The mediating role of technological innovation on the relationship between green supply chain management and social performance

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Abstract---Malaysia is currently seeing significant environmental pollution caused by manufacturing and export activities and heavily affecting the economy, society, and environment. This issue calls for investigation on how environmental sustainability, through technological innovation, can be integrated into current production operations to create a closed-loop system, thereby enhancing social performance. Green supply chain management (GSCM) is gaining attention because of increasing environmental deterioration, such as overflowing landfills, depletion of raw materials, and pollution in general. The purpose of this study is to examine the mediating role of technological innovation on the relationship between GSCM practices and social performance in 258 manufacturing firms in Malaysia certified with ISO 14001. Survey data were analysed using partial least squares structural equation modelling (PLS-SEM). The results revealed that GSCM practices had a significant and positive effect on technological innovation and social performance. Moreover, technological innovation had a positive effect on social performance. Technological innovation also mediated between GSCM and social performance.
performance. Therefore, the present paper confirms the positive effect of GSCM on the technological innovation of manufacturing firms, which in turn improves their social performance. The findings may help manufacturing firms to better understand the significant role of technological innovation in improving their GSCM practices and social performance.

**Keywords**—green supply chain management, technological innovation, social performance, manufacturing firms.

**Introduction**

In recent years, local and global environmental issues have become significant concerns of and challenges for business organizations. Increased economic consumption leads to a high level of material and energy utilization by business organizations. ‘Business organisations’, in this case, refer to manufacturing firms, which are believed to be the most significant contributor to environmental issues (Beamon, 1999). Supply chain management (SCM) has grabbed attention of industrialists globally because of the necessity for strategic planning in the maintenance, design, and operations of supply chain processes. SCM is the most important system used by modern organisations because it is integrated with various operational stages to meet and satisfy market needs and maximise profits (Shafique et al., 2017; Suryanto et al., 2018; Villanueva & García, 2013). While SCM can improve firm performance, some manufacturing firms have overlooked its negative impact on the environment, economy, and society, for example global warming, health diseases, global energy crisis, climate change, and pollution (Suryanto et al., 2018).

These issues motivate the researchers to investigate the effect of GSCM implementation on technological innovation and social performance in Malaysian manufacturing firms. The operations of these firms affect the environment, economy, and society. Environmental issues in Malaysia are becoming more challenging and complex (Shamsuddin et al., 2017; Suryanto et al., 2018; Vaghefi et al., 2015). These issues have resulted from various factors, including the implementation of new technologies for products, development of new types of products, transformations in manufacturing processes, use of cleaner technology, level of housekeeping, capability in managing environmental issues, outdated regulations, and unresolved past environmental issues (Khan & Qianli, 2017; Mohamad et al., 2018; Suryanto et al., 2018). These factors may increase environmental problems, such as water, air, and solid waste pollution.

Green supply chain management (GSCM) has recently emerged to respond and resolve those issues and support environmental protection, economic development, and social development. It is the adoption of green procurement, green manufacturing, and green distribution, thereby creating a green supply chain, to ensure the sustainable performance of the organisation (Çankaya & Sezen, 2019; Khan, 2019; Luthra et al., 2016; Naway & Rahmat, 2019). Wyawahare and Udawatta (2018) defined GSCM as the incorporation of environmental elements into SCM processes, for instance material sourcing and
selection, product design, manufacturing practices, final product delivery, and end of life management. GSCM plays an important role to support sustainable development by reducing environmental pollution, waste and costs; creating a stress-free working environment; and optimizing resource utilization (Gandhi et al., 2015). Furthermore, GSCM improves the financial and social performance of an organisation (Patidar, 2018). The 'green business' concept emerged in the late 1990s due to growing pressures from communities with an interest in sustainable economic development. In general, a green or sustainable business is one that implements green practices in an attempt to be environmentally friendly and ensures that each product, process, and manufacturing activity sufficiently minimise existing environmental issues while still generating profits (Ahmed et al., 2018).

