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What Do We Know About How Companies Manage Waste? The Effect of Tenure and Diversity of Directors on Disclosures

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ABSTRACT

This paper aims to analyze the effect of board tenure on firms' waste management disclosure and explore whether this effect is amplified by board gender and cultural diversity. The analysis is based on data from 832 large firms worldwide from 2011 to 2020. We draw on a multi-theoretical framework combining the Upper Echelons Theory (UET), Resource Dependence Theory (RDT), and the Resource-Based View (RBV) as our main theoretical underpinnings and complementing them with entrenchment theory, gender socialization theory (GST), and imprinting theory. The results indicate that board tenure positively affects waste management disclosure and that board diversity strengthens the direct impact of tenure on the waste information firms disclose to stakeholders. These results are robust to variations in methodological specifications. Additionally, the amplifying role of the health crisis triggered by the COVID pandemic is identified.

1 | Introduction

In words of the United Nations' Secretary General António Guterres, "every minute, the equivalent of one garbage truck full of plastic is dumped into the ocean. Meanwhile, pollution and chemicals are poisoning our water, air and soil. And a staggering 10% of all global greenhouse gas emissions come from growing, storing and transporting food that is never used" (United Nations 2023). According to the World Bank, total global waste generation is projected to be 3.40 billion tons by 2050, with approximately 50% originating from industrial sources (World Bank 2019). Furthermore, projections indicate that e-waste generation will increase significantly from 62 billion kilograms in 2022 to 82 billion kilograms by 2030 (United Nations 2025).

However, significant disparities exist across industries and regions (United Nations Environment Programme—UNEP 2015). At the country level, waste production has been linked to increased population and economic activity, with the largest projected increases occurring in Sub-Saharan Africa and South Asia (United Nations Environment Programme—UNEP 2024). In the European Union (EU), Finland had the highest waste per capita in 2022, with an average of nearly 20 tons per inhabitant (the latest data available from Eurostat). This figure is four times higher than the EU average of five tons per person and is primarily due to the large amount of mineral waste generated by mining and quarrying activities. At the sectoral level, the construction sector contributed 38.4% of the EU's total waste in 2022, followed by mining and quarrying (22.7%), waste and

water services (10.5%), manufacturing (10.4%), and households (8.9%). The remaining 9.2% came from other economic activities, primarily services (5.2%) and energy (3.0%) (Waste Statistics—Statistics Explained—Eurostat 2024).

These trends are associated with a variety of negative health and environmental impacts, ranging from accelerating climate change and biodiversity loss to causing health problems and exacerbating global resource inequalities (United Nations Environment Programme—UNEP 2015). Indeed, according to the United Nations Environment Program (UNEP), each year, between 400,000 and 1,000,000 people die from diseases such as malaria and cancer caused by mismanaged waste, a problem that also leads to other health issues, including hypersensitivity, reproductive impairment, increased birth defects, and endocrine disorders (United Nations Environment Programme—UNEP 2024). Additionally, waste causes soil, air, and water pollution; contributes substantially to climate change through greenhouse gas emissions; and endangers wildlife and marine life (United Nations Environment Programme—UNEP 2024).

Furthermore, the COVD-19 pandemic had a huge impact on waste generation, as efforts to curb its spread led to an increase in all types of waste across all industries, making the challenge of sustainable waste management even more pressing (Tripathi et al. 2020; Hantoko et al. 2021; Kaza et al. 2021; Singh et al. 2022). Although the urgency of waste management is global and requires measures at all stages of product life cycles; more efficient, longer product and material use; and doubling global recycling capacity from 660 to 1200 million tons, the challenges vary by industry and region (United Nations Environment Programme—UNEP 2015; Abubakar et al. 2022). For instance, sub-Saharan Africa and South America need the most significant increases in recycling capacity and investment in waste management infrastructure (eight and five times the current capacity and investment, respectively) (United Nations Environment Programme—UNEP 2024).

In response to this pressing issue, the circular economy concept has gained prominence (Sharma et al. 2021) as a systemic approach to economic development that emphasizes the sustainable use of resources and the minimization of waste (Gull et al. 2024; Mesjasz-Lech 2025). At the core of the circular economy lies the principle of the waste hierarchy (Aibar-Guzmán et al. 2023), which ranks waste management strategies according to their environmental desirability, starting with prevention, followed by reduction, reuse, recycling, recovery, and as a last resort, disposal (European Commission 2020).

