cost (Johansson, 2002). Accordingly, eco-design is considered one of the green supply chain initiatives because it integrates environmental aspects into product design process, taking into consideration entire flow of the product in its supply chain. This consideration is important because the majority of environmental impacts arise from production, consumption and disposal of the product are direct consequences of decisions made at the design stage (Handfield et al., 2001). At the design stage, the function of the product, process or service is defined, and raw materials, supplies and process chemicals are selected. These in turn determine the energy which will be consumed to create them and the waste which will be generated. The specific eco-design actions or activities vary between companies and products. However, the basic eco-design activities include the following:

1. **Design for reduction** or elimination of environmentally-hazardous materials such as lead, mercury, cadmium (Zsidisin and Siferd, 2001).
2. **Design for reuse** is a design that facilitates reuse of a product or part of it with or without minimal treatment of the used product (Sarkis, 1998).
3. **Design for recycling**, is a design that facilitates disassembly of the waste product, separation of parts according to material, and reprocessing of the material (Lin et al., 2001).
4. **Design for remanufacturing**, is a design that facilitates repair, rework, and refurbishment activities aiming at returning the product to the new or better than new condition (Beamon, 1999).
5. **Design for resource efficiency**, including reduction of materials and energy consumption of a product during use, in addition to promoting the use of renewable resources and energy (APO, 2004).

2.1.2. Green purchasing

Green purchasing is an environmentally-conscious purchasing initiative that tries to ensure that the purchased products or materials meets environmental objectives set by the purchasing firm, such as reducing sources of waste, promoting recycling, reuse, resource reduction, and substitution of materials (Carter et al., 1998; Min and Galle, 2001; Zsidisin and Siferd, 2001). Green purchasing means that purchasing or supply chain managers consider the issue of sustainability in their purchasing of inputs in addition to the traditional purchasing criteria of cost, quality, and delivery (Lambert and Cooper, 2000). Several green purchasing activities can be identified from the literature. Hamner (2006) summarized the basic green purchasing activities in seven points as follows:

1. **Product content requirements**: buyers specify that purchased products must have desirable green attributes such as recycled or reusable items.
2. **Product content restrictions**: buyers specify that purchased products must not contain environmentally undesirable attributes such as lead, CFCs or plastic foam in packaging materials.
3. **Product content labeling or disclosure**: buyers require disclosure of the environmental or safety attributes of purchased product content. Such disclosure can be done using green seals and indicators of relative environmental impact such as scientific certification system offered by various commercial organizations.
4. **Supplier questionnaires**: buyers send questionnaires to suppliers asking them to provide information about their environmental aspects, activities and/or management systems.
5. **Supplier environmental management systems**: buyers require suppliers to develop and maintain an environmental management system (EMS). However the buyer does not require supplier to certify the system.
6. **Supplier certification**: buyers require suppliers to have an EMS that is certified as fully compliant with one of the recognized international standards such as the British Standard 7750 (BS 7750), ISO 14001 from the International Organization for Standardization (ISO), and the European Union Eco-Management and Audit Scheme (EMAS).
7. **Supplier compliance auditing**: buyers audit suppliers to determine their level of compliance with environmental requirements.

Green purchasing deals mainly with controlling environmental performance of suppliers. Being located at the beginning of the forward flow of materials within an organization, purchasing is placed in an advantageous position to play a key role in the greening of products and activities (Carter et al., 1998; Preuss, 2001). However, incorporating environmental considerations into the purchasing function may post significant pressures and complications to the purchasing process because purchasing must consider the supplier’s environmental aspects, as well as supplier’s cost, lead-time, quality and flexibility (Handfield et al., 2002).

2.1.3. Supplier environmental collaboration

Supplier environmental collaboration extends green purchasing activities to include more collaborative activities performed by the buying firm to improve the supplier’s environmental performance (Bowen et al., 2001a). The main supplier environmental collaboration activities include the following:

1. **Supplier education**: includes conducting educational activities by buyers towards their suppliers about environmental issues and environmental management activities. Examples of these educational activities include holding awareness seminars for suppliers, informing the suppliers about the benefits of green practices, and bringing together suppliers in the same industry to provide them know-how information (Bowen et al., 2001a; Rao, 2002).
2. **Supplier support**: includes providing direct support from buyers to suppliers to help them improve their environmental performance. Examples of these support activities include setting up environmental teams to guide suppliers in their development of environmental programs, visiting suppliers premises to provide on-site technical assistance, and providing financial assistance to suppliers to improve their environmental performance (Hines and Jones, 2001; Walton et al., 1998).
3. **Joint ventures**: In this form of collaboration, buying firm works jointly with its suppliers and establishes common teams and joint long-term programs to develop green innovations and solutions such as clean technologies and green product designs (Bowen et al., 2001a; Vachon and Klassen, 2006a,b).

Unlike green purchasing, supplier environmental collaboration entails a lot of involvement and investment in suppliers’ operations. In this case, buyer focuses less on immediate outcome of suppliers’ environmental efforts (e.g. compliance to green standards), and more on the process by which more environmentally sound products or process might be achieved (Vachon and Klassen, 2006a,b).
2.1.4. Customer environmental collaboration

Similar to supplier environmental collaboration, customer environmental collaboration involves direct intervention of a firm to improve the environmental performance of its customers. Customer environmental collaboration includes exchange of technical information between a firm and its customers, in addition to willingness to learn about each other’s operations in order to plan and set goals for environmental improvement. It also implies cooperation to reduce the environmental impact associated with product flows in the supply chain (Vachon and Klassen, 2007a,b). The specific customer environmental collaboration practices are similar to those mentioned for suppliers previously, except the selling firm takes the ownership of the activities:

1. Customer education
2. Customer support
3. Joint ventures

2.1.5. Reverse logistics

Reverse logistics focuses primarily on the return or take-back products and materials from the point of consumption to the forward supply chain for the purpose of recycling, reuse, remanufacture, repair, refurbishing, or safe disposal of the products and materials (Carter and Ellram, 1998; Alvarez-Gil et al., 2007; Stock, 1998). Reverse logistics encompasses the traditional logistics activities of transportation and inventory management, but its focus is to get product back from customers rather than moving product to customers (Goldsby and Stank, 2000; Mollenkopf and Closs, 2005). Used or end-of-life products returned into the forward supply chain for three main purposes (Beamon, 1999; Wells and Seitz, 2005):

1. Reuse, is the process of collecting used products from the field, and distributing or selling them used. The ultimate value of the product is reduced, without additional processing.
2. Remanufacturing, is the process of collecting a used product from the field, assessing its condition, and replacing defective or obsolete parts with new or refurbished parts. The identity and functionality of the original product is retained.
3. Recycling, is the process of collecting used products, disassembling them, separating them into material categories, and processing them into recycled products, components, and/or materials. The identity and functionality of the original materials is lost.

In conclusion, there are five basic categories of green supply chain initiatives described in the literature; eco-design, green purchasing, supplier environmental collaboration, customer environmental collaboration, and reverse logistics. In real life, it can be observed that some of the above-mentioned initiatives are widely adopted while others are low. Therefore, for this study, only three initiatives will be studied. They are reverse logistics, green purchasing and environmental collaboration since they are commonly adopted in Malaysia. This raises a question about what benefits or outcomes to business organizations in adopting green supply chain initiatives.

2.2. Outcomes of green supply chain initiatives

Outcomes are defined in this study as the results that are actually realized from adopting green supply chain initiatives by manufacturing firms. While environmental initiatives are considered to involve considerable costs and investments, especially during initial stages (Min and Galle, 2001), and it is against sound business strategy and a poor allocation of firm investment that generally generate negative returns to shareholders (Walley and Whitehead, 1994), many scholars believe that these initiatives are no longer a threat, but a business opportunity (e.g., Paul, 1995; Porter and van der Linde, 1995; Hutchinson, 1996; Martin, 2005; Heese et al., 2005) and even a source of sustained competitive advantages (Hart, 1995; Sinding, 2000). For green supply chain initiatives, previous studies found that these initiatives result in numerous performance outcomes and can be broadly classified into four categories:

1. **Environmental outcomes**: include effects of green supply chain initiatives on the natural environment inside and outside the firm (Bowen et al., 2001; Rao, 2002; Vachon and Klassen, 2006b, 2007a,b; Zhu and Sarkis, 2004; Zhu et al., 2007).
2. **Economic outcomes**: are financial benefits that reflect to the whole organization such as profitability sales, market share, and productivity (Carter et al., 2000; Rao and Holt, 2005; Ritchie et al., 2001; Zhu and Sarkis, 2004).
3. **Operational outcomes**: Are benefits that reflect on the operational level of the organization such as cost reductions, quality, flexibility, and delivery (Carter et al., 2000; Chung and Tsai, 2007; Rao and Holt, 2005; Ritchie et al., 2001; Vachon and Klassen, 2006b, 2007a,b).
4. **Intangible outcomes**: Are conceptual or difficult to quantify outcomes such as organizational image and customer satisfaction (Smith, 2005).

2.2.1. Environmental outcomes

Environmental outcomes represent positive consequences of green supply chain initiatives on the natural environment inside and outside organizations. They include reduction of solid/liquid wastes, reduction of emissions, resource reduction, and decrease of consumption for hazardous/harmful/toxic materials, decrease of frequency of environmental accidents, and improved employee and community health (Fives Winds International, 2003; Geyer and Jackson, 2004; Zhu and Sarkis, 2004). The literature tends to support the idea that green supply chain initiatives have positive environmental outcomes. For instance, Frosch (1994) argued that an inter-firm linkage facilitated by proximity could lead to improvement in environmental performance. Florida (1996) stated that closer bonds between suppliers and customers can facilitate cleaner production. Geyer and Jackson (2004) identified environmental benefits of green supply chain as: (1) diversion of products from landfill of the end-of-life waste, (2) replacing primary with secondary resources in the reverse supply chain, thus avoiding the environmental burdens of production processes. Zhu and Sarkis (2004) analyze data from the manufacturing sector in China and found significant positive relationships between green supply chain initiatives (green purchasing, eco-design, and customer cooperation) and environmental performance.

2.2.2. Economic outcomes

Economic outcomes are financial benefits that result from green supply chain initiatives. Economic outcomes include profitability, revenue growth, increase in market share, and increase in productivity (Mollenkopf and Closs, 2005; Stock et al., 2006; Zhu and Sarkis, 2004). Green supply chain initiatives can lead to economic outcomes in many ways. Mollenkopf and Closs (2005) identified four ways that reverse logistics can generate financial benefits to a firm: (1) increased revenues from “secondary” sales (sale of reprocessed or remanufactured products) and from reducing discounting levels by offering fresh stock in place of unsold or low-selling stock, (2) the goodwill earned from acting in a socially or environmentally responsible manner can produce real economic value, (3) cost reductions that come from the reduced cost of goods sold and lower operating expenses can enhance profitability (4) better management of returns inventory can improve asset turnover.
In addition, Heese et al. (2005) emphasize that a firm can often gain a competitive edge by introducing product take-back. Using its market acuity, its reputation, its better access to original parts and its potential to efficiently refurbish used products in-house, a manufacturer that takes back and resells refurbished products creates an additional source of income. Partially passing these benefits onto the customer by means of price discounts, a refurbishing manufacturer not only increases its unit margin, but also its market share. Stock et al. (2006) add further that effective product manufacturer not only increases its unit margin, but also its market share. Stock et al. (2006) add further that effective product returns strategies and programs can result in increased revenues, lower costs, improved profitability and enhanced level of customer service. Nevertheless, studies on the economic benefits of green supply chain initiatives found varying results. Bowen et al. (2001a) suggest that economic performance is clearly not being reaped in short-term profitability and sales performance. Min and Galle (2001) found that green purchasing lead to increased operational costs, and this in turn may have a negative impact on firm’s financial performance. Zhu et al. (2007) found no significant impact on economic performance. However, other studies suggest a positive relationship between green supply chain initiatives and economic performance (Carter et al., 2000; Rao and Holt, 2005; Zhu and Sarkis, 2004).

