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REVIEW ARTICLE

A REVIEW OF MANAGING CARBON EMISSIONS FOR SUSTAINABLE SUPPLY CHAIN MANAGEMENT

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ABSTRACT - Carbon emissions were one of the most critical contributors to climate change, and the recent climate agreement had agreed for all participating countries to reduce their emissions. Malaysia has pledged to reduce 45 per cent of its carbon emissions by 2025. However, reducing carbon emissions from the industry was still limited due to voluntary reporting, particularly among manufacturers. Thus, it is ambitious for the Malaysian government to achieve its target by 2025. A complete review is performed to go through the literature and determine the review's research path. This review aims to investigate the low carbon performance based on the manufacturing industry's low carbon supply chain practices. The findings show that low carbon production was insignificant in reducing overall carbon emissions. In contrast, the rest of the low carbon supply chain practices were by the Natural Resource-Based-View (NRBV) theory. It helps to identify companies' low carbon supply chain practices to reduce carbon emissions and meet environmental regulations. Additionally, the review also provided new insight into mediating effect that contributes to the organizational theory of NRBV. The theoretical hypotheses were tested with bias-corrected and accelerated (BCA) bootstrap confidence intervals. The instrument used in this review is a questionnaire, and the questionnaire consists of five (5) scales which tapped on (LCSCM), energy management, and low carbon performance. Responses from the respondent were collected via an online survey between Malaysian manufacturing industries. SmartPLS was used to perform the model and structural analyses. The result shows that LCSCM influence carbon performance directly and indirectly, so the hypotheses are supported. This review is one of the earliest attempts to record empirical evidence regarding companies' low carbon supply chain practices and performance. Thus, the review shows results can be used and extended to develop low-carbon supply chain frameworks.

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1.0 INTRODUCTION

Energy management, processing, and logistics contribute substantially to high carbon emissions. As a result, manufacturing companies must move to a more sustainable production model to reduce carbon emissions through low-carbon supply chain management (LCSCM) (Ali et al., 2021). LCSCM is a strategic and environmentally focused initiative that focuses on energy effectiveness and reducing carbon to accomplish operational excellence and cost savings. Reduced carbon emissions would aid in environmental sustainability and be a necessary component of long-term development (Akram et al., 2020). Malaysia's carbon emissions are increasing due to the rapid growth of energy demand (Corridor et al., 2020). There are usually two contemporary literature threads regarding low carbon transition. The first is energy conservation and sustainability programs, cost-effective, and reliable ways to reduce carbon emissions from energy use and protect the environment (Li, 2020).

Malaysia is still inadequate in monitoring carbon emissions and obtaining accurate data is expensive (Alasinrin et al., 2021). As a result, carbon emission recording is limited, even though it can help to boost carbon efficiency. Furthermore, Malaysian companies lack experience with renewable energy sources (Li, 2020). As a result, neglected industrial businesses cannot measure their carbon production and reduce emissions. Since there are no clear, direct financial advantages for smaller businesses with low energy intensity, there are no visible recommendations for energy efficiency to manage carbon emissions (Hu et al., 2020). So, it makes identifying the origins and causes of excessive carbon emissions challenging and complex in its activity (Shaharudin & Fernando 2021).

Therefore, the review manages to identify the LCSCM practices that will improve the low carbon performance. In addition, it also provides an overview of how energy management mediates the relationship between low-carbon supply chain management and low-carbon performance. The analysis contributes to the theory by introducing a framework for multidisciplinary research focusing on a low carbon performance where natural resource-based view (NRBV). As a result,

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the point of view for interpreting the theory by defining new research and development opportunities for monetizing sustainability concepts such as carbon emissions. Companies can use these review findings as incentives for businesses to attain low-carbon productivity in practice, which necessitates various strategies for planning, measuring, and regulating low-carbon operations in both upstream and downstream chains.

Based on the framework of the review paper, empirical evidence that contributes to the low carbon performance of literature on how energy management practices can achieve integrated levels of performance should also include carbon performance indicators. The industry will be able to improve low carbon performance by adopting LCSCM among firms in the industry because LCSCM reduces greenhouse gases. Energy management provides insights on how firms can improve their low carbon emissions to achieve low carbon performance. It can be applied also to production processes and distribution in the industry. This review shows a company can achieve low-carbon performance by practicing low-carbon supply chain management. When a company is practicing energy management, it can gain better low-carbon performance. It contributes to the understanding of how to reduce carbon emissions to overcome climate change which is one of the biggest threats to sustainable development. A company can improve products and processes by practicing carbon reduction and it is in line with NRBV theory that underlined the importance of resources that are unique to other competitors, thus resulting in the company achieving performance and competitive advantage.