As significant waste generators, firms are increasingly expected to minimize waste generation and manage it appropriately (Maia et al. 2021; Gull et al. 2023; Gavurova et al. 2026). In this sense, the circular economy principles and the waste hierarchy provide a normative framework for designing corporate strategies to decouple economic growth from resource consumption and environmental degradation (Maia et al. 2021; Aibar-Guzmán et al. 2023; Enciso-Alfaro and García-Sánchez 2025). Responsible waste management enables companies to contribute to the Sustainable Development Goals (SDGs). It allows them to help achieve SDG 12 (Responsible Consumption and Production) and Target 12.5, which aims to significantly reduce waste generation by 2030 through prevention, reduction, recycling, and reuse. Additionally, stakeholders have expressed strong interest in this issue, demanding greater transparency from companies regarding waste prevention, waste-related business impacts, and waste management practices (Gull et al. 2024; Bai et al. 2025).

Accordingly, corporate waste management and the disclosure of related information should be evaluated in terms of quantitative reductions and alignment with the waste hierarchy and circular economy principles (Maia et al. 2021; Mesjasz-Lech 2025). Corporate waste management disclosure refers to disclosing information about companies' efforts to manage waste and their performance in doing so (Maia et al. 2021; Bogdan et al. 2022; Ha and Mansi 2023). By disclosing waste management-related information, companies respond to the growing demand from stakeholders for transparency regarding how they address one of the planet's most critical environmental challenges (da Rosa et al. 2015; Shahab et al. 2022; Bai et al. 2025; Bogdan et al. 2025). Therefore, waste management-related disclosure is a key component of broad corporate environmental reporting (Ha and Mansi 2023; Centinaio 2024). Nevertheless, despite its significance, waste management-related disclosure has received limited attention in the academic literature (Adler et al. 2022; Wulansari and Adhariani 2023; Bai et al. 2025; Bogdan et al. 2025). While recent bibliometric studies (e.g., Sohel Rana et al. 2025) focus on sustainable waste management, none identify a key related to waste disclosure, leaving important gaps in our understanding of corporate sustainability disclosure practices.

Among the few studies that have examined corporate waste disclosure, Ahsan et al. (2024) recently found that high-quality corporate governance positively influences the extent and quality of waste disclosure by U.S. firms through several channels, which is a similar result to that obtained by Bai et al. (2025) in the context of S&P 500 firms. Corporate governance plays an important role in shaping firms' approaches to social and environmental challenges (Gull et al. 2024). In particular, the board of directors is a key corporate governance mechanism that determines the strategic direction and disclosure policies of the company (Benjamin et al. 2020; Buallay et al. 2022; Martínez et al. 2022), including decisions related to waste management initiatives and the transparency of related disclosures (Shahab et al. 2022; Gull et al. 2023; Bai et al. 2025). In this sense, the composition of the board of directors affects how this body performs its functions (Suttipun 2021; Toukabri and Alwadai 2024), influencing firms' environmental orientation and performance (Harjoto et al. 2015; Dodd et al. 2022), as well as the level and quality of its social and environmental disclosures (Rao and Tilt 2016; Katmon et al. 2019; Khan, Khan, and Senturk 2019; Al Amosh and Khatib 2022; Cormier et al. 2022; Bai et al. 2025; García-Sánchez et al. 2025). A few recent studies have analyzed the effect of some board characteristics on waste disclosure specifically. Abd-Mutalib et al. (2021) found no significant relationship between board size or gender diversity and e-waste disclosure in Malaysian firms. Conversely, Ahsan et al. (2024) document the positive effects of board size, independence, and gender diversity on waste disclosure by U.S. companies; and Bai et al. (2025) reported that board independence and gender diversity positively affect waste-related disclosure among S&P 500 firms.

