

Accentuating the interconnection between green intellectual capital, green human resource management and sustainability

Modelling
sustainability
via green HRM

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Abstract

Purpose – The study aims to investigate the relationships between green intellectual capital, green human resource management (HRM), and sustainability.

Design/methodology/approach – The research is based on information gathered from 112 large Malaysian manufacturing companies.

Findings – The study findings revealed that green human capital and green relational capital positively influence green HRM. In addition, green HRM positively related to social, environmental and economic performance. Besides, green HRM positively mediates the relationships between green human capital and economic, social and environmental performance. Finally, green relational



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capital improves sustainability (economic, environmental, and social performance) mediated by green HRM.

Originality/value – The current study contributes to the literature by examining green IC (green human capital, green structural capital, and green relational capital) as an independent variable and green HRM as a mediating variable for sustainability (economic, environmental, and social performance). The findings and recommended for the managers of large manufacturing firms and practitioners to invest in green IC to achieve sustainability through green HRM.

Keywords Green human resource management, Green intellectual capital, Sustainability, Manufacturing firms, Malaysia

Paper type Research paper

1. Introduction

The fourth Industrial Revolution (IR 4.0) in the 21st century has brought tremendous progress to humanity with various technologies, including the internet of Things (IoT), blockchain and artificial intelligence. The IR 4.0 enables the transformation of the entire management, governance systems and production. The large-scale changes can be observed across companies, industries, and countries. Previous researchers such as [de Sousa Jabbour et al. \(2018\)](#), [Ghobakhloo \(2020\)](#), [Kamble et al. \(2019\)](#) and [Müller et al. \(2018\)](#) argued that digital connectivity and information development and sharing can have paradoxical impacts on sustainability. On one hand, the digitization of manufacturing operations and business processes may bring several benefits such as reduced waste, increased resource efficiency and manufacturing productivity ([Tortorella and Fettermann, 2018](#)).

On the other hand, despite the enormous possibilities they offer, these technologies put greater pressure on the planet, its resources and society. According to [Carvalho et al. \(2018\)](#), large-scale production, demands for primary raw resources, and trash disposal have increased dramatically due to this revolution, and environmental protection has become more complicated. Interestingly, [Beier et al. \(2017\)](#) shared similar thought, they state that increased automation of production and digitalization of industrial processes offer great opportunities for environmental sustainability, such as improving resource efficiency and increasing employment of renewable energy; however, they also foresee the challenges society faces in terms of unemployment.

The impact of IR 4.0 on sustainability has been the focus of recent research ([Beltrami et al., 2021](#); [El Baz et al., 2022](#)). In this regard, the United Nations (UN) has proposed implementing the 17 Sustainable Development Goals (SDGs) in Agenda 2030 for sustainable development. The agenda balances the three sustainable development dimensions, namely economy, environment, and society. Furthermore, the 17 SDGs aim to address major global sustainability concerns with ideal outcomes to which governments and businesses may contribute ([United Nations, 2015](#)). The significance of businesses in attaining sustainable development is clearly defined in SDG12. Target 12.6 states that organisations, enormous and international corporations, are pushed to adopt sustainable practices and include sustainability data in their reporting cycles ([United Nations, 2017](#)).

Building upon these ideas, [Ejsmont et al. \(2020\)](#) point out that IR 4.0 might lead to the deployment of smart technologies and the development of digital sustainable operation, which contribute to sustainability and the achievement of SDGs. In line with this idea, [Ghobakhloo \(2020\)](#) highlight that the development of human resources is critical to realizing the sustainability function of IR 4.0. This argument is further supported by [Jabbour et al. \(2019\)](#) who agree that green human resource management (HRM) plays a vital role in contemporary organizations to facilitate corporate-level sustainability initiatives.

In particular, the national policy in the Malaysian context on IR 4.0 formulated in 2021 aims to improve the country's readiness to adopt IR 4.0 and steer socio-economic transformation with technology ([Bedi, 2021](#)). Undeniably, Malaysia has embarked on a journey towards digitalisation and sustainable development, and the impact on the manufacturing industry is prevalent. Thus, more efforts are needed to ensure that employees keep up with current trends

to remain competitive and promote the companies' sustainable performance. The criticality of green intellectual capital (IC) in enhancing long-term sustainable performance was highlighted in previous studies (e.g. Yusoff *et al.*, 2019; Yusliza *et al.*, 2020). Nevertheless, the mediating role of green HRM in this association has remained unclear.

In this perspective, the present research gives a unique viewpoint on establishing a green HRM paradigm that investigates how green HRM mediates the association between green IC and sustainability. Its importance can be demonstrated in the existing literature.

First, prior research discovered a consistent positive relationship between different dimensions of green IC and different dimensions of sustainability (Sidik *et al.*, 2019; Yadiati *et al.*, 2019; Yusoff *et al.*, 2019; Malik *et al.*, 2020; Yusliza *et al.*, 2020; Asiaei *et al.*, 2021; Khan *et al.*, 2021a, b; Shah *et al.*, 2021; Wang and Juo, 2021). We extend the state-of-the-art literature in emerging markets on this relationship by incorporating green HRM as mediator. Earlier research by Jabbour and Santos (2008) highlighted that HRM involves some important aspects related to management, such as innovation, cultural diversity, and the environment, which contribute to the development of sustainable organizations. Jabbour *et al.* (2019) extend the state-of-the-art literature on circular economy business models through the inclusion of green HRM, as they called "the human side of organizations". Jabbour *et al.* (2019) further argued, circular economy and green HRM are the two fields remain largely separate area of knowledge. A study Pham *et al.* (2019) in Vietnam stress the benefits of green HRM in boosting pro-environmental behaviour and improving the company reputation and financial performance. Roscoe *et al.* (2019) using sample of Chinese manufacturing firms and asserts that key enablers of green organizational culture, including leadership value, information credibility, peer engagement, and employee empowerment, positively mediate the relationship between green HRM practices and environmental performance. These findings imply that green HRM plays a crucial role in promoting sustainable development of an organization. Resultantly, the current research examined green HRM as a mediator in the relationship between green IC and sustainability.

Secondly, as shown in Table 1, prior research has assessed green HRM as a mediator in many instances. Thus, green HRM is justified to mediate the relationship between green intellectual capital and sustainability.

Next, Mansoor *et al.*, (2021) examined green IC and environmental performance via green HRM. However, they measured green IC using two dimensions: green human capital (HC) and green relational capital (RC). In addition, they tested the relationship with only environmental

Author	Year	Study
Guerci, Longoni and Luzzini	2016	Environmental performance, customer pressure and regulatory stakeholder pressure
Jia, Liu, Chin and Hu	2018	Transformational leadership, green creativity and green passion
Ahmad and Umrani	2019	Ethical leadership style and job satisfaction
Agyabeng-Mensah, Ahenkorah, Afum <i>et al.</i>	2020	Internal green supply chain practice, firm performance and supply chain environmental cooperation
Islam, Khan, Ahmed and Mahmood	2020	Ethical leadership and in-role and green behaviour
Liu, Liu and Yang	2020	Green procurement and top management support
Singh, Giudice, Chierici and Graziano	2020	Green innovation and green transformational leadership
Zhao, Liu and Sun	2020	Proactive environmental strategy and environmental reputation
Ahmad, Islam, Sadiq and Kaleem	2021	Ethical leadership and in-role and green behaviour
Úbeda-García, Claver-Cortés, Marco-Lajara and Zaragoza-Sáez	2021	Performance, environmental outcomes and corporate social responsibility

Table 1.
Studies using green HRM as mediating variable

performance. They gathered data from 187 human resource managers or directors at Pakistani manufacturing companies.