2.0 AN OVERVIEW OF THE MANUFACTURING INDUSTRY

The manufacturing industry is currently changing from mass production to custom manufacturing. Rapid progress has helped increase productivity in manufacturing and industrial applications. The manufacturing sectors include automobile, biotechnological, building materials (components) and chemical components, computer hardware, electrical and electronic devices, technical aid, iron and steel industries and machinery, medical (primary or manufactured) equipment, metal (primary and manufactured), paper and paper products, and rubber products (for the industry). This review examines Malaysia's manufacturing industry's environmental pollution.

2.1 NRBV Theory

The method used in this analysis is a quantitative and organizational theory from a natural resources-based view (NRBV). This review's results would support the NRBV theory, which emphasizes the importance of non-industry capital in assisting a firm's growth and competitive advantage (Shi et al., 2012). To reduce carbon emissions in Malaysia, several problems must be tackled. It is more difficult to overcome because Malaysia is a developing nation. Inefficient infrastructure, which makes it difficult to reduce carbon emissions by using less polluting modes of transportation, reduces carbon emissions (Böttcher & Müller, 2015). Carbon performance is inadequate due to a lack of funds to purchase the device or install technology to help low-carbon performance.

The firm's NRBV is still cited in the literature as a practical and creative approach to sustainable operations, especially carbon performance (Alam et al., 2019). Although the NRBV is intended to benefit the firms in terms of carbon performance, its importance stems from its strategic appeal rather than its environmental intentions. According to the paper, the initial NRBV experiments and subsequent attempts at theory extension and growth involve a broad range of potentially significant capabilities. Furthermore, an investigation of the NRBV's synergistic relationship with LCSCM and low carbon efficiency, which will help in NRBV implementation is needed. When these skills are brought together, energy management practice is used to direct the carbon efficiency process of NRBV capabilities (Beatriz et al., 2020). This review concludes with an empirical review of NRBV's capabilities to bridge the theory-practice gap and refine existing literature. Furthermore, it provides businesses with an easy and attractive way to reduce carbon emissions.

NRBV theory and LCSCM have been linked in numerous research studies to understand better a firm's competitive position and carbon output change (Lee & Min, 2015). In essence, it is unclear how specific LCSCM practices can translate into strategic capital for a firm, resulting in a competitive advantage and improved results. LCSCM encompasses downstream activities such as sourcing, product creation, production, distribution, and storage to energy management (Nie et al., 2020). This review recognized the significance of energy management in natural resource-based attributes when describing LCSCM practice components, such as how a particular type of LCSCM practice generates causally uncertain, socially dynamic resources contributing to carbon production.

A direct contribution is inadequate to understand the links between organizational LCSCM and low-carbon performance fully. The complex interactions between NRBV and LCSCM aspects, on the other hand, lead to a better understanding of their impact on low-carbon performance. In terms of theory advancement, this review systematically reviewed the literature on LCSCM's links to NRBV, low carbon performance, and energy management and then investigated the possible interactive relationships between those measurement models using previously established operational constructs. As a result, this theory creation exercise aimed to create a more rigorous and alternative conceptual framework for understanding LCSCM in NRBV and how it interacts with low carbon efficiency. LCSCM has been studied more thoroughly and scientifically in terms of theoretical development by combining NRBV and organizational theories and investigating both the firm's internal and external perspectives. By taking a more systematic approach to a firm, the method complements the LCSCM case-based empirical analysis.

The natural resource-based view (NRBV) provides a solid theoretical foundation for discussing how resources and skills contribute to low-carbon performance. These ideas shed light on the resource-efficiency relationship. According to

the NRBV, a firm's competitive advantage is based on various resources, each with unique properties that make them valuable in achieving carbon efficiency. Recognizing that a firm's resources are insufficient to generate a competitive advantage elevates the strategic significance of the firm's actions or ability to use its resources to its advantage. Because of government and market sustainability issues, businesses are finding it difficult to endorse successful LCSCM. The NRBV definition is extended by integrating natural environmental constraints and opportunities and suggesting that carbon performance will provide a long-term competitive advantage. According to the NRBV, firms must accumulate LCSCM and manage capital to adapt to the natural environment and achieve long-term productivity. A firm's ability to imagine sustainable technology and goods gives it a competitive edge in the industry. The NRBV was refined further to highlight the connections between LCSCM, energy management, and manufacturing carbon performance.

2.2 Low Carbon Performance

Low carbon performance refers to the production, tracking, evaluation, and reduction of carbon emissions throughout the supply chain, which includes product, procurement, production, and logistics, as well as distribution networks (Shaharudin et al., 2019). It is a world leader in carbon emissions, one of the most critical environmental concerns. Environmental and health implementation, inclusivity, and economic growth create a prosperous, safe, sustainable, and dependable community for this generation and future generations (Nie et al., 2020).

