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Drivers of sustainable business model innovations. An upper echelon theory perspective

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ABSTRACT

This study explores the factors that drive the adoption of sustainable business model innovations (SBMIs). In this mixed-method (qualitative and quantitative) study, we draw on upper echelon theory to identify the factors that have led firms to switch from conventional products and processes to sustainable business innovation. This study of senior managers uses qualitative data to understand the mechanisms adopted by top management to make the switch to SBMIs. Data was gathered from 285 middle managers to empirically validate the theoretical model. The study concludes that in the top management team (TMT), ambidextrous learning has a positive association with the firm's decision to adopt SBMIs. However, TMT diversity and university-industry collaboration are positively associated with ambidextrous learning by top management and, subsequently, the adoption of SBMIs. Our findings also suggest that transformational leadership positively moderates the association between TMT diversity and ambidextrous learning. However, the impact on the relationship between collaboration and ambidextrous learning is negative.

1. Introduction

Over the last few years, sustainable business model innovations (SBMIs) have become important contributors to sustainable development (Velter et al., 2022). These innovations promise the conservation of the natural environment (Joyce and Paquin, 2016). SBMIs involve the fusion of societal and environmental issues into the core innovations of the firm (Bocken and Geradts, 2020) to mitigate reputational risk and build transparency into its activities (Macmillan, 2020). SBMIs have the potential to generate new revenue streams for the firm and reduce the overall cost of operations (Weidner et al., 2021). Likewise, adopting SBMIs improves organizational resilience (Buliga et al., 2016) and reputation (Homburg et al., 2013), keeping the firm ahead in the race to meet stakeholder concerns (Fobbe and Hilletofth, 2021; Schaltegger et al., 2012).

SBMIs offer various benefits, and there is a growing inclination among top management to rethink their profit-making business models to incorporate elements of sustainability (Zhu and Liu, 2021; Stubbs and Cocklin, 2008). However, for these initiatives to be impactful, organizations need to break from an incremental and localized approach toward holistic change across the organization and address its broader context (Adams et al., 2016). Incorporating such changes requires a fundamental shift in the way organizations conceptualize the purpose of business and reengineering every process of that business (Osterwalder and Pigneur, 2010).

The literature on SBMIs is still in its nascent stages, with most work being exploratory in nature (Bashir et al., 2022). Prior studies on SBMI have primarily focused on understanding the concept (Bashir et al., 2022), identifying its sub-components (Shakeel et al., 2020), understanding its roots in business model innovation (BMI) (Minatogawa et al., 2022), and building an integrated SBMIframework (Pan et al., 2022; Sinkovics et al., 2021). There is little prior research on understanding the antecedents of SBMI, which has been recognized as an important research gap to be addressed (Minatogawa et al., 2022).

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Furthermore, even when the antecedents of SBMI have been identified, they have not been tested empirically (Pan et al., 2022; Sinkovics et al., 2021).

While sustainability-led innovations are increasingly becoming imperative, businesses have typically perceived such innovations through a liability prism, considering pro-environmental concerns to be sunk costs and unnecessary. There is little in the extant literature on business models addressing environmental challenges (Pedersen et al., 2018), but there is evidence of organizations failing to develop a meaningful and deliberate strategy for addressing sustainability issues (Dyllick and Hockerts, 2002). For instance, the operationalization of sustainable development and model building within organizations is still weak (Stubbs and Cocklin, 2008). In fact, SBMI is regarded as key in integrating environmental sustainability and value creation logic in firms (Lüdeke-Freund, 2010); however, academic inquiry into the drivers of such innovation is limited at present.

While there is literary evidence available on how BMIs could be leveraged to deliver sustainability (Stubbs and Cocklin, 2008), there is no comprehensive model delineating the antecedents of firms embedding sustainability in their core business processes. While there is evidence that firms are increasingly taking up SBMIs (Ritala et al., 2018), the factors leading to the adoption of such initiatives have not been considered. Of the limited efforts in this direction, Bocken and Geradts (2020) have identified the drivers and barriers of SBMIs, but there is little clarity in their model as to the path that firms can follow to incorporate SMBIs. Other studies have focused on building an all-encompassing theoretical framework without offering empirical proof of the factors that drive the adoption of SBMIs (Pan et al., 2022; Sinkovics et al., 2021).

Scholars argue that organizational innovation is a strategic issue and is likely to be influenced by the top management team (TMT) in the firm (Slater et al., 2014; Wang and Dass, 2017). Nevertheless, research efforts in this direction are yet to pick up. TMTs are considered an important driver of BMI (Ni et al., 2022). While the role of the TMT is a well-established factor in BMIs (Esau and Piening, 2022; Narayan et al., 2021; Zhang and Zhu, 2022), it is not well understood in the context of SBMI.

Most strategic decision-making is done at the TMT level (Talke et al., 2011), and senior managers should have the ability to acquire new knowledge and simultaneously refine their existing knowledge and skills. While university-industry collaborations look promising (Arvanitis et al., 2008; Plewa et al., 2013), their role in transferring critical knowledge and skills to TMTs has not been well explored. Similarly, researchers have empirically validated the role of team diversity in the adoption of innovative ideas (Homberg and Bui, 2013; Talke et al., 2011; Auh and Menguc, 2005), but the role of diversity in ingraining an exploratory and exploitative learning orientation in the TMT has not been explored. Moreover, while most innovations seem clearly motivated by firms' economic interests, the way TMT diversity enables SBMI in the firm requires theoretical and empirical validation.

Prior literature has examined the phenomenon of SBMI from the perspective of organizational capabilities and resources by drawing upon theories such as dynamic capability (Bashir et al., 2022; Guo et al., 2022) and stakeholder (Guo et al., 2022) theory. Understanding SMBI requires going beyond resource and stakeholder-based approaches (Shakeel et al., 2020). Upper echelon theory has previously been used in the context of BMI (Chen, 2022; Ni et al., 2022; Narayan et al., 2021). As SBMI often provides organizations with new direction (Guo et al., 2022), upper echelon theory can be useful in the context of SBMI as the role of top management in achieving these outcomes is critical (Hambrick and Mason, 1984). Furthermore, upper echelon theory views complex and strategic decisions as a function of behavioral factors rather than the objective calculation of economic optimization (Hambrick and Mason, 1984).

There are, therefore, several gaps in the extant literature regarding SBMIs. First, there is scant literature on the antecedents of SBMIs. The few studies focusing on the factors influencing the adoption of SBMIs, merely list these drivers. This does not offer a clear picture of how these factors drive the adoption of SBMIs. Second, prior studies do not offer empirical proof of the mechanism by which the factors identified drive the organizational adoption of SBMIs. Third, existing studies focus on organizational capabilities and resources to explain SBMIs, and there is an urgent need to look beyond the dynamic capability theory and stakeholder theory to explain the adoption of SBMIs.

The present study aims to fill these gaps by exploring and empirically examining the factors that help TMTs to successfully adopt and refine SBMIs. Data are collected using a mixed-method survey design; the technique offers unique insights (Pollok et al., 2019; Grimpe et al., 2017), allowing an understanding of the mechanisms adopted by firms to learn and refine knowledge and skills. As the antecedents of SBMI are not well-established, we conducted an inductive study to identify the factors that drive SBMI in an organization. The qualitative study is followed by a quantitative study to empirically validate the association of the factors with SBMI adoption. In particular, the paper examines the relationship among two antecedents, namely TMT diversity (TMT*D*) and university-industry collaboration (*UIC*), a mediating variable, TMT ambidextrous learning (*TMTAL*), and the outcome variable *SBMI*, with transformational leadership (*TL*) acting as a moderating variable.

This study contributes to extant literature on SBMIs in three ways. First, we identify various antecedents to the adoption of SBMIs in organizations. These antecedents include factors internal to the organization such as TMT diversity, transformational leadership, TMT ambidextrous learning as well as factors that involve external collaborations between the organization and universities. The study thus offers a clear view of how organizations drive their effort toward SBMIs.

Second, this is the first study to identify and empirically test the antecedents of SBMIs in organizations. We use a robust mixed-method design wherein we first identify the factors leading to SBMIs using qualitative methods. Based on our analysis of the qualitative data, we formulate a framework for SBMI, which is then empirically tested using the quantitative method. Third, we have moved beyond the perspective of organizational capabilities and resources to explain SBMIs using upper echelon theory, which offers a valuable perspective on the role of the TMT in adopting SBMIs. From a practitioner's perspective, the results provide insights regarding the sustainability mindset of organizations, which should be dominant among the upper echelons. This mindset needs to be integrated with the organization's BMIs.

2. Background literature

2.1. Sustainable business model innovation

BMI is at the intersection of innovation and value creation and has been the subject of growing interest in the recent past (Spieth et al., 2014). BMI is increasingly considered a critical driver of firm performance. While providing a holistic understanding of the ways in which a firm does business (Beattie and Smith, 2013), BMI technically aims to create new forms of economic value generation that are sufficiently radical to change the existing competitive landscape (Ireland, 2001).

