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The Impact of Solar Photovoltaic (PV) Adoption on Corporate Image and Business Sustainability in Malaysian Small and Medium Enterprises (SMEs)

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ABSTRACT

Solar photovoltaic (PV) is a rapidly growing renewable energy technology that converts sunlight directly into electricity. As a clean and sustainable alternative to fossil fuels, solar PV is increasingly recognised as a critical component in shifting to a low-carbon economy. Solar PV is often associated with a high upfront cost. Nevertheless, solar PV adoption can provide significant long-term financial benefits and energy saving in the long run, especially for small businesses. Even though many incentives have been introduced to promote solar PV adoption, the number of studies focusing on the impact of such adoption, particularly in Malaysian small and medium enterprises (SMEs), is still scarce. As a result, little is known about how solar PV adoption can benefit SMEs. This study, therefore, examined the relationship between (1) solar PV adoption and corporate image; and (2) solar PV adoption and business sustainability (economic, environmental, and social). A quantitative research approach was employed to gather the data, which involved distributing a questionnaire to the targeted users. Data from sixty-nine (69) SMEs from manufacturing industries were analysed using SmartPLS (version 4.0). The manufacturing sector was selected as it is among the significant contributors to the increase in carbon dioxide emissions. Hence, the key players' awareness and understanding of the issue are crucial to promoting solar PV's future adoption. The outcome of this study reveals a positive relationship between solar PV adoption and corporate image, and economic and environmental sustainability. There is no evidence, however, to support the relationship between solar PV adoption and social sustainability. This research contributes theoretically to bridging the gap in understanding the impact of solar PV adoption on corporate image and business sustainability, particularly in the context of manufacturing SMEs. Practically, this study provides recommendations on how the results could be exploited to promote solar PV adoption among SMEs.

1. Introduction

The energy sector has contributed to 28% of Malaysia's GDP and provided daily electricity to over ten (10) million users [1]. In 2020, the energy consumption per capita was 2.8 toe, where the

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electricity consumption increased from 3 900 kWh per capita in 2010 to 4,700 kWh [2]. In line with the increment in energy and electricity consumption, an increment in carbon dioxide (CO_2) emissions in the upcoming years is anticipated. For example, Malaysia's CO_2 emissions for 2019 were 396.11 Mt, a 3.1% increase from 2018 [3].

The manufacturing sector contributes to 24% of Malaysia's growth domestic product (GDP) [4], the second contributor to Malaysia's economy. Husaini and Lean [5] predicted that expanding the manufacturing sector drives the increased demand for electricity. However, the current energy supply (i.e., electricity) highly depends on fossil fuels. Approximately 90% of the overall energy generation mix is attributed to coal and natural gas [6]. As such, more energy consumption causes more CO_2 to be released into the atmosphere, adding to global warming and other harmful effects of climate change. As a result, dependency on fossil fuels must be reduced by exploring potential resource diversification via green energy sources, renewable energy, and cleaner energy resources.

According to Alam and Rashid [7], renewable energy is the transformation of natural energy with the help of advanced technology to replace conventional energy solutions to reduce global warming problems. In this context, renewable energy could be generated from Malaysia's natural resources, such as large hydro, solar photovoltaic, biogas, biomass, and small hydro [6].

The Seventh Malaysia Plan has documented the importance of renewable energy generation. Accordingly, various initiatives and action plans to generate renewable energy have been implemented to support green technology aspirations. These measures include, among others, the establishment of the National Energy Policy, National Bio-fuel Policy 2006, National Green Technology Policy 2009, National Renewable Energy Policy 2010, and The Green Technology Master Plan 2017-2030. Renewable energy and green economy have also been identified as the fifteen (15) proposed Key Economic Growth Activities under the Shared Prosperity Vision 2030 [8]. The Shared Prosperity Vision 2030 is the government's roadmap towards building Malaysia as a real Asian Tiger. Most recently, the government launched National Energy Policy (2022-2040) to support Low Carbon Nation Aspiration 2040 via renewable energy.

Solar energy is one of the most viable options for Malaysia because the country receives a high amount of sunlight throughout the year, and its location is in proximity to the equator. Malaysia receives solar irradiance in the range of 1,575 – 1,812 kWh/m2 throughout the year, which is considered a strong level of solar radiation [9]. Hence, solar energy is naturally available and can be utilised for renewable energy power generation. A solar photovoltaic (PV) system is a technology that converts sunlight into electricity by using solar panels. Solar panels consist of photovoltaic cells that absorb sunlight and convert it into direct current (DC). The DC is then converted into alternating current (AC) through an inverter, which can be used to power various electrical devices and appliances.

In recent years, Malaysia has been making noteworthy progress in promoting the adoption of solar energy. For example, the introduction of the Net Energy Metering (NEM) programme for solar PV enables all domestic, commercial, industrial, and agricultural sectors to apply. Along with this incentive, the Sustainable Energy Development Authority (SEDA) has launched the NEM calculator on its website to assist in calculating the potential monthly savings of solar energy generation, the upfront cost needed, the simple payback period, and the environmental impact [10].

Small, and Medium Enterprises (SMEs) are the backbone of the economy. In Malaysia, 97.4% of business establishments are SMEs, with 1,226,494 establishments across sizes of small, medium, and microenterprises in 2021 [11]. Given its larger number of establishments, the potential contribution of SMEs as the key driver of green technology is significant, especially for businesses with their own buildings for operations. SMEs could exploit the opportunities to leverage the incentives provided by the government to adopt sustainable practices and support the national agenda. Nevertheless, the

capability of SMEs to participate in this opportunity is often hindered because even though solar energy is considered "free" renewable energy, the technology and tools (e.g., installing the PV system) to harness solar power are high cost. Due to various limitations, such as financial constraints, SMEs are reluctant to invest in new technologies or any innovations, particularly if they feel uncertain about their ability to manage the technologies and the payback period of the investment. Hence, the adoption of solar PV among SMEs is progressing slowly for distinct reasons, such as a lack of awareness and high upfront costs.

The Malaysian government has announced various incentives to promote the adoption of green technology, such as solar PV, among businesses, including SMEs. The incentives include Green Investment Tax Allowance (GITA), Green Income Tax Exemption (GITE), and Green Technology Financing Scheme 2.0 (GTFS 2.0). In addition, the financial institutions also participate in supporting renewable solar initiatives, which include the CIMB SME Renewable Energy Financing programme and Hong Leong Bank SME Solar Financing. Both financing programmes aimed at providing SMEs with full financing to cover the cost of solar PV systems and installation. However, despite the Malaysian government's effort to develop and promote the generation and utilisation of renewable energy, it was revealed that only 2% of Malaysia's energy was generated by renewable energy sources [12]. This fact indicates that electricity generation through renewable energy is deficient. It was reported that Malaysia's solar PV capacity is expected to reach 337 gigawatts (GW), but solar PV's installed capacity in 2021 was only 1.8 GW [13]. It shows that Malaysia's adoption rate of solar PV is still low (for both industries and residential users). The same concern was also highlighted by Lau *et al.,* [14], which emphasised the long existence of solar PV, but the adoption rate remained low. Such low adoption was due to most Malaysians being unaware of the initiatives introduced by the government; therefore, they hesitated to invest in solar PV [14]. Thus, the challenge is how Malaysia could focus on achieving a 23% penetration of the total energy generation mix for electricity generation by 2025 and 30% by 2030 [6].

Despite all the initiatives introduced by the Malaysian government, it is imperative to highlight the benefits of adopting solar PV to SMEs for them to realise its potential beneficial impact. In contrast, numerous studies have demonstrated the positive effects of adopting green technologies [15-19]. To date, a study that explicitly analyses the impact of solar PV adoption on businesses has yet to exist. Consequently, little is known about the impact of solar PV adoption, particularly in SMEs. Wang *et al.,* [20] expressed concern regarding the adoption rate of solar PVs in the commercial sector. Historical data suggests a lower eventual adoption rate in the commercial sector than in residential usage. Due to the massive number of Malaysian SMEs and their contribution to the country's economic development, it is essential to investigate the impact of using solar PV on businesses. Such impact can be observed in two areas: enhancing the corporate image, as more consumers and stakeholders become environmentally concerned and strive to support sustainable enterprises and improving sustainable business performance by saving on electricity bills to reduce operating costs and improve long-term profitability. The second area is reducing carbon footprint, contributing to a more sustainable future, as well as demonstrating their commitment to sustainability and social responsibility.

Due to the lack of information about the association between solar PV adoption and its impact on corporate image and business sustainability, this study sheds light on this gap by examining the relationship between (1) solar PV adoption and corporate image; (2) solar PV adoption and economic sustainability; (3) solar PV adoption and environment sustainability; and (4) solar PV adoption and social sustainability. The findings of this study could further enhance the understanding of solar PV adoption and its impact on SMEs.

