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Research article

The relationship between entrepreneurial energy efficiency orientation and carbon footprint reduction: The mediating role of green networking and identification of barriers to green practices

Douglas A. Adu [a], Xihui Haviour Chen [b,*], Mudassar Hasan [a], Xiaoxian Zhu [c], Nugun Jellason [c]

[a] Department of Finance, Performance and Marketing, Sustainable Finance Research Group, Teesside International Business School, Teesside University, Tees Valley, UK
[b] Edinburgh Business School, Heriot-Watt University, Edinburgh, UK
[c] Department of Leadership, Management and Human Resource, Teesside International Business School, Teesside University, Tees Valley, UK

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ABSTRACT

Motivated by the growing attention to climate change and the crucial role businesses could play in reducing greenhouse gas emissions, this study investigates entrepreneurial energy efficiency orientation in the context of carbon footprint reduction initiatives of small-and medium-sized enterprises (SMEs). We enhance understanding of the climate change action of SMEs by taking into account the mediating mechanisms (i.e., identification of green barriers and green networking) through which firm entrepreneurial energy efficiency orientation leads to superior carbon footprint reduction initiatives by overcoming barriers to green practices. A survey of 252 SME owners and top managers in the Tees Valley region, Northeast England, supported the direct impact of entrepreneurial energy efficiency orientation on overcoming barriers to green practices and the mediating role of identification of green barriers and green networking in this focal relationship. These findings reveal the importance of entrepreneurial energy efficiency orientation, identification of green barriers and green networking in helping SMEs overcome barriers to green practices and improving carbon footprint reduction initiatives.

1. Introduction

Global climate change resulting from greenhouse gas (GHG) emissions is currently a top concern for businesses, governments, and other stakeholders (Orazalin et al., 2023; Adu, 2022). Over the past two decades, climate change has also received increasing attention from academics, professionals, regulators and environmental activists (Adu et al., 2022a; Haque and Ntim, 2020) and has assumed a leading spot in business, political, and economic agenda (Orazalin et al., 2023). In the United Kingdom (UK), the Office for National Statistics (ONS) reports that GHG emissions from businesses are yet to abate significantly (ONS, 2021). This is amidst concerns about limiting GHG emissions in the UK in line with the Paris Agreement's net zero target of decarbonising all sectors of the UK economy by 2050 (UNCCC UN Climate Change Conference, 2021).

Small and medium sized enterprises (SMEs) make up the bulk of businesses worldwide (Organisation for Economic Co-operation and Development, 2017). SMEs represented 99% of all enterprises and generated an average of 70% of jobs in 2015 in the European Union, accounting for 45% of total employment (OECD, 2017). Although the studies on SMEs' management and economics have received much attention, little is known about how these businesses behave regarding the transition towards low GHG emissions (Bartolacci et al., 2020). In particular, SMEs have not previously featured prominently in public policy discourses on the GHG emission reduction agenda despite the sector's potential to contribute to driving down GHG emissions (e.g., Barrett et al., 2018). Considering the GHG emissions of SMEs in policy discourses is pertinent because about 60% of all GHG emissions and 70% of global pollution are attributed to SMEs (European Commission, 2010). For instance, it is estimated that SMEs are accountable for

* Corresponding author.
E-mail addresses: d.adu@tees.ac.uk (D.A. Adu), Xihui.chen@hw.ac.uk (X.H. Chen), m.hasan@tees.ac.uk (M. Hasan), x.zhu@tees.ac.uk (X. Zhu), n.jellason@tees.ac.uk (N. Jellason).

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60–70% of European industrial pollution (OECD, 2017).

The UK presents a unique context for this study because of its legislative agenda to achieve the reduction of net emissions of GHG to 100% by 2050 amidst the increased number of SMEs in this domain generating a high level of emissions (ONS, 2021). In the UK, SMEs constitute 99% of the businesses, generating about 60% of commercial waste (ONS, 2021) and contributing about half of the UK's total industrial emissions (British Business Bank, 2021). Pursuing a greener economy and a more sustainable planet depends heavily on SMEs' responsible behaviour, particularly regarding their environmental footprint (Afolabi et al., 2023; Crossley et al., 2021). Thus, climate and sustainability practices among SMEs have recently been the subject of a global movement and rapid accountability demand from multi-stakeholders, including governments, especially in the UK (Afolabi et al., 2023; Adu et al., 2023a). To become the first major economy in the world to enact rules requiring all GHG emissions to be zero by 2050, the UK government revised the Climate Change Act 2008 in 2019 (HM Government, 2019). In addition, the UK government established six carbon budgets under the independent climate change committee's recommendations,[1] with the sixth budget encompassing a short-term goal of lowering emissions by 78% by 2035 compared to 1990 levels (HM Government, 2021; Climate Change Committee, 2022). Accordingly, based on the Climate Change Act 2008 (2050 target amendment), the UK's climate action change broadly entails actions to encourage cleaner alternatives in energy supply, to reduce carbon emissions, to promote corporate reporting of carbon emissions, and to support energy efficiency and climate action abroad (HM Government, 2022). The UK government has also introduced other policy initiatives to encourage UK businesses to move towards a greener economy, such as the fuel duty tax, the climate change levy (to be paid by polluters in the business sector on every unit of energy consumed), the energy company obligation, and contract for difference (Afolabi et al., 2023).

The measures mentioned above demonstrate the UK government's unwavering commitment to the net zero emissions target and ambition for businesses to embrace sustainability. However, the regulatory landscape and rules favour larger companies (Afolabi et al., 2023; Adu et al., 2023b; Chaudhry et al., 2023). Notably, it may be argued that the carbon policies relevant to SMEs are essentially normative, notwithstanding the certainty that is currently available about the carbon emissions targets (Afolabi et al., 2023). Although there is a possibility that SMEs will soon be subject to mandatory climate-related financial reporting (HM Government, 2021), the government's current initiatives for SMEs are based on voluntary interventions and an appeal for SMEs to participate in various actions to combat climate change and reduce carbon emissions (e.g., Afolabi et al., 2023; Adu et al., 2022a). Accordingly, exploring SMEs' behaviour and perspectives in this context remains an appropriate focus issue and is the research's foundation. This is because of the prominence of climate change, the direction of UK government policy, and the significant role SMEs need to play based on their environmental footprint (Afolabi et al., 2023).

Scholarly interest in entrepreneurial orientation (EO) has steadily grown over the past 30 years (Covin and Wales, 2019),. EO is defined as the willpower to innovate, take risks and have a proactive attitude regarding marketplace opportunities (Rauch et al., 2009). In this context, entrepreneurial energy efficiency orientation (EEEO) has gained momentum, mainly due to rising energy bills and climate change initiatives across the globe. EEEO refers to the strategic posture of a firm regarding decision-making activities and initiatives that result in a substantial reduction in energy usage. In this regard, EEEO plays a crucial role because engaging in energy-efficient operations requires an entirely different outlook and a business model that improves the ability of the firm to make a paradigm shift in its operations. At the same time, carbon footprint reduction (CFR) among SMEs continues to attract the attention of academics and policymakers due to the acceleration of climate change (Adu, 2022).

Gaps exist in the literature on the impact of EEEO on CFR. A more significant chunk of the historical literature has examined barriers to green practices among SMEs (Gupta and Barua, 2018; Mangla et al., 2017; Longoni et al., 2014; Mathiyazhagan et al., 2013; Horbach et al., 2012; Mudgal et al., 2010), without exploring mechanisms that may help the firms to overcome these barriers. This has limited our understanding of how SMEs may contribute towards combating climate change through GHG emission reduction initiatives. At the same time, whereas the prior literature has examined the impact of EO on various organizational outcomes such as international performance (e.g., Karami and Tang, 2019; Gupta and Batra, 2016), limited attention has so far been paid to the impact of EEEO on CFR.

We attempt to bridge the gap in the literature by surveying SMEs in the UK to investigate the channel through which EEEO can help SMEs to overcome barriers to green practices and improve their CFR. First, we examine the interrelationships among EEEO, identification of green barriers (IB), green planning (GP), green networking (GN) and the selection of green innovation approaches (GI). Second, the study investigates the associations among IB, GP, GN, GI and CFR. Finally, we distinctively explore the mediating roles of IB, GP, GN and GI on the association between EEEO and CFR. Accordingly, in this paper, we investigate how EEEO as a posture-based entrepreneurial strategic orientation (Karami and Tang, 2019; Lumpkin and Dess, 1996) can help SMEs overcome barriers to green practices and improve their CFR through IB, GP, GN and GI.

Our comprehensive analyses are informed by theoretical insights from a multi-dimensional neo-institutional theory (NIT) that integrates legitimisation and efficiency perspectives (Haque and Ntim, 2020). In this regard, NIT maintains that SMEs' response to institutional forces may be influenced by two motives: legitimisation (social/symbolic perspective) and efficiency (economic/substantive perspective) (Meyer and Rowan, 1977). These forces, which can be normative (worldwide norms), cognitive/educative/mimetic (learning from or copying others), or regulative/coercive (government rules) in nature (Chen et al., 2023), frequently result in isomorphic or similar structures/behaviour (Powell and DiMaggio, 1991). Accordingly, SMEs may symbolically comply with such institutional forces to acquire (extend), maintain (keep), and restore (defend) organizational legitimacy (O'Keeffe et al., 2016; Purwandani and Michaud, 2021; Zhu et al., 2012a). In this case, SMES may pretend to engage in GHG emission reduction practices to improve their profitability and protect owners' interests mainly, but such symbolic gestures may not lead to enhancement in actual CFR (reductions in GHG emissions) (Adu et al., 2022a; Haque and Ntim, 2020). By contrast, and from the efficiency (substantive/economic) view of NIT, SMEs are more likely to initiate economically (substantive) efficient/cost-effective CFR-related practices that may consequently improve both their profitability and actual GHGs emission reduction. The subsequent substantive improvements in CFR (Haque and Ntim, 2020; Ntim and Soobaroyen, 2013) will serve the interests of SME owners, managers, humanity and the environment at large (Haque and Ntim, 2020). In this case, NIT theoretical perspectives suggest that UK SMEs exposed to different stakeholder pressures and environmental regulations through EEEO can employ IB, GP, GN and GI as channels for enhancing CFR that may (i) improve reputation and maintain legitimacy (Adu et al., 2023a; Haque and Ntim, 2020; Burke et al., 2019) and/or (ii) substantively reduce carbon footprint through improved efficiency and reduced operating costs (Adu et al., 2022a; Orazalin et al., 2023).

In doing so, we sample 252 SMEs across the Tees Valley region in the UK. We employ the structural equation modelling (SEM) approach in our analysis. The study shows that EEEO positively affects IB, GP, GN and CFR. Further, our findings reveal that IB and GN are positively

[1] The independent climate change committee is a statutory body, set up under the climate change Act 2008 and saddled with the responsibility to advise the UK and devolve government on the UK's progress in tackling climate change (Climate Change Committee, 2022).

associated with CFR, whilst GP and GI have no effect on CFR. Next, we show that the relationship between EEEO and CFR is contingent on IB and GN capabilities. By contrast, GP and GI do not mediate the link between EEEO and CFR. Thus, we identify IB and GN as channels interlinking EEEO and CFR.

