GREEN SUPPLY CHAIN PRACTICES AND ENVIRONMENTAL SUSTAINABILITY: A CONCEPTUAL FOCUS ON THE CHINESE MANUFACTURING SECTOR

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Abstract. This study focused on green supply chain practices and the drive for environmental sustainability in the Chinese manufacturing sector. The study adopted systems theory and relied on literature to explore the connectivity among affected stakeholders and examine current practices in the Chinese manufacturing sector. The study developed a suggested model to improve existing green supply chain practices and promote environmental sustainability. The study emphasized the engagement of affected stakeholders beyond linear supply chain partnerships to develop effective collaborations addressing challenges in green supply chain management and environmental sustainability. The study recommends further research using a mixed methods approach and a multi-sectoral focus on green supply chain management and environmental sustainability in China.
Keywords: *environmental sustainability, impact evaluation, partnership collaboration, stakeholder engagement, manufacturing sector*

Introduction

The drive for environmental protection has become a common practice among stakeholders in different sectors of the Chinese economy. The Chinese manufacturing sector has benefited from global development trends, which have resulted in an increase in demand for goods and services, profitability, optimal productivity, and the expansion of the entire sector. The expansive operations of organizations in the Chinese economy have resulted in complex effects that pose significant challenges to the environment, such as pollution and industrial waste generation.

The government has developed several proactive policies drives to institute environmental protection practices, and to promote a procedure of awareness and compliance to extant environmental sustainability rules among practicing organizations, and supply chain partners, especially in the manufacturing sector (Sheng et al., 2023). The government has also responded to global climate change demands by taking corresponding actions to enhance environmental protection, through several national policy initiatives in the Chinese economy, such as the drive to reduce carbon emission to enhance environmental sustainability through deliberate policy measures, especially in the Chinese manufacturing sector (Wang and Yang, 2021).

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Another relevant factor is effective communication of policy initiatives to drive the message for compliance among practicing organisations and their supply chain partners, on the need to commit to the implement required changes in their operations that align with the environmental sustainability expectations, while pursuing their operational objectives. Such awareness initiatives can also prompt their understanding of the impacts of their operations on their host environment and provide the intrinsic drive to maintain continuous improvement on their operations in line with the drive for environmental sustainability.

The Chinese manufacturing sector has provided a steady source of growth to the Chinese economy in the last three decades, part of the effects of that growth is the broad challenge of keeping the operations in the manufacturing sector in tandem with the environmental sustainability expectations. For example, China has a high-level carbon emission and industrial waste that require the attention of stakeholders to address and pursue environmental sustainability. This has resulted in the task to continuously search for effective environmental sustainability that can enhance the commitment of practicing manufacturing organisation to environmental protection, while focusing on the operations of these manufacturing organisation in the Chinese economy (Wei et al., 2021).

While green supply chain practitioners acknowledge the drive for environmental sustainability, what is of concern to stakeholders is ways to leveraged on it to enhance the pursuit of environmental sustainability, especially in the Chinese manufacturing sector that complex activities that are prone to posing concerns to the environment? The Chinese economy has recognized the need to address the complex effects of wide manufacturing activities such as waste management, pollution control measures, culminating in the drive for carbon neutrality by 2060 (Davidson et al., 2021; Abbas and Tong, 2023).

The current study focuses on addressing these key questions: first, how can the adoption of green supply chain practices be re-invented to facilitate the drive for environmental sustainability among practicing organizations in the Chinese Manufacturing sector? And second, how can environmental sustainability risks be addressed through the adoption of green supply chain practices?

This study relies on existing trends of findings and arguments from extant literature. This is aimed to establish broad understanding of the current practices of green supply chain among partners in the Chinese manufacturing sector. The main objective of the study is focused on exploring the impacts of these practices on the drive to improve on current environmental sustainability in China. The study puts premium on how the engagement of affected stakeholders can support the development of a suggested model for improvement, based on findings from extant literature considered in the study. In what follows, the structure of the study is revealed. The next section presents literature review on existing literature about the focus of the study. The is followed by the material and methods. The next section presents the suggested model for improvement. The results section presents the content of the model and further discussed in the subsequent section. The next section presents the managerial and theoretical implications of the study. The final section presents the conclusion and the recommendation for further studies.

Literature review

The practice of green supply chain has become a model among organizations in the manufacturing sector. The sector focuses on engaging supply chain management

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practices with an intent to minimize the impacts on the environment. Manufacturing organizations, while driving the pursuit of set operational objectives and the sustainability of their business activities, they are made to engage in green supply chain practices. Key green supply chain management practices include green purchasing, green marketing, non-hazardous disposal, green production, environmental information disclosure, and green recycling (see Sheng et al., 2023). Moreover, the entire ambience of green supply chain anchors on the integration of environmentally responsible principles, that comprises of benchmarking activities that comprise the manufacturing processes to ensure due consideration of environmental support into supply chain management (Yang and Wang, 2020; Shekarian et al., 2022).

Across diverse contexts, these studies highlight the critical role of renewable energy, governance, and global integration in driving sustainability. Amin et al. (2025) show that renewable energy, innovation, and human capital foster US decarbonization. Jaaffar et al. (2024) reveal that governance experience and financial strength shape Malaysian firms' green practices. In Africa, Osabohien et al. (2025) demonstrate that renewable energy reduces emissions but resource dependence undermines sustainability. Similarly, Osabohien et al. (2024) find that ASEAN's global value chain participation enhances energy efficiency and sustainability when aligned with clean energy adoption.