Because of their effect on carbon performance, carbon-intensive materials should be carefully regulated to achieve sustainability goals. More resources and natural capital are unavoidable in the absence of new energy sources for new building materials. These emerging technologies consume a lot of energy. They must be shipped over long distances until they can be used in manufacturing. Energy consumption can be used to assess carbon performance. Energy consumption in a few countries has become uncontrollable due to economic development (Kuo et al., 2018). For example, due to the high cost of procedures, there is no reliable review or data on reducing carbon emissions in Malaysia to meet potential energy demand on an affordable and low-carbon performance (Lăzăroiu et al., 2020). Innovation requires the use of a variety of technologies. In Malaysia, however, there has been no investment or innovation in energy research, growth, and demonstration (R&D). An aggressive demand-side management scheme, efficient power use, and economic pressure on carbon-intensive energy sources are needed to reduce emissions from energy consumption (Mariano et al., 2017). As a result, much research on carbon-intensive goods, energy usage, and carbon pollution has been required to practice carbon efficiency.

In order to achieve better carbon efficiency, the sustainability issue of carbon emission should be carefully analyzed from supply chain practices that can check its social, environmental, and economic impact (Qin et al., 2019). However, few researchers have previously focused on the interactions between external and internal contextual factors for low carbon outcomes (LCP) (Kadefors et al., 2019). Furthermore, the newly built industrial area was having difficulty enforcing numerous carbon mitigation initiatives. On the other hand, most of the research on their early environmental consciousness activities was explained as a concern of the newly formed organization. Low-level workers' education and environmental consciousness have been lauded as significant achievements in implementing carbon-reduction initiatives (Faerber et al., 2018).

Efforts to minimize carbon emissions from a firm's operations will help it achieve its efficiency goals. The anticipated direct and indirect benefits of reducing carbon emissions are fueling hopes of increased competitiveness. It is anticipated that more efficient use of inputs, especially electricity, would save money and reduce the need for compensatory measures such as pollution certificates or taxes. Furthermore, corporate environmental and carbon emission reduction schemes have been driven by the promise of less concrete financial benefits, such as increased profits from enhancing their environmental credentials and strengthening their consumer relationships. The carbon efficiency of a firm and its goods can be used as a differentiator and environmental marketing.

Furthermore, rising regulatory pressure alone would not convince industrial companies to follow low-carbon practices. It can also help businesses achieve their competitiveness goals by requiring them to adopt carbon-cutting initiatives. According to the analysis, higher carbon production and economic success have a positive link, indicating that there appears to be no trade-off between enhanced carbon efficiency and financial goals. As a result, policymakers' initiatives to encourage manufacturing enterprises to become more carbon-efficient may boost productivity. Smaller enterprises have a limited impact on low-carbon output, therefore policymakers can supply carbon efficiency advice and funds to meet their competitiveness requirements. The government may encourage manufacturers to implement energy management systems to improve accountability and, as a result, understand carbon emissions and costs. Financial incentives, such as tax cuts, would encourage companies to pay more attention to their energy use, raising awareness of future savings. Germany is taking several moves in this direction right now (Böttcher & Müller 2015). Recently, for instance, a proposal to financially fund the implementation of energy management systems was made. Small and medium-sized enterprises, for example, will receive financial support to implement carbon-cutting innovations, including high-efficiency air-conditioning systems (Taufiq et al., 2021). Given the still-minor effect of competitiveness expectations on low-carbon output adoption and the significant benefits to low-carbon efficiency and, indirectly, economic performance, interventions should be extended while the effectiveness of specific steps is thoroughly monitored.

The firm will invest in carbon-reducing technologies and systems to achieve carbon efficiency, such as complete or partial electrification. More energy-related research and training, with an emphasis on decarbonization, is likely.

Innovation, adaptability, and flexibility are all factors that can help a firm reduce its carbon emission. End-use energy conservation, power supply decarbonization, increased reliance on low- or zero-carbon energy sources, carbon capture, utilization, and sequestration technologies, and substitution of traditional fossil-fuel-based industrial feedstocks with low- or zero-carbon feedstocks are all examples of ways to minimize emissions gradually. Because of the low cost and wide range of options for reducing power sector emissions, electrification of technologies in end-use sectors such as transportation, residential and commercial buildings, and manufacturing, in conjunction with power sector decarbonization, has been described as one of the main components to achieving deep cuts in carbon emissions. Essential reductions in GHG emissions associated with direct fuel combustion can be achieved if the carbon intensity of electricity production continues to fall and fossil-fueled technologies are replaced with electric technologies. To conclude, LCP research should be conducted from various perspectives to identify the area that releases the least carbon into the atmosphere. The table below shows the type and sources that cause pollution in the atmosphere.