Identification of green barriers is primarily concerned with how SMEs may explore and address the various barriers to green innovation in their operation (Gupta and Batra, 2016). In particular, Gupta and Barua (2018) observe that SMEs face numerous barriers to implementing green innovative practices. We make a strong case for SMEs to identify, address, and overcome these barriers. Next, planning refers to a series of actions that facilitate achieving goals (Greene and Hopp, 2017; Hopp and Greene, 2016; Van Oijstaeijen et al., 2020). In this context, if SMEs lack planning capability, their efforts to overcome barriers to green practices will be in vain (Adu, 2022). From the CFR perspective, GP can play a crucial role in terms of entrepreneurial characteristics and green practices' success. Green networking refers to processes that enhance the exchange of ideas on green practices (Adu, 2022). In this regard, GN entails processes and mechanisms that can reduce energy consumption and improve operational efficiency. Firms can succeed in overcoming barriers to green practices through GN as it enables the firms to share and receive best green practices quickly in a highly dynamic business environment. The selection of green innovation approaches refers to the processes and channels firms adopt in the innovative and green practices section. Due to the barriers and complexity of green practices (Adu et al., 2023a; Orazalin et al., 2023; Haque and Ntim, 2020), firms must select the most appropriate and cost-effective green approaches as these can have critical implications on how the firms can overcome barriers to green practices with beneficial impact on CFR.

Our study makes several new contributions to the extant SMEs' carbon footprint literature. The unique contribution of this study is that it is the first study to examine the effects of EEEO on IB, GP, GN and GI in a combined framework. Whilst the prior research has primarily looked at the association between green innovation and carbon footprint (Bai et al., 2019; Robinson and Stubberud, 2013), there has been limited research on the value relevance of EEEO. Our findings show that EEEO positively impacts IB, GP, GN and GI. Our results should motivate owners and managers of SMEs in the UK to embrace and actively learn energy efficiency ways in their business operations as these have been established to boost the firms' IB, GP, GN and GI.

Second, to our knowledge, our study is one of the early studies investigating the influence of IB, GP, GN and GI on CFR. Our findings suggest that IB, GP, GN and GI directly impact CFR. While research on climate change is steadily increasing, there's a lack of exploration into how IB, GP, GN, and GI collectively impact CFR. Previous studies have primarily focused on identifying these variables in SME initiatives rather than investigating their influence on CFR (e.g., Gupta and Barua, 2018; Mangla et al., 2017; Dubey et al., 2015; Mathiyazhagan et al., 2013). Some highlighted issues include the absence of reward systems for green innovations (Gupta and Barua, 2018), limited commitment from SME entrepreneurs (Mathiyazhagan et al., 2013), and reluctance to adopt green practices (Zhu et al., 2012a, 2012b). Additionally, factors like insufficient human resources for green innovation (Collins et al., 2007), a lack of training programs for green innovation (Mangla et al., 2017; Longoni et al., 2014), and inadequate access to government subsidies and financial incentives (Hojnik and Ruzzier, 2016) have been identified. Furthermore, issues such as limited bank support for green practices (Mathiyazhagan et al., 2013) and knowledge sharing and transfer (Yao et al., 2019) have been reported. However, the indirect and causal aspects of these relationships remain understudied, and our research fills this gap.

Additionally, previous research has explored IB, GP, GN, and GI's effects on various business outcomes (e.g., Karami and Tang, 2019; Yao et al., 2019; Abdullah et al., 2016; Chilamkurti et al., 2009). For instance, Karami and Tang (2019) found that networking capability benefits SMEs' international performance in New Zealand. Chilamkurti et al. (2009) showed GN's role in reducing the carbon footprint of the ICT industry. Yao et al. (2019) highlighted trading and GN's positive impact on emissions reduction in Chinese SMEs. Other studies noted the positive influence of GN on innovation and performance (Wang and Wang, 2012; Du et al., 2007), while Abdullah et al. (2016) emphasized GI's role in promoting green products among Malaysian SMEs. However, none of these studies have explored IB, GP, GN, and GI's effects on CFR. Our research addresses this gap by enhancing our understanding of how IB, GP, GN, and GI influence CFR. The results indicate that the UK government and regulators should pay more attention to identifying barriers, planning and selecting green initiatives challenges that confront SMEs, and encouraging green knowledge sharing among SMEs. For example, the regulators can organise regular energy efficiency and CFR workshops/training to equip and enhance owners and managers of SMEs with IB, GP, GN and GI capabilities. In particular, IB, GP and GI can boost the SMEs' ability to explore energy-efficient ways of production, which could lead to savings from energy bills and increase the firm's profitability. The regulators may help solve SMEs' carbon emissions problem by promoting these factors. As Karami and Tang (2019) recommended, SME owners and managers should be vigilant in identifying new GN ties in domestic and overseas markets to increase their access to vital information and other complementary resources.

Finally, our study is the first to examine the mediating role of IB, GP, GN and GI on the association between EEEO and CFR. Methodologically, despite increasing research on IB, GP, GN, and GI in SME environmental initiatives, there's limited empirical evidence on their influence on the EEEO-CFR relationship (Adu, 2022a; Al-Ghazali et al., 2022; Yao et al., 2019). For instance, Yao et al. (2019) explored knowledge sharing and emission trade's impact on carbon emissions reduction in Chinese SMEs. Al-Ghazali et al. (2022) investigated green transformational leadership and green organizational identity's effect on green creativity in Pakistani SMEs. However, no study has examined whether IB, GP, GN, and GI mediate the EEEO-CFR relationship. Our study fills this gap by analysing IB, GP, GN, and GI's role in SMEs' carbon emissions reduction performance. Our findings indicate that IB and GN positively mediate the EEEO-CFR relationship, whereas GP and GI do not mediate the EEEO-CFR nexus. To that effect, our results demonstrate that IB and sharing green networking capabilities with other SMEs, partners, suppliers, regulators, and other stakeholders are crucial mechanisms that can help SMEs in the UK overcome barriers to green initiatives and improve their CFR. In this regard, IB and GN can thus be considered valuable resources. Hence, it would be beneficial for owners and managers of SMEs to take full advantage of their existing relationships by developing regular green practices conversations with their associates (Karami and Tang, 2019). This will enable the ongoing growth of their current resources and the flow of green practices information and knowledge required to improve operational efficiency and CFR. In particular, given the relative importance and the role of GN in helping SMEs overcome barriers to green SMEs and CFR, the UK government and regulators should consider developing SMEs' GN platforms to promote the sharing of best green practices among the firms. This can either be a website, an App, or any other platform for discussing energy efficiency issues. Furthermore, regulators and the UK government may set up an annual Green Award Scheme for SMEs and their employees who make outstanding contributions to the green SMEs agenda to recognise excellence.

The rest of this paper is organized as follows. Section 2 provides the study's background. Section 3 presents the theoretical framework, followed by a review of prior studies and hypotheses development in Section 4. Section 5 explains the research methodology. Section 6 presents the results, and Section 7 concludes.

2. Carbon footprint reduction initiatives around the world

Increasing issues over rising GHG emissions levels globally have led

the international community to respond to carbon footprint and global warming by undertaking different initiatives and reforms (Orazalin et al., 2023; Adu, 2022; Haque and Ntim, 2020). The first global effort to tackle carbon footprint and global warming was initiated by the United Nations Framework Convention on Climate Change (UNFCCC), in 1992 following the Rio Earth Summit, which became binding in 1994 (Orazalin et al., 2023). Climate scholars largely maintain that the UNFCCC was unsuccessful in addressing the rising levels of GHG emissions globally (Orazalin et al., 2023; Gills and Morgan, 2020).

In 1997, the Kyoto Protocol (the first worldwide treaty) was adopted as an extension of UNFCCC (Orazalin et al., 2023). The Protocol is a legally binding global pact that requires ratified nations to improve their energy efficiency to reduce carbon footprint and global climate disruption (Adu et al., 2022a). To implement the Protocol, European countries, including the UK, adopted several climate change laws and policies (European Commission, 2015). In particular, the UK has taken considerable steps to conform with the "Kyoto Protocol" by passing the Climate Change Act (CCA) in 2008 (DECC, 2015). The first budget started in 2008 and ended in 2012, and the last budget will run from 2023 to 2027 (DECC, 2015). The CCA specified four mandatory "carbon budgets" collectively aimed at carbon footprint spread over 5-year consecutive periods (DECC, 2015). In 2015, the Paris Climate Agreement was instituted to replace the Kyoto Protocol. The main goal of the Paris Agreement is to keep the rise in mean global temperature well below 2 °C (3.6 °F). To achieve this, the agreement required each country to prepare and maintain nationally determined contributions to minimise GHG emissions and accelerate climate change adaptation (Orazalin et al., 2023).

In 2009, the Department for Environment, Food and Rural Affairs (DEFRA), acting on behalf of the UK government, issued guidelines on reporting carbon footprint reduction. The objective was to compel UK firms to create a commercial awareness of carbon footprint and to limit their contribution to GHG emissions, thereby reducing global warming. Some scholars maintain that firms are steadily responding to these concerns by reducing GHG emissions and adopting various carbon reduction initiatives in areas such as energy consumption, recycling, use of water and biodiversity initiatives (Adu et al., 2023a; Haque and Ntim, 2020; Haque, 2017). Additionally, the firms are to extend their carbon reduction initiatives by demanding that their supply chain partners also commit to reducing GHGs by employing technological solutions to minimise their carbon footprint and other forms of pollution (Chen et al., 2023; Haque, 2017; Li et al., 2015). Thus, increasingly green practices and carbon footprint reduction initiatives are becoming crucial in decision-making in the UK. Consequently, this study seeks to explore how EEEO of SMEs operating in the UK can help the firms to overcome barriers to green practices and ultimately respond to climate change risks/threats through improved carbon footprint reduction (CFR).

3. Theoretical framework

As we explore the relationship among entrepreneurial energy efficiency orientation (EEEO), identification of barriers to green practices (IB), green planning (GP), green networking (GN), selection of green innovation approaches (GI) and carbon footprint reduction (CFR), we deem it appropriate to draw insights from neo-institutional theory (NIT) framework to inform our analysis. The neo-institutional theoretical perspective defines the concept of 'institution' as economic and social practices, beliefs and norms concerning various aspects of the society (law/politics/religion) that are universally accepted (Powell and DiMaggio, 1991). In this regard, 'economic institutions' can be categorized into formal (rules or statutes) or informal (conventions or norms) (Haque and Ntim, 2020). Based on these arguments, some scholars argue that the main objective of economic institutions of firms is to increase economic growth (Doğan et al., 2020; Ntim and Soobaroyen, 2013). The implication is that NIT can explain the actions of institutions or firms (Adu et al., 2022a).

First, the economic NIT perspective is primarily concerned with economic efficiency (Ntim and Soobaroyen, 2013). Discernibly, economic NIT perspective arguments are consistent with agency and resource dependence theories that economic institutions (firms/organizations) should focus on maximizing their own interests at the expense of other groups by competing with them for limited resources.

Second, Powell and DiMaggio (1991) extended NIT by focusing on institutional pressures that can force firms to seek economic efficiency and social legitimacy. We identified coercive or regulative, educative or mimetic, and normative forces as the three main pressures. Coercive or regulative institutional pressures denote the presence of institutions that can compel firms to conform to accepted standards (government laws/regulations) (Powell and DiMaggio, 1991). Educative or mimetic institutional pressures denote firms' tendency to copy their peers' behaviour (the process of voluntarily learning and sharing best practices) (Haque and Ntim, 2020; Powell and DiMaggio, 1991). Finally, normative pressures denote widely anticipated and accepted standards of social behaviour (international norms or practices) (Powell and DiMaggio, 1991).

In this case, NIT suggests that firms set norms, rules and practices for the employees of the firms to conform. The theory asserts that the differences in norms, rules, practices, environments and necessities may explain the differences in engagement of carbon footprint reduction initiatives. The theory expects SMEs to align their business activities with the environmental values of the society in which they operate (Orazalin et al., 2023). Accordingly, this framework postulates that SMEs obtain legitimacy if the activities/operations of the SMEs are consistent with the values of the society in which they operate (Adu, 2022).