This paper is structured as follows. Firstly, the research objectives and their importance are introduced. Following this, a review of the literature and hypotheses are presented. The research method is then explained, and the findings of the study are discussed. Finally, the conclusions and implications of the study are presented.

2. Literature Review, Research Model and Hypotheses

2.1 Solar PV in Malaysia

A solar photovoltaic (PV) is a power system that harnesses the energy of the sun using solar cells or A solar photovoltaic (PV) is a power system that harnesses the energy of the sun using solar cells or photovoltaic cells. This process, known as the photovoltaic effect, converts sunlight (photons) into electrical energy. According to Zahedi [21], solar PV can be installed on residential rooftops or the walls of commercial buildings as a grid-connected PV application. Solar PV systems typically comprise several components, including solar panels, inverters, batteries (optional), and a mounting system. The solar panels are fabricated of connected individual solar cells to form a module. These modules are then mounted on a frame, which can be fixed to a roof or mounted on the ground. The solar panels generate direct current (DC), which is then converted into alternating current (AC) by an inverter. AC can be easily transmitted over long distances with minimal energy loss, making it more efficient and cost-effective. In addition, AC is the standard form of electrical power used by residential and business premises.

Solar PV has the highest potential to meet Malaysia's high energy demand compared to other renewable energy sources [14, 22]. Unlike wind or hydro, solar is an abundant resource readily available that provides clean and sustainable electricity. Solar PV is considered a clean energy source in this context because it operates quietly and does not produce hazardous or toxic waste during energy production [23]. In addition, solar PV power production has been recognised as the most environmentally friendly method, making it a sustainable option for electricity production [24].

In its effort to promote the adoption of renewable energy, Malaysia has produced three (3) strategic documents highlighting the aspirations to increase renewable energy capacity and reduce carbon emissions. The strategic plans recognised solar PV as part of Malaysia's renewable energy mix and a major source of renewable energy that can help to meet Malaysia's energy demand and reduce its dependence on fossil fuels, as tabulated in Table 1.

Table 1
The strategic plan documents related to solar energy

	Green Technology Master Plan 2017-2030	Malaysia Renewable Energy Roadmap	National Energy Policy 2022-2040
Focus	Developing green technology industries and promoting sustainable development	Increasing renewable energy use and reducing carbon emissions	Developing a sustainable energy mix and ensuring energy security for Malaysia
Time frame	2017-2030	Launched in 2021	2022-2040
Goals and Targets	• Plans for green technology development to create a low-carbon and resource-efficient economy.	• Achieving 31% RE share in the national capacity mix by 2025 • Attaining decarbonisation of the electricity sector by 2035.	• Enhancing macroeconomic resilience and energy security. • Achieving social equitability and affordability. • Ensuring environmental sustainability.

Feed-in Tariff (FiT) and Net Energy Metering (NEM) are two initiatives implemented by the Malaysian government to encourage the adoption of renewable energy. The initiatives aim to promote sustainable energy development, reduce greenhouse gas emissions, and increase the country's energy security. Information related to FiT and NEM is summarised in Table 2.

Table 2
Comparison between government initiatives on renewable energy

	FiT	NEM	NEM 2.0	NEM 3.0
Implementation Date	2011	2016	2019	2021
Focus	Allows electricity produced from indigenous renewable energy resources to be sold to power utilities at a fixed premium price for a specific duration.	Prioritises self-consumption and any surplus to be exported and sold to the utility at a displaced cost.	Allowed excess solar electricity to be compensated on a one-on-one basis instead of the displaced cost, effective in early 2019.	Provide the opportunity for more users to install solar PV systems on the roofs of their respective buildings for an electricity bill reduction.
Eligible systems	Solar PV, biomass, biogas, mini-hydro, geothermal and wind energy.	Solar PV	Solar PV	Solar PV
Types				1. NEM Rakyat Programme – Domestic applicants 2. NEM GoMEn Programme – Government Ministries and Entities 3. Net Offset Virtual Aggregation (NOVA) – Commercial, Industrial, Agriculture, and Mining Buildings
Implementing Agencies	SEDA		SEDA	SEDA

* Large Scale Solar mechanism is not included

In addition to the above initiatives, the government has introduced three (3) key financial enablers to further support the growth of the renewable energy sector, namely the Green Investment Tax Allowance (GITA), the Green Income Tax Exemption (GITE), and the Green Technology Financing Schemes (GTFS). These incentives aim to encourage investment in renewable energy projects and promote the development of green technology. The GTFS was first introduced in 2010 and provided financing for renewable energy projects through participating financial institutions. This scheme targets individuals, small and medium-sized enterprises (SMEs), and corporations in Malaysia. The GTFS 2.0, introduced in 2019, is an expansion of the GTFS scheme that offers financing for a broader range of green technology projects. The eligibility criteria for GTFS 2.0 have been extended to producers and users of green technology and energy service companies (ESCOs) [25]. GITA was also introduced in 2010 to provide tax incentives to businesses investing in renewable energy. Companies that (1) acquire qualifying renewable technology assets and are listed under the MyHIJAU directory and (2) undertake qualifying green technology projects for business or own consumption are eligible for a 100% tax deduction on qualifying capital expenditure. GITE, introduced in 2012, provides tax exemptions to businesses that generate income from renewable energy projects (i.e., service provider companies listed under the MyHIJAU directory. The companies are eligible for income tax

exemption of 70% on statutory income for qualifying green services activities for a period of 3 years of assessment [26].

Despite the Malaysian government's efforts to encourage the adoption of solar PV, such as the NOVA programme under the NEM 3 scheme and tax exemption, the impact of solar PV on SMEs is not widely understood, which may contribute to the low adoption rate. SMEs may be hesitant to invest in solar PV as they are unsure of the potential benefits and do not fully comprehend the positive impact solar energy can have on their operations. Therefore, the impact of solar PV adoption must be examined to address the poor adoption rate among SMEs.

2.2 Corporate Image

Corporate image is viewed as the overall perception of consumers or the public of a company, such as the business name and products or services offered [27,28]. From a different point of view, Worcester [29, p. 573] referred to corporate image as "the net result of all experiences, impressions, beliefs, feelings, and knowledge people have about a company". The author suggested corporate image as a crucial determinant for the success or failure of any organisation.

Dowling [30] asserted that a company has many images depending on how people view them. The company manages the images as a foundation to establish the desired corporate image in the mind of various target audiences. Abratt and Mofokeng [31] highlighted that corporate image is formed over a long-time and cannot be detached from the public where it operates. Hence, competitors cannot imitate [31]. Company image is crucial as it can drive customer loyalty [32], customer satisfaction [33], and new investors [34].

Corporate image has been widely cited in corporate social responsibility (CSR) as it is crucial in establishing a company's public image and reputation. Even though CSR activities are considered voluntary to show companies' readiness and willingness to carry out their social responsibility [35], most firms consider CSR a strategy to enhance their corporate image [36]. Corporate image is associated with organisational performance levels [37]. For example, Alamgir and Nasir Uddin [38] argued that CSR could improve business image and increase the company's performance. According to the authors, CSR could strongly build corporate image via socially responsible business operations, creating a positive impression on the firm's performance. CSR activities have positively strengthened the bank's corporate image in the banking sector. Al-Mubarak *et al.,* [39] suggested that four (4) component activities of CSR, namely economic, legal, ethical, and philanthropic responsibilities, significantly affected the bank's corporate image. Similarly, Dudutari *et al.,* [40] emphasised that CSR activities performed by banks in Nigeria significantly impacted the banks' image, where banks with social engagement improved their image and ensured environmental sustainability.

The role of CSR is also crucial in improving SMEs' corporate image. Le [41] conducted a study to look further into how CSR activities impact SMEs' performance through the role of corporate image. Using stakeholder and resource-based view theories, the authors posited that CSR could lead to positive customer perception, which would improve the corporate image of the company. In a recent study by Khamis and Wan Ismail [42], the authors investigated the relationship between CSR and corporate image in Egyptian construction SMEs. The findings confirmed that CSR practices positively impacted SMEs' corporate image.

Nevertheless, little is known about the impact of solar PV adoption on improving corporate image. Hence, research in the related areas focused on green innovation's impact on green corporate image enhancement was examined. Green innovation emphasises invention (e.g., new ideas, goods, services, or processes) related to environmental issues [33,43], such as minimising environmental damage and promoting natural resource usage. Similarities between solar PV adoption and green

innovation are in terms of the environmental commitments and the benefits both of which offer to the environment. Hence, adopting solar PV can be seen as developing the green image of the business. Presenting a green image could attract more customers as many customers prefer to purchase goods from environmentally friendly companies, hence, improving consumer brand loyalty.