This study examines the effects of GSCM and green innovation practices on the social performance of manufacturing firms. Though there is much evidence for the positive relationships between GSCM, green innovation, and social performance (Abdullah et al., 2017; Abu Seman et al., 2019; Bhusan et al., 2017; Martínez-Ros & Kunapatarawong, 2019; Sundram et al., 2017; Verma et al., 2018), the effect of GSCM on social performance remains inconclusive (Moori et al., 2018; Xu et al., 2019; Z. Yang et al., 2019). Moreover, most environmental issues in Malaysia are contributed by manufacturing firms. Therefore, there is an urgency to investigate this relationship on a sample of Malaysian manufacturing firms. The present study attempts to examine how manufacturing firms can increase their social performance through GSCM and technological innovation. This paper provides empirical evidence to help manufacturing firms determine their ideal social strategies. In addition, this study examines the direct and indirect effects of GSCM and technological innovation on social performance. It aims to explain the variables that can potentially improve technological innovation and social performance of manufacturing firms. More specifically, it examines the mediating effect of technological innovation on the relationship between GSCM and social performance.

**Literature Review**

**Green Supply Chain Management**

Beamon (1999) defined GSC as the extension of the traditional supply chain that includes activities whose main objective is to reduce the environmental impact of a product throughout its entire cycle, such as resource saving, green design, and product recycling and reuse. GSCM are various initiatives and activities undertaken by organisations to cope with institutional pressure and improve overall supply chain and firm performance (Qorri et al., 2018). GSCM has caught the attention of scholars because of its benefit to the environment and organisational performance. Srivastava (2007) stated that GSCM includes green purchasing, green design, green distribution, green production, reverse logistics, and logistics marketing activities. Walker et al. (2008) explained that GSCM practices are implemented in all stages of the product lifecycle, such as production, purchasing, distribution, use, and disposal. GSCM comprises many activates, such as production, design, supply, assembly packaging, logistics, and distribution (Eltayeb & Zailani, 2014; Handfield et al., 1997; Mohamad et al.,
Therefore, GSCM is a broad concept. The limitations of GSCM studies are based on the researcher’s objectives, as in the case of any supply chain management research (Zhu et al., 2008).

Manufacturing firms have been recognized as one of the largest contributors to environmental pollution. A main reason for this is because many companies are involved in the manufacturing process, from the procurement of raw materials up to delivery of products, which invariably leads to the production of waste materials and other substances that can be harmful to the environment (Hassan, 2016; Ho et al., 2015). The Malaysian government is making efforts to ‘green’ its manufacturing sector through various initiatives and incentives. The direct and indirect consumption of energy for manufacturing emit carbon dioxide (CO₂), which negatively affects the environment. CO₂ is one of many pollutants created by the manufacturing industry and related to GDP growth (S. Islam et al., 2017; Shafique et al., 2017). The manufacturing sector, therefore, is one of the main contributors to economic, social, and environmental issues.

Those issues motivate the researchers to investigate how GSCM implementation can help Malaysian manufacturing industries to gain competitive advantages and improve their social performance. The manufacturing firms’ operations will affect the environment, economy, and society. Environmental issues in Malaysia are becoming more challenging and complex (Shamsuddin et al., 2017; Suryanto et al., 2018; Vaghefi et al., 2015). These issues have resulted from various factors, including the implementation of new technologies for products, development of new types of products, transformations in manufacturing processes, use of cleaner technology, level of housekeeping, capability in managing environmental issues, outdated regulations, and unresolved past environmental issues (Khan & Qianli, 2017; Mohamad et al., 2018; Suryanto et al., 2018). These factors may increase environmental problems, such as water, air, and solid waste pollution.

Recently, Le (2020) explained that the attention of scholars to GSCM practices and social sustainability has been limited compared to economic, financial, environmental, and operational performance. Esfahbodi et al. (2016) found a positive relationship between GSCM and cost and environmental performance, but not social performance. Social performance was measured in terms of increasing health care facilities for the local community. GSCM improves the social performance of firms in the supply chain (Wang & Dai, 2018). It gives a positive image to the firm, which is highly important for both customer and employee satisfaction and loyalty (Hoffman, 2001). Hassan (2016) and Zampese et al. (2016) asserted that GSCM could improve brand image, stakeholder relations, and employee motivation.