In this case, Adu (2022) argues that CFR initiatives can enhance legitimacy as stakeholders may associate this practice as a feature of well-governed SMEs. This suggests that by making efforts to reduce carbon footprint, SMEs can improve their reputation and gain the support of stakeholders, including customers, regulatory organizations and investors (Adu et al., 2023b). Strong legitimacy enables businesses to compete more successfully in the market, gain good access to financial resources, recruit and keep competent employees, and strengthen stakeholder interactions (Chaudhry et al., 2023; Oliver, 1991).

Accordingly, we apply NIT to explain carbon footprint guidelines introduced by the UK government and adopted by SMEs in the UK. When taken together, NIT theoretical perspectives suggest that UK SMEs exposed to different stakeholder pressures and environmental regulations through EEEO can employ IB, GP, GN and GI as channels for enhancing CFR that may (i) enhance reputation and maintain legitimacy (Adu et al., 2023b; Haque and Ntim, 2020; Burke et al., 2019; Haque and Ntim, 2020) and/or (ii) substantively reduce carbon footprint through improved efficiency and reduced operating costs (Adu et al., 2022a; Orazalin et al., 2023).

In this regard, SMEs essentially encompass an informal structure regularly managed by their founders/owners (Afolabi et al., 2023). Specifically, and based on the NIT perspective, owners' and managers' personal attitudes and choices can immensely affect SMEs' ethical behaviour and climate change initiatives. The implication is that the carbon footprint strategy direction and level of accountability that SMEs can take on are more in the control of their owners. This indicates the impact of SME owners' orientation and viewpoints on the strategy and level of SME engagement in carbon emission reduction (Afolabi et al., 2023). For instance, SME owners' energy efficiency orientation can help the firms undertake economically efficient actions to tackle climate change by adopting IB, GP, GN and GI initiatives that may lead to improved CFR (Orazalin et al., 2023; Adu, 2022; Haque and Ntim, 2020). In this case, the EEEO of SME owners can be expected to influence the CFR strategy of the firms such as IB, GP, GN and GI (Adu, 2022), implying that EEEO may positively impact SMEs' IB, GP, GN and GI capabilities.

Within the economic efficiency NIT perspective, SMEs that seek to

operate efficiently and reduce their cost of operation will explore channels of reducing their energy consumption by engaging in IB, GP, GN and GI activities (e.g., Yao et al., 2019; Mangla et al., 2017; Dubey et al., 2015). For instance, GP has been identified as a critical driver in helping businesses overcome barriers to green initiatives and low GHG emissions (Adu et al., 2023a). In this case, GP can create a business environment that will help SMEs to invest in CFR by employing low-emission energy or equipment and/or developing low-carbon technology (Adu et al., 2023b), thus overcoming barriers to green initiatives. This suggests that GP may have a positive effect on CFR. Further, SMEs are increasingly required to build strategic green alliances that include various forms of collaboration to learn from or exchange expertise to preserve or develop a competitive advantage (Yao et al., 2019). The sharing of green technologies, supplier-buyer green alliances, outsourcing contracts, and shared green manufacturing arrangements have all been identified to improve CFR (Chen et al., 2023; Grant and Baden-Fuller, 2004). GN can influence the initial decisions on energy efficiency choices, including the type of green investments and the selection of green partners due to the knowledge gained through GN, which can help SMEs overcome barriers faced in CFR. The economic efficiency view of NIT predicts that GI activities of SMEs can increase CFR and boost profitability through enhanced operational effectiveness, efficient energy savings, and improved access to resources. Thus, with the conception of NIT, the premise of this study remains that the EEEO of SMEs owners will influence the firm's IB, GP, GN and GI capabilities. In addition, the NIT theoretical perspective predicts that firms' IB, GP, GN and GI will be associated with improved CFR. Finally, the efficiency NIT aspect maintains that implementing IB, GP, GN, and GI activities can strengthen the relationship between EEEO and CFR. Hence, NIT predicts that IB, GP, GN and GI can mediate the EEEO-CFR nexus.

4. Literature review and hypotheses development

4.1. Entrepreneurial energy efficiency orientation, barriers to green practices and carbon footprint reduction

The NIT predicts the climate change initiatives of firms. It stresses the reaction to stakeholder expectations, which might require firms to communicate how their actions are congruent with environmental values (Alatawi et al., 2023). In this regard, the economic efficiency view of NIT postulates that SMEs should align their operational activities with the environmental values of the society where the firms operate (Adu et al., 2023a; Meyer and Rowan, 1977). In particular, the theory maintains that SMEs that minimise the negative impact of their operation on the environment gain a competitive advantage by way of obtaining access to critical resources that are rare, valuable and difficult to substitute. For example, NIT posits that with vital engagement CFR initiatives, SMEs can increase their access to financial resources, attract and keep skilled employees, foster better relationships with stakeholders, and compete more successfully in the market.

In this case, SMEs may seek to put lots of effort into engaging in green practices since increased engagement will lead to obtaining a competitive advantage in the market and sustaining long-term value creation (Mathiyazhagan et al., 2014). However, SMEs' adoption and implementation of green practices are frequently hampered by numerous barriers (Gupta and Barua, 2018). For example, Gupta and Barua (2018) observe that SMEs face multiple barriers to implementing green innovative practices. We make a strong case for SMEs to identify, address, and overcome these barriers. Meanwhile, some scholars maintain that the energy efficiency orientation of owners/managers of SMEs may play a crucial role in helping their businesses identify barriers to green practices and possibly overcome barriers to green initiatives (Walker et al., 2008; Hillary, 2004).

Synthesis of literature by Gupta and Barua (2018) reveals that SMEs face seven main types of green innovation barriers. The barriers are briefly discussed below. The first barrier is related to managerial, organizational and human resources. In brief, this is mainly concerned with the lack of commitment from SME entrepreneurs (Mangla et al., 2017; Mathiyazhagan et al., 2013; Dubey et al., 2015). The main barriers in this category include a lack of commitment from SMEs entrepreneurs (Mangla et al., 2017; Dubey et al., 2015; Mathiyazhagan et al., 2013; Zhu et al., 2012a, 2012b); reluctance to switch to green practises (Zhu et al., 2012a, 2012b); lack of human resources for green innovation (Collins et al., 2007); lack of training and consultancy programmes connected to green innovation practices (Mangla et al., 2017; Longoni et al., 2014; Urban and Naidoo, 2012); lack of interaction with government agencies and participation in government-sponsored programmes related to green initiatives (Gupta and Barua, 2018); high costs for SMEs to obtain certifications related to green practices (Hillary, 2004); and lack of reward systems for green innovations (Gupta and Barua, 2018).

Second, SMEs are confronted with technological and green resource-related barriers (lack of capabilities in green innovation and R&D (Silva et al., 2008; Safi et al., 2021). Key barriers under this type include lack of R&D and green innovation capabilities (Silva et al., 2008); technological and market uncertainty and fear of failure related to green innovations (Rao and Holt, 2005); the inability of technologies to absorb green innovations developed by others; lack of new technology, materials, processes, and skills for innovation (Chen et al., 2023; Collins et al., 2007); lack of investments in R&D for green innovation (Kerr and Nanda, 2015); complex designing process to reuse/recycle products and reduce resource usage.

Third, financial and economic barriers have been identified as essential obstacles facing SMEs in their drive towards engaging in green practices (Gupta and Barua, 2018). Critical barriers in this area involve lack of economies of scale for green products for SMEs due to lesser demand (Gupta and Barua, 2018); less return on investment compared to investments in green technologies (Matus et al., 2012); lack of access to government subsidies and financial incentives (Hojnik and Ruzzier, 2016); lack of bank facilities to promote green practices (Mathiyazhagan et al., 2013); high change over costs from traditional to green system (Mudgal et al., 2010); high costs of disposing hazardous wastes (Mathiyazhagan et al., 2013).

The fourth barrier identified is poor stakeholders' commitment and external partnership (Gupta and Barua, 2018). External connection is critical for SMEs to carry on green innovation practices (Gupta and Barua, 2018). The main barriers in this category include supply chain partners' reluctance to share information on green practices (Dhull and Narwal, 2016; Li et al., 2015; Mudgal et al., 2010; Walker et al., 2008); other SMEs' ignorance of green practices (Dhull &- Narwal, 2016; Wolf and Seuring, 2010); poor communication with external partners and lack of pressure from large organizations to switch to green practices (Gupta and Barua, 2018).

The fifth barrier involves the lack of government support for green innovative practices (Gupta and Barua, 2018). Critical barriers in this area include complex and strict rules for green practices (Zhu et al., 2012a, 2012b); poor enforcement of climate policies, which gives a trespassing advantage to few (Zhu et al., 2012b,a) lack of government training programmes for SMEs to adopt green practices (Gupta and Barua, 2018); and lack of government assistance for SMEs to upgrade their technology (Gupta and Barua, 2018). SMEs' sixth challenge is customer and market-related barriers (Gupta and Barua, 2018). Lack of consumer interest in green products (Dhull and Narwal, 2016; Silva et al., 2008); ignorance of green products (Dhull and Narwal, 2016; Mudgal et al., 2010); and inability to obtain resources from the market to produce green products (Gupta and Barua, 2018) are some of the barriers that fall under this category.

The final barrier identified is inadequate information and knowledge concerning green practices (Gupta and Barua, 2018). The critical barriers in this category include employees' and entrepreneurs' ignorance of green practices and laws (Mangla et al., 2017; Longoni et al., 2014; Mathiyazhagan et al., 2013; Horbach et al., 2012; Mudgal et al., 2010);

employees' inability to recognise environmental opportunities; lack of understanding of green technologies, including recycling and reverse logistics facilities (Mathiyazhagan et al., 2013; Walker et al., 2008); lack of belief in the environmental benefits of green products (Woolman and Veshagh, 2006).

Thus, based on the above discussion and the economic efficiency view of NIT, which stresses the importance of EEEO in helping SMEs to identify and address barriers in green practices, and thereby combating climate change issues, we expect the identification of barriers to green practices to mediate the relationship between EEEO and CFR. Hence, we construct the following hypotheses:

H1a. Entrepreneurial energy efficiency orientation (EEEO) has a positive direct effect on the identification of barriers to green practices (IB).

H1b. The identification of barriers to green practices (IB) has a positive direct effect on carbon footprint reduction (CFR).

H1c. The identification of barriers to green practices (IB) mediates in the relationship between entrepreneurial energy efficiency orientation (EEEO) and carbon footprint reduction (CFR).

4.2. Entrepreneurial energy efficiency orientation, green planning and carbon footprint reduction

Theoretically, the legitimisation perspective of NIT maintains that firms may employ symbolic CFR initiatives. Still, implementing such practices will aim to win key stakeholders' support rather than bring about meaningful change in the firm's behaviour towards CFR in real terms (Crossley et al., 2021). By contrast, the economic efficiency view of NIT suggests that firms that seek to engage in substantive GHG emission strategies will seek to implement CFR initiatives that will lead to actual and fundamental changes in a firm's behaviour and practice concerning CFR issues (Adu et al., 2023b; Crossley et al., 2021). According to the economic efficiency orientation of NIT, proactive green practices strategies are more likely to limit carbon footprint reduction and improve the financial performance of firms through increased operational efficiency, effective energy savings, and greater access to critical resources. In addition, businesses that engage in GHG emission reductions may be able to attract and retain climate-conscious investors (Adu et al., 2023b). In this regard, scholars maintain that businesses should be aware that on top of being beneficial to the environment, strategies for reducing carbon footprint and green policies represent crucial channels for sustainable business growth (Adu, 2022). Despite the potential beneficial impacts of adopting high energy efficiency and low GHG emissions on business growth, research shows that SMEs are yet to fully embrace this paradigm shift (Purwandani and Michaud, 2021; Bradford and Fraser, 2008) due to significant barriers that deter the SMEs from doing so (Adu et al., 2023b; Bradford and Fraser, 2008). For instance, many SMEs perceive carbon footprint reduction initiatives as requiring substantial cost and effort (Revell and Blackburn, 2007). Others observe that SMEs may be unaware of options that can help them to reduce their carbon footprint or how to implement these measures (Bradford and Fraser, 2008), suggesting that energy efficiency behaviour may not be a central principle in the firm. The findings of this prior research indicate that energy efficiency orientation of owners/managers of SMEs may play a crucial role in helping their businesses overcome barriers to green initiatives.