Eiadat *et al.,* [16] defined environmental-related innovations as manufacturing practices that focus on reducing waste and pollution for ecological well-being, which can impact the development of a corporate green image [44]. To create a corporate green image, a company must possess green core competence, which includes environmental capabilities, technologies, or expertise (know-how) that is rare, less imitable, no substitute, and able to provide environmental needs and contributions for the benefit of customers [44]. It is all about the efforts made by organisations to create the perception in a consumer's mind that a green image is linked to environmental commitment and concern [44]. In this regard, companies are shifting their marketing strategies to foster a green image in their consumers' minds due to the advantages that a green corporate image may provide [18]. The companies create green products, including advertising, packaging, and labelling, to promote their environmental consciousness. Findings from Raja and Agrawal [18] suggested that such efforts have successfully positively impacted the corporate green image. In the green supply chain management context, Shekari and Ghatari [45] revealed its strong impact on the corporate image. Similarly, green supply chain management focuses on green purchasing, cleaner production, recovery, pollution, and eco-design.

In Malaysia, Eltayeb *et al.,* [46] assessed the relationship between the green supply chain initiative (GSCI) and its outcome in ISO 14001 (a standard for environmental management systems) certified manufacturing firms. The study suggested that applying GSCI impacted the environment and economy positively, produced intangible outcomes, and caused cost reductions. In this context, intangible outcomes include corporate image improvement. In a different study on how corporate image can mediate the relationship between green promotion and Gen Y green purchasing decisions, Bathmanathan and Rajadurai [47] revealed a significant impact of green advertising on green corporate image and green corporate image on Gen Y purchasing. A recent study on electronic green supply chain management by Lin [48], which integrates IT resources and quality attributes, to see their impact on the firm's performance. Such integration is crucial because an electronic green supply chain enables the partners to share green objectives and strategies for developing a green corporate image towards competitive advantage [48].

Based on the above discussion, it can be concluded that the literature investigating the issues of solar PV adoption and its impact on the firm's corporate image is severely limited and underexplored, especially compared to the growing literature related to other green innovations and initiatives. Hence, there is a need to conduct a study that explores how such adoption could enhance the corporate image.

2.3 Business Sustainability: Economic, Environmental and Social Sustainability

Sustainable performance is crucial for a business to succeed in a competitive environment [49]. Previously, businesses measured sustainability in terms of the companies' profitability (financial capability). The concept of sustainability was then expanded to the harmonisation of the business's financial aspect with social and environmental dimensions [49,50]. In this context, organisations should focus more than just profits but also measure the impact of their businesses on the environment and social to achieve business sustainability. Sustainability is defined as "meets the needs of the present without compromising the ability of future generations to meet their own needs" [51,52]. Specifically, Bansal and DesJardine [51] defined business sustainability as the ability

of businesses to respond to short-term financial needs without sacrificing their or others' ability to fulfil customers' long-term needs. In this regard, business sustainability focuses on the shared value opportunity [51] for the firm to create value for the business and society simultaneously. The three aspects of sustainability, economic, environmental, and social, are also known as the Triple Bottom Line approach.

Paying attention to business sustainability in the environmental, social, and economic context is becoming increasingly crucial for all companies in various industries. Business sustainability helps organisations achieve economic (e.g., business growth), social (e.g., social justice and human development), and environmental development (e.g., green and clean environment). Hopkins *et al.,* [53] revealed that sustainability could affect business value creation. These factors create a stronger brand and pricing power, promoting operational efficiencies and supply chain optimisation, enhancing the ability to retain and motivate employees, improving customers' loyalty, enhancing the ability to enter a new market, and lowering the cost of capital and operational risks. In a different study, Manninen and Huiskonen [54] explicated business sustainability as the role of businesses to incorporate environmental and social concerns into the companies' business strategies and practices to increase competitive advantages.

While studies assessing the impact of green innovation and initiatives towards sustainability are growing, current literature on solar PV adoption and sustainability is still scarce. Hence, the discussion of how other green innovations affected sustainability is used. Considering the potential contribution of green innovation, research concentrating on its impact on business sustainability is growing considerably. Li *et al.,* [17] studied green innovation in Chinese manufacturing companies. The authors categorised green innovation into three (3) dimensions: green product innovation, recycling, and green publicity. They found evidence that green innovation had a significant positive effect on a firm's financial (e.g., increasing profitability), environmental (e.g., reducing carbon emission), and social (e.g., improving personal values) performance. Looking from the perspective of green supply chain management, Cankaya and Sezen [15] conducted a study to uncover the impact of green supply chain management on sustainability. Green supply chain management is measured using eight (8) indicators: green purchasing, green manufacturing, green distribution, green packaging, green marketing, environmental education, internal environmental management, and investment recovery. Using two face-to-face and e-mail surveys on manufacturers in Turkey, the study discovered that only green purchasing did not impact sustainability, and the other seven (7) indicators contributed positively to sustainability.

While Rizki and Augustine [19] adapted their work from Cankaya and Sezen [15], their results differed. Rizki and Augustine [19] studied 222 manufacturing companies in Indonesia. In their study context, sustainability performance was measured using four (4) indicators: economic, social, operational, and environmental. However, their study failed to support the relationship between green purchasing, green manufacturing, green marketing, and the internal environment on sustainability performance. Nevertheless, other factors, such as green distribution, eco-design, environmental education, and green information system, positively and significantly impacted sustainability performance.

Much research on business sustainability was conducted in the manufacturing industries due to its potential contribution to the economy and environmental degradation [55]. Zhao and Huang [56] revealed that green transformational leadership, green human resources management (HRM), green innovation, and organisational support significantly impacted China's manufacturing companies' sustainable business performance. In this regard, the companies' green efforts contributed to achieving sustainable business performance. Looking into the manufacturing industry in Pakistan, Ullah *et al.,* [57] used a hybrid methodology to uncover the drivers of how green innovation could

promote business sustainability. The study found that cost reduction and government support are the most critical drivers of green innovation for sustainable practices.

Using a resource-based view as the foundation, Yong *et al.,* [55] examined the impact of Malaysian manufacturing firms' green HRM practices on sustainability. The findings suggested that only green recruitment and green training impacted sustainability. In the context of green intellectual capital, Yusliza *et al.,* [58] found that green intellectual capital impacted sustainable economic, environmental, and social performance. The authors conducted the study at 112 large Malaysian manufacturing companies. Their findings suggested that the companies' intangible resources assisted organisations in achieving sustainable performance. Both Yong *et al.,* [55] and Yusliza *et al.,* [58] studies used large manufacturing companies as their respondents to observe the impact of green innovation on sustainable performance.

The impact of green innovation on sustainable performance was assessed in the context of SMEs. For example, Purwanto *et al.,* [59] found the impact of green innovation and green supply chain management on SMEs' sustainable performance. Purposive sampling was used in the study, and it explained that such green initiatives could affect SMEs' sustainable performance. On the other hand, Singh *et al.,* [60] surveyed 248 manufacturing SMEs in Abu Dhabi related to the impact of stakeholder pressure, green dynamic capabilities, and green innovation on performance. All the variables evaluated supported their influences on SMEs' performance. In addition, the study also revealed that green innovation mediates the impact of stakeholder pressure on green dynamic capability, and green dynamic capability mediates the impact of green innovation on the firm's performance. This study, however, examined one component of sustainable performance, namely, the firm's performance. In a different study on green manufacturing practices among SMEs, Afum *et al.,* [50] examined its impact on the sustainable performance of the economy, environment, and social. Their study disclosed a positive relationship between the variables assessed, indicating that green practices affected firms' economic, environmental, and social sustainability.

While studies assessing green innovation's contribution towards improving corporate image and sustainability are flourishing, none focus on how solar PV adoption could affect the business image, and economic, environmental, and social sustainability. Such a study is limited in the context of Malaysian manufacturing firms. Thus, to address the gap, the current research explores solar PV adoption and its impact on corporate image and business sustainability, namely, economic, environmental, and social factors.

3. Research Model and Hypotheses

The research model of this study is depicted in Figure 1. Solar PV adoption is measured by the intention of SMEs to adopt solar PV. Hence, solar PV adoption is defined as the state in which an organisation decides whether to adopt an innovation [61]. The impact of solar PV adoption is defined as the perceived benefits that potential adopters receive from using solar PV. Such impact is operationalised into four dimensions, namely corporate image (H1), economic sustainability (H2), environmental sustainability (H3), and social sustainability (H4).