2.2.3. Operational outcomes

Operational outcomes represent direct impact of green supply chain initiatives on operational performance of a firm. Operational outcomes include cost reductions, product quality improvements, improvements in delivery and flexibility (Chung and Tsai, 2007; Vachon and Klassen, 2006a). The most cited operational outcome of green initiatives in the literature is cost reductions. Porter and van der Linde (1995, p. 126) provide comprehensive view of how environmental activities can result in costs reductions: (1) materials savings resulting from more complete processing, substitution, reuse, or recycling of production inputs, (2) better utilization of by-products in producing more products, (3) elimination or reduction of cost of activities involved in discards or waste handling, transportation and disposal, (4) lower energy consumption during production process and during product use, (5) lower packaging costs, (6) lower product cost (for instance, from material substitution, and (7) conversion of waste into valuable forms. Moreover, Tibben-Lembke (1998) show that green supply chain impact on disposal costs through guaranteed disposal, regulatory compliance, economies of scale, better salvage price, better access to secondary markets, lower disposal cost, and lower transportation cost.

Global Environmental Management Initiative (GEMI, 2001) illustrates further three ways by which resource utilization can result in cost savings for a firm. First, through minimization of resource consumption cost per unit can be reduced. Second, minimization of wastes and discharges can result in minimization of waste disposal efforts and costs. Finally, cost savings can result from use of alternative green materials or devices such as use of reused and recycled materials instead of virgin materials. Similarly, Mollenkopf and Closs (2005) affirm that the use of recycled, refurbished, or remanufactured products in the forward supply chain can create additional revenue, reduce operating costs, and minimize the opportunity costs of writing off defective or out-of-date products. However, other studies doubt the cost reductions from environmental initiatives and argue that these initiatives lead to increased costs rather than reductions (Min and Galle, 2001; Walley and Whitehead, 1994). Other than cost reductions, some studies found positive relationships between green supply chain initiatives and other aspects of operational outcomes. Vachon and Klassen (2006b) explore the effect of green collaboration, with suppliers and customers, on operational performance. They found that green collaboration with customers is positively linked to quality, flexibility, and environmental performance, while collaboration with suppliers is associated with better delivery performance. Moreover, Chung and Tsai (2007) found that eco-design have positive impact on delivery and quality.

2.2.4. Intangible outcomes

Intangible outcomes represent conceptual or difficult to quantify outcomes of green supply chain initiatives such as improved product image and enhanced image and goodwill of a firm in the eyes of its stakeholders (customers, employees, and community). Such improved image is expected to generate customer satisfaction and loyalty, employee satisfaction, brand value, enhanced publicity and marketing opportunities, and better acceptance of a firm by local communities (Five Winds International, 2003: Jayaraman and Luo, 2007). Jayaraman and Luo (2007) identified intangible outcomes that result from green supply chains as: (1) offering green products can help companies retain environmentally conscious customers and employees, (2) returned goods can provide valuable information about customer reaction, expectations, habits, opinion and satisfaction level, (3) philantrophy and goodwill returns can significantly improve a corporate image and increase market share.

Five Winds International study (2003) compiled “success stories” of firms in North America that undertake green procurement initiatives. The study reports that these firms realized numerous intangible benefits from green procurement such as: (1) easier compliance with environmental regulations and demonstration of due diligence, (2) improved image, brand and goodwill, and support of environmental/sustainability strategy and vision, and (3) improved employee and community satisfaction through cleaner air and water, reduced risk of accidents, less demand for landfill and less demand for resources. It is evident from the previous sections that green supply chain initiatives can result in positive outcomes both for external environment and to adopting organizations. While this may add to the value and importance of green supply chain practices, question arises about how to diffuse these valuable and important initiatives among business organizations.

2.3. Framework and hypothesis development

The available empirical evidence suggests that green supply chain initiatives are associated with better environmental performance (reduction of hazardous pollutants, wastes, and material use, etc.), economic performance (financial gains, increase in market share, sales growth, etc.), operational performance (cost reductions, delivery quality) as well as intangible gains (improved organizational image customer satisfaction and loyalty, etc.). Fig. 1 presents the framework for this study.

The next section will detail the hypotheses that are developed to be tested for this research.

2.3.1. Effect of green supply chain initiatives on environmental outcomes

Green supply chain initiatives are expected to generate valuable environmental outcomes inside and outside organization. Inside organization, green supply chain initiatives may have significant effects in reducing consumption of hazardous materials and wastes.

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**Fig. 1.** Research framework.

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<th>Green Supply Chain Initiatives</th>
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<td>Eco-Design</td>
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<td>Green Purchasing</td>
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<td>Reverse Logistics</td>
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that may have negative effects on employees and general work conditions. Externally, green supply chain initiatives are expected to have positive effects on the natural environment through reducing emissions and wastes throughout product life cycle and reducing burden on the natural resources through reducing the amount of materials and energy usage in producing and using products. Numerous empirical studies found significant positive relationship between green supply chain initiatives and environmental outcomes. For instance, Zhu and Sarkis (2004) found that green purchasing and eco-design are significantly positively linked with environmental performance. Therefore, it is hypothesized that:

- **H1.1a**: Green supply chain positively affects environmental outcomes.
- **H1.1b**: Green purchasing positively affects environmental outcomes.
- **H1.1c**: Reverse logistics positively affects environmental outcomes.