According to Zhang (2022) green supply chain practices is speculated to have taken 0ff in the 2006 in China. This was a response to the massive industrial activities happening across sectoral divides in the economy. As result, many cases of environmental degradation were recorded which prompted engagement of a suitable approach to address the issues identified such as waste generation to preserve the host environment for man's habitation. However, Wang et al. (2025) it is difficult to clearly identifying the exact take-off of green supply chain in China, they reckon that the attention of stakeholders was largely drawn to its development across sector in the years 2020s. This heralded the launching several environmental protection programs such as Dual Carbon goal and the Beautiful China initiative. These were developed with the intention to have an integrated strategy development, through policy implementation that beckons on the practicing organizations, such as those in the manufacturing sector to towards environmental sustainability in the Chinese economy.

The Chinese manufacturing sector is a thriving sector of the national economy that contributes up to 26% of the national GDP and has engaged in several green supply chain initiative with the intention to maintain compliance to extant environmental protection rules of engagement among supply chain partners that engage in complex supply chain activities (China Briefing Report, April 18, 2025). Similarly, Sheng et al. (2023), who focused on a comparative study on green supply chain practices noting that relevant improvement on existing legal system is required in terms of environmental information disclosure, and tax subsidy, by the government agencies being an umpire stakeholder that have the responsibility to provide effective guidance across the entire manufacturing sector in China. They further explain the Chinese legal systems is broadly divided into three parts that function together to provide policy guidance for effective green supply chain practices and environmental sustainability. These include the national agency, representing the Chinese national government, responsible for making national laws and policies for engagement across sectors in the entire economy, to promote critical environmental welfare. The second cadre in the legal system is the regulation of state council that provides guidance on waste disposal recycling practices in the economy. The third cadre is the document of the state councils, ministries and commissions. These

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provide the programs and standards guiding the operational activities of practitioners in the critical sector of the Chineses economy (see *Figure 1*; Zhang, 2022).

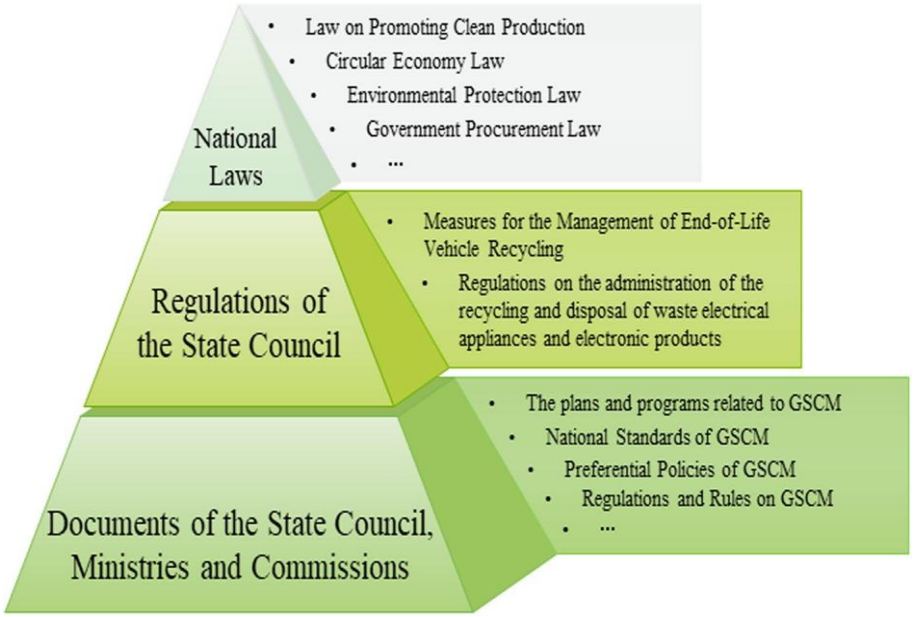

Figure 1. *Policy system of GSCM in China. Adapted from Sheng et al. (2023)*

Studies examine technological, financial, and sustainability challenges. Cheng et al. (2024) analyse Sybil attacks in resource exchange networks. Xu et al. (2025) show China's green finance reforms foster inclusive green growth. Ning et al. (2023) propose similarity-based manufacturing cost estimation. Deng et al. (2024) design diversified prompts for image emotion classification. Ding et al. (2024) apply big data in sustainable additive manufacturing. Jing et al. (2024) use patent text for design decisions. Liu et al. (2025) link knowledge sharing to supply chain governance. Meng et al. (2022) optimise low-carbon park energy dispatching. Dong and Yu (2024) link green bonds to energy innovation. Zhou et al. (2025) examine tourists' willingness to pay in parks. Huang et al. (2025) prioritise risks in China's new energy vehicle supply chain.

The broad practice of green supply chain practices has resulted in the quest to develop effective strategies and approaches to engage in the drive for a cleaner and sustainable environment while pursuing their manufacturing objectives. The core practices of the green supply chain include social, environmental, and economic focuses by the stakeholders involved (Moosavi et al., 2022). Examples of critical environmental wastes in the Chinese manufacturing sector are carbon emissions, pollution, and operational wastes. These require the engagement of partners who participate in complex supply chain practices such as the movement of materials across locations, anchored on a platform for sustained mitigating the adverse effects on the environment. The focus is to enhance minimizing carbon emissions, promoting ethical labour, and ensuring the responsible sourcing of materials along the supply chains (Gawusu et al., 2022; Khan et al., 2023). However, in their findings, Han and Wei (2025) found that while extant green supply chain practices such as the adoption of digital transformation can mitigate the waste generated by the firms (e.g., carborne emission) on the environment, they note that the amount of waste generated by the end-user -customers were not reduced or affected.