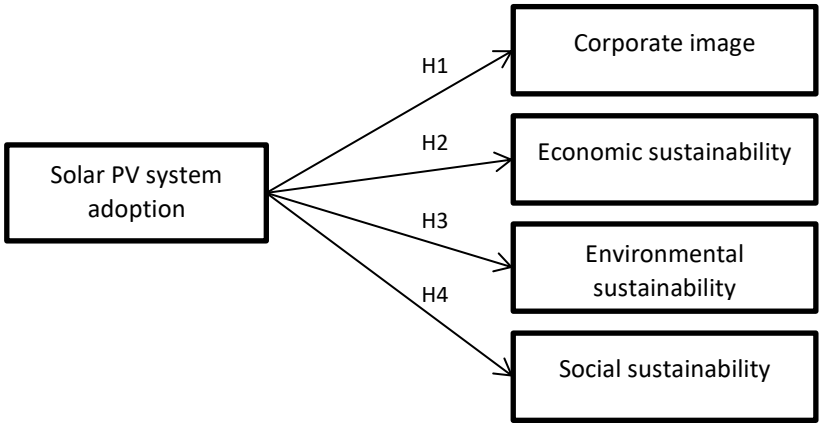

Fig. 1. The research model of the study

Corporate image can be considered an essential intangible resource due to its inimitable characteristic [31]. Researchers such as Alamgir and Nasir Uddin [38], Al-Mubarak *et al.,* [39] and Dudutari *et al.,* [40], found that corporate social responsibility activities could enhance a company's corporate image. CSR activities positively impacted corporate image enhancement among SMEs [41, 42].

Concerning green-related innovation, previous studies thus far have provided evidence that such innovation positively impacts the corporate image. Therefore, green-related innovation is associated with the commitment and concern of organisations to support environmental needs [44]. Hence, the more the companies involved in green-related innovation, the more the potential to create positive branding and customer loyalty, which strengthens their corporate image [18,45,48]. Considering the potential impact of solar PV adoption on improving the corporate image of the firms, the following hypotheses are postulated

i. *H1: Solar PV adoption affects the corporate image.*

Business sustainability focuses on the ability of the business to increase profitability (economy), protect the environment through the reduction of carbon emissions (environment), and improve the quality of life for those the business has an impact on social. Previous research shows that sustainability has had a positive impact on both large organisations [15,17,19] and SMEs [59]. For example, Li *et al.,* [17] discovered that green innovation affects a company's financial (e.g., increased profitability), environmental (e.g., reduced carbon emissions), and social (e.g., improved personal values) performance. Li *et al.,* [17] studied green innovation in Chinese manufacturing companies. The authors categorised green innovation into three dimensions: green product innovation, recycling, and green publicity. They found evidence that green innovation had a significant positive effect on a firm's financial (e.g., increasing profitability), environmental (e.g., reducing carbon emission), and social (e.g., improving personal values) performance. It is then postulated that solar PV adoption can improve the business sustainability of SMEs in terms of economic, environmental, and social sustainability, as follows

ii. *H2: Solar PV adoption affects economic sustainability.*
iii. *H3: Solar PV adoption affects environmental sustainability.*
iv. *H4: Solar PV adoption affects social sustainability.*

4. Research Methodology

4.1 Method

This study employed an explanatory design to examine the impact on corporate image and business sustainability among Malaysian SMEs. Quantitative data was mainly used for hypotheses testing.

The analysis unit of this study is the organisation, which focuses on manufacturing SMEs in Malaysia. The senior manager was selected as the key informant of the study, as in small businesses, the chief executive manager is usually the owner/manager [62]. In addition, SMEs' critical decision-making related to open innovation was highly influenced by the CEO/senior manager's characteristics [63]. Thus, the owner/manager is the key person in SMEs who has the power to direct the adoption of new technology in an organisation.

Manufacturing SMEs were selected because manufacturing needs to use energy to support their production lines in transforming raw materials into finished products. Hence, the residual impact of manufacturing SMEs on the environment is considered significant. As such, the residual impact contributes to Malaysia's carbon dioxide (CO_2) emissions. It is reported that Malaysia's CO_2 emissions increased at an average yearly rate of 6.12% from 14.7 million tonnes in 1972 to 251.6 million tonnes in 2021 [64]. In addition, Husaini and Lean [5] emphasised the positive association between electricity consumption and manufacturing output. In this regard, the authors revealed that the growth of manufacturing sectors could directly accelerate greater electricity demand. A report on System of Environmental-Economic Accounting Physical Supply & Use Table: Energy Account (MySEEA PSUT Energy) also revealed manufacturing as the primary user of energy products with 18,683 ktoe [65].

4.2 Sampling and Data Collection Procedure

SME manufacturing companies listed under the Federation of Manufacturing Malaysia (FMM) were selected as the samples. The questionnaire was distributed online using an online survey tool, i.e., SurveyMonkey. The decision was made because the data collection period was at the end of the Covid-19 pandemic (moving toward the endemic phase). The targeted respondents were invited to join the study via e-mail. The attached cover letter explained the research objectives and invited the owner/senior manager to participate. The cover letter also assured the respondents that their responses would be treated as confidential and anonymous. Due to the low response rate, the researchers distributed the questionnaire to all members in the sampling frame. The larger the samples, the more the result can be generalised. As a result, a total of 2,085 questionnaires were distributed. A follow-up e-mail and phone call were made to improve the response rate. However, only 99 responses were received, with 16 (16.16%) adopters and 83 (83.84%) non-adopters of solar PV. Twenty-four (24) responses (adopters – 16; non-adopters – 8) had more than 20% missing values and were thus excluded from the analysis. Six (6) responses were not included as they were from the service company (affiliate members of FMM). The final analysis involved sixty-nine (69) responses, all of which were from non-adopters of solar PV. Such responses were considered acceptable because surveys involving SMEs often yielded low responses [66].

As presented in Table 3, the majority of these businesses are founded after 2000 (44 or 58.67%) and are based in Selangor (33 or 44%). Most of the respondents (30 or 40%) are managers or executives (34 or 45.34%) with less than ten (10) years of experience (58 or 77.33%). Basic metals accounted for the highest percentage (17.39%) of manufacturing firms. Most manufacturing companies (89.85%) have approximately 5 to 15 employees, while more than half (60.87%) earn a sales turnover between RM300,000 and RM50,000,000.

Table 3
Organisational profile

Demographic	No.	%	Demographic	No.	%
Year of establishment			Location		
1960 -1970	3	4.35	Johor	16	23.18
1971 - 1980	2	2.90	Negeri Sembilan	3	4.35
1981 - 1990	8	11.58	Kedah	3	4.35
1991 - 2000	15	21.74	Pahang	2	2.90
2001 – 2010	29	42.03	Selangor	30	43.47
2011 - 2020	5	7.25	W.P. Putrajaya	1	1.45
Unidentified	6	8.70	Perak	3	4.35
Unsure	1	1.45	Pulau Pinang	4	5.80
Total	*69*	*100.0*	Melaka	6	8.70
Position			Unidentified	1	1.45
Owner/ Managing	10	14.49	*Total*	*69*	*100.0*
Director/CEO			Duration in current position		
Manager	26	37.68	Less than 5 years	27	39.13
Executive	32	46.38	5 – 10 years	27	39.13
Unidentified	1	1.45	10 – 15 years	4	5.80
Total	*69*	*100.0*	More than 15 years	10	14.49
Sector			Unidentified	1	1.45
Basic Metals	12	17.39	*Total*	*69*	*100.0*
Chemical	6	8.70	Full-time employees		
Electrical & Electronics	3	4.35	< 5 employees	2	2.90
Fabricated Metals	7	10.14	5 – 10 employees	29	42.03
Food, Beverages & Tobacco	11	15.94	10 – 15 employees	33	47.82
Furniture	1	1.45	> 15 employees	4	5.80
Machinery & Equipment	8	11.59	Unidentified	1	1.45
Non-Metallic Mineral	1	1.45	*Total*	*69*	*100.0*
Medical, Precision & Optical Instrument, Watches & Clocks	1	1.45	Sales turnover		
Paper, Printing & Publishing	3	4.35	Below RM300,000	3	4.35
Recycling	1	1.45	RM300,000 – RM999,999	9	13.04
Textile, Wearing Apparel, Leather	1	1.45	RM 1M – RM14,999,999	19	27.54
Others	14	20.29	RM 25M – RM50 M	14	20.29
Total	*69*	*100.0*	More than RM50M	24	34.78
			Total	*69*	*100.0*

4.3 Measures

All constructs were adapted from previously validated measures and literature reviews. The wording of several items was amended, and some items were deleted, referring to the feedback provided during the questionnaire pre-test. The measurement for these constructs used a 7-point Likert scale from (1) Strongly Disagree to (7) Strongly Agree. The details of the constructs and their sources are presented in Table 4.