In recent years, tackling pollution and other environmental sustainability issues have found their way into BMIs, with organizations incorporating sustainable innovations at the very core of their business models (Lüdeke-Freund et al., 2016). A sustainable business model involves creating and delivering superior economic value using an inclusive approach where firm interests and larger societal issues are addressed simultaneously (Lüdeke-Freund, 2010). Therefore, SBMI is not restricted to innovations in a particular domain (e.g., technological, process, or product innovation); rather, it pertains to the fundamental architecture of an organization and requires a holistic approach to BMI (Lüdeke-Freund et al., 2016).

An SBMI is a combination of BMI and a sustainable business model (Shakeel et al., 2020). In SBMI, the principles of sustainable value and

value innovation are combined while keeping the spirit of the business model at heart (Shakeel et al., 2020). At a functional level, SBMIs are based on the triple-bottom-line approach where the environment and society are considered important stakeholders, and their interests must be considered alongside the desire for economic profits (Stubbs and Cocklin, 2008). This has led to stakeholder and value-network perspectives in the realm of BMIs. Customers, suppliers, society, and the environment at large are seen as active agents in this change. Therefore, value is no longer restricted to the firm; its creation and capture are extended to all stakeholders, with collaborative ties (Beattie and Smith, 2013) and sustainable business models becoming the order of the day (Evans et al., 2017). SBMIs exhibit the firm intent to combine environmental, social, and economic value (Shakeel et al., 2020).

Prior literature describes SBMI in several ways that capture its components and sub-components (Shakeel et al., 2020). For instance, Lüdeke-Freund et al. (2018) proposed a detailed taxonomy for SBMI wherein 45 SBMI types were classified into 11 groups, including ecological, social, and economic dimensions of sustainability that led to value creation in various ways. Joyce and Paquin (2016) presented the triple-layered business canvas model to conceptualize SBMI, which included value proposition, value creation and delivery, and value capture. Bocken et al. (2014) proposed eight archetypes of SBMI based on the idea of optimization. Prior studies also indicate that there can be several drivers of SBMI, including infrastructure management, customer interface, and financial elements and the product that can help in developing SBMI (Rauter et al., 2017).

Firms are increasingly reshaping their product and service offerings by "servitizing" their value propositions, taking an active part in the upkeep and recycling of products, and thereby ensuring a reduction in hazardous waste disposal (Pecorari and Lima, 2021). SBMIs have simultaneous effects; they create a competitive advantage and improve the quality of human life (Garetti and Taisch, 2012). SBMIs are intended to introduce significant changes to the firm's way of doing business, including its value creation, capture, and delivery activities, but with the overarching goal of leaving a positive impact or reducing the overall negative impacts on the environment and society (Bocken and Short, 2016). However, the extent to which firms combine innovation and sustainability in their products depends on the industry in which it is engaged (Shakeel et al., 2020). For instance, while both technological and agricultural firms would engage in innovation and sustainability, the tilt toward sustainability may be more relevant for agri-product firms (Shakeel et al., 2020).

Though the performance implications of a sustainable BMI are well documented, the important challenge for an organization is its successful adoption and refinement. MNCs are still hesitant to adopt SBMIs (Ritala et al., 2018; Evans et al., 2017), which could be explained by the organization's lack of dynamic capabilities in the form of access, absorption and refinement of critical knowledge and lack of diversity in at the TMT level (Eisenhardt and Martin, 2000; Teece, 1998).

SBMIs are strategic in nature and essentially concern change management, which is the domain of the organization's top management. The effective implementation and refinement of SBMIs are ensured when TMTs possess the capabilities to explore and exploit knowledge while engaging in strategic decision-making (Ferraris et al., 2018) so that. Ties to external networks such as UICs play a significant role in determining ambidexterity and performance of firms engaging in SBMIs; organizations may not possess the abilities to ensure a steady flow of new knowledge and radical ideas, which are crucial for tackling the issues of pollution and other environmental challenges (Dezi et al., 2021).

2.2. Upper echelon theory

TMTs, higher-level managers, and CEOs, whose cognitive structures and value preferences influence an organization's strategic choices, are known as the upper echelons (Chuang et al., 2009). Strategic choices often have a behavioral component reflecting the idiosyncrasies of decision-makers (Hambrick and Mason, 1984). This points to the important role of the cognitive base of top managers, including their knowledge of future events, available alternatives, and the potential consequences of each strategic choice (Hambrick and Mason, 1984). These idiosyncrasies influence how executives frame decision situations and tend to limit their perceptions of situations. In upper echelon theory bounded rationality is the main decision-making logic among executives.

While upper echelon theory has not been applied in the context of SBMIs, it has been used in prior studies to explain the relationship between TMT and other organizational outcomes. One desirable characteristic of those in the upper echelon is entrepreneurial cognition, which positively affects proactive and reactive BMI during so-called "black swan" events such as COVID-19 (Ni et al., 2022). Observable demographic characteristics of CEOs influence the nature of CSR activities in the hospitality industry (Lee et al., 2018b). In addition, a firm's business model moderates the impact of TMT competence on organizational performance (Patzelt et al., 2008). The theory has also been used to understand the role of the TMT in BMI by small and medium enterprises in the printing and publishing industry (Narayan et al., 2021).

As a strategic organizational decision, SBMI warrants substantial capital investments with a strong commitment from top management (Cuerva et al., 2014). It is also argued that organizations need to improve their capabilities to carry out such endeavors successfully (Tseng et al., 2013), which signals the role of top management in planning and implementing SBMI. SBMI requires radical change at the core of business processes to ensure coordinated technological and social innovations rather than an incremental change to counterbalance the negative consequences of business activity (Bocken et al., 2014). The corporate sector is gearing up organizational resources and capabilities toward the development and adoption of SBMI in the wake of tightening regulations, climate change, and a crisis of social legitimacy (He and Jiang, 2019).

There is a growing body of research that supports the role of top management in adopting pro-environmental strategies (Nadeem et al., 2020). An organization's attitude toward environmentalism and sustainable development depends on the diversity of the top management team in terms of gender (Nadeem et al., 2020), age (Fabrizi et al., 2014), and self-efficacy (Arena et al., 2018). This is particularly important for environmental innovation, where diversity in perspectives enables diversity in business action (He and Jiang, 2019). This makes the lens of upper echelon theory a logical choice for the current study, which examines how the adoption and outcomes of initiatives taken for sustainability at the broad organizational level depend upon the strategic choices made at the top. The current study draws upon the upper echelon theory to understand various factors that drive SBMIs in organizations.

2.3. Top management team diversity, TMT ambidextrous learning and business model innovation

TMT diversity refers to the demographic and cognition-based heterogeneity in the TMT (Simons et al., 1999). Over the years, scholars have distinguished the different types of diversities that exist in groups. Among the more noticeable is job-relatedness diversity, which is the extent to which unique factors relevant to a particular task are accounted for (Pelled et al., 1999). Along similar lines, Simons et al. (1999) have examined four kinds of TMT diversity factors including age, educational level, tenure, and functional background.

Apart from age, the other three demographic factors; educational level, tenure, and functional background, are considered job-related as they capture task related cognitive aspects (Williams and O'Reilly, 1998; Pelled, 1996). While age may reflect the level of an individual's experience, such experience level constitutes a marginal portion of the total experience level, and therefore age is considered less job-related than

the other factors (Zenger and Lawrence, 1989). In this study, we include gender diversity as a critical factor shaping team dynamics (Lee et al., 2018a) since it enforces a wide range of acceptable behaviors in teams (Kanter, 1977). Moreover, social sensitivity among women helps debates and disagreements on controversial topics occur in a more supportive and trusting manner (Post et al., 2019; Woolley et al., 2010).

TMT diversity can help firms by exposing them to information about environmental issues through different stakeholder groups, including customers, suppliers, competitors, and policymakers (Khatib et al., 2021). Having a diverse set of individuals in the TMT intensifies productive discussions within the group on the firm's existing business practices and the future potential of particular innovations (García-Meca et al., 2015). TMT diversity helps the firm gain critical resources, and knowledge and build network ties, which, in turn, facilitate organizational innovation (Galia et al., 2015). Likewise, diverse TMTs have been shown to take up riskier projects and implement novel business models which have the potential to alter the course of the firm (Abebe and Myint, 2018).

Addressing the challenges of the growing strains on the natural environment requires that organizations invest in both exploitative and explorative organizational learning (Oehmichen et al., 2017). The ability of an organization to pursue these simultaneously is known as ambidextrous learning (Bresciani et al., 2018; Ferraris et al., 2018; O'Reilly and Tushman, 2013), and helps avoid the competency and failure traps of an exclusive focus on one or the other orientations (Tang et al., 2020). Ambidextrousness has a positive impact on BMIs (Ferraris et al., 2018). The exploitation-exploration duality helps organizations develop synergies among existing resources and capabilities with rapid experimentation and discovery of opportunities, enabling them to address the changing environmental conditions (March, 1991). This makes an ambidextrous-learning orientation among top management particularly important in the context of environmental sustainability.