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This observation leaves the stakeholders to project of environmental sustainability in the Chinese manufacturing sector with the responsibility to keep on searching a a more comprehensive approach to the mitigation on the adverse effects of the manufacturing sector on the host environment in China.

Scholars observe diverse strategic approaches to support effective and efficient green supply chain management practices. For instance, Cui et al. (2021) suggest the customer relationship management as guiding tool for strategic decision making in green supply chain management practices. They explain that customer relationship management can support the development of input material supply plans in reflection to customer demand patterns that can minimize the long-term impacts on the environment, through efficient implementation of manufacturing process (Yang et al., 2023).

Similarly, Xu et al. (2024) emphasise intelligent manufacturing that reflects standards for environmental preservation. They suggest that tools of innovation and technology can be adopted for supply chain optimization, in tandem with environmental management systems, within highly competitive markets. They recommend extending government policy development to offer the required to intelligent manufacturing in the pharmaceutical industry. Corroborating this argument, Wang et al. (2025) found that effective deployment of technology has the potential to support efficient energy usage that can result in operational efficiency through the process of creativity and innovation along supply chains, without compromising on the quality of goods and services in the Chinese manufacturing sector (Xu et al., 2025).

Other studies reckon that the practice of green supply chain practice enhance the mitigation of risk in Chinese manufacturing sector. Particularly Parast and Subramanian (2021) caution that disruptions can result in challenges across an entire operational structure. They advise the green supply chain practitioners and business partners to develop a joint approach to mitigate the chances of disruptions that can adversely affect the pursuit of the set operational objectives. Other commentators note that extant risks due to disruption can result in critical operational issues such as contractual breaches, cost effects, poor quality output can result in concerns such as customer turnover and low sales, due to disruption in timing in the manufacturing process. Other elements of risks are environmental security risks, operational lead time risk and rigidity to changes in the green supply chain management practices that can result in environmental challenges such as pollution (Um and Han, 2021; Yang et al., 2021; Khan et al., 2023).

Furthermore, these observers note that the challenges of risk and disruptions have remained part of supply chain management practices that cannot be eliminated due to business environmental forces that affect green supply chain management practices. Nevertheless, they suggest the development of suitable resilient actions that reflect the trends of changes in the supply chains, through a collaborative measure among green supply chain practitioners. They affirm that this can provide the respite to effectively address emerging disruptions that can result in risk for the practicing organizations.

For instance, Dong et al. (2021) found that green supply chain management practices have the intrinsic potential to facilitate technology innovation with embedded long term environmental sustainability drive it its content. They explain that local manufacturing firms can leverage the usefulness of their green supply chain management with partners to develop long term efficiency in their use of resources and provide a platform for environmental sustainability while pursuing their operational objectives. This is in tandem with the suggestion of Feng et al. (2022) who emphasize on the use of digital packages to management production processes to effectively manage the environmental

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effects across sectors in the Chinese economy. While their argument highlights the importance of environmental effects of the critical sectors such as manufacturing in China, it also provides a clarion call on the affected stakeholders to offer support to the process to facilitate the achievement of a sustainable environment while pursuing their operational objectives.

For example, Fu et al. (2025) suggest that green finance (Green finance is a financial support system that support environmentally friendly investment and encourage industry practitioners to embrace the necessary changes in their operations to aid the drive for environmental sustainability)can redirect the attention of supply chain practitioners in the Chinese manufacturing sector to the optimum engagement with green supply chain practices, to benefit stakeholders in the aspects critical social economic drives, such as employment generation and mitigation of operational financial constraints among manufacturing organisations. This can also promote environmental sustainability in the long run. Nevertheless, they suggest that the optimum implementation of green finance requires that development of policies to guide the process in the Chinese manufacturing sector (see Guo et al., 2024).

Based on this narrative, a core responsibility is the need for collaborative development that can enhance creativity and innovation among green supply chain partners that can promote compliance, and contribution of stakeholders to the broad objective to sustain the environment protection initiative while practice and pursuing set business goals. For instance, Sheng et al. (2023) caution that the Chinese legal system needs to improve on their existing relationships with stakeholders, in terms of relevant information circulation, especially in the manufacturing sector to enhance their awareness and expectation in terms of compliance to extant rule of engagement among practicing organizations and also position them to contribute to the identified issues of interest such as the drive for environmental sustainability. These highlight the complex activities that underpin green supply chain management in China, it also prompts need for accountability and evaluation of the potency of extant rule of engagement that guide the ambience of green supply chain management practices in China (*Figure 1*; Sun and Sun, 2021). Observers argue that accountability can project the tacit development of effective green supply chain management approaches that can drive both the productivity of the practicing organizations and underscore environmental sustainability (see Li, 2021; Junaid et al., 2022). The next section presents the methodology adopted in this study.