Table 4
Construct and their sources

Operationalisation	Items	Source
Adoption: The intention to adopt solar PV (the state to which an organisation decides whether to adopt an innovation)	*INT1* We will obtain more information about a solar PV system before using it.	[67,68]
	INT2 We will try out a solar PV system as soon as we can.	
	INT3 My company plans to have a solar PV system to generate electricity.	
	INT4 The probability of introducing a solar PV system in my company is very high.	
	INT5 My company is planning to have a solar PV system in future.	

Corporate image: The overall impression, feelings, and knowledge made in the mind of consumers or the public about a particular company	*CI1* By adopting a solar PV system, our company could appear in a favourable image.	[39,69,70]
	CI2 By adopting a solar PV system, our company's overall image could be improved.	
	CI3 By adopting a solar PV system, our company's trusted corporate image could be improved.	
	CI4 Adopting a solar PV system could positively impact our company's corporate image.	
Economic sustainability: The degree to which a firm can optimise its financial outcomes	*ES1* The adoption of a solar PV system could decrease the cost of energy consumption.	[15,17,49]
	ES2 The adoption of a solar PV system could improve our company's return on investment.	
	ES3 The adoption of a solar PV system could improve our company's position in the marketplace.	
	ES4 The adoption of a solar PV system could increase our company's net profit margin.	
Environment sustainability: The degree to which a firm is capable of reducing pollution and environmental accidents	*ENV1* The adoption of a solar PV system could improve our company's compliance with environmental standards.	[15,17,71]
	ENV2 The adoption of a solar PV system could reduce carbon dioxide emissions.	
Social sustainability: The degree to which a firm's responsibility towards the environment in which they operate and combines the interests of employees and society	*SS1* The adoption of a solar PV system could improve work safety.	[50]
	SS2 The adoption of a solar PV system could improve the living quality of the surrounding community.	
	SS3 The adoption of a solar PV system could improve the work environment.	
	SS4 The adoption of a solar PV system adoption could improve relationships with the community and stakeholders.	

5. Result and Discussion

This study utilised partial least squares (PLS) (via Smart PLS version 4.0) for statistical analysis. The PLS was chosen because it focuses on the structural equation modelling (SEM) technique that enables the simultaneous estimation and testing of causal links between numerous variables, which can be used with both small and large samples [72]. The study employed two data analysis stages: assessment of the measurement model and assessment of the structural model.

5.1 Assessment of The Measurement Model

Table 5 tabulates internal consistency by examining the loadings of indicators on their intended constructs. Most of the item's loadings exceed the minimum threshold value of .70, suggesting a good indicator of item reliability [73]. Even though the item loading for INT1 is greater than .60, it is considered adequate because other items have high scores of loadings (Ramayah *et al.,* [74]). The composite reliability (CR) value exceeds .90 is considered good reliability, as all items did not have redundancy and were measured in hugely distinct aspects of the construct domain. The average variance extracted (AVE) value for each measure is also greater than the threshold value of .50 [74,75], meeting the convergent validity requirement.

Table 5
Item Loadings for Indicators of Latent Constructs

Latent Variable	Item	Loading	CR	AVE
Adoption (ADP)	ADP1	.679	.937	.749
	ADP2	.853		
	ADP3	.951		
	ADP4	.898		
	ADP5	.920		
Corporate Image (CI)	CI1	.966	.982	.933
	CI2	.963		
	CI3	.968		
	CI4	.967		
Economic	ES1	.935	.938	.790
Sustainability (ES)	ES2	.882		
	ES3	.838		
	ES4	.898		
Environmental	ENV1	.974	.974	.950
Sustainability (BS)	ENV2	.975		
Social	SS1	.892	.968	.882
Sustainability (SS)	SS2	.960		
	SS3	.971		
	SS4	.933		

Discriminant validity was conducted to measure how well the construct is distinct. The Fornell-Larcker criterion was used to evaluate discriminant validity, where the square root of AVE was examined, and all the inter-construct correlations were compared. The square roots of the AVE of each construct, as depicted in Table 6, are greater than the cross-correlations between them, thereby suggesting discriminant validity.

Table 6
Discriminant Validity

	ADP	CI	ES	ENV	SS
Adoption (ADP)	.866				
Corporate Image (CI)	.421	.966			
Economic Sustainability (ES)	.414	.828	.889		
Environmental Sustainability (ENV)	.387	.789	.834	.975	
Social Sustainability (SS)	.269	.627	.781	.694	.939

Henseler *et al.,* [76] suggested that the Heterotrait-Monitrait (HTMT) ratio of correlation could estimate the actual correlation between constructs due to its ability to achieve higher specificity and sensitivity rates. The HTMT ratio value in Table 7 is less than .90 [77], suggesting evidence of discriminant validity.

Table 7
HTMT Ratio

	ADP	CI	ES	ENV	SS
Adoption					
Corporate Image (CI)	.446				
Economic Sustainability (ES)	.413	.881			
Environmental Sustainability (ENV)	.416	.820	.882		
Social Sustainability (SS)	.252	.647	.859	.708	

5.2 Assessment of the Structural Model

The relationship between the constructs was evaluated by examining the structural model via path coefficients, hypotheses testing, and variance explained by independent variables. By using SmartPLS 4.0, a bootstrapping procedure with five hundred resamples [78] was conducted to examine the path coefficient. The result of the structural model is summarised in Table 8. All three relationships (H1, H2, and H3) have a t-value of ≥ 2.58, thus significant at the .01 level. However, of the supported hypotheses (H1, H2, and H3), one is rejected (H4).

Table 8
Hypotheses Testing

Hypotheses		β	SD	t-stat	p-value	Result
H1	Adoption -> CI	.421	.115	3.652	.000	Supported [1]
H2	Adoption -> ES	.414	.080	5.200	.000	Supported [1]
H3	Adoption -> ENV	.387	.109	3.550	.000	Supported [1]
H4	Adoption -> SS	.269	.157	1.713	.087	Not Supported [2]

[1]At an alpha significance level of .01 ($p < .001$). [2]At an alpha significance level of .05 ($p < .05$)

Cohen [79] proposed that R2 values close to .26 should be considered substantial, while values close to .13 and .02 should be considered moderate and weak, respectively. As reported in Table 9, the model explained 16.5% of the variance in the corporate image (weak), 15.9% in economic sustainability (average), and 13.7% in environmental sustainability. These three variables hold moderate levels of predictive accuracy [79]. Meanwhile, the variance explained in the social sustainability was relatively small at .06% (weak).

Table 9
R square (R2) value of construct

Variable	R2
Corporate Image (CI)	.165
Economic Sustainability (ES)	.159
Environmental Sustainability (ENV)	.137
Social Sustainability (SS)	.059

5.3 Discussion

This paper examined the impact of solar PV adoption on corporate image, and business sustainability, namely economic, environmental, and social sustainability. The result of this study indicates that the adoption of solar PV has a positive impact on the corporate image (H1: the positive coefficient value of .421, and p-value .000 < .01). In this regard, the finding suggests that adopting solar PV could aid organisations in improving their corporate image. This improvement emerged as having a favourable corporate image in the mind of various target audiences, such as customers and suppliers. It is imperative as solar PV adoption can be viewed as the company's support towards green initiatives and a better environment. As emphasised by Chen [44] , displaying a green image could attract more clients because of their desire to purchase products from environmentally friendly businesses, thus later increasing brand loyalty to the company. In the same vein, previous studies confirmed that a positive corporate image could enhance business performance [80]. Additionally, Shrivastava [81] asserted that environmental technologies could help companies gain a competitive advantage via improved public image and establish a social presence in the market.

Apart from the impact of solar PV adoption on improving corporate image, this study also examined its impact on sustainable performance. Sustainable performance is crucial for SMEs to remain competitive [49]. This study analysed such impact on three components of economic, environmental, and social sustainability. The result of the path loadings revealed that the adoption of solar PV showed a positive and significant impact on economic sustainability (H2: the positive coefficient value of .414, and p-value .000 < .01). The result reflects that the respondents believed that by adopting solar PV, they could improve their company's economic sustainability. The improvement is in terms of reducing the cost of energy consumption, increasing the net profit margin, improving the company's return on investment, and positioning the company in the marketplace.