Besides, previous studies concerning the relationship between green IC or green HRM with sustainability has been conducted in various countries, as shown in [Table 2](#).

In addition, the literature gap revealed that empirical research associating green IC, green HRM, and sustainability remain scarce. This research investigated a fundamental gap in the current literature. Only scarce empirical evidence exists from growing economies, including Malaysia, one of the world’s most promising economies and a member of the Transpacific Partnership marketing region ([Yusliza et al., 2017](#)). The following significant research questions were addressed in this study:

- (1) Does green HRM mediate the relationship between green IC and sustainability?
- (2) Does green IC have a positive effect on green HRM and green HRM on sustainability?

Therefore, this study makes two contributions. First, it fills in the missing knowledge concerning green HRM as the mediator in the Asian setting. The findings will help advance theories in green IC, green HRM, and sustainability. Secondly, the findings may give researchers and practitioners actionable insights that they may implement the research findings that can result in competitive advantage for the firms.

The paper is organised as follows. Firstly, the theoretical background is presented along with the study hypotheses. Subsequently, research methodology is discussed, followed by data analysis. Next, discussions and implications with theoretical and practical contributions are explained. The last section presents the conclusion, limitations, and future research directions.

2. Literature review

2.1 Theoretical background

The Intellectual Capital-based View Theory (ICV) was used in this research. Several well-known scholars such as [Brooking \(1996\)](#), [Edvinson and Malone \(1997\)](#) and [Sveiby \(1997\)](#) created the theory. Other scholars, such as [Reed et al. \(2006\)](#), contributed to developing this idea, which researchers called “An Intellectual Capital-Based View of the Firm.” ICV is also a supplement to [Leonard-Barton’s \(1992\)](#) famous knowledge-based view (KBV). These ideas are founded on resource-based perspective theory and are intended to reveal the underlying knowledge-based dynamics that underpin a company’s value.

Country	Author
Australia	O’Donohue and Torugsa (2016)
Bahrain and United Arab Emirates (UAE)	Shah et al. (2021)
China	Roscoe et al. (2019)
Ghana	Acquah et al. (2021) , Afum et al. (2021)
India	Bangwal et al. (2017) , Cabral and Jabbour (2020)
Indonesia	Sidik et al. (2019) , Yadiati et al. (2019) , Muafi and Kusumawati (2021)
Iran	Asiaei et al. (2021)
Pakistan	Cheema and Javed (2017) , Gilal et al. (2019) , Malik et al. (2020) , Khan et al. (2021a) , Mansoor et al. (2021)
Palestine	Zaid et al. (2018) , Mousa and Othman (2020)
Spain	Delgado-Verde et al. (2014) , Úbeda-García et al. (2021)
Taiwan	Wang and Huo (2021)
Thailand	Kim et al. (2019) , Jirakraisiri et al. (2021)
Malaysia	Yong et al. (2019) , Yusoff et al. (2019) , Yusliza et al. (2020) , Nisar et al. (2021) , Rehman et al. (2021)

Table 2.
Green HRM studies according to countries and the authors

KBV evaluates the efficiency of an organisation's use of information technology and management systems and other knowledge-generating mechanisms and their impact on company performance excellence (Leonard-Barton, 1992; Nonaka *et al.*, 2001). The dynamics and concentration of knowledge capital anchored in an organisation, which is intimately tied to competitive advantage and company success, are addressed by ICV (Youndt and Snell, 2004). Conversely, Resource-based View (RBV) has been criticised for being overly broad, and an accurate description of competitive advantage is inadequate (Foss and Knudsen, 2003; Reed *et al.*, 2006). Therefore, based on the literature findings and considering the shortcomings of RBV, the present research utilised the ICV theory as an anchor to examine the function of green HRM as a mediating factor in the link between green IC and sustainability. A firm is assumed to attain sustainability through strategic support and green IC from the green HRM practices.

2.2 Sustainability

In recent years, the sustainability idea has received increasing attention due to the IR 4.0 evolution and the SDGs set up by the UN. The rapidly changing manufacturing industry and the IR 4.0 development have raised many environmental issues. Thus, companies have shown a great interest in responding to these issues and challenges (Higgins and Coffey, 2016). Besides, SDGs also serve as a blueprint for a prosperous and sustainable future. The companies are expected to provide substantive support in attaining these goals (United Nations, 2015).

The World Commission on Environment and Development (WCED) issued *Our Common Future* in 1987, frequently recognised as the Brundtland report. The document formulated a definition of sustainability to address the conflicts between environment and development goals. Sustainability was defined as the “development which meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, p. 8) in the document.

Besides, Elkington (1994) proposed the triple bottom line principle to characterise the three sustainability pillars: social, environmental, and economic dimensions. According to Elkington (1994), economic performance is concerned with financial performance, whereas environmental performance reduces environmental harm and resource exploitation. Social performance is concerned with stakeholders' well-being (e.g. customers, societies, and employees). IC and human resources practices play an essential role to achieve business sustainability. These two elements need to be unique, replicable, valuable, and non-replaceable. Many studies (e.g. Yusoff *et al.*, 2019; Yong *et al.*, 2020; Yusliza *et al.*, 2020) have laid the foundation for the contribution of green HRM and green IC to sustainability. In simpler words, companies that hire skilled employees with environmental knowledge, intangible asset (e.g. management system for environmental protection, the relationship between company and stakeholders), and practice green HRM may attain sustainability. Hence, this study utilised economic, environmental, and social performances to measure sustainability.

2.3 Green intellectual capital

IC is not a new concept for companies, and its importance in firms' value creation process is evident. Some scholars have examined IC from a resource-based view perspective. According to Youndt and Snell (2004), IC can add value and improve firm performance by lowering expenses, boosting consumer advantages, or a blend of the two. Yang and Lin (2009) denoted that intangible resources tend to yield value for firms and assist them to maintain their market competitiveness. However, since its inception in 2008, green IC has received little attention (Yong *et al.*, 2019).

Chen (2008) was the pioneer to establish the notion of green IC, which he defined as “the total stocks of all kinds of intangible assets, knowledge, capabilities, and relationships about environmental protection or green innovation in the individual level and the organisation level within a company” (p. 277). Liu (2010) subsequently outlined green IC as “the integration of green and environment knowledge sources and knowing capability of companies for

improving competitive advantage” (p. 2). Similarly, [Lopez-Gamero et al. \(2011\)](#) explained that green IC as “the sum of all knowledge that an organisation is able to leverage in the process of conducting environmental management to gain a competitive advantage” (p. 21). Based on these definitions, the firms’ competitive advantage can be obtained through intangible assets on environmental protection.