Emissions dynamics and the imperative for green supply chains in China's manufacturing sector

The graphical evidence of sectoral emissions (*Figures 2 and 3*) in China highlights two important insights with direct relevance to the manufacturing sector and its role in advancing environmental sustainability. The CO_2 emissions chart shows that manufacturing and construction rank among the largest contributors to total emissions, second only to electricity and heat. This reinforces the centrality of industrial processes, construction activities, and resource-intensive production to China's overall carbon profile. The greenhouse gas emissions chart, which includes methane, nitrous oxide, and other gases, expands this picture by revealing that emissions linked to manufacturing and construction remain persistently high, alongside electricity and heat. These trends demonstrate that while energy-related emissions dominate, the industrial sector is a critical driver of environmental degradation and thus central to the debate on sustainability transitions.

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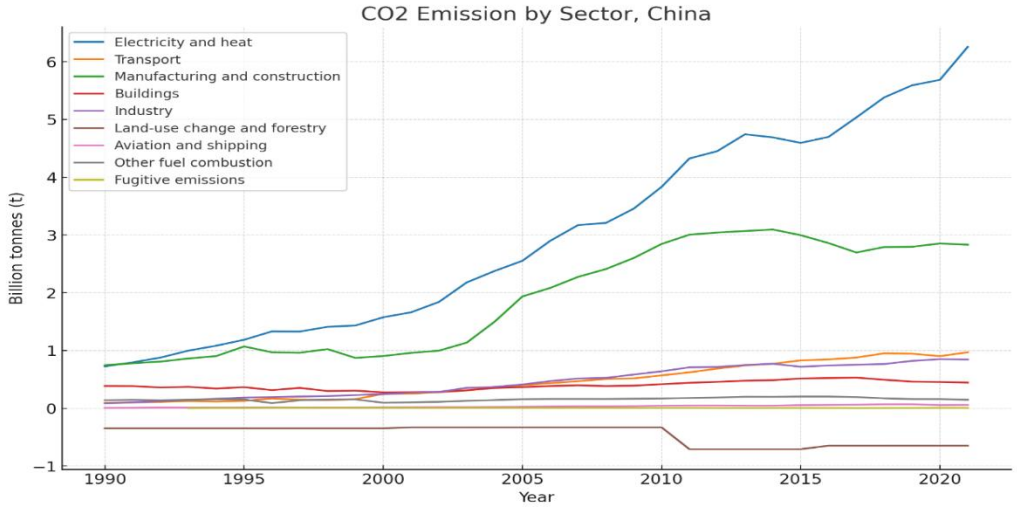

Figure 2. *China's CO_2 emission by sector. Source: Authors' computation using our World in data*

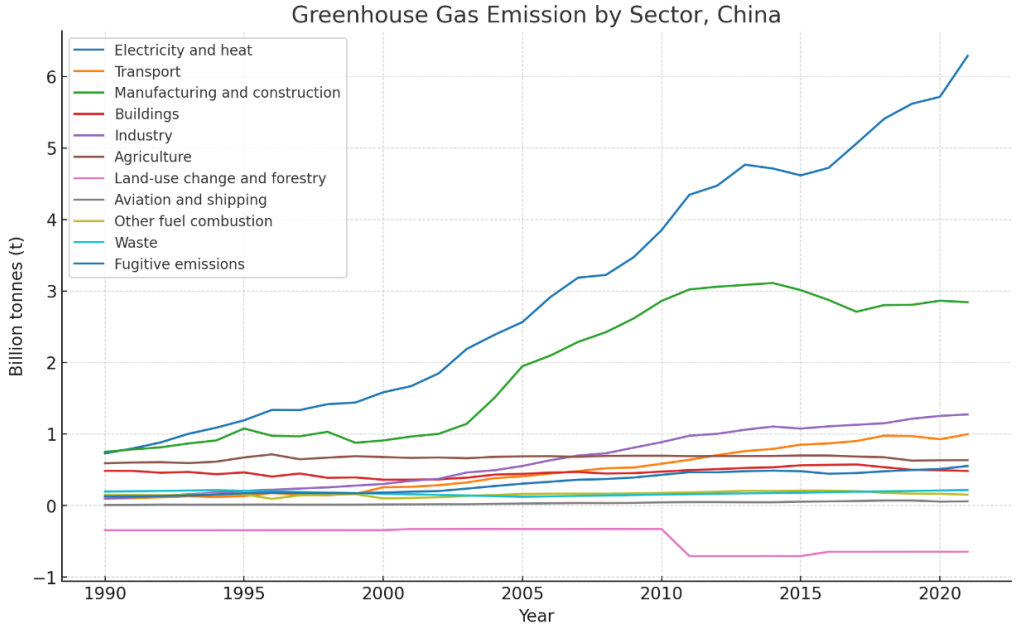

Figure 3. *China's GHG emission by sector. Source: Authors' computation using our World in data*

From the perspective of the first research question, how green supply chain practices can be reinvented to facilitate sustainability, the evidence suggests that addressing manufacturing-linked emissions requires interventions not only within the production process itself but also across upstream and downstream supply chains. Emissions associated with electricity and heat generation, for instance, feed directly into the carbon intensity of manufacturing, while waste management, fugitive emissions, and transport contribute indirectly to the footprint of industrial supply chains.