**Green Supply Chain Management in Malaysia**

In Malaysia, discussions on GSCM and technological innovation are still in the preliminary stage. Most firms are still behind in the implementation of both (Abdullah et al., 2016). Eltayeb et al. (2011) stated the level of acceptance and implementation of GSCM is lower in Malaysian-owned firms compared to international and multinational firms. Obstacles to GSCM implementation include the size of the organisation and high cost of adoption (Shamsuddin et al., 2017).
Organisations that implement GSCM are mostly large manufacturing companies (Lee et al., 2010). According to Abdullah et al. (2016), implementing GSCM is expensive because of the accompanying training, learning, technology, and capabilities. Moreover, research on green innovation in Malaysia is still rare. This can be seen from the fact that the implementation of this concept is still in the preliminary stage in Malaysian firms. Firms must overcome certain barriers to implement GSCM and green innovation. Manufacturing firms must have the capability to adopt GSCM and green innovation and realise sustainable economic growth.

The Malaysian government provides two tax incentives to manufacturing firms that implement green practices in their operations: pioneer status (PS) and investment tax allowance (ITA) (Singh, 2017). The purpose of these incentives is to encourage more green investments and operations. The ITA is given for a period of five or ten years to firms that implement green practices and technology in the areas of renewable energy, energy efficiency, green building, green data centre, and waste management (MIDA, 2020). The ITA grants an allowance of 60% on the firm’s qualifying capital expenditure, such as factory, plant, machinery, or other equipment used for the approved project incurred within five years from the date the first qualifying capital expenditure is incurred (MIDA, 2021). Therefore, the implementation of GSCM will allow manufacturing firms to enjoy tax allowance.

Malaysia is taking steps to go green in the coming years and improve economic, environmental, and social performance. The Twelfth Malaysia Plan 2021-2025 (12MP), presented to the public in September 2021, encompasses three dimensions, namely environmental sustainability, economic empowerment, and social re-engineering, that are supported by governance and policy tools. Under environmental sustainability, the 12MP covers various issues such as climate change mitigation and adaptation, green technology, and renewable energy. All three dimensions are consistent with the 2030 Sustainable Development Goals (SDGs) Agenda of the United Nations.

In recent years, Malaysia is moving forward to be an industrialised economy and moving from material production to manufacturing. The manufacturing sector is one of the main sources of economic growth and industrialisation. However, it has a negative impact on the environment because it creates waste and pollution and consumes a significant amount of natural resources. The sector or its individual corporations are among the largest contributors of environmental issues, considering that society mostly depends on industrial products to sustain its living standard. These corporations consume resources and emit pollutants throughout the manufacturing process.

While there have been many studies on the adoption of GSCM and green innovation in developing and developed countries, similar studies in the Malaysian context have been minimum (Seman et al., 2018). GSCM adoption differs from a country to another because each has its own obstacles, such as firm size, suppliers, buyers, communities, customers, legislation and regulations, mode of implementation, and internal and external pressures (Eltayeb et al., 2011; Jabbour et al., 2016; Seman et al., 2018). Previous studies show that GSCM practices are very advanced in developed countries such as Germany,
Japan, and other European countries (Scur & Barbosa, 2017). However, in developing countries such as Malaysia, GSCM is still considered a new concept in both practice and research (Rao, 2002; Umar et al., 2016).