Intangible assets are valuable, rare, and not easily imitated. Green IC ensures that companies fully comply with international environmental legislation, and it addresses the customers’ environmental consciousness and realises the companies’ value creation. According to [Chen’s \(2008\)](#) suggestion, the current study included three types of green IC: green HC, green structural (SC), and green RC.

2.4 Green human resource management (green HRM)

Green HRM is a promising concept, which has attracted growing attention from researchers and industrial practitioners. [Jabbour \(2013, pp. 147–148\)](#) denoted that green HRM involves a “systematic, planned alignment of typical HRM practices with the organisations’ environmental goals”. Similarly, [Afum et al. \(2021\)](#) described green HRM as the critical utilisation of human resources in firms’ environmental management. Implementing green HRM as an eco-friendly human resources practice can improve efficiencies, effectiveness, and environmental sustainability ([Yu et al., 2020](#)).

Many areas can be studied under the green HRM system incorporating green job analysis and job descriptions, selection and recruiting, training, empowerment, performance evaluation, rewards, and participation in the decision-making process ([Jabbour, 2011; Renwick et al., 2013; Tang et al., 2018; Amrutha and Geetha, 2020](#)). Likewise, [Kim et al. \(2019\)](#) believed that green HRM includes the top management communicating the environmental plan or other details to employees, educate them to increase environmental awareness, empower them to participate in environmental protection activities, and rewarding them to encourage environmental responsibility.

When green HRM is implemented, employees are more likely to comprehend, respect, and adhere to an organisation’s environmental aims ([Masri and Jaaron, 2017; Afum et al., 2021](#)). The employees have been equipped with environmental protection knowledge and skills that help resolve environmental issues and assist in implementing green plans ([Cabral and Dhar, 2020](#)), resulting in a sustainable competitive advantage and improved environmental performance ([Ren et al., 2018](#)). According to the literature, green HRM is crucial for gaining a competitive advantage and improving company performance.

2.5 Hypothesis development

2.5.1 The relationship between green intellectual capital and green HRM. [Chen’s \(2008\)](#) included three types of green IC, such as green HC, green SC, and green RC. Green HC, with its environmental capabilities and commitment to related activities, is an intangible asset of a company and is deeply rooted in its employees, not the organization ([Chen, 2008; Huang and Kung, 2011](#)). Green SC is an intangible asset owned by a company, which consists of ecological infrastructure, systems, databases, organizational culture, etc. and aims to achieve the company’s environmental protection and green innovation ([Chen, 2008; López-Gamero et al., 2011](#)). Lastly, green RC is an intangible asset based on the relationships between a company and its stakeholders regarding corporate environmental management and green innovation to maintain corporate reputation and competitive advantages ([Chen, 2008; López-Gamero et al., 2011](#)).

In today’s competitive global business environment, organizations must adapt to changing environmental conditions by continuously introducing changes and adopting new environmental initiatives. Several researchers affirmed the vital role of green IC in implementing environmental initiatives, specifically in green innovation. [Ali et al. \(2021\)](#)

indicated that green innovation implementation in Pakistan small and medium-sized manufacturing enterprises (SMEs) were significantly implicated by green HC and green SC. [Chen and Chang \(2013\)](#) demonstrated that green HC beneficially affects green innovation performance in Taiwanese manufacturing organisations. They also revealed that green HC also works as a mediator in the positive links between corporate environmental ethics and the two outcomes: performance in green innovation and green relationship learning. Furthermore, green organisational capital indirectly impacts environmental product innovation ([Delgado-Verde et al., 2014](#)). The results demonstrate that the achievement of environmental product innovation was significantly reliant on employee collaboration (e.g. green social capital).

In the HRM field, [Kong and Thomson \(2009\)](#) believed that the catalyst for strategic HRM adoption should be IC. A handful of researchers filled the gap highlighted by [Kong and Thomson \(2009\)](#) and gained a greater understanding of the environment. Green IC has a vital part in the adoption of green HRM. For instance, [Yong et al. \(2019\)](#) discovered that green RC and green HC are positively associated with adopting green HRM in Malaysian manufacturing companies. Employees have accumulated environmental knowledge and expertise from past jobs, allowing them to make suggestions regarding environmental practices. Resultantly, they tend to impact green HRM practices. In addition, [Yong et al. \(2019\)](#) pointed out that manufacturers tend to embrace green HRM practices if the green RC agrees with the concept of green HRM practises and the perks. Conversely, [Mansoor et al. \(2021\)](#) confirmed that green HC is deeply embedded in workers and is positively correlated to the green HRM in Pakistani manufacturing firms.

The Intellectual Capital-based View Theory (ICV) aims to narrow the focus on intangible assets, and green HRM has been declared a form of competitive advantage. Based on this theory, green IC can be considered as an important intangible asset for a firm to gain a competitive advantage. Therefore, the following hypotheses were suggested:

- H1. Green HC positively affects green HRM.
- H2. Green SC positively affects green HRM.
- H3. Green RC positively affects green HRM.

2.5.2 The relationship between green HRM and sustainability. Companies are paying more attention to sustainability due to tremendous pressures from society toward social and environmental responsibility. Besides the financial profits, sustainable companies must also consider environmental and social impacts in the business decision-making process. The HR function plays an important role and many studies (e.g. [Malik et al., 2020](#); [Yong et al., 2020](#); [Mousa and Othman, 2020](#); [Khan et al., 2021a, b](#)) delved into how a firm's pro-environmental HRM practices improve its sustainable performance. Previous researchers highlighted the contribution of a few green HRM initiatives on the firms' sustainable performance, including green recruitment ([Yong et al., 2020](#); [Malik et al., 2020](#)), green selection and green rewards ([Malik et al., 2020](#)) and green training ([Yong et al., 2020](#)).

Undertaking Green HR initiatives can result in greater efficiencies, lower costs, and potentially lead to sustainable growth of a business ([Mishra et al., 2014](#)). The availability of staff with environmental knowledge and skills, together with HR practices, which encourage engaging in environmental initiatives, constitute an incentive to obtain a competitive advantage and business sustainability among the companies. Green HRM has the highest potential for incorporating sustainability into an organization that seeks prosperity, social equity, and environmental integrity ([de Souza Freitas et al., 2012](#)).

Green HRM was proven to have a good association with economic performance (e.g. [O'Donohue and Torugsa, 2016](#); [Longoni et al., 2018](#); [Zaid et al., 2018](#); [Mousa and Othman, 2020](#)), in which an organisation's economic value increases if its employees are motivated and committed ([Weber, 2008](#)). Surprisingly, [Acquah et al. \(2021\)](#) found a contradictory result

proving that green HRM practices negatively influence economic performance. They believed that this result might be due to the high financial costs of employee training and green reward, which may adversely implicate the organisations' profitability in the short term.