Manufacturing sustainability in China cannot, therefore, be disentangled from broader systemic reforms across related sectors. The second research question, which considers

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how environmental sustainability risks can be addressed through green supply chains, is equally illuminated by these findings. Both charts reveal risks that manifest in several forms: regulatory risks arising from China's tightening climate policies, reputational risks in global markets increasingly demanding low-carbon products, and operational risks linked to overdependence on carbon-intensive electricity and materials. These risks, if left unmitigated, threaten the long-term competitiveness of China's manufacturing sector in a global economy that is steadily shifting toward sustainable trade and low-carbon value chains.

The evidence points to several implications for industrial and environmental policy in China. The close linkage between electricity and industrial emissions underlines the urgency of accelerating the energy transition, with stronger incentives for renewable energy use and efficiency standards tailored to heavy-emitting industries such as steel, cement, and chemicals. At the same time, the rise in emissions from waste and other fuel combustion suggests the need for greater integration of circular economy principles, with emphasis on recycling, resource recovery, and reduced material intensity across supply chains. Equally important is the role of sustainable sourcing, as emissions are amplified by the extraction and processing of raw materials. Institutionalising green procurement policies and embedding supplier-level compliance with low-carbon standards would extend environmental accountability beyond factory gates and strengthen sustainability across the chain.

Transparency is also critical to managing environmental risks. Digitalisation of supply chain management through tools such as blockchain and artificial intelligence could enhance the traceability of carbon flows across production networks, enabling regulators and firms to optimise practices in real time. In addition, the charts reveal the importance of addressing emissions that lie outside manufacturing but nonetheless influence industrial sustainability, particularly agriculture, waste, and fugitive emissions. Stronger industrial symbiosis policies that link manufacturing firms with agricultural and waste sectors for instance, by converting by-products into industrial bioenergy, would not only reduce emissions but also support cross-sectoral resource efficiency.

These pathways reflect the broader imperatives of sustainable development. The integration of renewable and low-carbon technologies into industrial production is essential for advancing the Sustainable Development Goals, particularly those relating to industry, innovation, responsible consumption, and climate action. Achieving this requires the active engagement of stakeholders across firms, government, and society, alongside a regulatory environment that enforces coherence with China's dual carbon targets of peaking emissions by 2030 and achieving carbon neutrality by 2060. By embedding sustainability practices into supply chains, the manufacturing sector can also position itself more competitively in international markets shaped by carbon border adjustments and sustainability certification systems.

The trajectory of emissions, as revealed in both CO_2 and GHG datasets, demonstrates that China's manufacturing sector sits at the heart of the environmental sustainability challenge. Green supply chain practices represent a viable pathway to mitigate risks, reduce emissions, and enhance competitiveness. However, this transformation depends on the effective interplay of industrial policy, technological innovation, and collaborative governance. By reframing supply chains as vehicles of sustainability rather than vectors of emissions, China's manufacturing sector can transition from being a major source of environmental stress to becoming a cornerstone of the global sustainability agenda.

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Materials and methods

This study adopted a qualitative approach, using a conceptual review to explore the topic from the perspective of trends of finding ideas and arguments from extant literature. This was to develop an understanding of the practices of green supply chain management and the drive for environmental sustainability in the Chinese manufacturing sector. According to Heinonen and Gruen (2024), conceptual research anchors a process of scientific inquiry in an identified issue of interest, built on a theoretical foundation, to develop learning to address the identified issue in focus. They reckon that conceptual research provided a platform for the development of an in-depth understanding and provide the lens to the development of new theories for further learning based on the context under consideration.

Conceptual research basically centers on exploring and expanding ideas and findings from literature with the aim to develop a comprehensive understanding of the phenomenon of interest through a process of extensive review of existing research studies with the focus on addressing the identified problem in the context of current research (Nag and Ahmad Malik, 2023). The adoption of conceptual approach in this study was to provide a detailed analysis of complex business problems, on transparent process of due consideration of existing literature, aimed to develop a suggested model to address identified business problems (Namazi et al., 2023).

Researchers adopt several other approaches to address identified problems such as the impact of green supply chain management practices on environmental sustainability focused on in this study. For instance, the quantitative approach relies on collected quantitative data to test stated hypotheses to reach logical conclusion. The findings are duly reported for learning and decision-making aimed at improving existing practices. Sometimes, studies also adopt a mixed approach, which combines both the qualitative and quantitative approaches to explore a research topic and develop findings for improvement (Taherdoost, 2022; Ghanad, 2023).

However, the choice and adoption of a conceptual approach such as the conceptual review adopted in this study is justified by the intent to develop an in-depth understanding of the identified issues of interest- green supply chain practices and the drive for environmental sustainability. Conceptual research embraces the guiding effects of theories. Scholars note that theories provide a lens to explain the problem focused in a research process. This can have a wider implication of findings from research beyond the context under which the study was conducted (Crane et al., 2016). In this study, the adopted theory is presented in the next Section.

The relevance of systems theory

This study adopts systems theory to explore the topic. Systems theory is developed on the principles of structure of various parts that function on connected relationships towards stated purpose. Systems theory was adopted to provide a lens to understand the topic of green supply chain management practices and the impact on the drive for environmental sustainability in the Chinese manufacturing sector. Systems theory aided the study to view the conceptual from the perspective of the stakeholders who are either involved or affected in the process of green supply chain practices and the drive for environmental sustainability (see Ufua et al., 2018).

In the literature, studies have adopted other theoretical underpinnings to explore green supply chain management in China. For instance, Yu et al. (2017); and Shibin et al.