Table 1. Emission of pollutants to the atmosphere by type and sources, Malaysia 2009 -2019

Year	Industrial	Power plant	Motor vehicles	Others	Total
2009	166.3	595.9	1762.8	60.3	2585.26
2010	113.9	619.2	1,829.69	60.5	2,623.23
2011	116.4	633.5	1,905.61	90.6	2,746.14
2012	86.4	693.2	2,024.59	151.5	2,955.66
2013	85.998	701.831	2,025.59	142.389	2,955.81
2014	101.9	742.9	2,092.00	88.2	3,024.90
2015	85.3	746.8	2,149.51	88.5	3,070.18
2016	101.9	774.5	2,192.28	80.4	3,149.14
2017	96.422	791.435	2,271.84	68.433	3,226.33
2018	96.594	821.619	2,359.04	107.517	3,384.77
2019	113.865	832.917	2,379.98	131.196	3,457.96

(Source from Department of Environment, 2019)

2.3 Low Carbon Supply Chain Management

In terms of revenue per unit, activities, pollution discharge fees, production process, and overall emissions, LCSCM is often known as a carbon emission reduction. When it comes to LCSCs, there are two primary schools of thought. The first school of thought differentiates LCSC from Green Supply Chain Management due to its goal of reducing greenhouse gas (GHG) emissions, its close association with oil, and its voluntary reduction of carbon emissions (GSCM). According to the second school of thinking, LCSC is a GSCM extension that indirectly helps businesses reduce carbon emissions. This research looks at the planning, monitoring, tracking, and mitigation of carbon emissions in the supply chain, including product, procurement, production, and logistics, including distribution networks (Shaharudin et al., 2019).

A low-carbon supply chain's short-term aim is to eliminate or minimize waste in firm and supply chain processes such as low-carbon procurement, product, production, logistics, and delivery while also tracking and reducing carbon emissions (Orsini & Marrone, 2019). However, the review was determined to be deficient in two major areas: the state of LCSCM in Malaysia and incentives for developing a green supply chain in Malaysia. It is easier to understand why Malaysian enterprises are reticent to embrace low-carbon supply chain operations in this light (Biermann et al., 2020). Malaysian companies' lack of awareness of the initiatives outlined in the current literature for establishing green supply chains is a popular source of difficulty in promoting low-carbon supply chain activities.

According to Rodrguez and Fernando (2021) on carbon performance issues in Malaysian manufacturing firms, the emphasis is on lowering the cost of implementing carbon practises, improving processes through green practises, conforming to international trade norms, and applying low-carbon efforts to SMEs. However, due to an unappealing economic climate and low pay packages, Malaysian factories fail to maintain talent. As a result, financing environmentally sustainable developments is prohibitively costly for many small-to-medium-sized businesses (SMEs), even with government subsidies. Furthermore, as the global economy weakens, Malaysian manufacturers must choose between keeping their talented workers satisfied and efficient or investing in expensive environmental solutions. As a result, companies must strike a balance between profitability and adhering to national and international environmental regulations. So, this is a challenging task that often necessitates the skills and knowledge that Malaysia lacks.

According to Shaharudin et al. (2019), LCSCM can be defined as reducing emissions in the product, manufacturing, and logistics industries, as well as broadening the scope of low-carbon operations. Additionally, LCSCM minimises carbon emissions across the board, including unit income, operations, carbon discharge charges, manufacturing processes, and overall emissions (Böttcher & Müller 2015). When it comes to LCSCMs, there are two schools of thought. The first school of thought contrasts LCSCM with Green Supply Chain Management (GSCM) since LCSCM focuses on reducing greenhouse gas (GHG) emissions, increasing energy connection, and reducing voluntary carbon emissions (Correia et al.,

2013). According to the second school of thought, LCSCM is a supplement to GSCM that assists firms in indirectly reducing carbon emissions (Fernando & Lin, 2017).

In this review, LCSCM is described as the design, control, monitoring, and reduction of carbon emissions along the supply chain, which encompasses product design, purchasing, process manufacturing, and logistics, including distribution networks, while taking both ways of thinking into account (Shaharudin et al., 2019). As a result, this review shows that LCSC conceptualization is more linked with the first school of thinking, which regards LCSCM as a subset of GSCM. Indeed, LCSCM integrates GSCM information such as total firm carbon emissions, energy use, and subsequent emissions measurements, as well as carbon-intensive elements in product fines, and taxes for firms to discharge carbon emissions, manufacturing processes, and activities. Pollution, waste reduction, general environmental rules compliance, the firm's environmental reputation, and environmental performance are all components of GSCM. The previous economic vision is turned into a green one by GSCM, compelling industrial enterprises to reconsider their tactics to achieve low carbon performance (Correia et al., 2013). As a result, organisations should strive for long-term sustainability as well as profitability.