Consequently, the adoption of solar PV can be utilised as an innovation that can support SMEs to achieve sustainable business performance. On this basis, SMEs can plan for economically profitable activities with a balance between creating wealth and using various resources for profit generation [82]. Only a few studies were conducted to understand the impact of solar PV adoption; therefore, this study investigated the related areas of green innovation and technology. Green innovation and technology focus on the use of environmentally friendly technologies in manufacturing processes to create products and services with little adverse impact on the environment [60]. Accordingly, the finding of this study is consistent with Afum *et al.,* [50], where green manufacturing practices in Ghanaian manufacturing SMEs positively impact economic performance significantly. The discovery of the study is also in line with Cankaya and Sezen [15], who found that green production had a positive relationship with economic performance.

The finding of this study provides evidence to support the positive impact of solar PV adoption on environmental sustainability (H3: the positive coefficient value of .387, and p-value .000 < .01). Numerous studies in the areas of green innovation and technology have also revealed the same fact. For example, Li *et al.,* [17] discovered that green product innovation had a substantial positive relationship with environmental sustainability. Here, adopting such innovation could help the company focus on reducing emissions and energy usage, which benefit the environment. In the same vein, Wang *et al.,* [20] discovered that green innovation practices could positively impact environmental sustainability in terms of reducing air emissions, hazardous waste, consumption of gasoline/fuel, and improved environmental compliance. In addition, Yusliza *et al.,* [58] also unveiled that green intellectual capital could lead to positive environmental sustainability. Therefore, the finding of this current study indicates that the adoption of solar PV could aid manufacturing SMEs to comply with environmental standards and reduce carbon dioxide emissions. Such adoption would positively affect the company's commitment to supporting natural environment conservation.

In contrast to other findings, this study, however, failed to establish any relationship between solar PV adoption's impact and social sustainability. Hence, H3 is rejected, which is rather bizarre. This insignificant relationship may be due to the following reasons. Several researchers [83, 84] stated that social sustainability did not receive the same level of attention as environmental and economic sustainability. As a result, research on social sustainability among SMEs is still lacking and at an early stage [85]. In addition, SMEs were viewed as incapable of adopting and practising social sustainability because they are not capital-intensive businesses [85].

6. Conclusion

This paper addressed the literature gap in the study of the impact of solar PV adoption on corporate image, and economic, environmental, and social sustainability. The lack of prior empirical work in the analysis of such impact justified the significance of this article in adding value to the body

of knowledge linked to technological innovation (i.e., solar PV) and SMEs. This study enriches the literature on the impact of solar PV adoption on enhancing corporate image and sustainable business performance through economic, environmental, and social sustainability. From a practical point of view, Malaysian SMEs in the manufacturing industries can exploit the findings of this study to start exploring opportunities to adopt solar PV because of its benefits (i.e., corporate image and economic and environmental sustainability). Hence, the results of this study may serve as supporting evidence to encourage the adoption of solar PV among SMEs.

Consequently, the Malaysian government may use the outcome of this study to promote and attract more SMEs to adopt solar PV through the development of policies [86] and incentives. The result can be used to inform the development of promotional materials and campaign aiming at educating SMEs on the benefits and potential return on investment of solar PV adoption. This effort can therefore further encourage solar PV uptake among SMEs. In this context, adopting solar PV contributes to the enhancement of SMEs' corporate image and maximising economic and environmentally sustainable performance. This effort can assist SMEs in strengthening their presence in the market in several ways. Firstly, the adoption of solar PV leads to a positive corporate image as part of the firm's social responsibility to promote renewable energy in minimising environmental damage. Secondly, solar PV adoption reflects the effort of the SMEs in finding a balance between a competitive market and commitment to create minimal waste for a better environment (environmental sustainability) towards increasing business efficiency (economic sustainability). It is also imperative to note that the data of this study were collected from a specific industry (i.e., manufacturing SMEs); therefore, generalising the results to other industries requires further research. Further research is also necessary to provide more comprehensive understanding of the impact of solar PV adoption, taking into account other factors, such as understanding customer demand [87]. In this regard, understanding customer demand is crucial in promoting sustainable practices for achieving sustainability goals.

Overall, a study investigating the impact of solar adoption in Malaysia is significant. It can provide valuable insights into the benefits and challenges of renewable energy adoption, particularly for SMEs. By promoting a greater understanding of the potential benefit of solar energy, this study can contribute to the growth of the green technology industry in the country and help to reduce carbon emissions, leading to a more sustainable future for Malaysia.

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References

[1] Economic Planning Unit, National Policy Energy 2022-2040, (2022).
[2] Enerdata. "Enerdata." May 1, 2022.
[3] The World Bank. "Total greenhouse gas emissions (kt of CO2 equivalent) – Malaysia." February 5, 2023.
[4] Department of Statistics Malaysia. "Malaysia Economic Performance Fourth Quarter 2022." February 20, 2023.
[5] Husaini, Dzul Hadzwan, and Hooi Hooi Lean. "Does electricity drive the development of manufacturing sector in Malaysia?." *Frontiers in Energy Research* 3 (2015): 18. https://doi.org/10.3389/fenrg.2015.00018
[6] Ministry of Energy, Green Technology and Water Malaysia. "Green Technology Master Plan Malaysia 2017–2030." (2017).
[7] Alam, Syed Shah, and M. Rashid. "Intention to use renewable energy: mediating role of attitude." *Energy research journal* 3, no. 2 (2012): 37-44.
[8] Secretary General Ministry of Economic Affairs. "Shared Prosperity Vision 2030." 2019.
[9] SEDA Malaysia. Malaysia renewable energy roadmap, (2021).
[10] SEDA Malaysia. "Net Energy Metering (3.0)." January 30, 2023.

[11] SMECORP. "SME Definitions." December 3, 2023.
[12] Chu, M. M. "Malaysia can generate more electricity if all roofs use solar panels, says Yeo." May 2019.
[13] IRENA. Malaysia Energy Transition Outlook, (2023).
[14] Lau, Lin-Sea, Yuen-Onn Choong, Chooi-Yi Wei, Ai-Na Seow, Chee-Keong Choong, Abdelhak Senadjki, and Suet-Ling Ching. "Investigating nonusers' behavioural intention towards solar photovoltaic technology in Malaysia: The role of knowledge transmission and price value." *Energy Policy* 144 (2020): 111651. https://doi.org/10.1016/j.enpol.2020.111651
[15] Yildiz Çankaya, Sibel, and Bulent Sezen. "Effects of green supply chain management practices on sustainability performance." *Journal of Manufacturing Technology Management* 30, no. 1 (2019): 98-121. https://doi.org/10.1108/JMTM-03-2018-0099
[16] Eiadat, Yousef, Aidan Kelly, Frank Roche, and Hussein Eyadat. "Green and competitive? An empirical test of the mediating role of environmental innovation strategy." *Journal of World business* 43, no. 2 (2008): 131-145. https://doi.org/10.1016/j.jwb.2007.11.012
[17] Li, Liang, Hajar Msaad, Huaping Sun, Mei Xuen Tan, Yeqing Lu, and Antonio KW Lau. "Green innovation and business sustainability: New evidence from energy intensive industry in China." *International Journal of Environmental Research and Public Health* 17, no. 21 (2020): 7826. https://doi.org/10.3390/ijerph17217826
[18] Raja, Sowmya, and Richa Agrawal. "Creating a Green Image: Marketing Efforts and Customer Sentiments." In *Australian and New Zealand Marketing Academy Conference*, vol. 3, no. 5. 2012.
[19] Rizki, Adam Firman, and Yvonne Augustine. "Green supply chain management practices: direct effects sustainability performance." *Technium Soc. Sci. J.* 28 (2022): 389. https://doi.org/10.47577/tssj.v28i1.5795
[20] Wang, Wenyu, Nanpeng Yu, and Raymond Johnson. "A model for commercial adoption of photovoltaic systems in California." *Journal of Renewable and Sustainable Energy* 9, no. 2 (2017): 025904. https://doi.org/10.1063/1.4979899
[21] Zahedi, Ahmad. "Solar photovoltaic (PV) energy; latest developments in the building integrated and hybrid PV systems." *Renewable energy* 31, no. 5 (2006): 711-718. https://doi.org/10.1016/j.renene.2005.08.007
[22] Vaka, Mahesh, Rashmi Walvekar, Abdul Khaliq Rasheed, and Mohammad Khalid. "A review on Malaysia's solar energy pathway towards carbon-neutral Malaysia beyond Covid'19 pandemic." *Journal of cleaner production* 273 (2020): 122834. https://doi.org/10.1016/j.jclepro.2020.122834
[23] Ibrahim, Adnan, Mohd Yusof Othman, Mohd Hafidz Ruslan, Sohif Mat, and Kamaruzzaman Sopian. "Recent advances in flat plate photovoltaic/thermal (PV/T) solar collectors." *Renewable and sustainable energy reviews* 15, no. 1 (2011): 352-365. https://doi.org/10.1016/j.rser.2010.09.024
[24] Ahmad, Salman, Razman bin Mat Tahar, Jack Kie Cheng, and Liu Yao. "Public acceptance of residential solar photovoltaic technology in Malaysia." *PSU Research Review* 1, no. 3 (2017): 242-254. https://doi.org/10.1108/PRR-11-2016-0009
[25] GreenTeach Malaysia. "Green technology Financing Scheme." February 20, 2023.
[26] Malaysian Green Technology and Climate Change Corporation. "Green Investment Tax Allowance (GITA) & Green Income Tax Exemption (GITE)." February 9, 2023.
[27] Rashid, Zabid Abdul. "Service quality and the mediating effect of corporate image on the relationship between customer satisfactionand customer loyalty in the Malaysian hotel industry." *Gadjah Mada International Journal of Business* 15, no. 2 (2013): 99-112. https://doi.org/10.22146/gamaijb.5474
[28] Makanyeza, Charles, and Lovemore Chikazhe. "Mediators of the relationship between service quality and customer loyalty: Evidence from the banking sector in Zimbabwe." *International Journal of Bank Marketing* 35, no. 3 (2017): 540-556. https://doi.org/10.1108/IJBM-11-2016-0164
[29] Worcester, Robert. "Reflections on corporate reputations." *Management decision* 47, no. 4 (2009): 573-589. https://doi.org/10.1108/00251740910959422
[30] Dowling, Grahame R. "Developing your company image into a corporate asset." *Long range planning* 26, no. 2 (1993): 101-109. https://doi.org/10.1016/0024-6301(93)90141-2
[31] Abratt, Russell, and Thabiso Nsenki Mofokeng. "Development and management of corporate image in South Africa." *European Journal of Marketing* 35, no. 3/4 (2001): 368-386. https://doi.org/10.1108/03090560110382075
[32] Hart, Allison E., and Philip J. Rosenberger III. "The effect of corporate image in the formation of customer loyalty: An Australian replication." *Australasian Marketing Journal* 12, no. 3 (2004): 88-96. https://doi.org/10.1016/S1441-3582(04)70109-3
[33] Chang, Nai-Jen, and Cher-Min Fong. "Green product quality, green corporate image, green customer satisfaction, and green customer loyalty." *African journal of business management* 4, no. 13 (2010): 2836.
[34] Pina, Jose M., Eva Martinez, Leslie De Chernatony, and Susan Drury. "The effect of service brand extensions on corporate image: an empirical model." *European Journal of marketing* 40, no. 1/2 (2006): 174-197. https://doi.org/10.1108/03090560610637374