**Technological Innovation**

According to the Organisation for Economic Co-operation and Development (OECD) (2018), the novelty characteristic of innovation is based on the use and application of new or modified technology. Oslo (2005) defined the term ‘technological’ as new or improved products and processes. An organisation can make various types of modifications in its processes, use of factors of production, and type of output to improve productivity and performance. Innovation is also defined as technology or management practice that a firm is implementing for the first time, regardless of whether other organisations or users have previously adopted it. It may also refer to significant restructuring or improvement of a process (Nord & Tucker, 1987). Technological innovation enables organisations to develop innovation capabilities, encourage corporate entrepreneurship, create investment opportunities in scientific and technological endeavours, and ensure the sustainable growth of corporate entrepreneurship in the competitive market (Rojas et al., 2014). In short, technological innovation play an important role in firm and economic growth.

Many scholars argue that product, process, marketing, and organisational innovation can create competitive advantages for the company in terms of price, quality, and delivery (Bhushan et al., 2017; Kafetzopoulos & Psomas, 2015; Wang et al., 2019; Yang & Roh, 2019). The fast-growing economy of Southeast Asian countries such as Malaysia requires shifting the organisational value area from non-technological to technological activities, such as introducing and developing new technologies. Nonetheless, non-technological strategies, such as transforming organisational process, re-establishing business strategies and external network, marketing, and customer interaction, are still needed to support the competitive advantages of manufacturing companies (Seman et al., 2018; Zailani et al., 2015; Zaipul & Ahmad, 2017).

Initial observations showed a link between innovation and competitive advantage, hence embracing Industry 4.0 technologies and processes enables a firm to gain an advantage over global competitors. Innovation enhances competitiveness as the firm can react to market shifts and current trends in technology and innovation (Menon & Shah, 2019). The Malaysian Ministry of International Trade and Industry (MITI) introduced the national Industry 4.0 policy, which is expected to transform the global landscape of manufacturing and make significant improvements to quality and productivity. Embracing Industry 4.0 is a new source of competitive advantage for a firm (MITI, 2018). This policy requires Malaysia to improve its technological level in the manufacturing industry so as to enhance innovation and competitiveness.

While technological innovation has become an important topic in developing countries such as Malaysia, studies on the subject have been minimum. In contrast, there is significant research on green innovation in developed countries such as the United States and Sweden (Calza et al., 2017; Rozar et al., 2015;
Seman et al., 2018; Tan, Zailani, Tan, & Shaharudin, 2016). Furthermore, there are limited studies that discuss technological innovation as a mediator between GSCM practices and social performance (Moori et al., 2018; Xu et al., 2019; Z. Yang et al., 2019). Thus, this study examines how GSCM practices (internal environmental management, green purchasing, eco-design and packaging, investment recovery, and cooperation with customers) influence technological innovation and social performance, and how technological innovation mediates between GSCM practices and social performance. Past studies have failed to highlight the multidimensionality of technological innovation and only examined the concept of technology innovation in general (Camisón & López, 2010; Camisón & Víllar-López, 2014; Lee et al., 2018; Nuryakin, 2018; Raymond et al., 2013).

**Social Performance**

Social performance is the “firm’s ability to be socially responsible for the community stakeholder relationship through CSR programmes, improve the social quality of employees, and equality without discrimination” (Fernando & Saththasivam, 2017). Bowen (1953) provided the first definition for the concept: strategies, decisions, and actions of the organisation to create value for society. Carroll (1979) further defined social performance as an organisation’s consideration of stakeholder expectations on social, ethical, legal, and economic aspects. Wartick and Cochran (1985) categorised corporate social responsibility (CSR) into three dimensions of economic responsibility, public responsibility, and social responsiveness. More firms are incorporating sustainability elements into their business practices and manufacturing operations, for instance waste management, resource efficiency, and CSR programs, to improve social performance and gain competitive advantages (Le, 2020). Manufacturing companies are required to carry out their social responsibilities, and corporate social performance is gaining importance in strategic management (Distelhorst et al., 2017). The assumption of social responsibilities by firms is driven by growing pressures from stakeholders, government, and customers to consider the social impact of their activities (Davis et al., 2020). Therefore, social sustainability has become a significant factor in maintaining corporate sustainability.