However, ambidextrous learning is a strategic matter and requires a change of mindset, the presence of the appropriate culture, resource commitments, and structural reengineering within an organization (Heracleous et al., 2017). Since the control of such strategic decisions, including innovation, mainly lie with those in the upper echelon of management, the implications of a diverse TMT seem clear. It is the top management that is in charge of identifying innovation opportunities, implementing strategic plans, and allocating resources to balance exploration and exploitation (Ben Rejeb et al., 2019). In support of this, Oehmichen et al. (2017) emphasized the expertise and knowledge level of directors as critical to balancing this exploration-exploitation conflict. Diversity among TMT members is important in overcoming groupthink, broadening the knowledge base of the team, and facilitating ambidexterity (Almor et al., 2020).

In the same vein, SBMI is dependent on organizational commitment to sustainability, which again hinges on the unique characteristics of top management. An organization's commitment to sustainable development depends on top management's support including diverse stakeholder groups in framing organizational policies (He and Jiang, 2019). This suggests that a diverse and heterogeneous TMT will ensure that complex issues pertaining to society and the environment are not neglected, and innovative solutions are developed (Nadeem et al., 2020). Therefore, greater TMT diversity allows for the growth of pro-environmental initiative among team members, which will result in the adoption and refinement of SBMI. In line with the above arguments, it is hypothesized:

H1. TMT diversity has a positive association with ambidextrous learning in the TMT.

H2. TMT diversity has a positive association with firms' SBMI.

2.4. University-industry collaboration, TMT ambidextrous learning and sustainable business model innovation

Knowledge and technological resources are considered critical as they enhance the firm's overall innovative success (Paroutis et al., 2015; Papadopoulos et al., 2013; Decarolis and Deeds, 1999). While inflows of external knowledge have become increasingly important in the innovation process, this is facilitated by the establishment of collaborations with universities (Kogut and Zander, 2009). Universities are not only effective in creating new knowledge and technologies but also work toward resolving different social and economic issues (Laredo, 2007; Metcalfe and Ramlogan, 2005). Several organizational innovations have been developed in universities and then transferred to firms through rights purchases or other licensing and incubation agreements (Fan et al., 2019). These collaborations create new opportunities for firms in terms of radical and incremental innovations, which is why they are supported by an increasing number of firms (Herrera et al., 2010; Ahuja et al., 2008; Yli-Renko et al., 2001). As TMT members are responsible for most of the strategic decisions of the firm vis-à-vis radical and incremental innovations, it requires learning new knowledge and refining previously learned knowledge; university collaborations can support this.

Therefore, building on the qualitative results, we posit that TMT members, in order to maintain a steady flow of innovative ideas, team up with universities through different collaborative agreements to gather critical knowledge. This knowledge would not only help them in pursuing radical innovation but also in refining their existing offerings. Moreover, as universities are increasingly focusing on developing technologies that help address sustainability issues, it has a huge potential for firms as they can adopt such technologies to initiate changes in their overall business model. While such innovations and solutions are secured by IP rights (Fan et al., 2019), having collaborative agreements can allow firms to achieve a first-mover advantage. As the competition between firms is intensifying, firms having exclusive rights to sustainable innovations developed through university collaborations can adopt such technologies faster and gain a competitive edge over rival firms. In line with the above arguments, we hypothesize that:

H3. UIC has a positive association with TMTAL.

H4. UIC has a positive association with firms' SMBI.

2.5. Mediating role of TMT ambidextrous learning

BMI refers to the design of the firm's content, structure, or governance to create value by way of continuous exploitation of opportunities (Amit and Zott, 2001). It encompasses a system of different independent activities, such as the choice of customers, products, or service offerings (Casadesus-Masanell and Ricart, 2010; Zott et al., 2011). As the environment is becoming ever increasingly polluted, customers are becoming aware of their consumption practices and are demanding products that are environmentally sustainable (Yalabik and Fairchild, 2011). Likewise, there are increasing calls for the adoption of sustainable business practices from different stakeholders, including the government, NGOs, and the media (Li and Ding, 2013; Shen et al., 2020).

While innovating the overall business model to suit such demands may sound easy, overcoming the challenges associated with radical technologies often requires a complex learning strategy (Koen et al., 2011). As strategic decision-making is driven by TMTs in firms (Hambrick and Mason, 1984), having knowledgeable team members is essential for appropriate decisions. It is reasonable to believe that a TMT orientated toward exploring new knowledge while exploiting previously learned knowledge would significantly help in initiating and refining sustainability-oriented changes to the firm's business model.

The pursuit of ambidextrous learning in the TMT is strengthened by the inclusion of a diverse set of members in terms of age, educational qualification, and functional background (Smith and Tushman, 2005).

Although diversity is likely to prove effective in SBMI, ambidextrous learning in the TMT plays a significant role; regular modifications and course correction in the firm's strategies are necessary once such changes are initiated. Diverse TMT members not only bring new knowledge but also engage in meaningful dialogues and discussions that keep the firm aligned to exploitation strategies (Edmondson, 2002; LePine and Van Dyne, 1998).

University collaboration also significantly enhances the knowledge of TMTs and, in turn, helps them to make better decisions. University-produced knowledge and innovation are acquired by firms for financial gain and to stay ahead of the competition (Arvanitis et al., 2008). As universities have shifted their focus to sustainable innovation, adopting and integrating such technologies in an efficient manner requires a robust set of individuals in the firm's TMT. TMT members are often confronted with the need to make decisions to refine existing products and processes or initiate radical changes in the firm's overall business model. As such, they look for knowledge and innovation support from external partners, of which universities are the most promising. Therefore, firms are increasingly entering collaborative agreements with universities to gain access to new knowledge and innovations or to learn newer ways of refining their existing product offerings. As the TMT is primarily responsible for the firm's strategic decisions and shapes its future course of action, collaborative innovation with universities could help them develop an ambidextrous learning orientation to properly initiate SBMI in the firm and to make refinements as they proceed.

H5. TMT ambidextrous learning has a positive association with the firms' SBMI.

H6. TMT ambidextrous learning mediates the positive association between TMT diversity and firms' SBMI.

H7. TMT ambidextrous learning mediates the positive association between university collaboration and firms' SBMI.

2.6. Moderating role of transformational leadership

Transformational leaders are inspirational, considerate, charismatic, and intellectually stimulating (Bass, 1986). Leaders with transformational characteristics are change agents who challenge the status quo (Nemanich and Vera, 2009) and promote ambidextrous learning, which includes exploratory and exploitative learning (Vera and Crossan, 2004). While most firm strategies are shaped by the TMT, having a CEO with a transformational focus allows members to freely and simultaneously pursue exploratory and exploitative learning.

Moreover, a transformational leader can initiate changes in the TMT composition to allow for a more diverse TMT, which assists the firm's ambidextrous learning, an essential factor in the adoption, alignment, and refinement of BMIs. Transformational leaders also facilitate university-industry collaboration; such agreements bring new knowledge to the firm while also helping with the refinement of existing knowledge and skills. As transformational leaders have a higher inclination to restructure the firm's overall business model, any factor that helps realize this will gain their support. Therefore, it is worthwhile to assume that transformational leaders will significantly improve the positive impact of TMT diversity and university-industry collaboration on the TMT's ambidextrous-learning orientation. Accordingly, we hypothesize that:

H8. Transformational leadership moderates the positive association between TMT diversity and TMT ambidextrous learning.

H9. Transformational leadership moderates the positive association between UIC and TMT ambidextrous learning.

3. Methods

We have employed a multi-method approach, employing a literature review, a qualitative study using open-ended essays, and a cross-sectional survey. The use of multiple methods is necessary as the antecedents of SBMI are not well-established in the literature (Minatogawa et al., 2022). Further, research in SBMI is still in its nascent stage (Bashir et al., 2022). Under such conditions, the use of exploratory research as the first empirical investigation is necessary (Troise, 2022; Talwar et al., 2020). We performed a thematic analysis of the results obtained from the qualitative study. Four themes extracted from the thematic analysis were identified as the drivers for SBMIs in organizations. These drivers were further incorporated into the conceptual model based on a thorough analysis of prior literature (Table 1, Fig. 1).

3.1. Qualitative study

This study utilized an open-ended essay method to unravel the various factors that play a key role in the firm's decision to switch from polluting products and processes to SBMIs. This study was inductive in nature, and data was obtained using open-ended essays. Data collection through the open-ended essay method offers rich insights into data, which is why it is popular among social science and management researchers (Nasution et al., 2020; Salahuddin and Romeo, 2020; Talwar et al., 2020). We used the Prolific Academic platform to collect data from 22 senior managers with significant experience in strategic decision-making working across different manufacturing firms in the United Kingdom (UK). While collecting data, we only included firms that transformed their operations in environmentally friendly ways.