### 2.3.2. Effect of green supply chain initiatives on economic outcomes

Although the traditional view of environmental initiatives is that such initiatives are against sound business strategy and a poor allocation of firm investment that generally generate negative returns to shareholders (Walley and Whitehead, 1994), many scholars are in agreement that the environment makes good business sense and is no longer a threat, but a business opportunity (e.g., Paul, 1995; Porter and van der Linde, 1995; Hutchinson, 1996; Martin, 2005; Heese et al., 2005). Moreover, some authors believe that competitive strategies, such as cost, differentiation and niche strategies, can be weaved based on environmental concerns (Banerjee, 2001; Hart, 1995). Furthermore, empirical studies found significant positive association between green supply chain initiatives and economic performance. Sroufe (2003) found significant positive relationship (p-value < 0.01) between design practices (the use of substitution, reduction of materials contributing to environmental problems, the use of product and process redesign to eliminate potential environmental problems, redesigning to aid in disassembly, and the increased use of recycled materials) and operational performance (cost reductions, improved chances of selling products in international markets, benefits outweigh costs). Carter et al. (2000) and Zhu and Sarkis (2004) found also significant positive relationship between green purchasing and economic performance. Accordingly, it is hypothesized that:

- **H1.2a**: Green supply chain initiatives positively affect economic outcomes.
- **H1.2b**: Eco-design positively affects economic outcomes.
- **H1.2c**: Green purchasing positively affects economic outcomes.
- **H1.2d**: Reverse logistics positively affects economic outcomes.

### 2.3.3. Effect of green supply chain initiatives on operational outcomes

Operational outcomes represent direct impact of green supply chain initiatives on operational performance of a firm. Operational outcomes include cost reductions, product quality improvements, improvements in delivery and flexibility (Chung and Tsai, 2007; Vachon and Klassen, 2006a). However, other studies doubt the cost reductions from environmental initiatives and argue that these initiatives lead to increased costs rather than reductions (Min and Galle, 2001; Walley and Whitehead, 1994). Other than cost reductions, some studies found positive relationships between green supply chain initiatives and other aspects of operational outcomes. Vachon and Klassen (2006b) explore the effect of green collaboration, with suppliers and customers, on operational performance. They found that green collaboration with customers is positively linked to quality, flexibility, and environmental performance, while collaboration with suppliers is associated with better delivery performance. Moreover, Chung and Tsai (2007) found that eco-design have positive impact on delivery and quality. Accordingly, it is hypothesized that:

- **H1.3a**: Eco-design positively affects economic outcomes.
- **H1.3b**: Green purchasing positively affects operational outcomes.
- **H1.3c**: Reverse logistics positively affects operational outcomes.

### 2.3.4. Effect of green supply chain initiatives on intangible outcomes

Green supply chain initiatives, through their focus on reducing negative impacts on the environmental and promoting environmentally friendly products, are expected to improve the image of a firm in the eyes of its stakeholders including government, customers, suppliers, employees, and the public at large. This positive image is very important because it may lead to other intangible benefits such as gaining customer satisfaction and loyalty in addition to improved staff morale (Hoffman, 2001; Five Winds, 2003). Although no empirical test of the relationship between green supply chain initiatives and intangible outcomes is found in the literature, the available empirical evidence shows that environmental initiatives, in general, have significant intangible outcomes such as customer loyalty (Hui et al., 2001; Kassinis and Soteriou, 2003), staff morale (Hui et al., 2001), in addition to enhanced organizational image (Ann et al., 2006; Jayaraman and Luo, 2007; Mollenkopf and Closs, 2005; Perry and Singh, 2002; Poksinska et al., 2003; Sulaiman and Ahmad, 2002; Tan, 2005; Vastag and Melnyk, 2002). Therefore, this study hypothesizes that:

- **H1.4a**: Green supply chain initiatives positively affect intangible outcomes.
- **H1.4b**: Eco-design positively affects intangible outcomes.
- **H1.4c**: Green purchasing positively affects intangible outcomes.
- **H1.4d**: Reverse logistics positively affects intangible outcomes.

### 2.4. Control variables

To ensure robustness and credibility of results, this study controls for a number of extraneous or contextual variables that may affect the results of the study. The control variables in this are: type of industry, number of employees (firm size), firm ownership, number of suppliers, and participation in green-interested associations. The selection of these variables is based on previous studies that found significant effect of these variables on green initiatives. For instance, Banerjee (2001) found that high impact industries (e.g. chemical industry) have high green initiatives compared with low impact industries (e.g. textile industry). Bowen (2002) argues that larger firms are more committed to voluntary green initiatives because they have more resources and they are more visible to the society. Participation in green-interested associations, e.g. professional associations is expected to raise the level of awareness of green issues in a firm, and consequently its green initiatives (DiMaggio and Powell, 1983).

### 3. Methodology

#### 3.1. Sample and data

This study conducted a survey to obtain quantitative data for statistical testing of the hypotheses. The survey was conducted using mail questionnaire. Mail questionnaire method was employed in this study because of its advantage of covering wide geographical
questionnaires were addressed to the EMR in each firm. Considered to be the most appropriate respondent. Therefore, the addition to his knowledge about the business issues, this person is expected to be highly informative about green issues in his firm, in environmental performance in his firm. Because this person is regularly updating to the certification organization about progress certified firm but mainly comes from operations, quality control, and the certified firm. The EMR can belong to any department in the company as well as individual units or sites within companies. ISO 14001 certified firms were selected because they are expected to be embarked in the adoption of green purchasing initiatives. This is supported by the studies of Darnall et al. (2008), Sroufe (2003), and Zhu et al. (2008). A sampling frame is a list of all elements in a population (Sekaran, 2003). For this study, the sampling frame represents all ISO 14001 certified firms in Malaysia. The sampling frame was obtained from SIRIM organization in addition to the Federation of Malaysian Manufacturers (FMM) directory 2007 of Malaysian manufacturers (FMM, 2007). These two sources provided a sampling frame of 569 certified manufacturing firms in Malaysia by 2007. Given the small sampling frame of the study and the likelihood of low response from mail survey (Sekaran, 2003); all the 569 are included in the study. Thus, the sampling technique employed in this study is census. As such, the study made a mail survey of a total of 569 ISO 14001 certified firms in Malaysia.