The impact of corporate social performance is not only restricted to society, the environment, and stakeholders, but it also has positive effects on the organisation. For example, the firm has higher ability to attract talented employees (Greening & Turban, 1996), more financial access (Cheng et al., 2014), improved risk management (Koh et al., 2014), and more recommendations from stock analysts (Luo et al., 2015). Global market transformations calling for social and community responsibilities of firms have required them to consider social and environmental concerns in their business’ activities (Çankaya & Sezen, 2019). Social performance, in particular, appears to enable firms to join and compete in the global market.

The waste from manufacturing companies fills landfills and affects society. The World Health Organization (2018) in its Global Burden of Disease (GBD) report stated that ambient air pollution is one of the highest risk factors for disability and death. Household air pollution ranked eighth in the risk factor for early death, accounting for 2.6 million deaths around the globe. It comes from the use
of solid fuels (e.g., coal, wood, and dung) for heating and cooking. Ambient particulate matter (particulate matter less than or equal to 2.5 micrometres in aerodynamic diameter, or PM2.5) is the sixth highest risk factor for early death, accounting for 4.1 million deaths globally. Air pollution is responsible for many diseases, such as chronic lung disease, heart disease, stroke, and lung cancer (Peden et al., 2016).

CSR in Malaysia is still developing. Manufacturing firms are still facing difficulty in CSR practices because they are unable to effectively minimise waste, which negatively affect society and their health. For example, a recent case of intentional pollution occurred in Pasir Gudang, Johor Bahru in March 2019, causing students and teachers in nearby schools to suffer from dizziness, breathing difficulties, nausea, and vomiting. More than 100 schools were ordered to close as well. The chemical waste was intentionally dumped in the Kim Kim River in the early morning before the victims fell ill. The toxic pollutants were unable to be removed easily, and rain and wind spread them to other places (Yap et al., 2019). Based on the above discussion, the following hypotheses were proposed (see Figure 1):

- GSCM practices have a positive effect on technological innovation.
- GSCM practices have a positive effect on social performance.
- Technological innovation has a positive effect on social performance.
- Technological innovation mediates the relationship between GSCM practices and social performance.

![Figure 1. Research Framework](image)

**Methodology**

The quantitative methodology was employed to investigate the mediating effect of technological innovation on the relationship between GSCM practices and social performance in Malaysian manufacturing firms. Because of the Covid-19 pandemic, the questionnaires were distributed online to firms listed in the directories of the Federation of Malaysian Manufacturers (FMM) and Standard and Industrial Research Institute of Malaysia (SIRIM), which contain over 2,500 manufacturing and services firms of different sizes. Both directories are a valid representation of the research population. The research hypotheses were tested using partial least squares structural equation modelling (PLS-SEM) run with the SmartPLS software (Ramayah et al., 2018).
The items were measured on a five-point Likert scale, ranging from strongly disagree (1) to strongly agree (5). GSCM practices comprised five dimensions and were measured using 25 items (Çankaya & Sezen, 2019; Eltayeb & Zailani, 2014; Le, 2020; Tan et al., 2018; Zhu & Sarkis, 2004). Technological innovation comprised four dimensions and 22 items (Camisón & Villar-López, 2014; Kafetzopoulos & Psomas, 2015; Lee et al., 2018). Social performance was measured using seven items (Çankaya & Sezen, 2019; Cheah et al., 2019). The research data were collected from 258 manufacturing firms certified with ISO14001 in a period of approximately four months in 2021.

Results

Measurement Model Assessment

As recommended by Hair Jr et al. (2017), this study first measured the reliability and validity of the measurement model using Cronbach’s alpha and composite reliability (CR). Cronbach’s alpha evaluates the internal consistency of a construct. According to Hair Jr et al. (2017), the acceptable value of Cronbach’s alpha and CR is > 0.7. Table 1 shows that the Cronbach’s alphas and CR values of all constructs were > 0.70, indicating adequate internal reliability. Similarly, the factor loadings of most items were above the acceptable threshold of 0.7 (Hair Jr et al., 2017), except IEM5, GP1, PTI4, and PSI3, which were subsequently deleted. Average variance extracted (AVE) is a standard measure of convergent validity, and an AVE of > 0.50 is considered acceptable (Hair et al., 2010). The AVE values in this study ranged from 0.653 to 0.740. Satisfactory convergent validity was therefore established. To determine discriminant validity, the heterotrait-monotrait ratio (HTMT) was computed (Hair et al., 2017).