Moreover, several researchers emphasised the effectiveness of green HRM in promoting the organisations' environmental performance (Zaid *et al.*, 2018; Gilal *et al.*, 2019; Kim *et al.*, 2019; Roscoe *et al.*, 2019; Mousa and Othman, 2020; Acquah *et al.*, 2021; Afum *et al.*, 2021; Mansoor *et al.*, 2021; Úbeda-García *et al.*, 2021). These authors asserted that green HRM practices play an essential part in the development of employees' environmental awareness. Green HRM efficiently disseminates environmental culture knowledge and values depending on the talents and incentives of employees to strengthen environmental management, leading to the improvement of the organisations' environmental performance (Cantor *et al.*, 2012; Mousa and Othman, 2020).

Lastly, Zaid *et al.* (2018), Mousa and Othman (2020) and Acquah *et al.* (2021) discovered a positive correlation between green HRM and social dimensions of sustainable performance. The finding showed that companies implementing green HRM improved their green image, strengthened employee education and training, and improved society and employees' safety and health (Zaid *et al.*, 2018; Acquah *et al.*, 2021). Based on the above discussion, it is evident that green HRM and its implementation are very important for sustainability. Thus, the following hypotheses were recommended:

H4. Green HRM positively affect economic performance.

H5. Green HRM positively affect environmental performance.

H6. Green HRM positively affect social performance.

2.5.3 Mediating role of green HRM. The ICV theory highlights that companies need to focus and invest in intangible resources and knowledge capital to sustain competitiveness (Youndt and Snell, 2004). Thus, the overall process of implementing green HRM can be concluded in several ways.

First, green IC is an intangible asset capable of assisting a company to enhance its performance and gain a competitive advantage (Yang and Lin, 2009; Lopez-Gamero *et al.*, 2011). Yusoff *et al.* (2019) and Yusliza *et al.* (2020) found the role of green IC on business sustainability. The result implies that green skills, abilities, and capabilities as organizational assets are important for increasing community well-being, promoting economic growth, and serving as important contributors to cleaner production strategies (Yusliza *et al.*, 2020).

Second, companies aiming to achieve sustainability can effectively use their resources. The green HRM is beneficial because it is a practical and essential method of putting environmental policies into action (Zhao *et al.*, 2020). Third, green HRM can enhance employees' environmental knowledge and skills, which help to implement environmental strategies (Masri and Jaaron, 2017; Cabral and Dhar, 2020; Afum *et al.*, 2021). This argument aligns with Mansoor *et al.* (2021), who emphasised that companies required green HRM practices to impact corporate environmental protection. They also discovered that the function of green HC would be strengthened in the presence of green HRM practices, which enhances companies' environmental performance.

Previous scholars have established that a long-term competitive advantage or sustainability depends mainly on companies' green IC and green HRM practices. However, limited emphasis was given to how green IC can enhance sustainability based on green human resources. Conversely, Kong and Thomson (2009) believed that IC and HRM are closely related. However, they emphasised the need to ascertain IC's impact on HRM. Following literature, Haldorai *et al.* (2022) have also entailed that the level of intellectual capital found in an organization may influence the organization to make better decisions, improve organizational performance through well-defined strategic HRM.

In view of the literature support given above, the companies' acquisition of green IC is postulated to be the catalyst of sustainability. Besides, the human resource availability due to green HRM can be regarded as the company's ability to adopt environmental practices, which has an essential function in achieving sustainability. Drawing upon ICV, organizations gain sustainability through the strategic support of their green IC and green HRM practices. Therefore, this study investigates the possible mediating effect of green HRM on the relationship between green IC and sustainability:

- H7. Green HRM positively mediates the relationship between green HC and economic performance.
- H8. Green HRM positively mediates the relationship between green SC and economic performance.
- H9. Green HRM positively mediates the relationship between green RC and economic performance.
- H10. Green HRM positively mediates the relationship between green HC and environmental performance.
- H11. Green HRM positively mediates the relationship between green SC and environmental performance.
- H12. Green HRM positively mediates the relationship between green RC and environmental performance.
- H13. Green HRM positively mediates the relationship between green HC and social performance.
- H14. Green HRM positively mediates the relationship between green SC and social performance.
- H15. Green HRM positively mediates the relationship between green RC and social performance.

2.6 Research model

The evaluation of the mediating role of green HRM in the association between green IC (e.g. green HC, green SC, and green RC) and sustainability make this research unique. Figure 1 depicts the recommended conceptual model.

3. Methodology

3.1 Research setting and participants

The research objective is to determine the role of green HRM as a mediating factor in the association between green IC and sustainability through a correlational design and a cross-sectional empirical examination. A survey instrument and measuring scales were created to

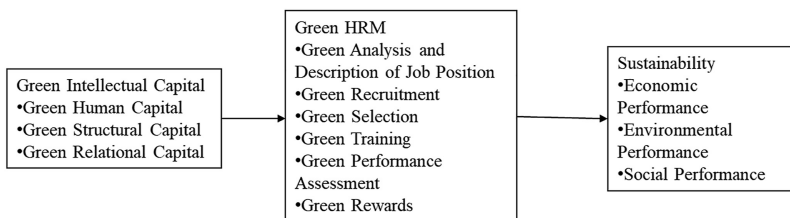


Figure 1.
Research model

validate the research model, and a pre-test was conducted to ensure that the scale was content valid. Four academics and four industry specialists collaborated on the revision and finalisation of the questionnaire. Items describing green IC, green HRM practises, and sustainability was included on the measuring scales utilised in the questionnaire.

The information was gathered from large manufacturing companies in Malaysia, characterised as businesses with more than 200 employees. The Federation of Malaysian Manufacturers (FMM) [Directory 2015](#) served as the sampling frame for this research, including all significant manufacturing enterprises in Malaysia ([FMM, 2015](#)). Additionally, 661 manufacturing enterprises with more than 200 employees were selected as a sample from the directory. Nevertheless, after omitting the eight firms used for interviews and four firms utilised for questionnaire pre-testing, the study population was reduced to 649. Resultantly, 649 significant manufacturing companies were approached via mail survey for this research. Due to the narrow sampling frame and the risk of a poor response from a mail survey, a census sampling technique was used ([Sekaran and Bougie, 2019](#)). Human resource managers or directors actively involved in HRM at large industrial enterprises in Malaysia were administered closed-ended questionnaires for data collection.

3.2 Measurements

The sustainability scale, which included social, economic, and environmental performance were measured utilising a 15-item scale adapted from [Zhu et al. \(2008\)](#), [Paulraj et al. \(2011\)](#) and [Laosirhongthong et al. \(2013\)](#). The participants were given a seven-point Likert scale to comment on, ranging from 1 (“not at all”) to 7 (“to a very great extent”).