This study combines issues related to the environment (green issues) with business aspects (supply chain). Therefore, the appropriate person to get the required data from should ideally have knowledge about the two aspects. Certification organizations usually appoint an Environmental Management Representative (EMR) in each firm to act as a link between the certification organization and the certified firm. The EMR can belong to any department in the certified firm but mainly comes from operations, quality control, and environmental health and safety departments. The EMR keeps all the documents regarding green issues in his firm and makes regular updating to the certification organization about progress in environmental performance in his firm. Because this person is expected to be highly informative about green issues in his firm, in addition to his knowledge about the business issues, this person is considered to be the most appropriate respondent. Therefore, the questionnaires were addressed to the EMR in each firm.

### Variables and Measurement

The questionnaires used in this research was gleaned and compiled from various validated instruments from the literature reviewed but some modifications were made to wording to suit the context of this research. The details of the constructs and their respective sources are presented in Table 1.

### Results

The total population of the study is 569 firms. Given that this study is using consensus, all the 569 firms are used in the study. However, after excluding the 16 firms used for the pre testing of the questionnaire and the two firms used for the interviews, the population of the study becomes 551. Accordingly, a total of 551 questionnaires were mailed to the respondents. After two reminder letters in addition to telephone calls and e-mails, 132 completed questionnaires were received. The response rate is 24%. This response rate is considered acceptable given the low response expected from mail survey (Sekaran, 2003) and generally low response rate for this type of correlational study in Malaysia. The response rate is also considered acceptable compared to other similar studies. For instance, Vachon and Klassen (2006a,b) study on green supply chain initiatives reported a response rate of 23%, Rao (2002) study on green supply chain initiatives in Southeast Asia (including Malaysia) reported a response rate of 10%.

To ensure that the received responses are representative of the population of the study, a response bias is conducted following the procedure suggested by Armstrong and Overton (1977) of comparing early with late responses. Early responses are defined in this study as responses received before sending the first reminder (17 days from the first mailing), whereas late responses are those received after that. According to this criterion, 59 responses are considered early responses and 73 responses are considered late responses. Chi-square test is used to test for significant differences between early and late responses among twelve characteristics of firms and respondents under study. All the twelve characteristics of firms and respondents (type of industry, age of the firm, number

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>that purchased items meets environmental objectives of the firm such as</td>
<td></td>
</tr>
<tr>
<td></td>
<td>reducing or eliminating hazardous items, reducing sources of waste,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and promoting recycling and reclamation of purchased materials</td>
<td></td>
</tr>
<tr>
<td>Eco-design</td>
<td>Environmental-conscious design of a product and its packaging that aims</td>
<td>Vachon and Klassen (2006a), Zhu et al. (2007)</td>
</tr>
<tr>
<td></td>
<td>at minimizing negative environmental impacts of the product and its</td>
<td></td>
</tr>
<tr>
<td></td>
<td>packaging throughout its entire life and promoting positive environmental</td>
<td></td>
</tr>
<tr>
<td></td>
<td>practices such as recycling and reusing of the product and its</td>
<td></td>
</tr>
<tr>
<td></td>
<td>packaging</td>
<td></td>
</tr>
<tr>
<td>Reverse logistics</td>
<td>The return or take-back of a product or packaging, after use, from</td>
<td>Carter and Ellram (1998), Rogers and Tibben-Lembke (2001)</td>
</tr>
<tr>
<td></td>
<td>customers or to suppliers for the purpose of reuse, recycling, reclamation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of materials from the product or packaging, or safe refil of products</td>
<td></td>
</tr>
<tr>
<td>Environmental outcomes</td>
<td>Actual impacts of green supply chain initiatives on environmental</td>
<td>Zhu et al. (2007), Rao (2002)</td>
</tr>
<tr>
<td></td>
<td>performance of a firm such as compliance to environmental standards,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>reductions in air emissions, resource consumption, and consumption of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>hazardous materials</td>
<td></td>
</tr>
<tr>
<td>Economic outcomes</td>
<td>Actual impacts of green supply chain initiatives on financial</td>
<td>Zhu et al. (2007), Rao (2002)</td>
</tr>
<tr>
<td></td>
<td>performance of the firm such as increase in profitability, productivity,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>sales, and cost reductions</td>
<td></td>
</tr>
<tr>
<td>Operational outcomes</td>
<td>Actual impacts of green supply chain initiatives on operational</td>
<td>Zhu et al. (2007), Rao (2002)</td>
</tr>
<tr>
<td></td>
<td>performance of a firm such as cost reductions, product quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>improvements, improvements in delivery and flexibility</td>
<td></td>
</tr>
<tr>
<td>Intangible outcomes</td>
<td>Actual impacts of green supply chain initiatives on difficult to quantify</td>
<td>Rao (2002), Kasisinis and Soteriou (2003)</td>
</tr>
<tr>
<td></td>
<td>conceptual aspects related the firm’s and product image in the eyes of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>external and internal stakeholders including customers, suppliers,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>employees, and the general public.</td>
<td></td>
</tr>
</tbody>
</table>
of employees, type of products, ownership status of the firm, participation in green-interested associations, job title, department attached to, years of work in the firm, qualification, gender, and age of respondents) show no significant differences between early and late responses. Therefore, it can be concluded that non-response bias is not an issue in this study.

4.1. Profile of sample firms and respondents

The characteristics of responding firms are presented in Table 2.