At the same time, GP has been identified as a key driver in helping businesses overcome barriers to green initiatives and low GHG emissions (Adu et al., 2023b). In support, climate scholars stressed that because energy efficiency and green practices involve substantial capital investments, businesses must plan and design innovative strategies/-policies to help maximise the full benefits of such massive investments (Orazalin et al., 2023; Adu, 2022; Haque and Ntim, 2020). Prior research highlights several ways firms may embed GP activities, including (i) firms improving the quality of products, services, and processes, (ii) strategy to acquire highly skilled workers, (iii) strategies on investing time and/or money in green/energy efficiency research, and (iv) plans on investing in technology that enhances energy efficiency (Adu, 2022; Rasoulinezhad and Taghizadeh-Hesary, 2022; O'Keeffe et al., 2016; Kostka et al., 2013). In particular, Adu (2022) stresses that due to the complex nature of green practices and GHG reduction initiatives, firms must recruit highly skilled employees to plan and implement these initiatives. For instance, green planning can create a business environment that will help SMEs invest in carbon footprint by employing low-emission energy or equipment and/or developing low-carbon technology (Adu et al., 2023b), thus overcoming barriers to green initiatives. In this circumstance, SMEs that do not engage in planning their GHG emission reduction activities may realise the necessity of GP as it will come across barriers and uncertainty. Prior studies observe that firms may overcome barriers in green practices by proactively embedding GP in their transition to a more energy-efficient and low GHG emission paradigm (Rasoulinezhad and Taghizadeh-Hesary, 2022; O'Keeffe et al., 2016; Kostka et al., 2013; Van Oijstaeijen et al., 2020).

Meanwhile, climate scholars contend that the extent to which firms engage in GP is significantly influenced/shaped by entrepreneurial orientation (Gupta and Barua, 2018; Bradford and Fraser, 2008). This is especially pertinent for complex energy efficiency issues and low GHG emissions, where SMEs face competing stakeholder demands and conflicting critiques (Orazalin et al., 2023). Some climate scholars suggest that SME owners/managers may be unaware of or uninterested in energy efficiency issues (e.g., Bradford and Fraser, 2008). For instance, a study based on SMEs in north-west England observed that SMEs rank climate issues relatively low on their list of business priorities (Bichard, 2000). An earlier study in England also observed that SMEs were yet to incorporate sustainable environmental strategies (Tilley, 1999). However, the rising energy cost is gradually challenging the status quo as businesses face unprecedented energy bills.

Further, other researchers provide evidence that SMEs have limited awareness of their environmental effects and little insight into how much they contribute to GHG emissions and global warming (Adu, 2022; Bradford and Fraser, 2008). By contrast, SMEs can easily plan and integrate/purchase costly energy-efficient equipment for profit maximisation and sustainable value creation if the owners/managers have an energy efficiency orientation (Andreou and Kellard, 2021; Wright and Nyberg, 2017). In this context, it can be argued that SMEs may invest in energy efficiency and green practices to ameliorate climate risks and enhance business economic sustainability, as predicted by the economic efficiency view of NIT.

Together, these findings demonstrate that the energy efficiency orientation of business owners and managers can positively influence how they plan and implement green initiatives/strategies, thereby helping businesses overcome barriers to adopting green practices. However, prior research has not assessed the interrelationship among EEEO, GP and CFR, and thus, we provide first-time evidence of these associations. Based on the economic efficiency and legitimation of NIT perspectives, as well as the discussions above, this study expects EEEO to help in overcoming barriers to green practices and increase their CFR through GP and develop the following hypotheses:

H2a. Entrepreneurial energy efficiency orientation (EEEO) has a positive direct effect on green planning (GP).

H2b. Green planning (GP) has a positive direct effect on carbon footprint reduction (CFR).

H2c. Green planning (GP) mediates in the relationship between entrepreneurial energy efficiency orientation (EEEO) and carbon footprint reduction (CFR).

4.3. Entrepreneurial energy efficiency orientation, green networking and carbon footprint reduction

Scholars have argued that entrepreneurial orientation can accelerate a firm's opportunity-seeking behaviours in crucial areas such as energy efficiency and carbon footprint reduction initiatives (Adu, 2022; Karami and Tang, 2019; Bradford and Fraser, 2008) because it engages firms in 'uncertain, entrepreneurial activities over time (Walker et al., 2008). For instance, entrepreneurial orientation may impact how SMEs explore and utilise GN opportunities to drive energy efficiency and carbon footprint reduction initiatives. Hence, examining the association between EEEO and GN would be particularly pertinent. In particular, prior scholars argue that the energy efficiency orientation of owners/managers of SMEs may play an essential role in helping their businesses overcome barriers to green initiatives through GN (Adu, 2022; Gupta and Barua, 2018; Bradford and Fraser, 2008).

According to Behyan (2016), a network is a grouping of two or more actors in a business relationship who work together to establish alliances and share information. These actors might be individuals, departments, or firms. Knowledge sharing among SMEs has attracted much attention in the last decade (Yao et al., 2019). For instance, a few but growing number of studies examining business networks maintain that although interest in networking is not new to the business, its usage in carbon footprint reduction of firms is becoming prevalent (e.g., Light, 2020). Based on the economic efficiency view of NIT, firms, through cognitive/educative/mimetic forces, may copy the behaviour and practices of other firms (the process of voluntarily learning and sharing best practices) (Haque and Ntim, 2020). This suggests that SMEs may significantly contribute to combating climate change by sharing green best practices with other businesses through green networking (GN). Within this theoretical perspective, SMEs will have to make fundamental changes in the firm's behaviour, goals and practices to meet the needs and expectations of societal stakeholders. In this regard, SMEs may undertake economically efficient actions to reduce their energy consumption and help combat climate change by seeking energy-efficient ways of operating and sharing such green initiatives with other businesses, which may lead to improved CFR.

Some of the notable GN channels identified in the literature include (i) gaining and sharing green business knowledge/information with other businesses, (ii) acquiring knowledge and sharing information regarding carbon emission regulations, (iii) selecting possible partners in advance to build green relationships, (iv) dealing flexibly with green partners, (v) discussing with green partners regularly on how to support each other to reduce waste and improve efficiency, and (vi) the appointment of employees who are responsible for maintaining a relationship with green partners (Adu et al., 2023a; Adu, 2022; Haque and Ntim, 2020; Gupta and Barua, 2018; Bradford and Fraser, 2008). In this regard, GN can provide a vital platform for gaining knowledge or learning about overcoming barriers to green practices and, hence, can motivate SMEs to reduce their carbon footprint. In other words, the GN approach can play a crucial role in SMEs CFR as it can provide a faster way to access best green practices and overcome barriers to green practices (Adu, 2022). This is especially pertinent because GN can help SMEs gain knowledge and become aware of current rules and regulations on GHG emissions.

Some scholars have argued that GN mechanisms may influence the link between energy efficiency orientation and CFR initiatives (Adu, 2022). For instance, GN can affect the initial decisions on energy efficiency choices, including the type of green investments and the selection of green partners due to the knowledge gained through GN, which can help SMEs overcome barriers faced in CFR. In addition, GN can also provide advice that helps SME owners and managers decide how to engage in green practices (Adu, 2022; Karami and Tang, 2019; Behyan, 2016). In this context, accessing knowledge and vital information can enable SMEs to overcome barriers to engaging in CFR.

Meanwhile, Milanzi (2012) explains that the effectiveness of networks is shaped by network composition, network size and strength of ties between the businesses. In this regard, SME owners and managers may gather crucial CFR initiative information by networking with other players such as distributors, suppliers, competitors, customers, industry associations, business consultants, banks and government agencies. By utilising the green practices knowledge acquired from other network actors, SMEs will adopt well-known channels that have a more beneficial impact on CFR. For instance, Yao et al. (2019) investigated whether SMEs would initiate a strategic alliance to share knowledge about emission reduction under the background of cap-and-trade in China. They report that sharing knowledge on CFR is conducive to reducing emissions of SMEs in the context of cap-and-trade. Furthermore, the results also show that the more knowledge-based compensation is granted, the more manufacturing firms are willing to share knowledge with partners who have complementary knowledge. In conclusion, Yao et al. (2019) suggest that government incentives, such as subsidies or rewards for knowledge-sharing can play a pivotal role in facilitating carbon emissions reduction efforts (Chen et al., 2023).

The arguments and empirical evidence above lead to the proposal that EEEO helps in overcoming barriers to green practices and increasing CFR through networking activities, and develop the following hypotheses:

H3a. Entrepreneurial energy efficiency orientation (EEEO) has a positive direct effect on green networking (GN).

H3b. Green networking (GN) has a positive direct effect on carbon footprint reduction (CFR).

H3c. Green networking (GN) mediates the relationship between entrepreneurial energy efficiency orientation (EEEO) and carbon footprint reduction (CFR).

4.4. Entrepreneurial energy efficiency orientation, selection of green innovation and carbon footprint reduction

Across the globe, various governments and other stakeholders are concentrating on this group of SMEs in order to assist them in reducing pollution and maintaining ecological balance because SMEs are one of the greatest generators of industrial pollution (Gupta and Barua, 2018). However, due to limited resources, SMEs cannot respond quickly to the changing demands of the stakeholders (Adu et al., 2022b; Gupta and Barua, 2018). Thus, there is a growing demand for green innovation among SMEs. This innovation enables them to optimize their resource utilization and transition to more energy-efficient operational practices, ultimately enhancing their Carbon Footprint Reduction (CFR) efforts. Green innovation encompasses the development and implementation of novel products, processes, and materials that not only minimise the release of harmful substances into the environment but also reduce the consumption of natural resources (Chen et al., 2023). It holds the potential to address the pressing challenge of reducing carbon footprints among SMEs. Similarly, Kemp (2010) defines green innovation as the development, assimilation, or exploitation of a product, production process, service, management, or business method that is novel to the organisation (developing or adopting it) and that results, throughout its life cycle, in a reduction of environmental risk, pollution, and other adverse impacts of resource use (including energy use), compared to pertinent alternatives.

The economic efficiency view of NIT predicts that the selection of green innovation approaches (GI) by firms can increase CFR and boost profitability through improved operational effectiveness, efficient energy savings, and improved access to resources. However, from a financial standpoint, such environmental activities demand significant work, come with substantial costs and risks, and may discourage firms from engaging in such initiatives. In support, other scholars maintain that SMEs face many barriers in selecting and adopting green innovation practices in their core business operations (Gupta and Barua, 2018).

Thus, there is a growing need for SMEs to address and overcome these barriers.