Participants worked across a range of industries, including food and beverages, building and construction, alternate fuel and energy technologies, aerospace, and the auto industry. Their experience varied from 11 to 30 years. Of the 22 participants, one refused to share data, and one failed the attention test. The remaining responses from 20 participants were used for thematic analysis. Participants were asked to provide a detailed response to predefined questions, which focused on a) SBMIs of the firm; b) the role of top management in the adoption of SBMIs; c) issues and challenges faced by TMT members in explorative and exploitative learning activities related to such innovations; and d) strategies adopted by firms to help transition toward SBMIs. A detailed participant profile is presented in Table 2.

3.2. Data coding and analysis

Guided by the principles of grounded theory, two researchers analyzed the data generated through the open-ended essays to extract

Table 1
Definition of the constructs.

Construct	Definition
TMT diversity; Simons et al. (1999)	TMT diversity is the heterogeneity in the TMT demographic characteristics and cognitions, including age, educational background, tenure, and functional background.
TMT ambidextrous learning; O'Reilly and Tushman (2013)	TMT ambidextrous learning is the ability of TMT members to simultaneously pursue both exploration and exploitation in organizational learning
University-industry collaboration; Rajalo and Vadi (2017)	Collaborative agreements between firms and university researchers to find innovative solutions.
Sustainable business model innovation; Bocken et al. (2014)	Innovating the overall value chain in an organization with the aim of attenuating the ill effects or strengthening the positive impact of firm's offerings on the environment and society.
Transformational leadership; Bass (1986)	A transformational leader is a person who creates a positive change among their followers by idealized influence, individualized consideration, inspirational motivation, and intellectual stimulation.

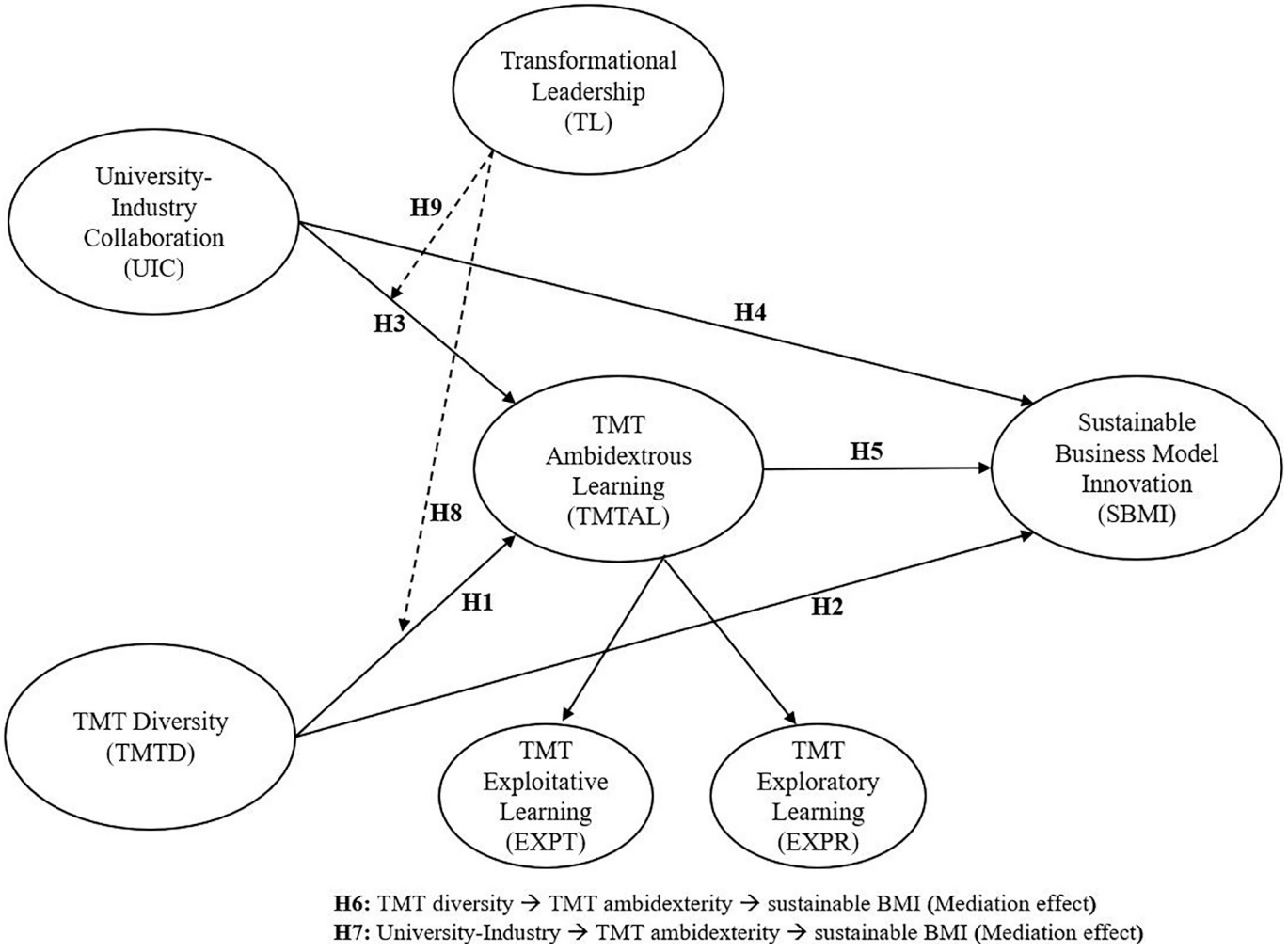

Fig. 1. Conceptual model of the study.

Table 2
Participant profile for qualitative research study.

Participant ID	Gender	Age	Location	Total work experience	Firm products	Number of employees
P1	M	29	UK	6	Opioid addiction drugs	250
P2	M	51	US	30	Medium voltage switchgear	200
P3	M	55	UK	2	Medical devices	1900
P4	M	48	UK	31	Electroplated components	20
P5	M	53	US	3	Various mainly batteries, torches	4500
P6	M	33	US	5	Food and beverages	499
P7	M	33	UK	6	Reprocessed plastics	30
P8	M	29	US	6	Opioid addiction drugs	250
P9	F	24	US	3	Tech products	60
P10	M	37	UK	6	Variety of flavored and natural drinks.	4500
P11	M	32	UK	6	Fleet solutions, manufacturing retail	5000
P12	F	32	UK	8	Apps to book shifts	2000
P13	M	20	UK	1	Various medications	100
P14	F	28	UK	4	Sport clothes	13
P15	M	30	UK	8	Metal castings	249
P16	M	41	UK	2	Car parts	77
P17	M	22	UK	1	Flow sensors	7
P18	M	31	UK	8	Sofas	350
P19	M	42	UK	16	Advertising campaigns	300
P20	M	31	US	2	Rentals, parking.	200

commonalities (Beyer and Holtzblatt, 1998). The Gioia method of analyzing data (Gioia et al., 2013) was used to bring rigor (Troise, 2022). The first-order codes were first drawn from the raw data using a sentence-by-sentence analysis (Laasch, 2018). From these first-order codes, we drew second-order codes, thereby moving from the participants' voices toward theorization. Finally, the second-order codes were combined into aggregate codes (Ferraris et al., 2019). The data structure for the qualitative study is presented in Fig. 2.

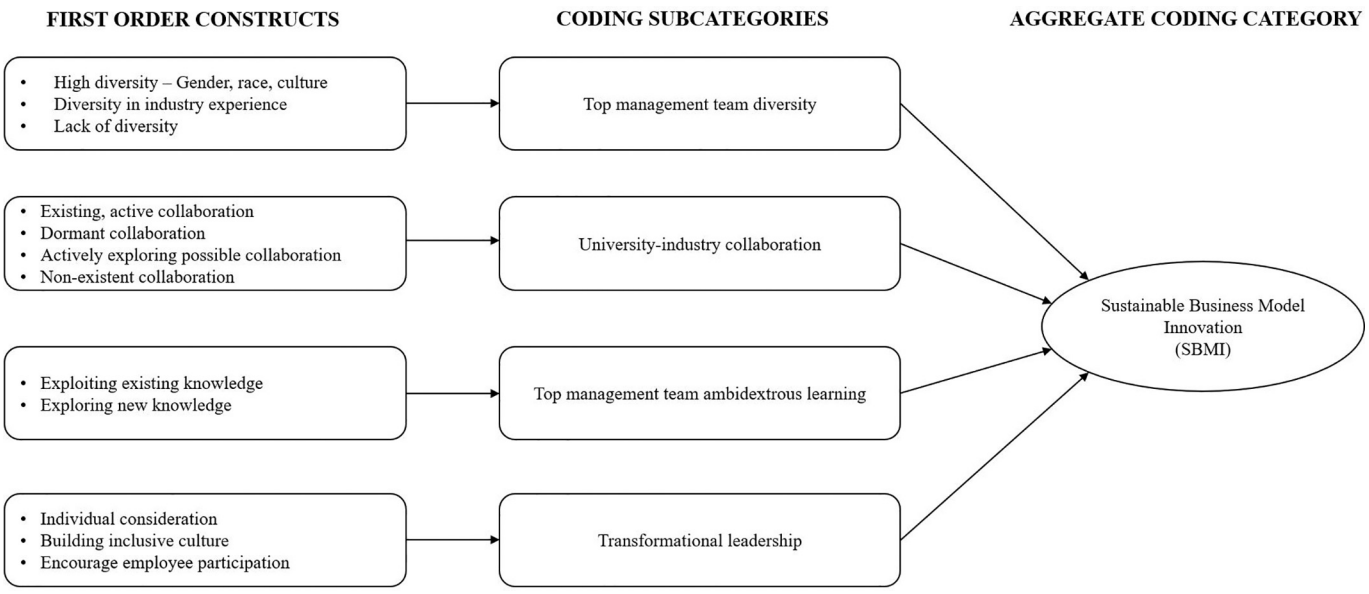

Fig. 2. Data structure for qualitative research study.