Manufacturing companies can practice green business practices, focus on sustainability initiatives, and try to minimise costs, improve product quality, raise stakeholder well-being, and lower their carbon footprint. The LCSCM strives to reduce carbon emissions while keeping control over the whole supply chain, including procurement, purchasing, production, distribution, and logistics. Every carbon chain function represents an opportunity to reduce carbon emissions by successfully controlling them (Li & Yu 2020). Companies can now reduce carbon emissions in their procurement activities by purchasing low-carbon energy and/or renewable energy, low-carbon materials, and low-carbon goods and services. After obtaining low-carbohydrate, low-carbon resources and low-carbon commodities or services, businesses can begin producing and developing their products. To reduce carbon emissions during the design stage, some companies collaborate to incorporate suppliers or consumers throughout the product design process (Hu & Su, 2018; Saxena, Jain, & Sharma, 2018; Tong, Mu, Zhao, Mendis, & Sutherland, 2019; Yang, Wang, & Ke, 2018). Companies can reduce carbon emissions by employing low-carbon materials throughout the design process and substituting renewable and recycled resources for traditional materials. Furthermore, firms can obtain fresh insights into material and product life cycles by utilising life cycle evaluations. Following the completion of the design process, businesses can begin production. Manufacturing is one of the major producers of carbon emissions. Companies may lower their carbon footprint now by using low-carbon energy sources such as renewable energy. They can invest in energy conservation and efficiency projects, low-carbon technologies and machinery, low-carbon materials, and life cycle assessment to reduce carbon emissions. Finally, firms can reduce carbon emissions by implementing environmentally friendly packages that reduce emissions and indirect environmental impact (Shaharudin et al., 2019). Finished commodities are typically kept or transported to a supply chain network after they have been manufactured.

Carbon emissions are becoming more of a focus. Businesses are concerned about greenhouse gas emissions from warehouse stocks, according to the literature (Li et al., 2017). The goods are delivered to the buyer by the firm from the warehouse. We recognise that reducing carbon emissions from supply chain travel is a priority for both businesses and consumers. A dynamic business climate, on the other hand, encourages greater collaboration between upstream and downstream businesses (Kaur & Singh, 2017). Carbon-efficient equipment is essential for increasing supply chain efficiency and reducing CO2 emissions necessitates tight cooperation (Panda et al., 2017). More than 1000 mainstream firms have made "carbon-free energy sources" a supply chain requirement, including Wal-Mart, IKEA, and IBM. It implemented several preferential cooperation measures to encourage its upstream and downstream industries to work together on low-carbon growth (Taufiq et al., 2021). By focusing on lower-carbon alternatives, logistics organisations may be able to minimise carbon emissions from transportation (Shaharudin et al., 2019). Companies may also invest in low-carbon technology for the building and consolidation of transportation routes. These are some of the major practices used by LCSCM to reduce and manage carbon emissions throughout the supply chain.

2.4 Procurement

Procurement aims to reduce carbon emissions by buying low-carbon energy supplies and consuming and purchasing goods and services with lower average life-cycle carbon emissions (Shaharudin et al., 2019). For the time being, low-carbon supply chain research has mainly concentrated on how businesses can function optimally in terms of costs, upgrades, and networks to optimize economic benefits while staying consistent with carbon regulations (Hu & Su, 2018; Saxena, Jain, & Sharma, 2018; Tong, Mu, Zhao, Mendis, & Sutherland, 2019; Yang, Wang, & Ke, 2018). In contrast, corporate procurement strategies have received less attention. Aside from industry environmental consciousness and government carbon policies, procurement orders from downstream companies have a direct impact on carbon emissions in upstream companies' production processes (Kaur & Singh, 2018; Ma, Ji, Ho, & Yang, 2018). When demand is volatile, large order quantities can quickly result in shortages and a loss of firm sales revenue. On the other hand, low-order quantities can rapidly lead to requirements and increase carbon emissions (Li, Li, & Cai, 2013). According to several sources, make-to-order manufacturing can help supply chain companies resolve procurement issues (Bai, Xu, & Zhang, 2018; Chen, 2012; Dey & Saha, 2018).

2.5 Product

The use of renewable and recycled products and reducing carbon-intensive materials and total emissions are all considered during product production (Böttcher & Müller 2015). Over the life cycle of a product, careful material selection, such as green or recycled raw materials, can save energy, and reduce CO2 emissions. Previous research examined additional insulation and RLR upgrades as an energy-saving measure in an industrial life cycle evaluation to boost low carbon-based goods (Taufiq et al., 2021). As NGOs and policymakers take steps to reduce carbon emissions, such as raising market awareness, government engagement, and channel alignment, manufacturers increase their pollution reduction efforts and charge higher prices for low-carbon goods. The supplier can only put in more effort before channel coordination is implemented (Li et al., 2017). Controlling finished products and downstream markets by the government is counterproductive. A cost-sharing deal in the supply chain, on the other hand, is needed to enable producers to make more significant efforts to reduce pollution. Simulations and sensitivity tests are provided to validate the effectiveness of the findings. As a result, low-carbon products that follow environmental regulations in the supply chain help to increase carbon performance.