[35] Kim, Minjung, Xuemei Yin, and Gyumin Lee. "The effect of CSR on corporate image, customer citizenship behaviors, and customers' long-term relationship orientation." *International Journal of Hospitality Management* 88 (2020): 102520. https://doi.org/10.1016/j.ijhm.2020.102520
[36] Chen, Chih-Cheng, Asif Khan, Tanaporn Hongsuchon, Athapol Ruangkanjanases, Yen-Tzu Chen, Ornlatcha Sivarak, and Shih-Chih Chen. "The role of corporate social responsibility and corporate image in times of crisis: The mediating role of customer trust." *International journal of environmental research and public health* 18, no. 16 (2021): 8275. https://doi.org/10.3390/ijerph18168275
[37] Huang, Chung-Fah, and Ho-Chi Lien. "An empirical analysis of the influences of corporate social responsibility on organizational performance of Taiwan's construction industry: Using corporate image as a mediator." *Construction management and economics* 30, no. 4 (2012): 263-275. https://doi.org/10.1080/01446193.2012.668620
[38] Alamgir, Mohammed, and Mohammad Nasir Uddin. "The mediating role of corporate image on the relationship between corporate social responsibility and firm performance: An empirical study." *International Journal of Business and Development Studies* 9, no. 1 (2017): 91-111.
[39] Al Mubarak, Zainab, Anji Ben Hamed, and Muneer Al Mubarak. "Impact of corporate social responsibility on bank's corporate image." *Social Responsibility Journal* 15, no. 5 (2019): 710-722. https://doi.org/10.1108/SRJ-01-2018-0015.
[40] Dudutari, Bereprebofa, Ndudi Francis, and Aloamaka Judith Ifeanyi. "Driving a positive brand image to customers through strategic corporate social responsibility: The case of deposit money banks in Nigeria." *International journal of economic perspectives* 16, no. 4 (2022): 39-52.
[41] Le, Thanh Tiep. "Corporate social responsibility and SMEs' performance: mediating role of corporate image, corporate reputation and customer loyalty." *International Journal of Emerging Markets* (2022). https://doi.org/10.1108/IJOEM-07-2021-1164
[42] Khamis, Naglaa Ibrahim, and Wan Khairuzzaman Wan Ismail. "The impact of corporate social responsibility on corporate image in the construction industry: a case of SMEs in Egypt." *Journal of Sustainable Finance & Investment* 12, no. 1 (2022): 128-146. https://doi.org/10.1080/20430795.2021.1930992
[43] Bathmanathan, Vathana, and Chikako Hironaka. "Sustainability and business: what is green corporate image?." In *IOP Conference Series: Earth and Environmental Science*, vol. 32, no. 1, p. 012049. IOP Publishing, 2016. https://doi.org/10.1088/1755-1315/32/1/012049
[44] Chen, Yu-Shan. "The driver of green innovation and green image–green core competence." *Journal of business ethics* 81 (2008): 531-543. https://doi.org/10.1007/s10551-012-1407-2
[45] Shekari, H., and A. Rajabzadeh Ghatari. "Promoting corporate image: A reflection on green supply chain management approach." *International Journal of Management and Business Research* 3, no. 4 (2013): 311-324.
[46] Eltayeb, Tarig K., Suhaiza Zailani, and T. Ramayah. "Green supply chain initiatives among certified companies in Malaysia and environmental sustainability: Investigating the outcomes." *Resources, conservation and recycling* 55, no. 5 (2011): 495-506. https://doi.org/10.1016/j.resconrec.2010.09.003.
[47] Bathmanathan, Vathana, and Jegatheesan Rajadurai. "Redefining the value proposition through green promotions and green corporate image in the era of Industrial Revolution 4.0: a study of Gen Y green consumers in Malaysia." *International Journal of Environmental Technology and Management* 22, no. 6 (2019): 456-477. https://doi.org/10.1504/IJETM.2019.104920
[48] Lin, Hsiu-Fen. "IT resources and quality attributes: The impact on electronic green supply chain management implementation and performance." *Technology in Society* 68 (2022): 101833. https://doi.org/10.1016/j.techsoc.2021.101833
[49] Haseeb, Muhammad, Hafezali Iqbal Hussain, Sebastian Kot, Armenia Androniceanu, and Kittisak Jermsittiparsert. "Role of social and technological challenges in achieving a sustainable competitive advantage and sustainable business performance." *Sustainability* 11, no. 14 (2019): 3811. https://doi.org/10.3390/su11143811.
[50] Afum, Ebenezer, Victoria Yaa Osei-Ahenkan, Yaw Agyabeng-Mensah, Joseph Amponsah Owusu, Lawrence Yaw Kusi, and Joseph Ankomah. "Green manufacturing practices and sustainable performance among Ghanaian manufacturing SMEs: the explanatory link of green supply chain integration." *Management of Environmental Quality: An International Journal* 31, no. 6 (2020): 1457-1475. https://doi.org/10.1108/MEQ-01-2020-0019.
[51] Bansal, Pratima, and Mark R. DesJardine. "Business sustainability: It is about time." *Strategic organization* 12, no. 1 (2014): 70-78. https://doi.org/10.1177/1476127013520265
[52] World Commission on Environment and Development. "Our common future." December 5, 2022.
[53] Berns, Maurice, Andrew Townend, Zayna Khayat, Balu Balagopal, Martin Reeves, Michael S. Hopkins, and Nina Kruschwitz. "The business of sustainability: what it means to managers now." *MIT Sloan Management Review* (2009).

[54] Manninen, Kaisa, and Janne Huiskonen. "Factors influencing the implementation of an integrated corporate sustainability and business strategy." *Journal of Cleaner Production* 343 (2022): 131036. https://doi.org/10.1016/j.jclepro.2022.131036.