4.2. Factor analysis of green supply chain initiatives

Factor analysis was performed for all the items included in green supply chain initiatives. The analysis starts with evaluating the appropriateness of the data or correlation matrix for factor analysis. As outlined in the methodology chapter, for the data matrix to be appropriate for factor analysis (factorability of the correlation matrix), there must be sufficient number of statistically significant correlations in the matrix as indicated by KMO measure of sampling adequacy and Bartlett’s test of sphericity. The KMO measure should be at least 0.6 and Bartlett’s test of sphericity should be significant (Hair et al., 1998; Pallant, 2003). By inspecting the values in Table 2, the KMO measure of sampling adequacy is 0.88 and the Bartlett’s test of sphericity is significant (p < .01) which indicates that the matrix meets the assumption of factor analysis and can be factorized. The three extracted factors matched the conceptualized types of green supply chain initiatives; green purchasing, eco-design, and reverse logistics. All items for green purchasing loaded on factor 1 with loading values above the specified limit of 0.45 and cross loadings below 0.35. Similarly, the items of eco-design and reverse logistics loaded on factors 2 and 3, respectively, with loading values above 0.45 and cross loadings below 0.35. The total variance explained by the three factors is 67.47% which exceeded the minimum value of 0.60 recommended by Hair et al. (1998).

4.3. Factor analysis of green supply chain initiatives outcomes

The result of factor analysis for the items that measure the outcomes from green supply chain initiatives is presented in Table 3. The table shows that the value of KMO measure of sampling adequacy is 0.896 (above the recommended level of 0.6) and Bartlett’s test of sphericity is significant (p < .01). This indicates that conditions of factor analysis were satisfactorily met and the data matrix is appropriate for subsequent factor analysis. The items were loaded on four distinct factors with eigenvalues above 1. The four factors cumulatively captured 73.36% of the total variance in the data (above the recommended level of 60%). The loading values of all items are above the minimum value of 0.45 on one factor and below the maximum value of 0.35 on other factors. Recalling that there are three outcomes from green supply chain initiatives (environmental, economic and intangible outcomes), it is clear from the inspection of the four extracted factors that two of them correspond to two of the outcomes from green supply chain initiatives. Specifically, factor 1 captures all the items of the intangible outcomes and factor 2 captures all the items of environmental outcomes. However, the items of economic outcomes split between factors 3 and 4.

Table 2
Profile of responding firms.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Categories</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of industry</td>
<td>Electrical and electronics</td>
<td>68</td>
<td>51.5</td>
</tr>
<tr>
<td></td>
<td>Chemicals</td>
<td>19</td>
<td>14.4</td>
</tr>
<tr>
<td></td>
<td>Rubber and plastics</td>
<td>14</td>
<td>10.6</td>
</tr>
<tr>
<td></td>
<td>Metals and machinery</td>
<td>24</td>
<td>18.2</td>
</tr>
<tr>
<td>Age of the firm</td>
<td>≤15 years</td>
<td>32</td>
<td>24.2</td>
</tr>
<tr>
<td></td>
<td>&gt;15 years</td>
<td>100</td>
<td>75.8</td>
</tr>
<tr>
<td>No. of employees</td>
<td>Less than 100</td>
<td>10</td>
<td>7.6</td>
</tr>
<tr>
<td></td>
<td>100–250</td>
<td>31</td>
<td>23.5</td>
</tr>
<tr>
<td></td>
<td>251–500</td>
<td>37</td>
<td>28.0</td>
</tr>
<tr>
<td></td>
<td>501–1000</td>
<td>17</td>
<td>12.9</td>
</tr>
<tr>
<td></td>
<td>More than 1000</td>
<td>37</td>
<td>28.0</td>
</tr>
<tr>
<td>Type of products</td>
<td>Consumer products</td>
<td>56</td>
<td>42.4</td>
</tr>
<tr>
<td></td>
<td>Industrial products</td>
<td>76</td>
<td>57.6</td>
</tr>
<tr>
<td>Number of suppliers</td>
<td>≤10 suppliers</td>
<td>32</td>
<td>24.2</td>
</tr>
<tr>
<td></td>
<td>More than 10 suppliers</td>
<td>100</td>
<td>75.8</td>
</tr>
<tr>
<td>Supplier relationship length</td>
<td>1–5 years</td>
<td>10</td>
<td>7.6</td>
</tr>
<tr>
<td></td>
<td>More than 5 years</td>
<td>122</td>
<td>92.4</td>
</tr>
<tr>
<td>Customer relationship length</td>
<td>1–5 years</td>
<td>4</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>More than 5 years</td>
<td>128</td>
<td>97.0</td>
</tr>
<tr>
<td>Source of inputs</td>
<td>Domestic</td>
<td>37</td>
<td>28.0</td>
</tr>
<tr>
<td></td>
<td>Regional/Asian</td>
<td>30</td>
<td>22.7</td>
</tr>
<tr>
<td></td>
<td>Global</td>
<td>65</td>
<td>49.2</td>
</tr>
<tr>
<td>Ownership status of the firm</td>
<td>Malaysian fully owned</td>
<td>39</td>
<td>29.5</td>
</tr>
<tr>
<td></td>
<td>Foreign joint venture</td>
<td>18</td>
<td>13.6</td>
</tr>
<tr>
<td></td>
<td>American-based company</td>
<td>16</td>
<td>12.1</td>
</tr>
<tr>
<td></td>
<td>Japanese-based company</td>
<td>46</td>
<td>34.8</td>
</tr>
<tr>
<td></td>
<td>European-based company</td>
<td>10</td>
<td>7.6</td>
</tr>
<tr>
<td></td>
<td>Other (Korean/Taiwanese)</td>
<td>3</td>
<td>2.3</td>
</tr>
<tr>
<td>Green associations participation</td>
<td>Yes</td>
<td>72</td>
<td>54.5</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>60</td>
<td>45.5</td>
</tr>
</tbody>
</table>