2.6 Production

Low-carbon production refers to introducing new and improved production processes or enhancing existing ones, all of which are vital components in a manufacturing firm's attempts to minimize carbon emissions (Böttcher & Müller, 2015). In the face of growing consumer environmental consciousness and a dynamic market climate, businesses attempt to increase their economic and environmental performance to ensure long-term sustainability. Corporations concentrate more on environmental protection and production processes, especially low-carbon production, as carbon emissions rise and climate change become more unfavourable. Environmental consciousness imitates demand to allow all businesses to reduce emissions (Li et al., 2017). As a result, an increasing number of companies emphasize low-carbon performance to maximize profitability while also avoiding unfavourable climate change by decreasing emissions.

In contrast, a dynamic business climate promotes greater cooperation between upstream and downstream companies (Kaur & Singh, 2017). Carbon-efficient equipment is critical for rising supply chain efficiency and lowering CO2 emissions requires close collaboration (Panda et al., 2017). More than 1000 mainstream corporations, including Wal-Mart, IKEA, and IBM, have made "carbon-free energy sources" a supply chain requirement. They have introduced a variety of preferential cooperation policies to allow their upstream and downstream businesses to collaborate on low-carbon development (Taufiq et al., 2021).

2.7 Distribution

The method of storing and transporting products with minimum energy consumption, low carbon emissions, and environmentally friendly packaging is known as distribution (Shaharudin et al., 2019). Low-carbon distribution is needed for the development of a carbon-efficient supply chain. Technological investments in energy management systems in our warehouse operations are seen as strategic options for companies looking to minimize carbon emissions and become more environmentally conscious.

2.8 Logistics

Low-carbon logistics refers to the transportation of goods and products, a significant source of carbon emissions. As a result, to reduce their environmental effects, manufacturing companies are increasingly dependent on low-carbon logistics (Böttcher & Müller, 2015). To develop low-carbon logistics even more, there is a need to learn how to use an efficient performance evaluation framework to analyse logistics operations performance such as production, productivity, and cost in the context of low-carbon and sustainable development (Yang et al., 2019). Performance evaluation is a method of evaluating how well organizations operate and the value they offer to consumers and other stakeholders through a set of estimation, observation, and advisory approaches. It considers the behavior of managers in charge of designing competitive and operational strategies and the actions of the operators who put the process into effect (He et al., 2017). The challenges and methods for improving the logistics industry have been thoroughly researched from a variety of perspectives. For example, Abdulrahman et al. (2014) and Ali et al. (2021) reviewed the growth and implementation challenges faced by reverse logistics firms by internal and external stakeholders, identifying four significant obstacles from the management, financial, policy, and infrastructure perspectives.

2.9 Energy Management

The goal of energy management is to minimize energy waste while maintaining production quantity and quality flexibility and the environmental effect of firm efficiency. It is accomplished by either upgrading current technology and processes or investing in new energy-efficient technologies to meet energy demands precisely when and where they are needed (Fernando & Lin, 2017). The planning and maintenance of energy generation and utilization units and energy distribution and storage are all part of energy management. Customers have free access to the energy they need, and all goals include resource efficiency, environmental preservation, and productivity gains. By implementing an energy strategy, businesses will reduce risks and increase productivity in the manufacturing sector. According to Li and Yu (2020), energy management and improved demand-side energy storage would minimize total energy consumption and carbon emissions. Han and Wang (2018) stressed energy production and energy control systems. Energy management is described in the manufacturing industry as energy control, monitoring, and quality assurance.

A variety of devices may be used to assess energy management. Changes in energy management reduce carbon emissions by eliminating direct energy use or recycling waste energy in other processes. So, this includes optimizing equipment idle rates during start-up, repairs, and sluggish times, as well as heating and cooling. Thus, higher carbon emissions can be attributed to increasing energy efficiency (Fernando & Hor, 2017). The use of energy management practices to minimize the total energy consumption of a process, machinery, or product is referred to as energy efficiency (Han & Wang, 2018). Carbon emissions reduction has been defined as activities that result in lower levels of CO2 or CO2 equivalent gases in the atmosphere, causing the greenhouse effect, which causes global warming, climate change, and a deterioration in human quality of life. As a result, energy management seeks to reduce energy waste while simultaneously lowering a firm's environmental effect. It meets energy demand precisely when and where it is needed by utilising existing technology and processes as well as investing in new energy-efficient solutions.

According to the literature review, energy management covers policy and planning, implementation/operation, monitoring, organization, and culture (Fernando & Hor, 2017). The International Energy Agency 2017 has linked the two meanings: The systematic monitoring, review, and planning of energy use and systems, including energy management operations, procedures, and processes, is referred to as energy management. It is a feasible alternative to use an energy management system to put these procedures in motion. The mechanisms that a firm uses to work strategically on resources are referred to as energy management. Due to the complexity of industrial processes and the substantial number of variations in applications among different countries, regions, and firms, there is no official source of energy management techniques, as there has been in earlier research (Han & Wang, 2018). As a result, evaluating the effectiveness of the program can be challenging, especially when employing the same equipment, and there is no "one-size-fits-all" approach to energy management. The energy management team, on the other hand, is a modern management function that is constantly committed to incorporating new skills and ideas in order to achieve continual energy efficiency gains (Peng et al., 2020).