[Chen \(2008\)](#) developed the green IC scale, which has three dimensions: green RC, green HC and green SC. Eighteen items on the measure were rated on a five-point Likert scale ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). Finally, the green HRM practises measuring items were developed from [Jabbour \(2011\)](#) and [Yong and Mohd-Yusoff \(2016\)](#). Green analysis and job description, green recruitment, green selection, green training, green performance assessment, and green rewards were the six components of this construct. For each issue, a seven-point Likert-type scale ranging from 1 (“not at all”) to 7 (“to a great extent”) was used. The items utilised in the study questionnaire are listed in [Table 3](#).

4. Results

4.1 Demographic profile of responding firms

A total of 112 completed questionnaires were collected. According to the demographic analysis, the majority of the businesses were in the electrical and electronic industry (25%). Conversely, large manufacturing enterprises had 201 to 500 employees (42.0%), and the human resources department had five to ten people (35.7%). Most large manufacturing enterprises (61.6%) had been in business for more than 20 years, and most were multinational corporations (52.7%). Surprisingly, ISO 9000 certification was held by 88.4% of large manufacturing enterprises in this study, whereas ISO 14000 certification was held by 71.4%. The majority of businesses were situated in Penang (47.3%), Selangor (15.2%) and Johor (10.7%) in terms of geographical location.

4.2 Data analysis

The measurement and structural models were assessed utilising the partial least squares (PLS) statistical modelling tool with the SmartPLS 3.2.3 version ([Ringle et al., 2015](#)). As the data was acquired from a single source, the issue of Common Method Bias was initially investigated by assessing full collinearity, as per [Kock's \(2015\)](#) recommendations. All variables are regressed against a common variable in this method. If the variance inflation

Construct	Definition	Item	Adapted from
Economic Performance	The ability of an organisation to reduce costs associated with purchased materials, energy consumption, waste treatment, waste discharge and fines for environmental accidents	ECP1: Decrease in costs for materials purchasing ECP2: Decrease in costs for energy consumption ECP3: Decrease in fees for waste treatment ECP4: Decrease in fees for waste discharge ECP5: Decrease in fines for environmental accidents	Zhu <i>et al.</i> (2008)
Environmental performance	The ability of an organisation to reduce air emissions, energy consumption, hazardous material, material usage and compliance with environmental standards	ENP1: Improved compliance with environmental standards ENP2: Reduction in air emissions ENP3: Reduction in energy consumption ENP4: Reduction in material usage ENP5: Reduction in the consumption of hazardous materials	Laosirhongthong <i>et al.</i> (2013)
Social performance	The ability of an organisation to improve social welfare and betterment, community health and safety, risks to the general public, occupational health and safety of employees	SCP1: Improved overall stakeholder welfare SCP2: Improvement in community health and safety SCP3: Reduction in environmental impacts and risks to the general public SCP4: Improved occupational health and safety of employees SCP5: Improved awareness and protection of the claims and rights of people in the community served	Paulraj (2011)
Green HC	The summation of employees' knowledge, skills, capabilities, experience, attitude, wisdom, creativities, commitments and others about environmental protection or green innovation and was embedded in employees, not in organisations	GHC1: The contribution of the environmental protection of employees in our firm is better than our major competitors GHC2: Employee competence concerning environmental protection in our firm is better than that of our major competitors GHC3: The product and/or service qualities of environmental protection provided by the employees of this firm are better than our major competitors GHC4: The amount of cooperative teamwork concerning environmental protection in our firm is more than that of our major competitors GHC5: Our managers fully support our employees in achieving their goals concerning environmental protection	Chen (2008)
Green SC	The stocks of organisational capabilities, organisational commitments, knowledge management systems, reward systems, information technology systems, databases, managerial mechanisms, operation processes, managerial philosophies, organisational culture, company images, patents, copyrights, and trademarks about environmental protection or green innovation within a company	GSC1: The management system for environmental protection in our firm is superior to that of our major competitors GSC2: Our firm is more innovative concerning environmental protection than are our major competitors GSC3: The profit earned from the environmental protection activities of our firm is greater than that of our major competitors GSC4: The ratio of investments in R&D expenditures to sales for environmental protection in our firm is more than that of our major competitors GSC5: The ratio of employees to the total employees in our firm who are engaged in environmental management is more than that of our major competitors GSC6: Investments in environmental protection facilities in our firm are more than those of our major competitors GSC7: Competence in developing green products in our firm is better than that of our major competitors GSC8: The overall operational processes for environmental protection in our firm work smoothly GSC9: The knowledge management system for environmental management in our firm is favourable for the accumulation of the knowledge of environmental management	Chen (2008)

(continued)

Table 3.
Constructs/Items used
in the research
questionnaire

Construct	Definition	Item	Adapted from
Green RC	The stocks of a company's interactive relationships with customers, suppliers, network members, and partners about corporate environmental management and green innovation enable it to create fortunes and obtain competitive advantages	GRC1: Our firm designs products and/or services in compliance with the environmentalism desires of our customers GRC2: Customer satisfaction concerning the environmental protection of our firm is better than that of our major competitors GRC3: The cooperative relationships concerning the environmental protection of our firm with our upstream suppliers are stable GRC4: The cooperation relationships about the environmental protection of our firm with our downstream clients or channels are stable GRC5: Our firm has well cooperative relationships concerning environmental protection with our strategic partners	Chen (2008)
Green analysis and job description	Including environmental issues in all job descriptions translates commitment to the environment into employees' obligations, on top of their usual activities	GAJ1: Enable involvement in managing environmental activities GAJ2: Enable acquisition of knowledge on environmental management GAJ3: Demanding knowledge on environmental management	Jabbour (2011), Yong and Mohd-Yusoff (2016)
Green recruitment	The activities of either internal or external recruitment show a company's preference for candidates committed to the environment	GR1: The environmental performance of a company attracts new employees GR2: The company prefers to hire employees who have environmental knowledge	Jabbour (2011), Yong and Mohd-Yusoff (2016)
Green selection	Selection of people who are committed and sensitive to environmental issues, with the potential to contribute to the environmental management of a company	GS1: Employee selection takes environmental motivation into account GS2: All selection steps consider environmental questions	Jabbour (2011), Yong and Mohd-Yusoff (2016)
Green training	Provides employees with the required knowledge on the environmental policy of a company, its practices, and necessary attitudes	GT1: Environmental training is continuous GT2: Environmental training is a priority GT3: Environmental training is an important investment	Jabbour (2011), Yong and Mohd-Yusoff (2016)
Green performance assessment	Appraisal and register of employees' environmental performance throughout their career in a company and providing them with feedback about their performance in order to prevent undesirable attitudes or to reinforce exemplary behaviour	GP1: Every employee has specific environmental goals to achieve GP2: Contributions to environmental management are assessed GP3: Individual performance assessment results are recorded	Jabbour (2011), Yong and Mohd-Yusoff (2016)
Green rewards	Implementation of a system of financial and non-financial rewards for employees with a distinct potential to contribute to environmental management	GRW1: Cash rewards are provided to recognise environmental performance GRW2: Environmental performance is recognised publicly	Jabbour (2011), Yong and Mohd-Yusoff (2016)

Table 3.

factor (VIF) is less than 3.3, no bias exists from the single-source data. The result of the analysis, the VIF, was less than 3.3, indicating that single source bias was not a significant issue with the data.