Table 1
Item loadings, Cronbach’s alpha, CR and AVE

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Indicators</th>
<th>Loading (&gt; 0.7)</th>
<th>Cronbach’s Alpha</th>
<th>Composite Reliability</th>
<th>AVE</th>
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</thead>
<tbody>
<tr>
<td>Green purchasing (GP)</td>
<td>GP1</td>
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<td></td>
<td>GP2</td>
<td>0.893 0.902</td>
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<td></td>
<td>GP3</td>
<td>0.772</td>
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<td>GP4</td>
<td>0.753</td>
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<td>GP5</td>
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<td>GP6</td>
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<td>IEM2</td>
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<td>IEM3</td>
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<td></td>
<td>IEM5</td>
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<td>Eco-Design and Packaging (EP)</td>
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<td>EP2</td>
<td>0.840 0.777</td>
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<td><strong>Investment recovery (IR)</strong></td>
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<td>IR2</td>
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<td>IR3</td>
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<td>IR4</td>
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<td><strong>Customer cooperation (CC)</strong></td>
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<td></td>
<td>CC2</td>
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<td>CC3</td>
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<td>OI3</td>
<td>0.834</td>
<td></td>
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<tr>
<td></td>
<td>OI4</td>
<td>0.834</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>OI5</td>
<td>0.834</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Social performance (SP)</strong></td>
<td>SP1</td>
<td>0.846 0.780</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SP2</td>
<td>0.814 0.805</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SP3</td>
<td>0.870</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SP4</td>
<td>0.830</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SP5</td>
<td>0.830</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SP6</td>
<td>0.830</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SP7</td>
<td>0.787</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>


Henseler et al. (2014) suggested that an acceptable HTMT value is < 0.90. Table 2 shows that all HTMT values were lower than the recommended threshold. Goodness of fit (GOF) was measured using the standardised root mean square residual (SRMR). SRMR evaluates the overall fit of the model so as to assess its
predictive capabilities (Henseler et al., 2014). The SRMR was 0.07, which is within the acceptable range, indicating good model fit (Henseler et al., 2016).

Table 2
Assessment of Discriminant Validity using HTMT

<table>
<thead>
<tr>
<th></th>
<th>EP</th>
<th>GP</th>
<th>IEM</th>
<th>IR</th>
<th>MI</th>
<th>OI</th>
<th>PSI</th>
<th>PTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>CC</td>
<td>EP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.350</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GP</td>
<td>0.430</td>
<td>0.495</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEM</td>
<td>0.295</td>
<td>0.400</td>
<td>0.416</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>IR</td>
<td>0.411</td>
<td>0.477</td>
<td>0.547</td>
<td>0.313</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MI</td>
<td>0.354</td>
<td>0.393</td>
<td>0.571</td>
<td>0.427</td>
<td>0.535</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OI</td>
<td>0.261</td>
<td>0.231</td>
<td>0.329</td>
<td>0.212</td>
<td>0.160</td>
<td>0.165</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSI</td>
<td>0.293</td>
<td>0.264</td>
<td>0.398</td>
<td>0.257</td>
<td>0.265</td>
<td>0.255</td>
<td>0.485</td>
<td></td>
</tr>
<tr>
<td>PTI</td>
<td>0.169</td>
<td>0.379</td>
<td>0.401</td>
<td>0.155</td>
<td>0.309</td>
<td>0.274</td>
<td>0.444</td>
<td></td>
</tr>
<tr>
<td>SP</td>
<td>0.294</td>
<td>0.410</td>
<td>0.399</td>
<td>0.412</td>
<td>0.341</td>
<td>0.419</td>
<td>0.428</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.550</td>
<td>0.387</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Structural Model Assessment