Two researchers independently coded the respondents' statements in the initial phase of coding. In the second phase, we held frequent Zoom meetings to compare and discuss the codes to achieve inter-coder reliability. Following the recommendations of Gilgor and Autry (2012), the discrepancies in codes were further discussed and analyzed in an iterative manner until a consensus was reached among the researchers. Open and axial coding was conducted through QDA Miner, which allowed the researchers to code the transcripts independently and subsequently merge the files into one text to compare the codes. The discrepancies in coding were reconciled through each analyst's memos, which set out justifications for the thematic coding of particular statements. Using this method, we were able to extract themes to build our conceptual model.

We used the qualitative data obtained to identify various drivers of SBMIs. Based on the thematic analysis, we identified four drivers for SBMIs, namely, TMT diversity (TMT*D*), University-industry collaboration (*UIC*), TMT ambidextrous learning (*TMTAL*), and transformational leadership (*TL*). The qualitative data was used as input by adapting the items in each construct related to TMT*D*, *UIC*, *TMTAL*, and TL. An item pool was generated representing the four factors driving the adoption of SBMIs in organizations. The item pool was reviewed by two experts, from academia and industry, to adjust and map each item to the drivers of SBMIs.

3.3. Quantitative study

A cross-sectional survey was undertaken to examine the hypotheses. Data was collected from manufacturing firms based in the UK using the Prolific Academic platform. In selecting the sample, we sought responses only from those firms that had previously initiated changes in their products, processes, or business model to incorporate an element of sustainability. As this survey was conducted online, a check question asking respondents whether their firm had initiated any environment-friendly changes in their offerings was included in the instrument; this allowed the data for non-relevant respondents to be removed at the time of analysis. During our preliminary data examination, we identified 26 respondents belonging to firms that had not incorporated any such changes and removed these from the dataset, leaving a stable sample of 285 for data analysis.

Middle managers were targeted to fill the questionnaires as they are responsible for executing, and were thus appropriate for assessing, the firm's strategic decisions (Klein et al., 2021; Spanjol et al., 2012). The participant firms belonged to various industries: aerospace (10.9 %), automotive (13 %), food and beverages (4.2 %), fuel and energy (9.1 %), furniture and fittings (9.8 %), industrial supplies (11.2 %), pharmaceuticals (4.9 %), textiles and apparel (9.5 %), building and construction (13.3 %), electrical & electronics (14 %). The final set of 285 respondents had, on average, more than ten years of experience and included a fair mix of genders, with women amounting to 41.4 % of the total respondents.

3.4. Measures

Established measures were used to measure the various study constructs. Five items were used to measure TMT*D* and included items on age variation, areas of experience, nationalities, and gender diversity (García-Meca et al., 2015; Pelled et al., 1999). *UIC* was measured with eight items and included questions like "has your firm entered into research collaborations with universities" (Bellini et al., 2019). Nine items were used to measure SBMIs, and respondents were asked to indicate how well their firm had radically innovated in environmentally friendly ways in the last three years (Pedersen et al., 2018). *TMTAL* was measured as a higher-order construct of exploitation and exploration. Team exploratory learning included five items on the acquisition of new knowledge, and exploitative learning included five items on recombining and refining existing knowledge (Jansen et al., 2016). *TL* was measured with seven items and included items on the leadership qualities of the CEO (Carless et al., 2000). One question each was also included in the instrument to gather information about firm age, firm size, and industry type to control for these in our structural model. A five-point Likert scale was used to record responses with anchors ranging from (1) strongly disagree to (5) strongly agree (Figs. 4 and 5).

4. Results

4.1. Qualitative study

The analysis of qualitative data helped us uncover four firm factors that helped in achieving SBMI: TMT diversity, university-industry collaboration, TMT ambidextrous learning, and transformational leadership. In addition, our qualitative study results enabled us to better understand SBMI as a concept.

4.1.1. TMT diversity

The findings of our qualitative study indicate that TMT diversity was

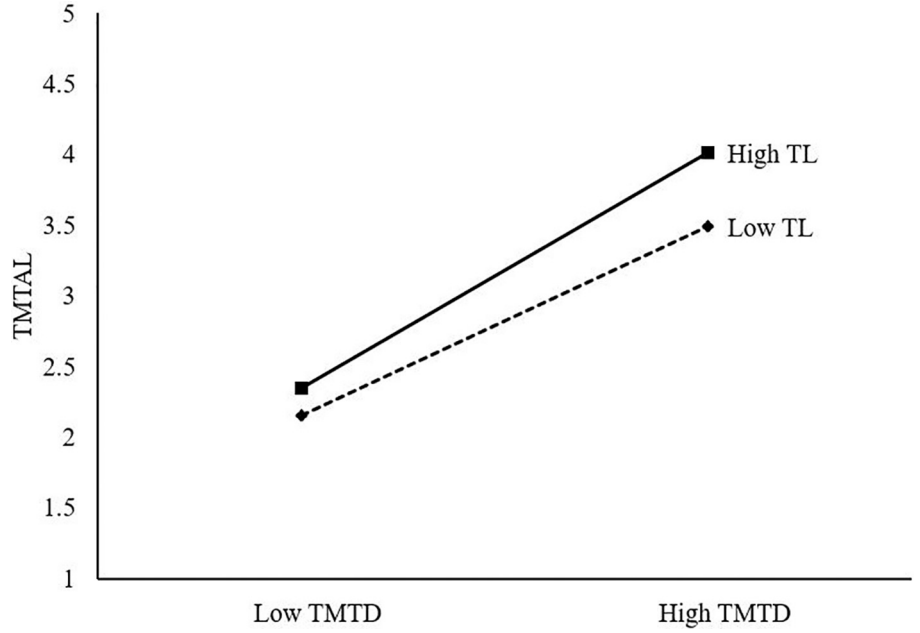

Fig. 4. Graphical representation of the moderating influence of transformational leadership on TMT diversity and ambidextrous learning.

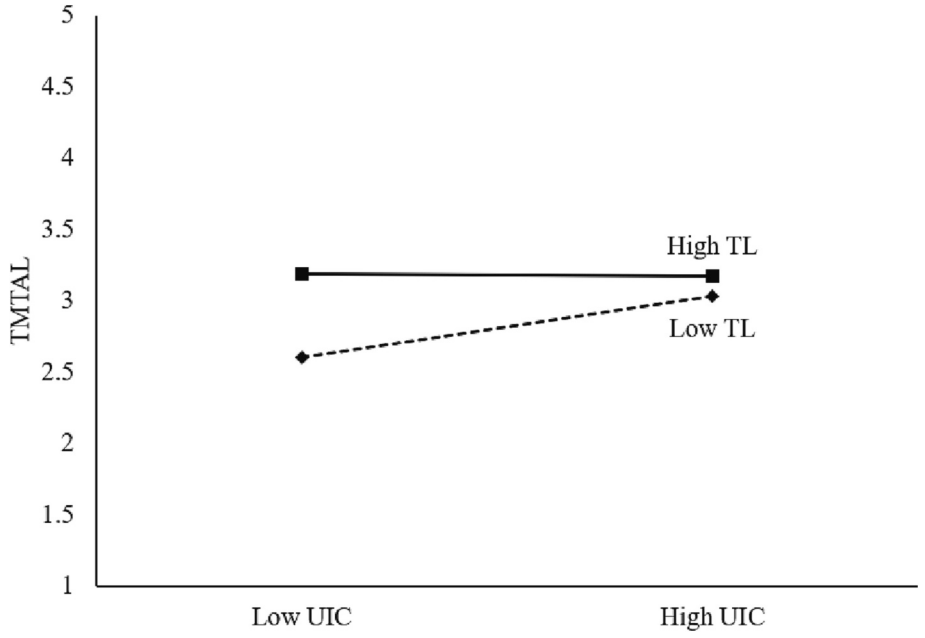

Fig. 5. Graphical representation of the moderating influence of transformational leadership on university-industry collaboration and top-management ambidextrous learning.