Synthesis of the literature reveals several approaches for SMEs to select to overcome these green barriers and adopt green innovations. These include (i) achieving innovation through green innovation initiatives, (ii) realising innovation through green innovation monitoring and follow-up, (iii) attaining innovation through green networking/network relations, (iv) achieving innovation through green regulation/government guidelines, and (v) achieving green innovation by using local partners/suppliers/distributors (Gupta and Barua, 2018). Scholars suggest that the energy efficiency orientation of owners/managers of SMEs may play an essential role in helping their businesses overcome barriers to green initiatives by selecting appropriate green innovation approaches (Gupta and Barua, 2018; Mathiyazhagan et al., 2014). In a related study, Crossley et al. (2021) conducted in-depth interviews and analysis of owners and managers of SMEs in the UK within a Neo-institutional theoretical framework. They document that SMEs employ a complex mix of symbolic and substantive environmental initiatives to enhance the legitimacy and sustainability of their operations.

Based on the theoretical arguments and the discussion above, we expect that these energy efficiency orientations of SME owners and managers can positively impact the selection of green innovation approaches and help the firms overcome barriers to green practices adoption with a beneficial impact on CFR. Yet, prior studies have not examined the interrelationship among EEEO, GI and CFR, so we provide first-time evidence on these relationships. Accordingly, we develop the following hypotheses:

H4a. Entrepreneurial energy efficiency orientation (EEEO) has a positive direct effect on green networking (GI).

H4b. Selection of green innovation approaches (GI) has a positive direct effect on carbon footprint reduction (CFR).

H4c. Selection of green innovation approaches (GI) mediates the relationship between entrepreneurial energy efficiency orientation (EEEO) and carbon footprint reduction (CFR).

Fig. 1 presents the conceptual framework, outlining the predicted relationships among EEEO, IB, GP, GN, GI, and CFR. It shows the direct effects of EEEO on IB, GP, GN and GI, the direct effect of IB, GP, GN, and GI on CFR, and the mediating effects of IB, GP, GN and GI on the EEEO-CFR relationship.

5. Methodology

5.1. Sample and data collection

To test our hypotheses, we draw on data collected from SMEs in the Tees Valley region, Northeast England. SMEs play a critical role in the UK economy. According to the UK Small Business Statistics (2022), SMEs account for 99.9% of the 5.5 million businesses. For example, a 2021 Tees Valley monthly economic update shows that 99.5% of businesses have been classified as SMEs. The choice of the Tees Valley region in England, UK is explicitly strategic for this research project as it is home to one of the most significant energy-intensive industrial clusters of small (er) businesses in Europe and is planned for industrial decarbonisation (Tees Valley Combined Authority, 2022). The Tees Valley region was identified in the recent 'Levelling Up the UK White Paper' as one of 20 high-value sectoral clusters in the UK (HM Government, 2022). SMEs account for a substantial proportion of private-sector economic activity in the UK.

The UK Small Business Statistics (2022) defines firms with less than 250 employees as SMEs. For this study, we considered all SMEs that operate in the Tees Valley region. Based on these criteria, we used the Fame Database to identify SMEs in all the industries across the Tees Valley region. As a result, our targeted sample reached 1,000 firms. Of these 1,000 firms, 580 did not participate in the survey for reasons such as having no interest in the research topic or being overloaded by business activities. Among the 420 firms who agreed to respond to our survey, 168 cases did not start nor submit the survey after three reminders. Thus, our final sample comprised 252 complete responses (See Table 1). The data collection began in May 2022 and ended in February 2023. We surveyed owners or top managers in charge of the SMEs since they have more knowledge and insights about the firms' energy and carbon emission activities. The survey was administered in-person and online, as blend surveys can control the risk of unrepresentative samples (Karami and Tang, 2019; Silva et al., 2008). Table 1 provides the final data, which contains 252 responses.

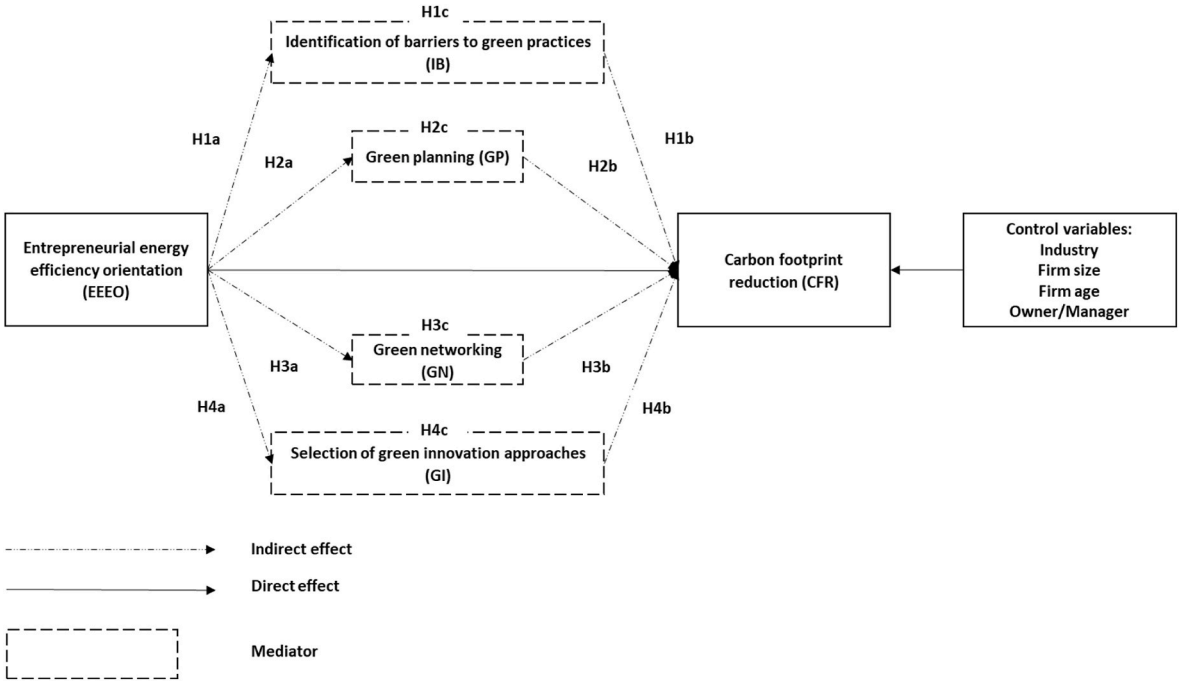

Fig. 1. Conceptual framework.

Table 1
Sample selection procedures.

Sample selection	No. of Firms	Percentage
Targeted sample	1,000	100
Firms that did not respond to the survey	580	58
Firms that agreed to respond to the survey	420	42
Firms that agreed but did not submit the survey	168	16.8
Final sample	252	25.2

We employ several techniques to increase the response rate. We adopted the motive of social exchange theory to encourage respondents about perceived costs and benefits. To guarantee that our respondents did not perceive the pre-notice emails as unsolicited, we sent them before the link to the online survey was distributed (Karami and Tang, 2019). We called them as a follow-up to confirm that respondents had received the pre-notice emails and were still interested in responding to the survey. Following their acceptance, we first emailed the online survey, which was made available to responders in desktop and mobile versions. Additionally, we followed up with non-respondents via email and telephone calls six and twelve weeks later. Second, we ensured respondents' privacy by committing to publish only aggregate findings rather than findings specific to any single firm (Silva et al., 2008). Third, we guaranteed that respondents would receive a summary of the findings (Karami and Tang, 2019). Due to the significance of learning from other successful SMEs, we thought this might be a significant incentive for respondents to complete the survey. Personalized emails and cover letters were also used.

Following Karami and Tang (2019), we used independent t-tests to determine whether there was any potential non-response bias between early and late responses in terms of our key variables (such as EEEO, IB, GP, GN, GI and CFR) and the control variables (e.g., industry, firm size, firm age and owner/manager education level). The study finds no significant differences between the two groups. Furthermore, the study employs the same tests to check for a non-response bias between the final sample of 252 cases and the 580 firms who did not accept the invitation to participate in the survey, as well as between the final sample of 252 cases and the 168 firms who agreed but did not complete the survey in terms of firm characteristics, such as firm size and firm age. No significant differences were observed, indicating no major threat of non-response bias in the data.

This research investigates underlying latent variables and measures them using relevant indicators (i.e., survey questions) identified from the literature (e.g., Karami and Tang, 2019)). In order words, this research discovers the factors that emerged from the survey questions loaded collectively. Therefore, this research will require 'Factor analysis' as the primary analytical technique. The factor analysis is in two main parts. The first part involves exploratory factor analysis (EFA), in which the underlying factors are discovered, and the development of the measurement model based on the factor loadings. Composite reliability and Average Variance extracted (AVE) are then used to ensure the internal consistency of the questionnaire and whether they accurately measure the construct. We employ a Model fit summary to ensure the reliability of the project data (Hatcher, 1994).

5.2. Measures

We self-designed the survey, employing a seven-point Likert scale ranging from "strongly disagree" (one point) to "strongly agree" (seven points) for measurement. A compilation of the survey questions can be found in Table 2. We adopted established scales Karami and Tang (2019), Chen et al. (2023), and Gerschewski et al. (2015), to measure various constructs. Specifically, we used these scales to assess EEEO with five questions (independent variable), GN with four questions (mediator variable), GP with six questions (mediator variable), the selection of GI approaches within SMEs with five questions (mediator variable), IB with nine questions (mediator variable), and CFR performance of SMEs with five questions (dependent variable).

Additionally, we control several firm-specific variables that may influence the construct (e.g., Karami and Tang, 2019). First, the total number of employees was used to measure the size of the SMEs. Larger firms may have more resources that influence their carbon footprint reduction. Hence, firm size was included (Haque and Ntim, 2020). Second, firm age was computed by the number of years that the SME has been in operation (Karami and Tang, 2019). Firm age is a crucial factor in firms' carbon footprint reduction because older firms may have accumulated more resources and more network relationships, which may influence the firms' carbon footprint reduction (Adu et al., 2022b). The owner/manager experience of the SMEs was controlled by the number of years of managing the business (Karami and Tang, 2019). Finally, the study includes eight industry groups based on the UK Small Business Statistics (2022) classification: (1) construction; (2) wholesale and retail; (3) transport; (4) manufacturing; (5) real estate; (6) textile, leather, clothing, and footwear; (7) furniture; (8) other SMEs.

6. Empirical results

6.1. Descriptive statistics and correlation analysis

Table 2 shows the descriptive statistics of all the survey questions employed in measuring the variables (including independent, dependent and control variables). The results of the descriptive statistics in Table 2 show that all the mean values range from 5.29 in Q1 to 5.30 in Q34. The results in the table also reveal that the highest standard deviation (SD) of 1.77 was recorded for Q15, while the lowest SD of 1.18 was recorded for Q6. The low SD implies that the data points are largely scattered around the mean values of their respective questions (Hair et al., 2014). Further, the results show that all mean values are above the value of 4.52. Together, from these two findings, it can be inferred that the responses are mostly loaded above neutral to agreed scales (Hair et al., 2014).

The measurement model in Fig. 2 demonstrates how different latent variables correlate with each other and factor loadings of latent variables with respective indicators. Based on the statistical outcomes derived from the measurement model in Fig. 2, we also summarize the factor loadings of each indicator (questions) in Table 2. Factor loading is the correlation coefficient for the variables and factors. It shows the variance explained by the variable on that particular factor. In the structural equation modelling (SEM) approach, as a rule of thumb, 0.6 or higher factor loading demonstrates that the factor extracts sufficient variance from that variable (Hu and Bentler, 1999; Hatcher, 1994). Accordingly, the factors have a good correlation coefficient with most of their respective indicators (measured variables). However, questions with lower factor loadings (below 0.60) in asterisks (i.e., Q2, Q4, Q6, Q30 and Q33) show lower factor loadings. These items (questions) with lower factor loadings will be excluded from the further analysis in our study.