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(2020), adopted the resources based and found that collaboration among partners and stakeholders was relevant to the development of knowledge skills needed for effective green supply chain management practices that can facilitate environmental sustainability, especially in critical sectors such as manufacturing focused on in this study.

Other studies also consider adaptive learning theory which uses a non-marginalization approach to learning, that combines the use of technology and methodologies to develop learning about a phenomenon of interest and prompts improvement based on the identified gaps and preference of the stakeholders involved in the process (see Wang et al., 2019; Rachmad, 2022). Systems theory is adopted to develop a suggested model based on the interest of the stakeholders who are involved to develop model for improvement on existing practices of green supply chain in the Chinese manufacturing sector. Systems theory provides a platform for a collaborative approach that can help stakeholders identify and address risk in a common course of interest (Can et al., 2021; Cabrera et al., 2022). Systems theory supports the adoption of an evaluation of operational process to enhance an improvement drive that meets the expectations of the stakeholders. In this study, systems theory is adopted to guide the re-evaluation of various ideas and findings from literature to develop an improvement approach to effective green supply chain management and the drive for environmental sustainability (Jackson, 2023).

Selection of literature

The study only considered published literature that were either in retrievable form in online sources or hard copies. All sourced relevant literature for consideration from multiple search engines. These included SCOPUS, the authors' institutional and personal libraries, Google Scholar. Other sources considered were journal web pages such as Springer, Emerald, and other relevant Web reports. The selection of literature was further guided by factors such as the keywords selected in this study, and the key variables focused on in this study. For ethical reasons, all selected literature was duly cited and documented following APA referencing style. The selected literature was subject to further screening to validate their relevance to this study presented in *Table 1*.

Table 1. *Criteria for literature selection*

Criteria for Selection	Criteria for Exclusion
Selected literature must align with the keywords adopted for this study.	Any literature outside the focus of the study was not selected.
Selected literature must be published.	Unpublished literature materials were not selected.
The abstract and content must align with the focus of this study.	Any literature not relevant to this study was not selected.
The materials must be significantly recent.	Extant literature that were older than 2014 were excluded to maintain the recency of the argument presented in the study.
The background location base focused in the selected literature were mainly from China, or emerging economy.	Except for comparative argument, the study excluded literature from the developed world backgrounds

Source: Authors' compilation

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Results

Development of suggested model for improvement

The findings from extant literature guided the development of a suggested model for improvement on existing practices of green supply chain management and the drive for environmental sustainability in the Chinese manufacturing sector. The suggested model presented in *Figure 4* detail factors for improvement on existing practices. These are further discussed in the subsequent section.

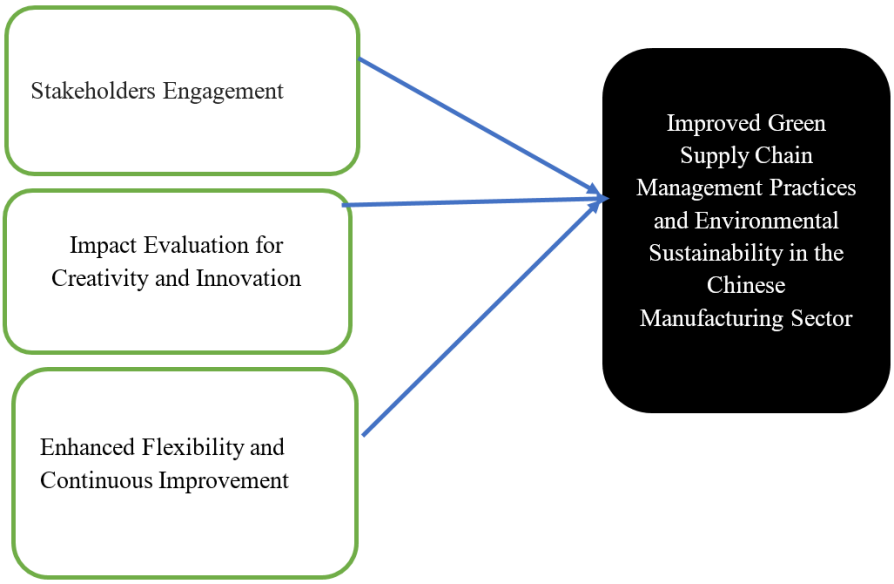

Figure 4. *A suggested model for improved green supply chain management practices and environmental sustainability in the Chinese manufacturing sector. Source: Authors' compilation*

Further discussion

Stakeholders engagement

Stakeholder engagement is fundamental to effective green supply chain management practices in the Chinese manufacturing sector. These are partners who either participate in or are affected by green supply chain management practices. This comprises the deliberate consideration of the interest and involvement of the relevant stakeholders in the green supply chain management practice, in relation to the drive for a sustainable environmental practice. Extant literature upholds the impact of stakeholders (see Ufua et al., 2022). For instance, Wu and Li (2020) found that stakeholder engagement theory supports partner social responsibility in the process of commitment to green supply chain innovation performance and knowledge transfer for awareness about green supply chain practices and environmental sustainability, especially in critical operational sectors such as manufacturing focused on in this study.