high in some firms and low in others. It was also indicated that diversity comprised several variables including gender, industry experience, years of experience, culture, race, and academic background. Therefore, in organizations were diversity was encouraged, the diversity among the TMT members was high and rich:

> Our management team is fairly diverse. It is 60/40 men to women. Some of us have many years of experience and some of us are fairly new to management and new to the industry. There is a wide age range from about 30 years old to one of our team members who is nearing retirement age. Some of our team have 20 or more years of experience working in the plastics industry, while Amanda is brand new, but she brings skills from her previous jobs.
>
> (P7)

Another participant spoke about how a culture of diversity exists and is actively encouraged in his organization:

> The leadership team is very diverse. It is comprised of people from a number of different walks of life and also different cultures and races. It is also split quite evenly between men and women. Diversity and inclusion are important in my company and is constantly reviewed at all levels. In addition, this forms part of the content on our annual employee survey and the results are published at all levels. Also, it is pretty diverse in terms of ages.
>
> (P5)

One participant spoke about how their TMT's diversity was built through years of effort, and describes this journey by saying:

> The team became more diverse over the next years. We now have almost 50 % woman in the board, and the average age got younger (CEO is 41). While most have an advertising background, people from tech companies such as Google and Facebook were recently added.
>
> (P19)

Another participant spoke of the lack of TMT diversity by stating how his organization had similar members on the TMT. He commented with skepticism:

> Our TMT is not diverse at all. There are 5 directors. All are men with degrees, over the age of 55. They all also have degree-level qualifications. Their skill sets are also very similar and come from the same manufacturing background and share the same experiences. The chairman of the company is also a man. He is over 80 years old.
>
> (P15)

The participant further notes that while the TMT is likely to be recomposed soon, they are likely to "most likely look for similar candidates to themselves" (P15).

4.1.2. *University-industry collaboration*

Participants spoke about different stages of university collaboration to further the SBMI agenda in their organizations. While some participants said that their organizations were actively collaborating and exchanging knowledge with universities, some said their organizations had no such plans. Some participants also spoke about existing collaborations that were inactive, and others mentioned that their organization was actively exploring the possibilities. One spoke about how UIC helped his organization strengthen SBMI:

> Yes, we contribute to environmental and safety standards and are a proactive part of a number of associations. This has proven beneficial and is also a good way to share learnings and best practice. We also contribute to these organizations sharing research findings where we can. We also highlight issues and share the discussion on looking at potential solutions etc.
>
> (P5)

Another participant spoke about how the UIC is dormant and has not helped much in SBMI:

> We do have links with universities however there is not much work between us on a regular occurrence. They seem to be very protective of their work and we as a company have to just through a few difficult hurdles to gain access. I believe larger corporate businesses have easier access because the university can gain more from them than a much smaller SME.
>
> (P15)

Therefore, university-industry collaboration ranges from no collaboration, the "non-existent state," to an "active state," where knowledge is actively exchanged between the organization and the university (Fig. 3).

4.1.3. *Top-management-team ambidextrous learning*

Several participants spoke about how their firm's top management was actively involved in ambidextrous learning, exploiting existing knowledge while also seeking new knowledge. One spoke of how top management engaged in two-way communication, thus amplifying the sustainability efforts of the organization:

> Yes – this is not seen any more just as something to leverage for internal and external communication, but rather as something that potentially can have a positive impact on revenues as well, both because it can generate efficiencies (cost reductions) and amplify the effect of communication reaching potential customers sensitive to the topic.
>
> (P19)

One of the participants spoke about exploring and exploiting knowledge within the organization in the context of SBMI:

> With inclusion of the environmental and sustainability director the environmental department discuss ideas within themselves and also speak with local government authorities to see which innovations would be the most beneficial to implement. A top five list is drafted up and a time period to implement such innovations is given to each item on the list.
>
> (P 15)

Another participant spoke about how knowledge of environmentally friendly products emanates from within as well as outside the organization, thus allowing the firm to exploit and explore knowledge:

> Management decides everything. We save electricity in the company, we provided ourselves with additional machines by spreading the work out and using less energy in the production process, we have introduced ecological paper in the company and ecological packaging for shipment of products to customers, and we give the leftover materials to art schools … introduction of a product line made of ecological materials, purchase of ecologically saving sewing machines, acquiring customers who place emphasis on ecology. This is how we significantly adapt our products to ecological solutions. We produce lines of ecological products we establish cooperation with companies with similar values also.
>
> (P14)

4.1.4. *Transformational leadership*

Participants spoke about how leaders used their position to generate positive influence within the organization. One of the participants spoke about the manner in which the CEO was empathic and caring toward him and gave him individualized consideration:

> He has great faith in his teams, even to entry level employees and is very willing to hear all new ideas and suggestions in terms of how the company can improve. He is a very approachable person and will always take time to have 1-2-1 discussions with people (no matter who they are). I myself was able to arrange one of these individual

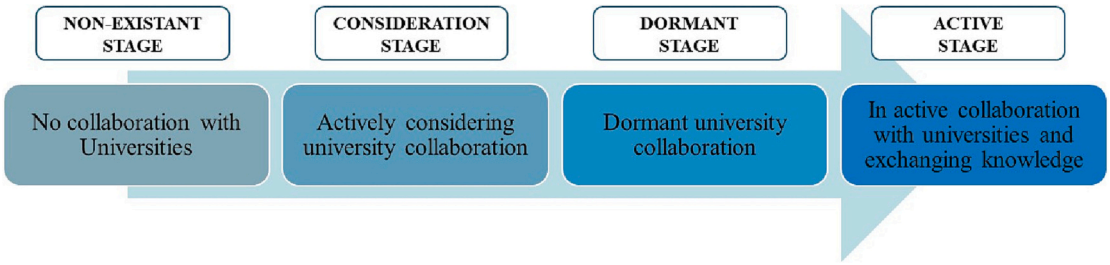

Fig. 3. Stages of university-industry collaboration.

chats previously when I wanted to discuss something, and he was open and willing.

(P12)

Another spoke about how the top management encouraged employees to participate in sustainable innovations, thus fostering a positive culture in the company:

The CEO is a very versatile person. He is the creative brain of the firm; however, he relies heavily on subordinates for creative tasks as well. As was my case when the sealing problem was delivered to me, and I was in charge of finding an innovative solution

. (P 17)

A middle-aged participant spoke about how he admired his CEO:

I really agree with his activities and how he does his job, he is a good role model. Mainly your profile is to get the results to reach the desired numbers, period. However, an extra aspect in your favor is that you are not limited to just doing your tasks. On his own initiative, he (the CEO) decides to ensure that all his staff are carrying out their activities in the best way possible.

(P 10)

4.1.5. Sustainable business model innovation

Participants spoke about various types of SBMIs undertaken by their organizations under its current leadership. One spoke about recycling as an important activity added by involving several members of the value chain:

The production chain not only ends when the products are channeled to their respective distributors, once the product is consumed, the bottles are collected thanks to a program to attract these resources with which the cycle can be renewed once more time.

(P15)

Another participant spoke about the agility in SBMI owing to the small size of the firm:

Since it is a relatively small company, there are no major opportunities for disruptive changes. However, as mentioned earlier, this is an ongoing process. A material that has been used previously and that can be proved that its use has a negative impact on the environment or that there is a more sustainable solution, is replaced immediately in future projects.

(P17)

Participants also spoke about the enthusiastic reception of sustainable products by top management:

We have launched a few new products that are very green, and these have been embraced by leadership.

(P3)

One of the members of the TMT noted the kind of SBMIs that thrived under his leadership:

We have developed a number of pro-environmental BMIs in the past 5 years. First, power saving. About 5 years ago we implemented a lighting switching system that is based primarily on motion sensors. There is no reason that warehouse lights need to be on in the whole warehouse. So, parts of the warehouse and offices are dark (when not being used). The most recent power savings happened when we switched from florescent lighting to LED throughout our office/warehouse. Second, we have diverted material away from the landfill.

(P 7)

In sum, the qualitative study identified four variables – TMT*D*, *UIL*, *TMTAL* and *TL* – that played a role in helping firms switch to SBMIs.

4.2. Quantitative study

As we have employed a single-respondent study design, there are potential risks of common method bias (Podsakoff et al., 2003). Method variance leads to measurement errors and thus has a negative impact on the validity of the results of a study (Campbell and Fiske, 1959). To check for common method bias in our dataset, we utilized Harman's single-factor test and found that the single factor explained only 31 % of the variance, which is well below the threshold limit suggested by Podsakoff et al. (2003), leading us to believe that common method bias is not an issue in this study.