According to Peng et al. (2020), the domains of energy management activities directly impact energy quality. However, there is insufficient evidence to demonstrate that energy-saving practices directly affect Malaysian industries' low carbon emissions. Manufacturing firms lacked the expertise and resources needed to monitor carbon reductions (Fernando et al., 2021). Environmental management may assist in understanding energy use and justifying the cost of energy efficiency upgrades. On the other hand, energy audits were not commonly used to track energy usage in Malaysian manufacturing. This is because Malaysia lacks energy management practices, where management engagement, energy literacy, and expertise are all barriers to low-carbon growth (Fernando & Lin, 2017). Malaysian industries are worried about carbon emissions because they are a fundamental concept of energy management. However, due to the industry's current lack of energy management and implementation, which is currently based on quick wins and disorganized energy efficiency outputs, it has not been fully incorporated and combined with today's manufacturing operations activities (Fernando & Lin, 2017).

The energy intensity per unit of GDP is shown in Table 2. It is a metric that measures how inefficiently the economy uses capital. It is calculated by multiplying one unit of GDP by one unit of energy. The cost of energy to GDP rises as energy intensity rises, and vice versa. The table explained the cost is unstable and changes every year. Since the cost of energy to GDP has a relationship with energy intensity, industries should reduce the cost of energy to increase the energy efficiency of the economy.

Table 2. Energy intensity per unit GDP

Energy Intensity per Unit GDP	
Year	Final Energy Intensity (to/GDP at 2015 Prices (RM million))
2008	54.05
2009	53.42
2010	50.49
2011	50.24
2012	54.03
2013	54
2014	51.56
2015	48.69
2016	51.6
2017	53.21
2018	47.44

3.0 THEORETICAL FRAMEWORK

The framework explained how to reduce carbon by practising LCSCM and the practices become more effective when management manages the energy as well. It shows that by practising low carbon procurement, product, production, distribution and logistics, the industries can achieve carbon performance. The NRBV theory is used here to emphasize the importance of an industry's growth and competitive advantage by achieving low carbon performance.

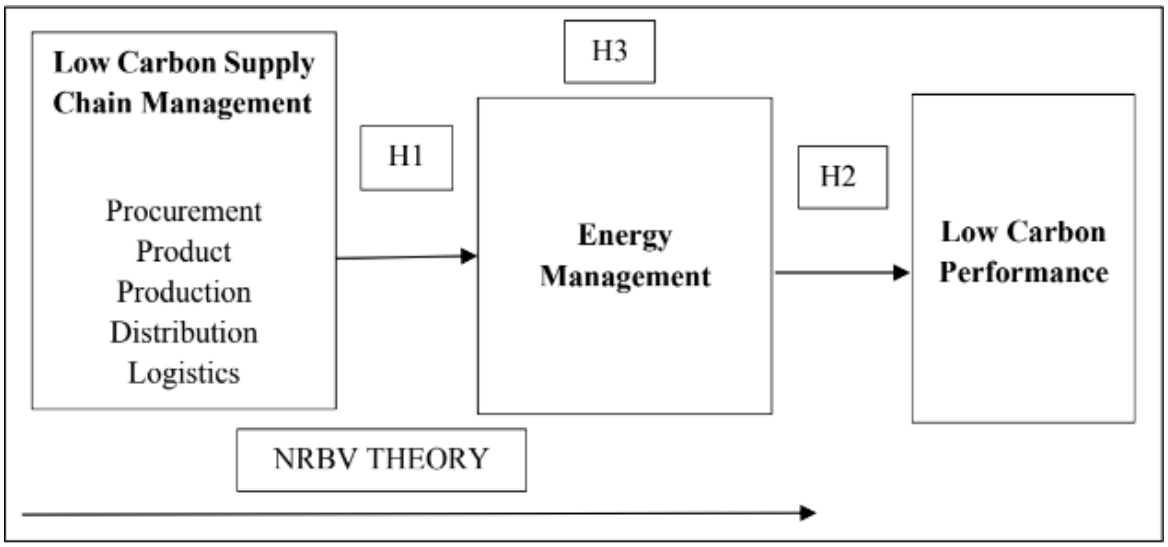

Figure 1. Theoretical framework

This review followed Aguinis et al. (2017) in having parsimony in the model. This review has no direct hypothesis from low carbon supply chain management to low carbon performance because according to Aguinis et al. (2017), if the literature supports the mediation variable, in this case, the energy management, then, testing the direct relationship between the independent variable to dependent variable is redundant. After all, the introduction of the mediation variable is to strengthen the relationship. Thus, comparing having mediation and no mediation does not add to the novelty of the research.