After confirming the validity and reliability of the measurement model, the structural model was evaluated and the hypotheses were tested (Hair Jr et al., 2017). In PLS-SEM, path coefficients and $R^2$ are used to assess the structural model. Figure 1 and Table 4 show the final structural model and the $R^2$ of the constructs. $R^2$ is the amount of variance in the endogenous variable (dependent variable) is explained by the exogenous variables (independent variables). The $R^2$ of the main target constructs should be high. The minimum acceptable $R^2$ proposed by Falk and Miller (1992) is 0.19. Meanwhile, Chin (1998) suggested that $R^2$ values of 0.67, 0.33, and 0.19 can be considered as strong, moderate, and weak, respectively.
The $R^2$ of technological innovation was 0.326, which means that 36% of the variance in technological innovation can be explained by product, process, marketing, and organisational innovation (see Table 3). The $R^2$ of social performance was 0.393, indicating that GSCM accounted for approximately 39% of its total variance.

### Table 3

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological Innovation</td>
<td>0.326</td>
<td>Strong</td>
<td>Moderate</td>
</tr>
<tr>
<td>Social Performance</td>
<td>0.393</td>
<td>Strong</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

The bootstrap method was used to evaluate the structural model (Chin, 2010). Table 4 shows the results of the hypotheses testing. GSCM had a strong direct relationship with both technological innovation ($\beta = 0.571$, $t = 8.608$, $p < 0.01$) and social performance ($\beta = 0.227$, $t = 3.492$, $p < 0.01$). Therefore, H1 and H2 were supported. Additionally, the direct relationship between technological innovation and social performance was significant and strong ($\beta = 0.469$, $t = 6.434$, $p < 0.01$). Thus, H3 was accepted.
Table 4
Structural model: direct effects

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Std Beta</th>
<th>Mean (M)</th>
<th>Std Error</th>
<th>t-value</th>
<th>p-value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1 GSCM→TI</td>
<td>0.571</td>
<td>0.0564</td>
<td>0.066</td>
<td>8.608</td>
<td>0.000</td>
<td>Supported</td>
</tr>
<tr>
<td>H2 GSCM→SP</td>
<td>0.227</td>
<td>0.0228</td>
<td>0.065</td>
<td>3.492</td>
<td>0.000</td>
<td>Supported</td>
</tr>
<tr>
<td>H3 TI→SP</td>
<td>0.469</td>
<td>0.467</td>
<td>0.073</td>
<td>6.434</td>
<td>0.000</td>
<td>Supported</td>
</tr>
</tbody>
</table>


The mediating effect was analysed next. As shown in Table 5, technological innovation had a partial mediating effect on the relationship between GSCM practices and social performance (β = 0.253, t = 5.206, p < 0.01). Thus, H4 was supported.

Table 5
Structural model: Mediation analysis

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Indirect Effect</th>
<th>Confidence interval</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Path coeff.</td>
<td>Std Error</td>
<td>t-value</td>
</tr>
<tr>
<td>H4 GSCM→TI→SP</td>
<td>0.253</td>
<td>0.060</td>
<td>4.219**</td>
</tr>
</tbody>
</table>

Note: ** = P < 0.001, LL: Lower level, UL: Upper level.

Conclusion

This study has reviewed the literature and presented empirical evidence on the interrelationships between GSCM practices, technological innovation, and social performance. The findings can support managers of manufacturing firms to implement GSCM practices to improve performance. This study has contributed to the empirical literature on sustainability management, more specifically GSCM, and the social performance of manufacturing firms. It presents a useful model to examine the direct effects of GSCM practices and technological innovation on social performance, as well as the mediating effect of technological innovation on the relationship between GSCM practices and social performance. The theoretical contribution of this study is twofold. First, it presents empirical evidence on the role of technological innovation as a mediator between GSCM practices and social performance. Second, it presents empirical evidence on the link between GSCM practices, technological innovation, and social performance in Malaysian manufacturing firms.

Acknowledgement

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