We also controlled for issues of social desirability bias by encouraging the informants to freely provide their responses (Nederhof, 1985). More specifically, the survey instrument began with an explanation of the purpose of the study and that the responses collected would be subjective and would vary according to the perceptions of the informants. The anonymity of the informants was maintained by not including any questions that could be used to track them or their firm. This procedure helped put the informants at ease and ensured that there was greater objectivity in the collected responses.

We also assessed the constructs for normality through skewness and kurtosis tests, and the results for which were well within (±1, ±3) the threshold (Hays, 1983). Similarly, the constructs were also examined for any multicollinearity, and the VIF values below 5 indicated the absence of multicollinearity among our constructs (Hair et al., 2010).

4.2.1. Scale reliability and validity

To assess the dimensionality of the constructs, we conducted a series of confirmatory factor analyses (CFA). In the initial run of the CFA, we specified the four main constructs and 32 observed variables and excluded several items during the various iterations until the model fit improved significantly. After the exclusion of *EXPR5, EXPT5, BrD4, BMI7, UIC8,* the model fit indices revealed $\chi^2 = 2.17$, *CFI* = 0.95, *IFI* = 0.95, *TLI* = 0.94, *RMSEA* = 0.064 which are within the acceptable limit (Hu and Bentler, 1999). Once the model fit threshold was achieved, we examined the reliability and validity of the constructs. The reliability of the constructs was assessed through composite reliability in the CFA, and the values above 0.8 indicate that the indicators of the latent constructs are internally consistent (Bagozzi and Yi, 1988).

The validity of the constructs was examined through convergent and discriminant validity tests. Convergent validity was established through the average variance extracted (AVE), listed in Table 3, from which it is clear that a minimum threshold limit of 0.5 was achieved. Discriminant validity was assessed through the Fornell and Larcker (1981) criteria which mandate the square AVE loadings for each construct to be greater than its inter-construct correlations. The square AVE loadings extracted in Table 4 clearly support this proposition.

4.2.2. Hypothesis testing

We ran several structural models to analyze the various hypotheses. In the first model, TMT*D*, *UIC*, *TMTAL*, and *SMBIs* were included along with the control variables. *TMTAL* included TMT exploration and exploitation as the two first-order factors. The model fit indices ($\chi^2 = 2.09$, *IFI* = 0.94, *CFI* = 0.94, *TLI* = 0.93, *RMSEA* = 0.062) were well within the acceptable threshold (Hu and Bentler, 1999). The standardized beta coefficients (Table 5) from TMT*D* to *TMTAL* ($\beta = 0.76$) is significant at $p < 0.01$, which lends support to the Hypothesis 1. Similarly, the standardized beta coefficient from TMT*D* to *SBMI* ($\beta = 0.43$) is also positive and statistically significant at $p < 0.01$, supporting Hypothesis 2. *UIC* also has a positive association ($\beta = 0.13$) with *TMTAL*, and the results are statistically significant at $p < 0.05$, which proves Hypothesis 3. *UIC* also has a positive association with *SBMI* ($\beta = 0.24$, $p < 0.01$), which leads us to accept Hypothesis 4. The statistics also reveal that *TMTAL* has a significant positive association with *SBMI* ($\beta = 0.37$, $p < 0.01$), which proves Hypothesis 5. While firm age and industry type did not have any effect on the adoption of SBMIs, firm size had a minor

Table 3
Internal consistency and converged validity construct.

Construct	Items	Estimate	CR	AVE
TMTAL	EXPR	0.82	0.86	0.76
	EXPT	0.92		
TMTD	TMTD1	0.78	0.90	0.69
	TMTD2	0.85		
	TMTD3	0.89		
	TMTD5	0.80		
BMI	BMI1	0.79	0.92	0.59
	BMI2	0.76		
	BMI3	0.69		
	BMI4	0.80		
	BMI5	0.77		
	BMI6	0.74		
	BMI8	0.81		
	BMI9	0.75		
UIC	UIC01	0.87	0.96	0.81
	UIC02	0.87		
	UIC03	0.94		
	UIC04	0.92		
	UIC05	0.93		
	UIC06	0.94		
	UIC07	0.82		
EXPR	EXPR1	0.79	0.91	0.72
	EXPR2	0.80		
	EXPR3	0.89		
	EXPR4	0.90		
EXPT	EXPT1	0.81	0.91	0.73
	EXPT2	0.85		
	EXPT3	0.88		
	EXPT4	0.87		

Table 4
Descriptive and correlational scores.

	Mean	SD	UIC	TMTD	SBMI	TMTAL
UIC	2.01	1.04	0.90			
TMTD	2.80	0.91	0.25	0.83		
SBMI	2.49	0.74	0.35	0.48	0.76	
TMTAL	3.24	0.94	0.32	0.79	0.54	0.87

Table 5
Results of the structural model.

Structural paths	β	se	t	p
Firm age → SBMI	−0.02	0.05	−0.32	NS
Firm size → SBMI	0.04	0.06	0.62	NS
Industry type → SBMI	−0.06	0.06	−0.96	NS
TMTD → TMTAL	0.76	0.05	15.16	***
UIC → TMTAL	0.13	0.06	2.35	**
TMTAL → TMT exploratory learning	0.82	0.04	20.55	***
TMTAL → TMT exploitative learning	0.93	0.03	27.24	***
TMTAL → SBMI	0.37	0.14	2.73	***
TMTD → SBMI	0.43	0.06	6.65	***
UIC → SBMI	0.24	0.06	4.00	***

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

but positive effect.

We followed the recommendations of Baron and Kenny (1986) to test for the mediating effect of *TMTAL* on the relationships between TMT*D* and *SBMI* and between *UIC* and *SBMI*. Accordingly, a bias-corrected bootstrap with 95 % confidence intervals was specified. The results (Table 6) show full mediation for the relationship between *TMTD* and *SBMI* as the direct path in the presence of the mediator; *TMTAL* dropped out of significance, which lays support for Hypothesis 6. Hypothesis 7 is partially accepted as the direct relationship between *UIC* and *SBMI* in the presence of the mediator is still statistically significant. Although the direct relationship in the absence of the mediator and the indirect

Table 6
Mediation analysis.

	Direct effects without the mediator		Direct effects with the mediator		Indirect effects	
	β	C.R	β	C.R	β	p
TMTD → SBMI	0.43	6.65 (***)	0.15	1.06 (NS)	0.28	***
UIC → SBMI	0.24	4.00 (***)	0.19	3.38 (***)	0.05	***

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

relationship through *TMTAL* is statistically significant, we can only conclude that there is no support for full mediation.

We ran a separate model to test for the moderating impact of *TL* on the relationship between TMT*D* and *TMTAL* and between *UICs* and *TMTAL*. The results, in Table 7, reveal that the *TL* positively influences the impact of *TMTD* on *TMTAL*, which supports Hypothesis 8. However, *TL* has a negative influence on the relationship between TMT*D* and *TMTAL*. Although the impact is statistically significant, we fail to accept Hypothesis 9 as the results run counter to our theorization (Figs. 4, 5).

5. Discussion

The objective of this study was to identify a mechanism that firms can use to address environmental issues through the adoption of SBMIs (Bogers et al., 2020; Ferraro et al., 2015). Utilizing upper echelon theory, we identified four factors that influence the adoption of SBMI in organizations. The framework theorized that the ambidextrous-learning orientation of the TMT will positively influence the SBMIs in a firm, and having a diverse TMT and appropriate university collaborations in place will positively influence the ambidextrous learning of TMT members. Moreover, we also theorized that the presence of a transformational leader would positively strengthen the positive influence of TMT diversity and university-industry collaboration on TMT ambidextrous learning.

Three separate models were run to empirically test these hypotheses. The results reveal that TMT diversity has a positive influence on both TMT ambidextrous learning and SBMIs. This conforms with prior research suggesting that TMT diversity positively impacts BMI (Reficco et al., 2021; Zona et al., 2013). Moreover, as it was found that the TMT's ambidextrous learning mediates the positive relationship between TMT diversity and SBMIs, it can be said that diversity at the TMT level will lead to intense discussions on different strategic issues of the firm, which would positively influence the exploitative learning capabilities of the TMT members (García-Meca et al., 2015). Similarly, the presence of a diverse set of individuals brings new knowledge, skills, and creativity to the firm, which would positively influence the exploratory learning potential of TMT members (Galia et al., 2015). The joint impact of this explorative and exploitative learning potential by way of TMT ambidextrous learning would significantly improve the adoption and refinement of SBMIs in the firm (Ferraris et al., 2018).

Furthermore, university-industry collaboration has a positive influence on TMT ambidextrous learning and SBMIs. This is in line with prior literature, indicating that external collaborations foster ambidexterity

Table 7
Moderation analysis.