Table 3
Cronbach’s alpha, mean and standard deviation of major variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of items</th>
<th>Cronbach’s alpha</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green purchasing</td>
<td>9</td>
<td>0.929</td>
<td>3.37</td>
<td>.74</td>
</tr>
<tr>
<td>Eco-design</td>
<td>9</td>
<td>0.931</td>
<td>3.48</td>
<td>.79</td>
</tr>
<tr>
<td>Reverse logistics</td>
<td>6</td>
<td>0.914</td>
<td>2.74</td>
<td>.87</td>
</tr>
<tr>
<td>Environmental outcomes</td>
<td>6</td>
<td>0.884</td>
<td>4.08</td>
<td>.52</td>
</tr>
<tr>
<td>Economic outcomes</td>
<td>4</td>
<td>0.907</td>
<td>3.74</td>
<td>.60</td>
</tr>
<tr>
<td>Cost reductions</td>
<td>3</td>
<td>0.879</td>
<td>3.35</td>
<td>.73</td>
</tr>
<tr>
<td>Intangible outcomes</td>
<td>7</td>
<td>0.917</td>
<td>3.95</td>
<td>.50</td>
</tr>
</tbody>
</table>

Note: The predictors were measured using a 5-point Likert scale with (1, not at all; 5, very high extent). The outcomes were measured using a 5-point Likert scale with (1, strongly disagree; 5, strongly agree).
4. This indicates that there is a new variable or type of outcome emerges from the factor analysis.

By inspecting the items encompassed in the two factors, it is clear that factor 3 captures items that reflect general economic performance of the firm (productivity, profitability, revenue, and market share). Therefore, this factor will retain the name of economic outcomes. However, the items for factor 4 focus specifically on cost reductions (decrease in production, material, and packaging costs). Therefore, this factor will be given the name ‘cost reductions’. This splitting is justifiable because economic outcomes reflect more the overall performance of the firm while cost reductions focuses more on the operational level. Nevertheless, cost reductions returned back as part of operational outcomes. Therefore, the revised framework and revised hypotheses are shown in Fig. 2.

Based on the revised framework the following hypotheses are formulated to be tested.

- **H1.1:** Green purchasing (GP) positively affects outcomes
  - H1.1a: Green purchasing positively affects environmental outcomes.
  - H1.1b: Green purchasing positively affects economic outcomes.
  - H1.1c: Green purchasing positively affects cost reductions.
  - H1.1d: Green purchasing positively affects intangible outcomes.

- **H1.2:** Eco-design (ED) positively affects outcomes
  - H1.2a: Eco-design positively affects environmental outcomes.
  - H1.2b: Eco-design positively affects economic outcomes.
  - H1.2c: Eco-design positively affects cost reductions.
  - H1.2d: Eco-design positively affects intangible outcomes.

- **H1.3:** Reverse logistics (RL) positively affects outcomes
  - H1.3a: Reverse logistics positively affects environmental outcomes.
  - H1.3b: Reverse logistics positively affects economic outcomes.
  - H1.3c: Reverse logistics positively affects cost reductions.
  - H1.3d: Reverse logistics positively affects intangible outcomes.

### 4.4. Reliability analysis and descriptive for the main variables of the study

Reliability analysis is conducted in this study to ensure that the measures of variables have internal consistency across time and across the various items that measure the same concept or variable (Sekaran, 2003). Reliability is measured in this study using Cronbach’s alpha coefficients. The measures are considered to have sufficient level of reliability when Cronbach’s alpha values equal to or greater than 0.70 (Nunnally, 1978). Table 3 provides the values of Cronbach’s alpha for all the variables. It appears from the table that the values of Cronbach’s alpha ranges between 0.884 and 0.931. These values well exceed the minimum value of 0.70. Thus, it can be concluded that the measures have acceptable level of reliability.

Taking into consideration that the scale used for green supply chain initiatives is 1–5 (with 3 is the middle point), the table shows that the most adopted green supply chain initiative in the Malaysian industry is eco-design (mean = 3.48, standard deviation = 0.79), followed by green purchasing (mean = 3.37, standard deviation = 0.74), and the lowest adopted green supply chain initiative is reverse logistics (mean = 2.74, standard deviation = 0.87). This means that, on average, the Malaysian firms adopted high eco-design and green purchasing, and low reverse logistics. From Table 3 we can also conclude that environmental outcomes value is the highest among the four values (mean = 4.08, standard deviation = 0.52) and closely followed by intangible outcomes (mean = 3.95, standard deviation = 0.50), economic outcomes (mean = 3.74, standard deviation = 0.60), and lastly cost reductions (mean = 3.35, standard deviation = 0.73). The result indicate that, on average, during the last three years the sampled Malaysian firms experienced high level of increase in environmental and intangible outcomes, above average increase in economic outcomes, and moderate cost reductions.

### 4.5. The effects of green supply chain initiatives on outcomes

Hypothesis two predicts that green supply chain initiatives (green purchasing, eco-design, and reverse logistics) positively affect the four categories of outcomes (environmental outcomes, economic outcomes, cost reductions, and intangible outcomes). In step one, the analysis tests the effect of control variables on dependent variable. In step two, the independent or predictor variables were introduced to test their marginal effect on the dependent variable. Table 4 shows the result of the two step

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Multiple regressions: effects of control variables and green supply chain initiatives on outcomes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
<td>Environmental outcomes</td>
</tr>
<tr>
<td>Control variables</td>
<td>Step 1</td>
</tr>
<tr>
<td>Type of industry</td>
<td>0.018</td>
</tr>
<tr>
<td>Number of employees</td>
<td>0.011</td>
</tr>
<tr>
<td>Firm ownership</td>
<td>0.004</td>
</tr>
<tr>
<td>Number of suppliers</td>
<td>0.004</td>
</tr>
<tr>
<td>Participation in green associations</td>
<td>0.004</td>
</tr>
<tr>
<td>Model variables</td>
<td>Green purchasing</td>
</tr>
<tr>
<td>Eco-design</td>
<td>0.019</td>
</tr>
<tr>
<td>Reverse logistics</td>
<td>0.017</td>
</tr>
<tr>
<td>F value</td>
<td>0.004</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.084</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.075</td>
</tr>
<tr>
<td>F change</td>
<td>0.004</td>
</tr>
</tbody>
</table>

*p < 0.05.
**p < 0.01.
regression analysis for testing the effect of control variables and green supply chain initiatives on environmental outcomes. In step one, none of the control variables have significant effect and the variables explain only 4% of variance in the dependent variables. After adding the three types of green supply chain initiatives, R square increased by 29%, and the model as a whole becomes significant ($F = 7.02, \rho < 0.01$). Of the three types of green supply chain initiatives, only eco-design shows significant effect on environmental outcomes ($\beta = 0.66, \rho < 0.01$). Thus, hypothesis H1.2a (eco-design positively affects environmental outcomes) was supported.