4.2.1 Measurement model assessment. The loadings, average variance extracted (AVE), and composite reliability (CR) were tested to confirm the convergent validity and reliability of the measuring items. Table 4 shows that all the AVE were above 0.5 and CR was above 0.7 (Hair et al., 2020) for the first-order dimensions and the second-order constructs. Thus, the measurement items had sufficient convergent validity and reliability. The HTMT criterion was used to test discriminant validity, as per Franke and Sarstedt (2019). Table 5 shows that all ratios were less than 0.90, indicating that distinct measurements.

4.2.2 Structural model assessment. The *t*-values were generated using a bootstrapping approach with 5,000 resamples (Ramayah et al., 2018; Hair et al., 2020). Six hypotheses were developed (Refer to Table 6), which were direct relationships and another nine hypotheses for mediated relationships (see Table 7).

First, the in-sample prediction power of the model was assessed using the R^2 . The R^2 for green HRM was 0.358 ($Q^2 = 0.234$), economic performance was 0.113 ($Q^2 = 0.079$), environmental performance was 0.133 ($Q^2 = 0.083$) and social performance was 0.146 ($Q^2 = 0.108$). Thus, the model has a satisfying in-sample prediction and predictive relevance as all the Q^2 were

Constructs	Mean	Standard deviation	CR	AVE
Economic performance (ECP)	4.593	1.169	0.942	0.767
Environmental performance (ENP)	5.070	0.936	0.915	0.683
Green analysis and job description (GAJ)	3.991	1.197	0.946	0.855
Green human resource management (GHRM)	3.734	1.121	0.934	0.734
Green performance assessment (GPA)	3.551	1.369	0.965	0.901
Green recruitment (GREC)	3.614	1.296	0.931	0.871
Green rewards (GREW)	3.195	1.474	0.948	0.901
Green selection (GS)	3.385	1.350	0.968	0.938
Green training (GTR)	4.388	1.359	0.963	0.897
Green HC	3.610	0.610	0.908	0.666
Green RC	3.771	0.704	0.949	0.787
Social performance (SP)	5.172	0.971	0.946	0.780
Green SC	3.470	0.646	0.948	0.671

Table 4. Mean, standard deviation, composite reliability and average variance extracted

	1	2	3	4*	5	6	7	8	9	10	11	12	13
1. ECP													
2. ENP	0.882												
3. GAJ	0.171	0.243											
4. GHRM*	0.341	0.383	-										
5. GPA	0.321	0.314	0.602	-									
6. GREC	0.321	0.382	0.724	-	0.759								
7. GREW	0.340	0.318	0.524	-	0.883	0.669							
8. GSEL	0.332	0.336	0.633	-	0.867	0.882	0.777						
9. GTR	0.298	0.385	0.611	-	0.687	0.603	0.649	0.650					
10. GHC	0.296	0.377	0.347	0.582	0.522	0.588	0.461	0.555	0.537				
11. GRC	0.270	0.406	0.355	0.569	0.533	0.548	0.473	0.506	0.518	0.779			
12. SP	0.687	0.823	0.274	0.398	0.335	0.391	0.295	0.315	0.416	0.399	0.451		
13. GSC	0.248	0.350	0.384	0.570	0.543	0.548	0.447	0.519	0.489	0.813	0.813	0.370	

Note(s): *Second-order factor

Table 5. Discriminant validity (HTMT Ratio)

Hypothesis	Relationship	Std Beta	Std Dev	t-value	p-value	BCI LL	BCI UL	f ²
H1	GHC → GHRM	0.271	0.126	2.158	0.016	0.036	0.460	0.035
H2	GSC → GHRM	0.070	0.168	0.416	0.339	-0.220	0.331	0.001
H3	GRC → GHRM	0.307	0.133	2.320	0.009	0.087	0.528	0.046
H4	GHRM → ECP	0.336	0.078	4.309	p < 0.001	0.181	0.448	0.128
H5	GHRM → ENP	0.364	0.086	4.237	p < 0.001	0.210	0.481	0.153
H6	GHRM → SP	0.382	0.074	5.128	p < 0.001	0.267	0.510	0.171

Table 6. Hypothesis testing (direct effects)

greater than 0 (Fornell and Cha, 1994). The VIFs were all lower than 5, implying no multicollinearity in this study.

Green HRM were positively related to green RC ($\beta = 0.307, p < 0.01$) and green HC ($\beta = 0.271, p < 0.05$). Nevertheless, green SC ($\beta = 0.070, p > 0.05$) was not, indicating that H1 and H3 were supported, but H2 was not supported. Green HRM was positively related to

social performance ($\beta = 0.382, p < 0.001$), economic performance ($\beta = 0.336, p < 0.001$) and environmental performance ($\beta = 0.364, p < 0.001$). These results supported H4, H5 and H6.

Nine mediation effects were posited, and the results are exhibited in Table 7. All the mediation effects of green IC on performance were significant except for the relationship of green SC on performance. Thus, H7, H9, H10, H12, H13 and H15 were supported, while H8, H11 and H14 were not supported.

PLS-Predict is a holdout sample-based approach proposed by Shmueli *et al.* (2019), which makes case-level predictions on an item or construct level utilising the PLS-Predict with a five-fold procedure to examine predictive relevance. Table 8 demonstrates that all PLS model errors were lower than the linear regression (LM) model, indicating that the model has good predictive power.

5. Discussion

In recent years, the potential mediating relationship of green HRM between green IC and sustainability remains unknown. However, research has assessed the various factors and findings of green HRM that are growing. This research introduces the previously ignored perspective to the green HRM literature by examining how green IC influences the triple bottom line of sustainability. This research is the first to examine the theoretical framework, providing a deeper knowledge of manufacturing enterprises' sustainability. In short, this

Table 7.
Hypothesis testing
(indirect effects)

Hypothesis	Relationship	Std Beta	Std Dev	t-value	p-value	BCI LL	BCI UL
H7	GHC → GHRM → ECP	0.091	0.051	1.808	0.036	0.011	0.170
H8	GSC → GHRM → ECP	0.024	0.060	0.392	0.347	-0.076	0.121
H9	GRC → GHRM → ECP	0.103	0.055	1.878	0.030	0.027	0.207
H10	GHC → GHRM → ENP	0.099	0.056	1.772	0.038	0.004	0.179
H11	GSC → GHRM → ENP	0.026	0.067	0.380	0.352	-0.090	0.126
H12	GRC → GHRM → ENP	0.112	0.064	1.743	0.041	0.026	0.230
H13	GHC → GHRM → SP	0.104	0.057	1.818	0.035	0.015	0.201
H14	GSC → GHRM → SP	0.027	0.068	0.396	0.346	-0.089	0.122
H15	GRC → GHRM → SP	0.117	0.065	1.817	0.035	0.031	0.242