The results in Table 3 show that correlation exists among latent variables. The table reveals that the highest correlation of 0.96 exists between green networking (GN) and the selection of green innovation (GI). The results in Table 3 also show that the lowest correlation between identification of green barriers (IB) and green planning (GP) is 0.347.

To establish the convergent validity, we employ the factor loading of the indicator, composite reliability (CR), and the average variance extracted (AVE) by following Hair et al. (2014) (See Table 2). The threshold value for CR is considered 0.70 or higher (Hair et al., 2014). CR values over 0.70 indicate a higher internal consistency of constructs. The threshold value for AVE is considered good if it is 0.50 or higher. AVE values over 0.50 indicate a higher internal consistency of constructs (Hair et al., 2014). According to the above CR table, all factors show acceptable composite reliability (over 0.80) and AVE (over

Table 2
Descriptive statistics.

Question	No. Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Error	Std. Deviation	Factor loading	CR	AVE
Entrepreneurial energy efficiency orientation (EEEO)								0.83	0.69
Q1 In our firm, energy efficiency behaviour is a central principle	252	1.00	7.00	5.29	0.08	1.38	0.77		
Q2 In our firm, people are not aware of energy efficiency (reverse-coded);	252	1.00	7.00	4.53	0.11	1.70	0.45*		
Q3 In our firm, green practices are emphasized above all	252	1.00	7.00	4.96	0.10	1.57	0.87		
Q4 In our firm, people are willing to reduce energy consumption	252	1.00	7.00	5.40	0.08	1.22	0.47*		
Q5 In our firm, people are eager at being always first to bring green innovative ideas	252	1.00	7.00	4.82	0.10	1.53	0.87		
Green planning (GP) capabilities								0.80	0.71
Q6 We are improving the quality of our products, services, and processes	252	1.00	7.00	5.35	0.07	1.18	0.54*		
Q7 We are acquiring highly skilled workers	252	1.00	7.00	4.82	0.09	1.48	0.69		
Q8 We are investing time and/or money in green/energy efficiency research	252	1.00	7.00	4.96	0.09	1.54	0.81		
Q9 We are investing in technology that enhances energy efficiency	252	1.00	7.00	4.98	0.09	1.50	0.78		
Green networking (GN) capabilities								0.92	0.81
Q10 We gain and share green business knowledge/information from other firms	252	1.00	7.00	4.77	0.09	1.50	0.78		
Q11 We acquire and share knowledge regarding carbon emission regulations through individual and business relationships	252	1.00	7.00	4.79	0.09	1.41	0.68		
Q12 We select possible partners in advance to build green relationships	252	1.00	7.00	4.95	0.09	1.55	0.86		
Q13 We deal flexibly with our green partners	252	1.00	7.00	4.95	0.09	1.43	0.83		
Q14 We discuss with our green partners regularly on how to support each other to reduce waste and improve efficiency	252	1.00	7.00	4.87	0.10	1.59	0.83		
Q15 We appoint employees who are responsible for maintaining a relationship with our green partners	252	1.00	7.00	4.60	0.11	1.77	0.86		
Selection of green innovation (GI) approaches								0.93	0.85
Q16 we achieve innovation through green innovation initiatives	252	1.00	7.00	4.87	0.10	1.53	0.89		
Q17 We achieve innovation through green innovation monitoring and follow-up	252	1.00	7.00	4.80	0.11	1.68	0.88		
Q18 We achieve innovation through green networking/ network relations	252	1.00	7.00	4.82	0.10	1.63	0.86		
Q19 We achieve innovation through green regulation/ government guidelines	252	1.00	7.00	4.87	0.10	1.62	0.79		
Q20 We achieve green innovation by using local partners/ suppliers/distributors	252	1.00	7.00	5.04	0.09	1.51	0.82		
Identification of barriers (IB) to green practices								0.91	0.70
Q21 We are facing information/knowledge related barriers	252	1.00	7.00	5.33	0.08	1.38	0.72		
Q22 We lack seminars/workshops/trainings on SME green practices	252	1.00	7.00	5.32	0.09	1.44	0.67		
Q23 We are facing economic and cost or financial barriers	252	1.00	7.00	5.51	0.08	1.43	0.62		
Q24 We are facing regulatory and bureaucratic barriers	252	1.00	7.00	5.27	0.11	1.69	0.72		
Q25 We lack technical and engineering capabilities	252	1.00	7.00	5.39	0.08	1.40	0.79		
Q26 We have poor external green partnerships	252	1.00	7.00	5.27	0.09	1.51	0.73		
Q27 We face attitude/perception barriers related to SME green practices	252	1.00	7.00	5.55	0.08	1.32	0.77		
Q28 We face market and customer-related barriers	252	1.00	7.00	5.53	0.09	1.38	0.71		
Q29 We face a competition between economic growth/profit and the green agenda	252	1.00	7.00	5.63	0.09	1.47	0.60		
Carbon footprint reduction (CFR) initiatives								0.82	0.68
Q30 Our firm is looking for financial support from the UK government to help increase our carbon footprint reduction	252	1.00	7.00	5.60	0.08	1.30	0.47*		
Q31 Our firm is taking steps towards technological innovations to increase our carbon footprint reduction	252	1.00	7.00	5.23	0.09	1.39	0.79		
Q32 We are encouraging our employees to attend more seminars/workshop on green innovation to increase our carbon footprint reduction	252	1.00	7.00	5.18	0.10	1.61	0.82		
Q33 Issued green initiatives guidelines by government is helping SMEs to increase carbon footprint reduction	252	1.00	7.00	5.53	0.08	1.35	0.52*		
Q34 We are taking steps to increase the level of awareness of our green initiatives among our customers and investors so as to boost our carbon footprint reduction	252	1.00	7.00	5.30	0.08	1.35	0.79		

Notes: CR is composite reliability, and AVE is the average variance extracted. * Denotes survey questions with lower factor loadings that were excluded from the analysis.

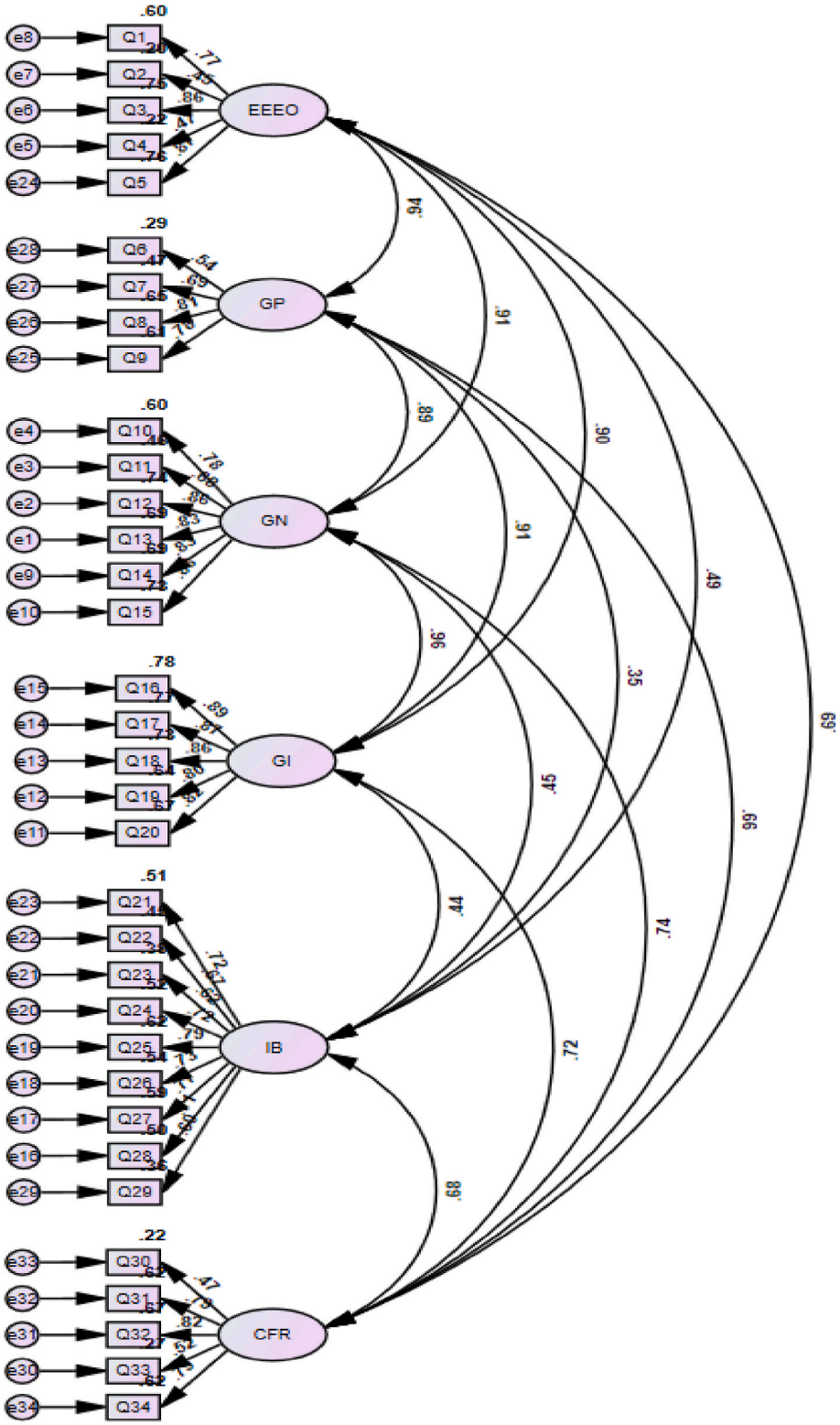

Fig. 2. Measurement model.

0.67). This indicates that the reliability of each item was good, as it suggests that all the factors show a higher level of internal consistency. In other words, the items used in the questionnaire effectively measure the respective construct. This output ensures the reliability of the questions included in the questionnaire.

6.2. The structural equation model (SEM)

The structural model in Fig. 3 illustrates the relationships conceptualised among the latent variables. The structural model (unstandardized) demonstrates path coefficients (relationships) existing among latent variables (Maximum likelihood Estimation, 95% confidence and 5000 bootstraps).

Table 3
Correlations.