4.0 CONCLUSION

This research presented a framework for multidisciplinary research focused on low-carbon performance, with a natural resource-based view (NRBV). As a result, this research contributes to the interpretation of the theory by identifying new research and development prospects for monetizing sustainability concepts like carbon emissions. The LCSCM and how it aided low-carbon production were the subjects of this review, which filled in gaps in the literature. The sustainability of low-carbon products can be improved when there is a link between production and LCSCM (Hu et al., 2020). The review contributes to the literature on low carbon performance by offering empirical data on how energy management methods can reach integrated performance requirements that must include carbon performance measurements in manufacturing firms.

Manufacturing firms and their supply chains are the largest major source of carbon emissions, accounting for about half of all emissions (Shaharudin et al., 2019). More than 90 per cent of emissions may be traced back to the supplier chains of companies (Mao et al., 2017). As a result of Malaysia's rapidly increasing energy consumption and resulting CO2 emissions, the country's transition to low-carbon electricity generation has become the topic of significant policy disputes. There are generally two streams of modern literature that are concerned with low carbon emissions (KeTTHA, 2014). It is important to note that the first strand of energy-related CO2 emissions is addressed by energy conservation and efficiency measures, which are effective and efficient approaches to address both energy-related CO2 emissions and energy security. Many studies have been conducted in Malaysia to investigate energy efficiency and CO2 emissions associated with energy use in various end-user industries (Begum et al., 2017; Moghimi et al., 2015; Zaid et al., 2014). Chong et al. (2019) have made a recent scientific contribution. To reduce CO2 emissions, the researchers say that Malaysia does not need to restrain its population or stifle its economic growth, but rather should promote energy conservation awareness and end-user energy efficiency. In addition, there is other research in this category that are concerned with determining the dynamic impact of energy consumption and economic growth on CO2 emissions (Begum et al., 2015; Farabi et al., 2019; Sulaiman & Abdul-Rahim, 2017).

While the research contributes to low carbon supply chain management (LCSCM), energy management and carbon performance in this area of inquiry, it also has some limitations. Reading and locating the right and acceptable literature reviews consumes a lot of time. To create a successful literature summary, there are several challenges. For example, the journal is not suitable for the analysis and the journal is incomplete. The journal is difficult to comprehend in some

situations. To reread the journal, therefore, a lot of time is needed. Other than that, regardless of the lack of references from previous researchers. The lack of previous research as a guideline and guide for this paper makes it more difficult.

First, we considered most of the journal articles published on or before the Covid-19 pandemic, and only those written about the low carbon supply chain management (LCSCM), energy management and carbon performance before the lockdown where the manufacturing sectors operates as usual. Thus, book chapters, books, research papers and articles were difficult to find in this research. As a result, there are limited studies on the supply chain during the Covid-19 pandemic. Second, Google Scholar was used to searching for articles, but it was hard to search for relevant studies via the websites maintained by individual publishers where the article should be paid to review. We may also have missed some other articles that were not included in the databases that we did use. The lack of empirical studies confirms that researchers, thus far, have had limited opportunities to collect and analyse real-world data. However, the empirical studies are expected to reveal important supply chain issues and difficulties faced in different contexts, since the pandemic has caused unique challenges for supply chains.

According to all indications, the development of energy-efficient solutions for energy-intensive industrial sectors has acquired significant impetus. Efforts to improve energy management methods have been proposed as a possible means of lowering energy consumption. However, in order to promote future improvements in industrial energy efficiency, an empirical assessment of the application of energy management and its outcomes is required to be conducted (Schulze et al., 2016). Future scholars that are interested in this subject area may be able to take advantage of the negligible findings, which may lead to new research prospects. Future research might build on the current findings by looking at the indirect effects of energy management methods on carbon reductions, which could be of particular interest. It is possible to postulate energy efficiency as an intervening variable in order to assess the indirect effects of LCSCM on carbon emission reduction.

Aiming to integrate energy policy into the review model, future studies should investigate ways that policymakers might push the industry to adhere to low-carbon emission and energy-management standards. A dearth of reviews exists, despite the growing importance of low-carbon energy in supply chain management literature, that addresses energy policy and sustainability compliance in relation to a country's respective policy and evidence of adoption. In the past, LCSC literature relevant to management and supply chain significantly favoured industry-based and carbon emission studies, while the policy side was mostly ignored. Because the policy has an impact on the rate at which LCSCM practices are adopted by businesses, future research efforts should be directed at this area of review. Environmental and energy policy research must be included in LCSCM studies if they are to be effective.

This research shows a company can achieve low-carbon performance by practicing low-carbon supply chain management. When a company is practicing energy management, it can gain better low-carbon performance. This research also well contributes to understanding how to reduce carbon emissions to overcome climate change which is one of the biggest threats to sustainable development. A company can improve products and processes by practicing carbon reduction. It is contributed that this is in line with NRBV theory that underlined the importance of resources that are unique to other competitors thus resulting in the company achieving performance and competitive advantage.

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