Table 8.
PLS-predict

MV	PLS RMSE	MAE	LM RMSE	MAE	PLS-LM RMSE	MAE	Q ² _predict
ECP1	1.472	1.205	1.576	1.287	-0.104	-0.082	0.054
ECP2	1.327	1.109	1.415	1.180	-0.088	-0.071	0.058
ECP3	1.298	1.071	1.410	1.132	-0.112	-0.061	0.032
ECP4	1.250	1.042	1.293	1.044	-0.043	-0.002	0.078
ECP5	1.227	1.037	1.267	1.025	-0.040	0.012	0.041
ENP1	0.997	0.821	1.076	0.833	-0.079	-0.012	0.059
ENP2	1.017	0.831	1.097	0.879	-0.080	-0.048	0.103
ENP3	1.078	0.856	1.092	0.900	-0.014	-0.044	0.058
ENP4	1.210	0.976	1.270	1.027	-0.060	-0.051	0.103
ENP5	1.155	0.860	1.225	0.956	-0.070	-0.096	0.073
SCP1	1.241	0.954	1.323	0.991	-0.082	-0.037	0.064
SCP2	0.964	0.788	1.043	0.861	-0.079	-0.073	0.116
SCP3	1.033	0.798	1.117	0.861	-0.084	-0.063	0.123
SCP4	0.994	0.834	1.077	0.897	-0.083	-0.063	0.128
SCP5	1.019	0.840	1.096	0.875	-0.077	-0.035	0.111

study answers whether green IC influences sustainability through the mediating role of green HRM practices.

First and foremost, the empirical findings showed that green HC significantly and positively impacts Green HRM, consistent with earlier research (Yong *et al.*, 2019; Mansoor *et al.*, 2021). The results discovered that employees' environmental knowledge abilities are ingrained in the employees, which further fosters the development of green innovation (Wang and Juo, 2021). Therefore, recruiting employees with superior environmental knowledge becomes a competitive advantage. The unique competencies of employees build strong teamwork, bringing innovation during the implementation of the HRM strategies. Hence, the statistically supported hypothesis affirms that employees with experience and knowledge of environmental issues are assets for the organisation. They tend to help devise and implement the policies, explicitly designing the job description, recruitment, selection, and training of the employees.

Second, the study discovered a positive and significant correlation between green RC and green HRM. The results aligned with Yong *et al.*'s (2019) findings, who discovered that green RC significantly impacted green HRM. Manufacturers and their network members appear to have a relationship focused on collaboration and sharing of knowledge. Resultantly, if the green RC embraces the concept of green HRM practices and the advantages connected with their implementation, manufacturers may be more motivated to do so. Yusoff *et al.* (2019) also asserted that green SC encourages businesses to embrace sustainable business practices. Manufacturing companies could also use green RC to build a collaborative discourse among their stakeholders to minimise the environmental effect and generate eco-friendly products, resulting in improved sustainable performance (Yusoff *et al.*, 2019).

Third, the empirical results supported H4, H5, and H6. Thus, the association between green HRM and all dimensions of sustainability was proven. The findings aligned with the prior studies where authors discovered that green HRM is positively related to sustainability (e.g. Daily *et al.*, 2012; Bangwal *et al.*, 2017; Cheema and Javed, 2017; Zaid *et al.*, 2018; Gilal *et al.*, 2019; Kim *et al.*, 2019; Roscoe *et al.*, 2019; Yong *et al.*, 2019; Cabral and Jabbour, 2020; Malik *et al.*, 2020; Mousa and Othman, 2020; Acquah *et al.*, 2021; Afum *et al.*, 2021; Khan *et al.*, 2021a,b; Mansoor *et al.*, 2021; Úbeda-García *et al.*, 2021).

Economic value is a value-added to an organisation with inspiring and dedicated employees (Weber, 2008), especially when employees are green-minded in the workplace after experiencing green aspects of HRM practices. Furthermore, through green HRM, the successful distribution of environmental ideology and standards to attain sustainability encourages employees' environmental management-based motivations and abilities. Additionally, a positive correlation between green HRM and social performance will result in lower costs, increased sustainability, and a new emphasis on corporate social responsibility, improving the company's brand and community health and safety (Jain *et al.*, 2017).

Next, another novel contribution of the present study is testing the mediating role of green HRM between green IC and the triple bottom line of sustainability. To the researchers' knowledge, no study has tested the said relationship except for Mansoor *et al.* (2021). Nevertheless, Mansoor *et al.* (2021) only assessed the mediation effect of green HRM on the correlation between green RC and green HC on environmental performance in Pakistan. The ICV theory also supports the result that a firm can attain sustainability through the green IC and strategic support from the green HRM practices (Youndt and Snell, 2004). Conclusively, employee knowledge, competencies, and skills are significant aspects of green RC and green HC in establishing green HRM practises, according to the support of the ICV theory. The synergetic effect of green RC, green HC and green HRM helps in improving business sustainability.

The study findings added to the current body of knowledge by responding to Kovács's (2008) reservations of assessing downstream and upstream customer consequences on environmental and social performance. The link between an organisation and its upstream or downstream customers can also be viewed as green RC. Downstream and upstream clients favourably impact all aspects of sustainable success. Collaboration with upstream clients affects environmental performance, and product-based performance is linked to downstream collaboration (Karaosman *et al.*, 2020). Thus, the results confirmed that the knowledge from both upstream and downstream in green RC also enhances the organisations' sustainability through green HRM policies and practices.

5.1 Theoretical contributions

This research makes significant theoretical contributions in the research and academic domains by stressing the mediating effect of green HRM on the association between green IC and sustainability, as per the ICV theory. Due to their green IC, employees with increased skills and understanding of green HRM operations aid in improving efficiencies, such as wastage, expense, and consumption reduction that enhance organisation economic, social and environmental performance. An organisation's sustainable performance capability to impart competitive advantage, which is the essence of ICV, is critical (Sheikh, 2021). Resultantly, green IC might be considered a valuable intangible asset for achieving a competitive advantage (Sheikh, 2021).

This study has several implications from a theoretical standpoint. Mansoor *et al.* (2021) investigated the mediation effect of green HRM on environmental performance and green HC. However, they disregarded other crucial aspects of green IC (green HC and green SC) and the triple bottom line of sustainability (e.g. economic and social performances). Therefore, the current study adds to the body of knowledge on the impact of green HRM on not only environmental performance but also organisations' social and economic performance. Moreover, the study also discovered the importance of green RC with the mediation effect of green HRM on the triple bottom line of sustainability.

This research also extended the work of Guerci *et al.* (2016) by revealing the positive and significant effect of green RC on the triple bottom line of sustainability and provided empirical evidence for a mechanism by which green HRM impacts the environmental performance. Guerci *et al.* (2016) has explained the role of stakeholder pressure with a single outcome of environmental performance with mediating variables. Thus, the mediation process of the study suggests a comprehensive framework for analysing the impact of green HRM practices on sustainability. The current study adds to the existing literature by addressing the topic of sustainability in the major industrial sector, which is undergoing a plethora of challenges from environmental implications. Only a few research on green IC in environmental management exist, and the majority have identified it as a sustainability determinant (Yusoff *et al.*, 2019; Malik *et al.*, 2020; Yusliza *et al.*, 2020; Ullah *et al.*, 2021). The research investigated green IC from the environmental management standpoint. It expanded on its contribution to generating and nurturing green HRM practices rather than directly culminating in sustainable performance.