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Entrepreneurial energy efficiency orientation (EEEO)	1					
(2) Green planning (GP)	0.94	1				
(3) Green networking (GN)	0.91	0.89	1			
(4) Selection of green innovation (GI)	0.9	0.91	0.96	1		
(5) Identification of green barriers (IB)	0.49	0.35	0.45	0.44	1	
(6) Carbon footprint reduction (CFR)	0.69	0.66	0.74	0.72	0.68	1

Based on the outcomes derived from the SEM in Fig. 3, we summarised the regressions (unstandardized) in Table 4. First, the results in Table 4 show that entrepreneurial energy efficiency orientation (EEEO) has a direct positive and significant impact on the identification of barriers to green planning (IB) at a 1% significance level, suggesting that the energy efficiency orientation of owners and managers of SMEs is associated with increased IB. This evidence offers empirical support to H1a and corroborates prior scholars' arguments that EEEO can help SMEs identify barriers and overcome barriers to green initiatives (Walker et al., 2008; Hillary, 2004). This evidence lends support to the economic efficiency view of NIT, in that SME owners and managers are likely to explore and identify green initiatives to reduce their production costs and ultimately help them overcome barriers to green innovation (Orazalin et al., 2023; Adu et al., 2022a; Gupta and Barua, 2018; Bradford and Fraser, 2008). Further, the results in Table 4 also show that IB has a positive and significant impact on carbon footprint reduction

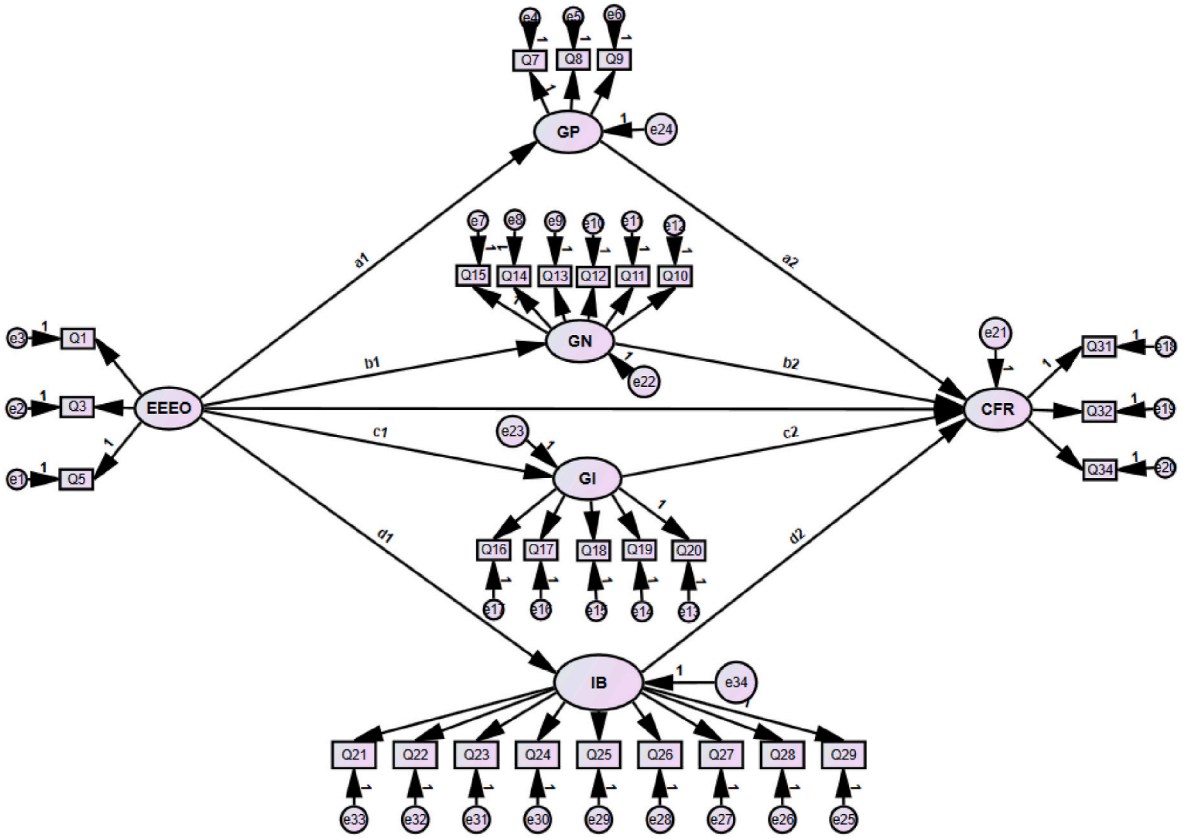

Fig. 3. Structural Equation Model
Note: EEEO is entrepreneurial energy efficiency orientation; GP is green planning; GN is green networking; GI is the selection of green innovation; IB is the identification of green barriers; CFR is carbon footprint reduction.

Table 4
Coefficients of parameters.

Parameter			Estimate	Lower	Upper	P-Value	Conclusion	Hypothesis
EEEO	→	IB	0.309	0.191	0.882	0.000	Significant	H1a Accepted
EEEO	→	GP	0.728	0.578	1.273	0.000	Significant	H2a Accepted
EEEO	→	GN	1.125	0.993	1.041	0.000	Significant	H3a Accepted
EEEO	→	GI	0.918	0.807	0.458	0.000	Significant	H4a Accepted
IB	→	CFR	0.512	0.286	4.035	0.000	Significant	H1b Accepted
GP	→	CFR	0.56	−0.855	1.706	0.327	Not Significant	H2b Rejected
GN	→	CFR	0.546	0.027	1.409	0.040	Significant	H3b Accepted
GI	→	CFR	0.328	−0.608	0.852	0.419	Not Significant	H4b Rejected
EEEO	→	CFR	−0.857	−3.706	1.034	0.342	Not Significant	E

Note: EEEO is entrepreneurial energy efficiency orientation; GP is green planning; GN is green networking; GI is green innovation; IB is the identification of green barriers; CFR is carbon footprint reduction; and e denotes the direct path from EEEO to CFR.

(CFR) at a 1% level, implying that H1b is empirically supported. The findings are also consistent with the notion that identifying green planning barriers by SMEs is a crucial step that can help the firms put in place effective mechanisms to address these barriers and improve CFR.

Second, the estimated results in Table 4 reveal that EEEO is positively associated with green planning (GP) at a 1% significance level. This result suggests that the energy efficiency orientation of SME owners and managers can help the firms to engage in increased GP, thereby offering empirical support to H2a. The findings reaffirm the economic efficiency NIT notion that EEEO strategy is a significant predictor of GP activities. Our results support the view that pro-energy efficiency-oriented founders/owners and managers tend to encourage the firms to engage in GP initiatives, hence the establishment of GP policy (e.g., Adu, 2022). This is consistent with prior studies (Gupta and Barua, 2018; Bradford and Fraser, 2008) that suggest that the extent to which firms engage in GP is significantly influenced/shaped by entrepreneurial orientation (Gupta and Barua, 2018; Bradford and Fraser, 2008). By contrast, the findings in Table 3 show that the relationship between GP and CFR is positive but insignificant. Thus, H2b is rejected. The results differ from prior studies that observe that firms may overcome barriers in green practices by proactively embedding GP in their transition to a more energy-efficient and low GHG emission paradigm (e.g., Rasoulinezhad and Taghizadeh-Hesary, 2022; O'Keeffe et al., 2016; Kostka et al., 2013; Van Oijstaeijen et al., 2020).

Third, the results in Table 4 show that EEEO is positively associated with green networking (GN) at a 1% significance level, thereby offering strong empirical support to H3a. The evidence provides empirical support to the economic efficiency view of NIT, which indicates that firms with EEEO owners and managers are likely to have high GN-related activities/initiatives. The findings corroborate past studies (Adu, 2022; Gupta and Barua, 2018; Bradford and Fraser, 2008), which suggest that firms with EEEO owners and managers are more likely to use GN as an effective management tool to improve their green initiatives. Furthermore, the findings in Table 3 align with our predictions that GN activities are indeed associated with increased CFR, as there is a positive and significant relationship between GN and CFR at a 5% significance level. Thus, H3b is empirically supported. Our findings are generally consistent with the suggestions of prior scholars and the economic view of NIT that GN may lead to an increase in green initiatives (Andreou and Kellard, 2021; Wright and Nyberg, 2017; Gupta and Barua, 2018). Specifically, the estimated results in Table 4 demonstrate a positive relationship between GN and CFR at a 5% significance level, providing empirical support to H3b. Our study, therefore, directly supports the argument that GN activities can contribute towards reducing CFR. The evidence is consistent with the economic efficiency NIT perspective, which argues that SMEs that seek to operate efficiently and reduce their cost of operation will explore channels of reducing their energy consumption by engaging in GN activities (e.g., Yao et al., 2019; Mangla et al., 2017; Dubey et al., 2015). The results also corroborate the findings of prior studies that report that sharing knowledge on CFR is conducive to reducing emissions of SMEs (e.g., Yao et al., 2019; Grant and Baden Fuller, 2004). Collectively, these findings suggest that SMEs with EEEO and GN exhibit greater environmental and climate change-related initiatives.

Fourth, these results captured in Table 4 show that EEEO is positively and significantly associated with selecting green innovation approaches (GI) at 1% significance level, hence providing empirical support to H4a. The findings indicate that SMEs with EEEO owners and managers tend to engage in high GI initiatives. This is consistent with prior studies (e.g., Adu, 2022; Gupta and Barua, 2018; Mathiyazhagan et al., 2014) that the selection of green initiatives by SMEs is dependent mainly on the EEEO of the owners and managers of the firms. Theoretically, this finding supports the economic efficiency view of NIT, in that firms are likely to engage in GI when the owners/managers have a strong energy efficiency affinity to reduce cost and improve operational efficiency. However, the results in Table 4 show that GI has a positive but insignificant impact on CFR. The results suggest that H4b is not empirically supported.

6.3. Multiple mediators analysis

We can summarize the indirect effects of respective multiple mediators based on the outcomes generated from the 'User-defined estimands' in SPSS Amos. When analysing the results in Table 5, we observe that only two variables, identification of green barriers (IB) and green networking (GN), mediate the relationship between EEEO and CFR. In this model, the entire relationship between EEEO and CFR is explained through these mediators, i.e., IB and GN. It's important to note that the absence of a mediator in the model leads to the disappearance of the direct relationship between EEEO and CFR, as evidenced in Table 4. Therefore, IB and GN serve as full mediators. To address this specifically, our analysis reveals that H1c, which predicted the mediating role of IB ($b = 0.158$, $t = 3.224$, $p = 0.000$) at a 1% significance level in the EEEO-CFR relationship. This evidence offers empirical support to H1c that EEEO can play a crucial role in helping SMEs identify and address barriers in green practices, become more energy efficient (reduce energy bills) and ultimately improve CFR. For instance, SME owners' energy efficiency orientation can help the firms undertake economically efficient actions to reduce GHG emissions by adopting IB initiatives that may lead to improved CFR (Orazalin et al., 2023; Adu, 2022; Haque and Ntim, 2020). In this case, the EEEO of SME owners can be expected to influence the CFR strategy of the firms, including IB (Adu, 2022). The results support the economic efficiency view of NIT that posits that SMEs should align their operational activities with the environmental values of the society in which the firms operate (Adu et al., 2023a; Meyer and Rowan, 1977). The findings are also consistent with the suggestion by scholars that the energy efficiency orientation of owners/managers of SMEs may play a crucial role in helping their businesses identify barriers to green practices and possibly overcome barriers to green initiatives, leading to improved CFR (Walker et al., 2008; Hillary, 2004).

Second, the results in Table 5 show that H2c is rejected, as the indirect relationship between EEEO and CFR through GP ($b = 0.407$, $t = 0.405$, $p = 0.305$) is statistically insignificant. Third, the estimated results in Table 5 reveal that the indirect relationship between EEEO and CFR through GN ($b = 0.614$, $t = 1.108$, $p = 0.038$) is statistically significant at a 5% level. The evidence provides empirical support to H3c and is consistent with the economic efficiency view of NIT. The theory predicts that SME owners' energy efficiency orientation can help the firms undertake economically efficient actions to tackle climate change by adopting GN initiatives that may lead to improved CFR (Orazalin et al., 2023; Adu, 2022; Haque and Ntim, 2020). In this case, the EEEO of SME owners can be expected to influence the CFR strategy of the firms such as GN (Adu, 2022). Our results suggest that GN mechanisms may influence the link between energy efficiency orientation and CFR initiatives (e.g., Adu, 2022; Yao et al., 2019; Mangla et al., 2017; Dubey et al., 2015). Fourth, in Table 5, we find insignificant results on the mediating impact of GI on the EEEO-CFR nexus, implying that H4c is rejected. The results show that the indirect relationship between EEEO and CFR through GI ($b = 0.301$, $t = 0.566$, $p = 0.415$) is statistically insignificant.