	Estimate	S.E.	C.R	P
TMTD * TL → TMTAL	0.08	0.021	3.80*	***
UIC * TL → TMTAL	−0.11	0.024	−4.70	***

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

and organizational performance (Dezi et al., 2021). As most strategic decision-making in firms is entrusted to TMTs, it requires the acquisition of new knowledge and the refinement of previously learned knowledge. Moreover, keeping up with pro-environmental regulations has become a challenge for incumbent firms as they lack the innovations and knowledge to address such regulations. Universities, on the other hand, have and continue to develop innovations that end up being adopted by firms (Fan et al., 2019). As universities are increasingly developing radical and incremental innovations, firms are cashing in by entering into collaborative agreements with them to acquire new knowledge and to refine their previously learned knowledge in order to stay ahead in the marketplace (Herrera et al., 2010; Ahuja et al., 2008; Yli-Renko et al., 2001). Such agreements not only help the firm to adapt and refine the SBMIs but also help their TMT members to maintain an ambidextrous learning orientation.

We also found that transformational leadership amplifies the positive impact of TMT diversity on TMT ambidextrous learning. Firms with such leadership tend to adopt new approaches rapidly as the TMT members are free to think in radical ways (Vera and Crossan, 2004). Transformational leaders change the organization's status and incorporate necessary changes in the TMT's composition. Such changes go a long way in shaping the strategic orientation of the firm and influencing its sustainability innovations. However, our analysis showed that transformational leadership negatively impacts the positive influence of university-industry collaboration on TMT ambidextrous learning. While this goes counter to our theorization, it is not impossible to imagine transformational leaders going against these collaborative agreements. Although transformational leaders are intellectually stimulating (Bass, 1986), in their quest to transform the way the firm acquires new knowledge, they may steer the firm in a different direction and embrace a closed innovation model focused on developing innovations in-house.

5.1. Theoretical contributions

This study makes several significant contributions to the literature on SBMI. The first contribution of the study is to identify the antecedents that drive SBMI in an organization. This was one of the main gaps in the literature that required further explication (Minatogawa et al., 2022). Due to the paucity of literature identifying antecedents, we used a multi-method approach and first identified the factors that lead to SBMI in an organization, thereafter empirically testing these to understand how they relate to the adoption of SBMI. This is significant as prior literature focused on establishing an integrative SBMI framework with antecedents and outcomes that lacked empirical validation (Pan et al., 2022; Sinkovics et al., 2021).

Second, this study applies upper echelon theory to understand the adoption of SBMIs, thereby moving beyond resource-based (Shakeel et al., 2020), dynamic capability (Bashir et al., 2022; Guo et al., 2022) and stakeholder (Guo et al., 2022) theories that dominate earlier studies. Furthermore, the study applies upper echelon theory (Hambrick and Mason, 1984) to the context of SBMIs, thus extending its application beyond BMI (Chen, 2022; Ni et al., 2022; Narayan et al., 2021). The application of upper echelon theory is clearly useful in understanding the role of the TMT in driving the adoption of SBMIs.

Third, this study theorized TMT diversity as a unique construct that influences strategic decision-making by the TMT. However, each demographic variable is a unique theoretical construct and may have a different influence on the firm's outcomes (Tang et al., 2020). By adopting an inductive approach, we have been able to develop a nuanced understanding of several factors identified in the research. For instance, TMT diversity comprises elements such as gender, age, varied experience, culture, race, and industry experience. The inductive study design also clarified the differences in TMT diversity; some participants indicated the lack of TMT diversity in their organizations. While there is a consensus among the researchers on the influence that TMT diversity has on the strategic decisions of the firm (Carpenter et al., 2004), there is still a need to delve deeper into the different components of TMT diversity so that their causal impact on the firm's strategic decision-making may be examined. Therefore, this research goes beyond the demographic diversity observed in the TMT (Lee et al., 2018a; Simons et al., 1999) by identifying new elements of TMT diversity including race, culture, variations in industry-wide experiences. Moreover, as indicated by the findings of this study, while the performance implications of diverse TMTs have received significant attention, researchers should also focus on unraveling the factors that may inhibit the restructuring of TMT from incorporating elements of diversity in them.

Fourth, the study contributes to prior literature in SBMI by identifying the role of university collaborations in driving SBMI adoption in organizations. While universities play an important role in resolving social and economic issues (Laredo, 2007; Metcalfe and Ramlogan, 2005), this study identified their role in contributing knowledge and innovative solutions to firms and positively influence the TMT ambidextrous-learning orientation. Furthermore, we were also able to draw upon various stages of collaborations of firms while forming such collaborative partnership with universities. Though we still have a limited understanding of the mechanisms through which such collaborative agreements turn fruitful for both industry and academia, this study has been able to clearly explicate the role of such university-industry collaborations in driving SBMIs. While such collaborative agreements may bind the firm to share critical information with the university research team, the manner in which the firms secure the risks of information leakage has not been explored. Likewise, the innovations developed as a result of such collaborations may face the same risk. Researchers are therefore required to explore the risks inherent in these collaborative mechanisms and the strategies that firms can adopt to overcome such challenges.

Lastly, this research study attempts to unravel the mechanisms adopted by TMTs to acquire and refine knowledge required for the successful implementation of SBMIs through an open-ended survey, the results of which were then theorized and verified by quantitative survey analysis. Although we ensured a robust process of open-ended data collection which forms the basis for the overall model proposed and validated in this study, alternate factors and models may still explain the adoption mechanisms of SBMIs. Moreover, the findings of this study may be influenced by national culture and related factors, which have a greater influence on the way individuals from a particular geography act at the workplace (Hofstede, 2016).

5.2. Managerial implications

This study has some important managerial implications. First, this study identifies several factors that drive the adoption of SBMIs in firms. Firms can invest in these capabilities, develop and nurture them to adopt SBMI. This will enable them to attain sustainable development for their firms (Velter et al., 2022). Moreover, these factors assume greater importance as developing sustainable and responsible solutions are the next big imperative for firms (Bogers et al., 2020).

Second, this study draws upon the upper echelon theory to hypothesize the positive role of TMT diversity and university-industry collaboration on the TMT ambidextrous-learning orientation. As TMT diversity has a positive influence on TMT ambidextrous-learning orientation and SBMIs, leadership should look at restructuring the TMT to incorporate elements of diversity in it. Having a diverse TMT will facilitate rigorous discussions on environmental sustainability issues while at the same time bring new knowledge and skills to the firm. Moreover, as TMT members get to know each other and they develop a deeper bond among themselves, negative biases are reduced (Ling et al., 2015; Harrison et al., 2002), which in turn should facilitate cooperation and support for radical ideas geared toward environment-friendly innovations.

Third, leaders in organizations that want to realize SBMIs should initiate collaborative agreements with research universities and look for

possibilities to develop radical or incremental innovations that address environmental pollution and related issues. Although the results reveal a possible negative impact of transformational leadership on the relationship between university-industry collaboration and TMT ambidextrous learning, collaborations still have great potential in terms of knowledge and innovation. The firm's leadership should focus on active agreements with universities and work toward ensuring that a member of the TMT is entrusted with being in close touch with the university to monitor progress. Such an arrangement will not only keep the research team on track but will also ensure rigorous discussions within the TMT on the various issues and challenges of SBMIs, as well as the investments and structural changes required to incorporate and refine such innovations.

6. Conclusion

This study identified and described the nuances of four antecedents – TMT diversity, university-industry collaboration, TMT ambidextrous learning, and transformational leadership – of the adoption of SMBI in organizations, applying upper echelon theory to explain the relationships.

As with any study, this has its limitations, which warrant proper acknowledgment so that future researchers can address them. First, our inclusion of only manufacturing firms can limit the generalizability of our findings; an investigation involving services firms may offer unique insights into that sector. Second, as the study's sample was taken from UK-based firms, its findings are limited to this context, and similar studies in other contexts may supplement the findings here. Third, while typical UK firms have a fairly diverse mix of employees, countries in the developing world still lag in workplace diversity. This gap could be addressed by future studies examining TMT diversity in detail to unravel the factors that help firms in such settings switch to sustainability-oriented innovations. Fourth, while diversity at the TMT level has various unique elements, future studies could look at the individual impact of different diversity factors on ambidextrous learning of the TMT and the adoption of SBMIs. Fifth, although university-industry collaboration has huge potential for both industry and academia, researchers should also understand and examine the various risks inherent in these efforts.

CRediT authorship contribution statement

Amandeep Dhir: Supervision, Conceptualization, Research Method & Validation, Review & Editing.

Sher Jahan Khan: Conceptualization, Methodology, Data Curation, Formal analysis, Writing – Original Draft.

Nazrul Islam: Supervision, Conceptualization, Research Method & Validation, Review & Editing.

Peter Rectham: Supervision, Review & Editing.

N. Meenakshi: Research Method & Validation, Review & Editing.

Data availability

Data will be made available on request.

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