Other observers support this claim with the submission that stakeholder engagement can facilitate awareness and commitment to the expectations in terms of joint supply chain management actions towards environmental sustainability while pursuing their green supply chain management practices. Chinese green supply chain organizations and partners strive towards their corporate reputation through minimization of waste,

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reductions in carbon footprint, and enhancement of operational cost efficiency. However, scholars argue that the engagement of stakeholders and partners can provide a platform for navigating the intersection of environmental responsibility and enduring profitability especially in the manufacturing sector, focused in this study (see Deng et al., 2021; Sahen et al., 2025; Liu et al., 2024).

The stakeholder engagement in green supply chain management practices coincides with systems theory adopted in this study. It emphasizes the connectivity that defines the relationships and actions among green supply chain partners in the Chinese manufacturing sector. Systems theory highlights the expression of interests, opinions, and contributions towards identified goals such as the drive for sustainability through effective green supply chain practices (see Schneider et al., 2017; Norris et al., 2025). Systems theory affirms that such connectivity promotes acceptable creativity and innovation among partners on a platform of agreement to a common course of pursuit such as the focus on green supply chain management practices and environmental sustainability. It also thrives on the development of boundaries that define what issues are relevant and their extent of consideration among partners, which also facilitate effective measurement of commitment and overall performance in the process of pursuing set objectives (see Ufua, 2020; Lilley et al., 2022; Midgley, 2023).

Furthermore, observers explain that effective stakeholder engagement can enhance the drive for China's efforts to adhere to global ecological standards through a broad collaborative effort by the stakeholders, especially from the critical sectors in the Chinese economy such as manufacturing focused on in this study (Xie et al., 2022). The argument of this study is that stakeholder engagement can enhance decision-making that reflects the context of green supply chain practices in the Chinese manufacturing sector.

Scholars explain that effective stakeholder engagement can underscore the strive for a balance between environmentally sustainable corporate practices, while pursuing business activities, coupled with compliance with regulatory standards and the making of environmental policy procedures (Gao et al., 2021; Xin, 2024). This is arguably suitable due to the involvement of the stakeholders involved with green supply chain management and the drive for environmental sustainability (see Li et al., 2020; Bernardelli, 2021). This narrative projects an integrative use of stakeholder engagement as a fundamental strategy to support effective green supply chain practices that can enhance environmental. This also provides a significant platform for evaluation of the impacts of decisions and actions taken towards the pursuit of project in the Chinese manufacturing sector. This is presented in the next subsection.

Impact evaluation for creativity and innovation

Effective stakeholder engagement in green supply chain management and environmental sustainability requires evaluation of the impacts on the environment and the supply chains in the Chinese manufacturing sector. The implementation of green innovation requires the integration of both the internal and external structures that shape operations of organizations in the Chinese manufacturing sector. This underscores the development of green innovation to address the residual challenge of environmental sustainability. These scholars reckon that evaluation refocuses the attention of the affected stakeholders to raising the important question, what worked well and what did not or what needs improvement (Liu et al., 2021; Sun and Sun, 2021).

The argument of this study is that impact evaluation can enhance optimum utilization of resources and stakeholders' commitment to effective green supply chain practices that

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focus environmental sustainability. Liu et al. (2024) highlight the responsibility of stakeholders, especially green supply chain partners in the Chinese manufacturing sector, to embrace the responsibility to maintain accountability in their commitment to environmental sustainability and ensure an 'un-breached' compliance to extant rules of engagement and improvement in their green supply chain practices. This study argues that evaluation can position the stakeholders to also embrace learning that positions them to the drive for improved green supply chain management practices a common pursuit among partners and practitioners in the Chinese manufacturing sector.

According to Li et al. (2022), impact evaluation is a yardstick to measure the amount of creativity and innovation adopted by stakeholders, needed for effective green supply chain practices. This facilitates the quest among green supply chain partners to address the inherent challenges associated with their operations, especially in the Chinese manufacturing sector which projects a steady trend of growth, resulting in operational waste generation. Impact evaluation, therefore, becomes a veritable to ascertain the level to which green supply chain management has address the challenges of environmental waste management and sustainability and raises the question what can be done better to continuously mitigate the impact of operational activities in the Chinese manufacturing sector on the environment?

The argument of this study is that impact evaluation has the intrinsic potential to support efficiency in the quest to address critical environmental risks posed by the operations of manufacturing firms and their partners in China on the long run. This is achievable through a process of continuous innovation and the drive to develop suitable approaches to practicing green supply chain management and the engagement of the affected stakeholders and partners towards optimum environmental sustainability. This implies that impact evaluation and environmental sustainability is a wide sectoral project that requires the contributions of green supply chain partners and critical support in terms of information that can enhance positive response to change signal across green supply chains in the Chinese manufacturing sector.

This narrative on impact evaluation validates the adoption of systems theory which supports a structural alignment and complex inter-functional practices among supply chains in the Chinese manufacturing sector. For instance, Yin et al. (2021) suggest the adoption eco- friendly innovation along supply chains can be achieved through processing, output, feedback and upgrade, coupled with improved regulatory procedure to provide the needed environmental sustainability in the Chinese economy. The argument of this study is that effective regulatory function can harness the integrity of all stakeholders in the entire ambience of green supply chain management practices and the drive for environmental sustainability in the Chinese manufacturing sector.