The result of regression analysis of control variables and green supply chain initiatives on environmental outcomes indicate that only participation in the association s show significant influence on economic outcomes and the control variables together explain 11% of variance in the dependent variable. In step two, the addition of green supply chain initiatives explains additional 7% of the variance. Of the three types of green supply chain initiatives, only eco-design shows significant effect on economic outcomes ($\beta = 0.35, \rho < 0.01$). Therefore, hypothesis H1.2b (eco-design positively affects economic outcomes) was supported.

The regression analysis for testing the effect of green supply chain initiatives on cost reductions show that participation in green associations reveals significant effect on cost reductions. However, the model is not significant and the control variables together explain only 6% of variation in cost reduction. After the addition of green supply chain initiatives, R square increased by 12% and the model became significant ($F = 5.36, \rho < 0.01$). Two variables show significant show significant positive effect on cost reductions; eco-design ($\beta = 0.32, \rho < 0.01$) and reverse logistics ($\beta = 0.19, \rho < 0.05$) while the effect of green purchasing is not significant. These results give support to hypotheses H1.2c (eco-design positively affects cost reductions) and H1.3c (reverse logistics positively affects cost reductions).

The regression analysis for testing the effect of green supply chain initiatives on intangible outcomes show that only participation in green associations has a significant effect on the dependent variable in step one. However, the control variables together explain only 7% of variance in the dependent variable and the model as a whole is not significant. In the second step, the addition of green supply chain initiatives adds additional 16% and the model becomes significant. Investigating the effect of three types of green supply chain initiatives on intangible outcomes reveals that only eco-design has significant effect on intangible outcomes ($\beta = 0.53, \rho < 0.01$). Therefore, hypothesis H1.2d (eco-design positively affects intangible outcomes) was supported.

5. Discussions

The results of this study, and the previous studies, imply that externally-oriented green supply chain initiatives, such as green purchasing and reverse logistics, have little effect on the internal performance of the firm. This may indicate that the benefits of these initiatives may reflect on external parties rather than on the firm. For instance, in green purchasing the firm focuses on improving environmental performance of its suppliers. While the benefit of such initiative may reflect indirectly on the firm, through obtaining green materials and other inputs, the direct effect goes to suppliers. This view is supported by Carter (2005) who found no direct relationship between purchasing social responsibility (PSR) and cost reductions, however, he found that supplier performance mediate the relationship between PSR and cost reductions, his study indicates the direct benefit of green purchasing reflects first on suppliers before it is reflected in firm performance. The above explanation is evidenced further by the strong rela-

tionship, found in this study, between eco-design and the four types of outcome. Eco-design is an internally-focused type of green supply chain initiatives. This means that the firm tries to improve environmental attributes of its products internally, with little cooperation or interaction with external parties such as suppliers and customers. Therefore, the impact of such improvement can be directly linked to the internal performance of the firm. This is evidenced also by Sarkis et al. (2007) who found significant effect of internal environmental management on economic performance and no effect of the externally oriented green supply chain initiatives (green purchasing and customer cooperation) on economic performance.

The significant effect of reverse logistics on cost reductions, found in this study, give indication that gaining economic benefits is the main purpose of performing reverse logistics in the Malaysian firms. This is evidenced also by the significant relationship found in this study between expected business benefits and reverse logistics. This means that the adoption of reverse logistics is reflected directly in reduction of costs of materials and packaging because the firm uses recycled or reused materials instead of virgin ones. However, the insignificant effect of reverse logistics on economic outcomes indicates that cost savings from reverse logistics are small in amounts, so, they are not reflected in ‘macro’ indicators of firm’s economic performance such as profitability and productivity. This is supported by Clift (2003) who showed that the high costs associated with product recovery and recycle make returned products and components economically uncompetitive compared with the ‘new’ ones. This study investigated the effect of green supply chain initiatives on intangible outcomes as a newly investigated relationship that is rarely found in the previous literature. Although the results of the study showed that only eco-design have significant effect on intangible outcomes, the results gives indication that intangible outcomes are distinguished types of outcomes that result from green supply chain initiatives. The results indicated that firms that performed eco-design realized significant intangible outcomes, in terms of improved company image and customer satisfaction and loyalty.

5.1. Limitations and recommendations

Future studies can investigate the effect of green supply chain initiatives on other measures of outcomes. The insignificant effects of green purchasing and reverse logistics on the outcomes suggest that the benefits of these initiatives are realized by external parties, such as suppliers and customers, rather than the focal firm. Therefore, future studies may consider utilizing inter-organizational measures of outcomes such as dyadic measures rather than measuring the outcomes only from internal perspective. Furthermore, future studies may investigate the effect of green supply chain initiatives on other kinds of outcomes such as operational outcomes. Although one kind of operational performance is covered in this study (cost reductions) other kinds, such as quality, flexibility, and delivery may need to be investigated.

5.2. Conclusion

Some green supply chain initiatives were found in this study to have direct impact on firm’s performance outcomes. This signifies that green supply chain initiatives can be of value to the organizations as well as to the external environment. Through designing environmentally friendly products and taking back products and packaging, business organizations can generate benefits to the environment, in the form of reduced waste and better resource utilization, in addition to economic benefits and cost reductions to the organizations. Therefore, green supply chain initiatives can play significant role in achieving the “triple bottom line” of social,
References