[55] Yong, Jing Yi, Mohd-Yusoff Yusliza, Thurasamy Ramayah, Charbel Jose Chiappetta Jabbour, Simone Sehnem, and Venkatesh Mani. "Pathways towards sustainability in manufacturing organizations: Empirical evidence on the role of green human resource management." *Business Strategy and the Environment* 29, no. 1 (2020): 212-228. https://doi.org/10.1002/bse.2359

[56] Zhao, Wei, and Lihua Huang. "The impact of green transformational leadership, green HRM, green innovation and organizational support on the sustainable business performance: Evidence from China." *Economic Research-Ekonomska Istraživanja* 35, no. 1 (2022): 6121-6141. https://doi.org/10.1080/1331677X.2022.2047086

[57] Ullah, Sajid, Farman Ullah Khan, and Naveed Ahmad. "Promoting sustainability through green innovation adoption: a case of manufacturing industry." *Environmental Science and Pollution Research* (2022): 1-21. https://doi.org/10.1007/s11356-021-17322-8

[58] Yusliza, Mohd Yusoff, Jing Yi Yong, M. Imran Tanveer, Thurasamy Ramayah, Juhari Noor Faezah, and Zikri Muhammad. "A structural model of the impact of green intellectual capital on sustainable performance." *Journal of Cleaner Production* 249 (2020): 119334. https://doi.org/10.1016/j.jclepro.2019.119334

[59] Purwanto, A., K. Fahmi, I. Irwansyah, R. Hadinegoro, I. Rochmad, S. Syahril, and E. Sulastri. "The role of green innovation and green supply chain management on the sustainability of the performance of SMEs." *Journal of Future Sustainability* 2, no. 2 (2022): 49-52. https://doi.org/10.5267/j.jfs.2022.9.003

[60] Singh, Sanjay Kumar, Manlio Del Giudice, Charbel Jose Chiappetta Jabbour, Hengky Latan, and Amrik Singh Sohal. "Stakeholder pressure, green innovation, and performance in small and medium-sized enterprises: The role of green dynamic capabilities." *Business Strategy and the Environment* 31, no. 1 (2022): 500-514. https://doi.org/10.1002/bse.2906

[61] Tornatzky, Louis G., Mitchell Fleischer, and Alok K. Chakrabarti. *Processes of technological innovation*. Lexington books, 1990.

[62] Thong, James YL, and Chee-Sing Yap. "CEO characteristics, organizational characteristics and information technology adoption in small businesses." *Omega* 23, no. 4 (1995): 429-442. https://doi.org/10.1016/0305-0483(95)00017-I

[63] Ahn, Joon Mo, Tim Minshall, and Letizia Mortara. "Understanding the human side of openness: the fit between open innovation modes and CEO characteristics." *R&D Management* 47, no. 5 (2017): 727-740. https://doi.org/10.1111/radm.12264

[64] Ritchie, Hannah. "CO_2 and Greenhouse Gas Emissions." Our World in Data, May 11, 2020.

[65] Department of Statistics Malaysia. "System of environmental-economic accounting: MySEEA PSUT 2015." November 20, 2022.

[66] Wei-Loon, K. O. E., R. O. N. I. Mastura, and Tee Suan Chin. "Influence of Individual Entrepreneurial Orientation on the Performance of Small and Medium Enterprises in Malaysia." *The Journal of Asian Finance, Economics and Business (JAFEB)* 9, no. 5 (2022): 325-333.

[67] Ali, Saqib, Petra Poulova, Ahsan Akbar, Hafiz Muhammad Usama Javed, and Muhammad Danish. "Determining the influencing factors in the adoption of solar photovoltaic technology in Pakistan: A decomposed technology acceptance model approach." *Economies* 8, no. 4 (2020): 108. https://doi.org/10.3390/economies8040108

[68] Peter, Raja, Laurence Dickie, and Vasanthi M. Peter. "Adoption of photovoltaic power supply systems: A study of key determinants in India." *Renewable Energy* 31, no. 14 (2006): 2272-2283. https://doi.org/10.1016/j.renene.2005.11.001

[69] Yeo, Roland K., Mark Goh, and Sophia Tso. "Corporate image and reputation of large Mainland Chinese enterprises." *Journal of Marketing Communications* 17, no. 3 (2011): 195-211. https://doi.org/10.1080/13527260903421466

[70] Young-Min, K. I. M., and Jin-Hwan Kim. "The relations between safety matters, corporate image and performance in logistics company." *유통과학연구* 17, no. 11 (2019): 35-45. https://doi.org/10.15722/jds.17.11.201911.35

[71] Nor-Aishah, Hassan, Noor Hazlina Ahmad, and Ramayah Thurasamy. "Entrepreneurial leadership and sustainable performance of manufacturing SMEs in Malaysia: The contingent role of entrepreneurial bricolage." *Sustainability* 12, no. 8 (2020): 3100. https://doi.org/10.3390/su12083100

[72] Hair, Joe F., Christian M. Ringle, and Marko Sarstedt. "PLS-SEM: Indeed a silver bullet." *Journal of Marketing theory and Practice* 19, no. 2 (2011): 139-152. https://doi.org/10.2753/MTP1069-6679190202

[73] Fornell, Claes, and David F. Larcker. "Evaluating structural equation models with unobservable variables and measurement error." *Journal of marketing research* 18, no. 1 (1981): 39-50. https://doi.org/10.1177/002224378101800104

[74] Ramayah, T. J. F. H., Jacky Cheah, Francis Chuah, Hiram Ting, and Mumtaz Ali Memon. "Partial least squares structural equation modeling (PLS-SEM) using smartPLS 3.0." *An updated guide and practical guide to statistical analysis* (2018).
[75] Hair, J. F., R. E. Anderson, B. J. Babin, and W. C. Black. "Multivariate Data Analysis: A Global Perspective, vol. 7 Pearson Education." *Upper Saddle River, NJ* (2010). https://doi.org/10.1016/j.jmva.2009.12.014
[76] Henseler, Jörg, Christian M. Ringle, and Marko Sarstedt. "A new criterion for assessing discriminant validity in variance-based structural equation modeling." *Journal of the academy of marketing science* 43 (2015): 115-135. https://doi.org/10.1007/s11747-014-0403-8
[77] Gold, Andrew H., Arvind Malhotra, and Albert H. Segars. "Knowledge management: An organizational capabilities perspective." *Journal of management information systems* 18, no. 1 (2001): 185-214. https://doi.org/10.1080/07421222.2001.11045669
[78] Deng, Nina, Jeroan J. Allison, Hua Julia Fang, Arlene S. Ash, and John E. Ware. "Using the bootstrap to establish statistical significance for relative validity comparisons among patient-reported outcome measures." *Health and quality of life outcomes* 11 (2013): 1-12. http://doi.org/10.1186/1477-7525-11-89.
[79] Cohen, Jacob. "Statistical power analysis." *Current directions in psychological science* 1, no. 3 (1992): 98-101.
[80] Wu, Shwu-Ing, and Syuan-Ru Lin. "The effect of green marketing strategy on business performance: a study of organic farms in Taiwan." *Total Quality Management & Business Excellence* 27, no. 1-2 (2016): 141-156. https://doi.org/10.1080/14783363.2014.959256
[81] Shrivastava, Paul. "Environmental technologies and competitive advantage." *Strategic management journal* 16, no. S1 (1995): 183-200. https://doi.org/10.1002/smj.4250160923
[82] Guinot, Jacob, Zina Barghouti, and Ricardo Chiva. "Understanding green innovation: A conceptual framework." *Sustainability* 14, no. 10 (2022): 5787. https://doi.org/10.3390/su14105787
[83] Govindan, Kannan, Mahesh Shaw, and Abhijit Majumdar. "Social sustainability tensions in multi-tier supply chain: A systematic literature review towards conceptual framework development." *Journal of Cleaner Production* 279 (2021): 123075. https://doi.org/10.1016/j.jclepro.2020.123075
[84] Yawar, Sadaat Ali, and Stefan Seuring. "The role of supplier development in managing social and societal issues in supply chains." *Journal of cleaner production* 182 (2018): 227-237.. https://doi.org/10.1016/j.jclepro.2018.01.234
[85] Chowdhury, Priyabrata, and Rezaul Shumon. "Minimizing the gap between expectation and ability: Strategies for smes to implement social sustainability practices." *Sustainability* 12, no. 16 (2020): 6408. https://doi.org/10.3390/su12166408
[86] Shadman, Saleh, Christina MM Chin, Eng Hwa Yap, Novita Sakundarini, and Sanjayan Velautham. "The role of current and future renewable energy policies in fortifying Malaysia's energy security: PESTLE and SWOT analysis through stakeholder engagement." *Progress in Energy and Environment* 16 (2021): 1-17.
[87] Chin, Thoo Ai, and Yang Kaihan. "Content Analysis on Reverse Logistics and Sustainability Performance." *Journal of Advanced Research in Business and Management Studies* 25, no. 1 (2021): 66-77.