Moving on, although the results in Table 5 reveal statistically significant mediating effects of IB and GN, it does not demonstrate the type of mediation effect. In other words, the results in Table 5 do not explain whether these effects are 'Full' or 'Partial' mediations. Testing the nature of the relationship requires us to check the statistical significance of the direct effect between EEEO and CFR variables with mediating variables. As demonstrated in Table 4, the direct effect from EEEO to CFR (Path e) is -0.857 ($p = 0.342 > 0.05$). It implies that the direct effect is statistically insignificant with mediators. According to this structural model, GN and IB variables fully mediate the relationship between EEEO and CFR.

Table 5
Results of multiple mediators analysis.

Relationship	Parameter	SE	T statistic (=Est./SE)	Indirect Effect	Confidence Level (95%)		P-Value	Conclusion	Mediation (Partial or Full)	Hypothesis
					Lower Bound	Upper Bound				
EEEO→IB→CFR	H1a, H1b	0.049	3.224	0.158	0.076	0.274	0.000	Significant	Full Mediation	H1c Accepted
EEEO→GP→CFR	H2a, H2b	1.005	0.405	0.407	−0.584	3.189	0.305	Not Significant	No Mediation	H2c Rejected
EEEO→GN→CFR	H3a, H3b	0.554	1.108	0.614	0.038	2.013	0.038	Significant	Full Mediation	H3c Accepted
EEEO→GI→CFR	H4a, H4b	0.532	0.566	0.301	−0.546	1.359	0.415	Not Significant	No Mediation	H4c Rejected

Note: EEEO is entrepreneurial energy efficiency orientation; GP is green planning; GN is green networking; GI is green innovation; IB is the identification of green barriers; CFR is carbon footprint reduction.

6.4. Model fit summary

The robustness of the above model can be tested using the popular model fit measurements in SEM. According to the model fit outcomes (Table 6), the developed model reflects strong fitness outcomes. Specifically, all the seven parameters, including Chi-square to degrees of freedom ratio (CMIN/DF), comparative fit index (CFI), root mean square error of approximation (RMSEA), incremental fit index (IFI), parsimonious normal fit index (PNFI), parsimony comparative fit index (PCFI) and adjusted goodness-of-fit index (AGFI) showed a fit model. Therefore, it can be concluded that our model is a good fit.

7. Conclusion

Over the past few decades, academics, practitioners, and regulators have become increasingly concerned with carbon footprint due to rising GHG emissions and their adverse effects on the planet and human lives. The effect of entrepreneurial energy efficiency orientation on the carbon footprint reduction of SMEs is a critical issue in climate change studies. Regrettably, there is limited research regarding the role of governance structures such as entrepreneurial energy efficiency orientation, identification of green barriers, green planning, green networking, and selection of green innovation approaches in addressing climate change challenges, especially in the SME sector. Accordingly, this study sought to bridge this gap in the literature by empirically exploring these interrelationships based on data relating to SMEs. This study proposes and documents evidence for the identification of green barriers and green networking capabilities as mediating mechanisms through which entrepreneurial energy efficiency orientation contributes to the carbon footprint reduction of SMEs. Specifically, the study's findings show that EEEO positively affects IB, GP, GN and CFR. In addition, our findings reveal that IB and GN are positively associated with CFR, whilst GP and GI have no such effect on CFR. Further, we show that the relationship between EEEO and CFR is contingent on IB and GN capabilities. By contrast, we observe that GP and GI have no mediating effect on the link between EEEO and CFR.

Table 6
Model fit summary.

Fit Indices	Sources	Threshold Value	Result	Interpretation
CMIN/DF	Marsh and Hocevar (1985), Bentler (1990), Hair et al. (2009)	<5.0 <5.0 reported if n > 200 <3.0 good; <5.0 sometimes permissible	1.893	Good Fit
CFI	Bentler (1990), Hatcher (1994)	>0.90 >0.90	0.939	Good Fit
RMSEA	Byrne (2001), Hu and Bentler (1999), Meyers et al. (2005)	<0.08 <0.05 <0.08 good fit, 0.08 to 0.1 moderate fit >0.10 poor fit	0.060	Good Fit
IFI	Meyers et al. (2005)	>0.90	0.939	Good Fit
PNFI	Meyers et al. (2005)	>0.5	0.797	Good Fit
PCFI	Meyers et al. (2005)	>0.5	0.851	Good Fit
AGFI	Hair et al. (2009)	>0.80	0.80	Good Fit

Note: The variables are defined as follows: adjusted goodness-of-fit index (AGFI), root mean square error of approximation (RMSEA), comparative fit index (CFI), incremental fit index (IFI), parsimonious normal fit index (PNFI), Chi-square to degrees of freedom ratio (CMIN/DF) and parsimony comparative fit index (PCFI).

The study offers new contributions to the carbon footprint literature based on insight from the neo-institutional theoretical framework. First, our results provide further evidence that SMEs' entrepreneurial energy efficiency orientation is positively related to increased identification of green barriers, green planning, green networking, and the selection of green innovation approaches. Second, our results contribute to the carbon footprint literature (Andreou and Kellard, 2021; Wright and Nyberg, 2017; Gupta and Barua, 2018) by showing that identification of green barriers, green planning and green networking are positively and significantly associated with carbon footprint reduction. Third, unlike prior studies that provide a direct link between SME characteristics and environmental performance (e.g., Crossley et al., 2021), we identify and test possible channels through which mediators may influence this relationship. In this regard, our study provides first-time evidence of the full mediating effects of the identification of barriers on green initiatives and green networking capabilities to capture the indirect association between entrepreneurial energy efficiency orientation and carbon footprint reduction. Finally, our results support the economic efficiency view of neo-institutional theory (Adu et al., 2023a,b; Haque and Ntim, 2020), in that SMEs, through the identification of green barriers and green networking, may engage in carbon footprint reduction initiatives as a credible means of improving operational efficiency, reduction of costs and ultimately lowering GHG emissions.

In addition to our findings' theoretical and empirical contributions, we also propose essential policy implications. First, our results indicate that SMEs' carbon footprint reduction could benefit from identifying green barriers. Thus, owners and managers of SMEs should promote ways of identifying green barriers in the firms as it has been recognised to improve the firm's carbon footprint reduction and offer sustainable value creation. For instance, identifying green barriers can boost the firms' capability for exploring energy-efficient ways of production, which could lead to savings from energy bills and increase the firm's profitability.

Second, the study results demonstrate that sharing green networking capabilities with other SMEs, partners, suppliers, regulators, and other stakeholders is another crucial mechanism to help SMEs overcome barriers to green initiatives and reduce their carbon footprint. Green networking can thus be considered a valuable resource. Hence, it would be beneficial for owners and managers of SMEs to take full advantage of

their existing relationships by developing regular green practices conversations with their associates (Karami and Tang, 2019). This will enable the ongoing growth of their current resources and the flow of green practices information and knowledge required to improve operational efficiency and carbon footprint reduction.

Third, given the relative importance and the role of green networking in helping SMEs overcome barriers to green SMEs and reduce carbon emissions, the UK government and regulators should consider developing and enhancing SMEs' green network platforms to promote the sharing of best green practices among SMEs. In this case, the UK government and regulators may collaborate with existing energy efficiency and clean energy app operators, such as SkySpark, Spacewell Energy, Smart meters and Energy Saving Trust to design fit-for-purpose integrated channels for SMEs to share and discuss energy efficiency and green practices. In addition, regulators such as Tees Valley Combined Authority and the Northeast of England Chamber of Commerce may create a platform on their existing websites solely to discuss energy efficiency issues and disseminate green initiatives in business operations. By doing so, the regulators will provide opportunities for SME owners, managers and employees to share and learn from other businesses' energy efficiency and carbon footprint reduction experiences.

Fifth, to recognise excellence, regulators and the UK government may set up an annual Green Award Scheme solely for SMEs and their employees who make outstanding contributions to the green SMEs agenda. Additionally, the UK government and regulators are strongly encouraged to provide financial support and promote existing Green Award Schemes such as UK Green Business Awards, Responsible Business Awards, The Green Apple Environment Award, Business Green Leaders Awards and Green Impact National Awards. In particular, as most of these existing awards are not explicitly targeted at SMEs, the UK government and regulators may work closely with the Green Award Schemes' organisers to expand the award types to include SME-specific categories. This is particularly important because the UK government has explicitly announced its commitment to achieving the net zero carbon emissions target and precisely called for more SMEs to lead the charge to the net zero agenda (HM Government, 2021).

Finally, our findings demonstrate how government policies and SME interests can be aligned to achieve the net zero carbon emissions target. For instance, the evidence from the study lends support to various policies and white papers issued by the UK government aimed at supporting businesses, especially SMEs, to deal with the ongoing energy crisis and reduce their carbon footprint, such as the 2020 Energy White Paper on 'Powering our net zero future' and the UK Prime Minister's ten-point plan for a green industrial revolution. In particular, the ten-point plan sets out the approach the UK government will take to build back better, support green jobs, and accelerate the path to net zero. The UK government has made several grants and schemes available in the energy market to help businesses cope with the global energy crisis. The UK government's scheme in 2022 resulted in lower energy rates for non-domestic energy users, including SMEs, non-profits, and government agencies, shielding them from growing energy prices (BEIS, 2022). The study's findings also provide useful policy implications to regulators in other countries who have signed up for a net zero emissions target, for example, China by 2060 and India by 2070.

The study also suffers from some limitations, including (i) focusing on SMEs in the Tees Valley region, (ii) using a moderately small sample of respondents, (iii) adopting neo-institutional theory and (iv) concentrating on the UK context. As a result, researchers should exercise caution when generalizing our findings to larger firms or firms in other countries. For example, the findings may or may not compare with those of developing economies with different climate-related policies and institutional settings. Nevertheless, the limitation of our study offers avenues for future research employing SMEs in developing or emerging markets. Future research may provide new insights by examining whether these relationships hold in large and publicly traded firms. Finally, we analyse the interrelationship among entrepreneurial energy efficiency orientation, identification of green barriers, green planning, green networking, selection of green innovation approaches, and carbon footprint reduction based on quantitative data collected from SME owners and managers and do not consider other information that might reflect actual practices and performance. In this regard, future studies might conduct comprehensive case studies and interviews with founders, owners, managers, investors and other stakeholders to provide new insights on carbon footprint reduction initiatives. Next, an inadequate number of studies investigated UK SMEs on carbon footprint reduction initiatives (Crossley et al., 2021). Thus, future research may undertake a more significant scale cross-country quantitative SME study, subdividing it into industry and SME size. This could help better understand the EEEO dynamics of various specifically targeted SMEs. Finally, this study adopted a neo-institutional theoretical position to identify SMEs' commitment to carbon footprint reduction initiatives. In this case, future studies may embrace additional theoretical avenues to advance understanding of the EEEO-CFR associations, which can go beyond economic efficiency and legitimisation perspectives.

CRediT authorship contribution statement

Douglas A. Adu: Conceptualization, Methodology, Investigation, Writing – original draft, Funding acquisition, Project administration, Supervision, Visualization, Formal analysis, Resources. **Xihui Haviour Chen:** Conceptualization, Data curation, Validation, Writing – review & editing, Funding acquisition, Supervision, Software, Visualization, Data curation, Investigation, Resources, Project administration. **Mudassar Hasan:** Conceptualization, Methodology, Investigation, Software, Writing – review & editing, Funding acquisition, Supervision, Visualization, Resources. **Xiaoxian Zhu:** Supervision, Writing – review & editing, Funding acquisition, Resources. **Nugun Jellason:** Writing – review & editing, Resources.

Declaration of competing interest

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Data availability

Data will be made available on request.

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