Similarly, Xu et al. (2023), while acknowledging the complex reality of green supply chain practices in the Chinese manufacturing sector, they suggest the adoption of g transform for effective green supply chain and environmental sustainability. They explain that digital transformation can facilitate a procedure to enhance the implementation of eco-friendly innovation that can support real-time improvement of environmental sustainability. However, scholars explain that the adoption of innovative packages such as digital transformation requires green learning initiatives among affected stakeholders to equip them with relevant information on how to adapt and comply to the digital transformation process. This has the potential to enhance their contribution to environmental sustainability while pursuing their operational objectives (see Ufua et al., 2021; Pham et al., 2023).

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Enhanced flexibility and continuous improvement

The embrace of flexibility and continuous improvement on existing approaches to green supply chain management and environmental sustainability. Flexibility in this context allows the stakeholders to identify various optional approaches to the practices of green supply chain management and positions them to make effective hybrid decisions to address the objectives of optimum green supply chain and environmental sustainability (see Edwin Cheng et al., 2022). Ye and Lau (2022), in their study opine that critical supply chain practices such as flexibility and improvement drives can enhance transformation towards environmental sustainability that can also facilitate long-term cost minimization, through a seamless process of efficient innovation and creativity.

Scholars hinge the drive for flexibility and continuous improvement on the practicing organizations and green supply chain partners to embrace the responsibility to develop flexibility dimensions along their supply chains in reflection to their green initiatives, covering practices such as green purchasing, and manufacturing procedures, in alignment with environmental sustainability (Liu et al., 2019). This implies that while flexibility and improvement in green supply chain practices can provide a suitable lens for operational effectiveness and environmental sustainability, it requires the participative commitment and collaboration of partners to implement. This is corroborated by the findings of Li et al. (2020) who suggested the flexibility and improvement on green supply chains must commence from the internal operational structure of the practicing organizations that can exemplify the model flexibility practice for external partners to assume in their contributions towards improvement that can facilitate environmental sustainability. They argue that effective internal flexibility has the intrinsic potential to enhance the collaboration of partners in assuming their roles to support the development of acceptable improvement on existing green supply chain practices, They also note that this can predicate a significant guidance, especially to umpire stakeholders, such as government agencies in the process of developing suitable policies and rules of engagement in the Chinese manufacturing sector, focused in this study (Ufua et al., 2021; Shang et al., 2023).

This discussion on flexibility and improvement aligns with the adoption of systems theory underpinning this study. This can provide a collaborative platform among green supply chain partners that can facilitate the identification of risk and obstructions to green supply chain practices and environmental sustainability. The argument of this study is that effective systems theory can transform from manufacturing waste and chaotic situation to environmental sustainability, through a concerted process of flexibility and the drive for improvement on existing practice. Systems theory provides a fair platform to explore and exploit the instrumentality of flexibility and improvement on existing green supply chain practices with minimal chance for marginalization of partners' interest. This study argues that this can enhance the willful contribution among partners to the pursuit of sustainable environment in the Chinese manufacturing sector (see Jackson, 2020, 2021; Ison, 2023).

Theoretical and managerial implication

The findings of this study provide critical implications that portray both theoretical and managerial impacts. The findings redirect the attention of practicing managers and organizations in the Chinese manufacturing sector to recognize the interest and commitment of affected stakeholders in the practice of green supply chains and the drive for environmental sustainability. The study validates the need to consider the interest of

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these stakeholders beyond the linear relationships along supply chains to include the relevant stakeholders that can offer significant support to the intention to drive green supply chain and environmental sustainability. This underscores the relevance of wider stakeholder engagement which facilitates the development of a comprehensive solution to identify issues of interest in an intervention such as green supply chain practices and environmental sustainability. This implies that acceptable commitment and collaboration can be achieved through the adoption of a structure for engagement with these stakeholders in the process, which can enhance productive idea development and commitment to implementation for effective supply chain management and environmental sustainability. However, while the engagement of these stakeholders can be slow, the decision and actions reached are usually validated by their commitment to implementation (Ufua et al., 2018).

The adoption of systems theory created a learning about the connectivity and effects of adopting the interactions with stakeholders who are either affected or involved with the practice of green supply chain and environmental sustainability in the Chinese manufacturing sector. This offered a precautionary platform for the consideration of decisions and actions among partners to address issues such as marginalization while pursuing green supply chains and environmental sustainability. Systems theory also embraces the impact of evaluation of adopted green supply chain practices with the aim to validate and improve on the current practices in the Chinese manufacturing sector.

Conclusion

This study focused on green supply chain and environmental sustainability in the Chinese manufacturing sector. While the study acknowledged the challenges of manufacturing waste and its adverse effects on the environment, it relied on literature to develop a suggested model for improvement on green supply chain practices to enhance environmental sustainability. Among the elements suggested in the model are stakeholder engagement, impact evaluation, flexibility, and continuous improvement. The study concludes with the argument that these can be implemented to further enhance effective green supply chain and environmental sustainability in the Chinese manufacturing sector.

However, while the study adopted systems theory to explore the topic, relying on existing literature and focusing on the Chinese manufacturing sector, it recommends that further studies can consider a mixed method approach combining both quantitative and qualitative approach to further explore the topic. This would facilitate consolidated learning that can further portray findings to help affected stakeholders and supply chain partners with the necessary awareness which can equip them to make more informed decisions that reflect the drive for environmental sustainability in the Chinese manufacturing sector. Further study can also focus on the impact of green supply chain in other sectors such as services in that also function in the Chinese economy. This is because they function and contribute to the Chinese economy which leaves them with the responsibility to contribute to environmental sustainability in China.

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