5.2 Practical implications

Besides theoretical implications, the study offers numerous practical implications for practitioners and policymakers related to a quadruple-helix model to achieve economic, social, and environmental sustainability in IR 4.0 that will help design strategies for the green economy. First, universities should broaden the description for green HRM to drive organisations to adopt precise green IC that may influence different aspects of the firms' sustainability. The study findings may assist HRM academics in empowering their learners

with a thorough understanding of why businesses use IC and green HRM practices to remain sustainable in the industry economically, environmentally, and socially, not only to one specific group but to a wide range of factors and set of actors. Thus, it must be placed within and without the organisation.

From an industry standpoint, the framework presented in this study aims to provide a reference for manufacturing firms to understand the influence of green ICs on green HRM that ultimately leads to sustainability. Managers involved in the decision-making processes about potential investments in green HRM may find the findings helpful. First, the findings offer evidence-based research on the positive effects of green HC and green RC on green HRM. As green HRM has received high attention in recent years, the adoption of the proposed model in manufacturing industry in developing countries can contribute to business sustainability. Therefore, to realize the benefits of green HRM implementation, businesses must devote their attention to these two green ICs. Given that green HC is owned by employees and not organizations; hence, in the process of establishing green HRM, organizations must enhance their human capital by educating them in environmental knowledge and skills and create a knowledge-sharing culture among employees to foster their creativity in environmental protection. Besides, green RC focuses on the organization's interactive relationship with its stakeholders. Specifically, managers can encourage their suppliers to take an active role in their environmental activities by communicating openly about their green initiatives and environmental protection, creating collaborative "green relationships" with suppliers (Haldorai *et al.*, 2022).

Second, resource scarcity remains a concern in manufacturing industry, and companies must build sustainable, future-oriented solutions to overcome this challenge. This study provides industrial managers with useful insights on the importance of green for the sustainability of manufacturing industry in Malaysia. In addressing sustainability concerns, green HRM can be viewed as an innovative approach that allows manufacturing to focus on developing green skills, abilities, and capabilities to be environmentally conscious. Top management should focus on getting employees into the habit of being environmentally responsible, especially at work. Resultantly, managers should consider establishing environmental goals and associating them with organisational rewards (Shah *et al.*, 2021). Among other things, the study also assists managers understand how to effectively motivate employees to increase operational efficiency, reduce cost associated with environmental issues, and improve social well-being. All of this promotes deeper employee engagement in performing green practices for more effective sustainable performance.

Third, valuing the detailed findings on the mediating effect of green HRM on three aspects of green IC and three aspects of sustainability, the study makes practical suggestions to practising managers who want to understand whether green IC is worth investing in improving the firm's green HRM and sustainability in terms of economic, social, or environmental performance. The result reveal that green HC and green RC contribute to sustainability through its influence on green HRM, and further suggest prioritising investments in green HRM, green HC and green RC, and less investment in green SC. Although the results highlight the importance of green HC and green RC in this model; however, companies should adopt a range of green HRM practices and align with sustainable solution. The HR department should recruit and select candidates with environmental knowledge and competencies, initiate environmental training to improve their skills, evaluate employee performance against green standards, and reward employee based on their environmental performance or engagement. As consumers become more concerned about the environment and health issues, the necessity for cleaner production of goods has increased, giving companies a competitive advantage. This concept can give the manufacturing sector a competitive advantage in implementing environmental business strategies through clean

technologies. Therefore, the green HRM and environmental business strategies will ultimately lead to business sustainability.

Concerning government implications, this study adds to the current debate about the government's and regulators' competence in encouraging ecologically acceptable outcomes, which aligned with [Guerci et al. \(2016\)](#). Governments and policymakers may want to re-evaluate the impacts of environmental pressures to frame them in a way that encourages the adoption of green IC (specifically, green HC and green RC) and green HRM practices that affect sustainability. Furthermore, the government may allocate some financial or non-financial support to companies investing in green training concerning environmental management and the criticality of IC that exploit the potential impacts of organisations' sustainability because the industry plays a critical role in environmental mitigation. Thus, practitioners may create and refine green-oriented strategies to achieve corporate sustainability by applying the green IC model and green HRM in manufacturing sectors.

In terms of societal, green practices (e.g. green IC and green HRM) might impact not only employees, business, and organisational environment to go green but also society. As society becomes more environmentally conscious, organisations need to find feasible ways to reduce ecological footprints which are economically viable that ultimately impact the environment to become cleaner, safer and healthier for the global society. Moreover, organisations must support product, process, design, and technological innovation in order to develop solutions for a healthy, peaceful, and damage-free society with enough natural resource availability for the future ([Mishra et al., 2014](#)). In the near future, green IC and green HRM as an initiative has the ability to become one of the finest practices for sustainable corporate success, subsequently regaining society's confidence.

5.3 Conclusion, limitations and future research directions

This research contains limitations that must be taken into account when interpreting the findings. However, these limitations also provide prospects for future research. First, cross-sectional data was utilised in this study, implying that the data are correlational and that causation cannot be proven. Conversely, cross-sectional self-report research gives essential information, which may be examined comprehensively in later research using various methodologies and data types ([Spector, 1994](#)). The study findings outline the way for future studies using time-lagged or longitudinal designs and objective or multiple report data to examine these factors.

Second, the results are according to responses from large Malaysian manufacturing firms, limiting the generalizability to other settings. Nonetheless, the findings may be applied to other sectors, including higher education, processing, telecommunications, hotels, SMEs, hospitality, banking, construction, aviation, oil and gas, and health sectors. These industries can reduce emissions in various ways with different costs and complexities. Nevertheless, the generalizability of the present study cannot be confirmed. Future research might establish external validity by using data from other industries, sectors, and locations worldwide.

Third, sustainability is suspected of leading organisational performance and business strategy gradually. However, the current study did not test the notion and cannot prove the claim. Nevertheless, prior studies have demonstrated a correlation between sustainability and organisational performance ([Sarfraz et al., 2021](#)) and organisational learning ([Hermelingmeier and Wirth, 2021](#)). Thus, the same findings could be unsurprisingly observed in manufacturing firms and identifying the correlation would be valuable. Thus, future studies in the industrial sector might assess the link between sustainability, organisational performance, and organisational learning. Fourth, this study has found an

insignificant relationship of green SC. Hence, future research may evaluate the control variables in the manufacturing industry and operational business years in different groups to shed light on the role of green SC comprehensively.

In conclusion, this study is hoped to inspire studies on how green HRM and green IC can affect a firm's sustainability and competitive advantage for the stakeholders' well-being.

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