Among board characteristics, tenure refers to the length of time a director has served on a firm's board, particularly salient due to its influence on directors' decision-making patterns and firm-specific experience (Katmon et al. 2019; Sun and Bhuiyan 2020). In this respect, the corporate governance literature emphasizes the importance of balancing the benefits of accumulated expertise and organizational learning with the potential drawbacks of excessive director tenure, which can compromise board independence (Rao and Tilt 2016; Huang and Hilary 2018; Patro et al. 2018). Although directors can gain firm-specific knowledge and experience through longer tenures, this can also lead to over-familiarity with management, which can undermine directors' independence and their ability to provide objective oversight (Sun and Bhuiyan 2020). However, despite the acknowledged importance of tenure in shaping board effectiveness (Huang and Hilary 2018; Sun and Bhuiyan 2020), compared to other board characteristics, the effect of board tenure on sustainability performance and transparency has been understudied by scholars (Patro et al. 2018; Bella and Pratama 2025; Gallego-Álvarez and Rodriguez-Dominguez 2025), and previous studies have yielded mixed results (Katmon et al. 2019; Khan, Khan, and Senturk 2019). Furthermore, to our knowledge, no prior study has explicitly investigated the impact of board tenure on waste disclosure.

This paper aims to fill this gap in the literature. Thus, our objective is twofold. First, we aim to analyze the effect of board tenure on the waste management information that firms disclose, and second, we aim to determine whether this effect is moderated by board gender and cultural diversity. Both characteristics have been shown to positively influence waste management (Shahab et al. 2022; Gull et al. 2023; Issa and In'airat 2025) and environmental information disclosure (Rao and Tilt 2016; Khan, Khan, and Senturk 2019; Haque and Jones 2020; Suttipun 2021; Martínez et al. 2022), including waste management-related information (Ahsan et al. 2024; Bai et al. 2025).

Board diversity is key to ensuring that the interests of diverse stakeholders are reflected in the board's strategic decisions (Cormier et al. 2022). It enriches board deliberations by including different values, knowledge, backgrounds, skills, and cognitive frameworks, enhancing the board's creativity and ability to solve problems and attract resources (Katmon et al. 2019). Although board diversity encompasses several dimensions, such as age, education, professional experience, and independence, we focus on gender and cultural diversity as salient forms of demographic and cognitive heterogeneity that can bring alternative perspectives, values, and problem-solving approaches to board deliberations (Martínez et al. 2022). Furthermore, in an international playing field, it has been demonstrated that gender and cultural diversity on the board can better manage global requirements (Al-Najjar et al. 2025). Therefore, it is reasonable to assume that they influence the quality and extent of information that companies disclose about their waste management activities and outcomes (Ahsan et al. 2024; Bai et al. 2025).

This study focuses on these three core dimensions (board tenure, gender diversity, and cultural diversity) for theoretical and empirical reasons (Katmon et al. 2019). Theoretically, these dimensions are consistent with the postulates of Upper Echelons Theory (Hambrick and Mason 1984), Resource Dependence Theory (Pfeffer and Salancik 1978), and the Resource-Based View (Barney 1991), which emphasize the importance of directors' experiential knowledge, demographic characteristics, and external linkages in shaping firms' strategic outcomes. Board tenure reflects the accumulation of firm-specific knowledge over time, which is critical in navigating the complexities of waste management (Patro et al. 2018). Gender and cultural diversity, in turn, represent important identity-based characteristics of directors that have been recognized as influential determinants of corporate environmental engagement (Dodd et al. 2022; Martínez et al. 2022; Gull et al. 2023; Issa and In'airat 2025), including sustainability disclosure (Khan, Khan, and Saeed 2019; Qureshi et al. 2020; Suttipun 2021; Buallay et al. 2022; Ali et al. 2025), and, in particular, waste disclosure (Ahsan et al. 2024; Bai et al. 2025).

Furthermore, their selection is based on current empirical gaps. While previous literature has examined the effects of gender and cultural diversity on environmental, social and governance (ESG) disclosure individually (Khan, Khan, and Saeed 2019; Centinaio 2024; Ali et al. 2025; Gallego-Álvarez and Rodriguez-Dominguez 2025), the interaction between these characteristics and board tenure, particularly in the context of specific environmental disclosure components such as waste management, remains underexplored. Therefore, this study aims to offer a more nuanced understanding of how internal board dynamics influence corporate transparency regarding waste management disclosure, a critical aspect of sustainability reporting (Ha and Mansi 2023; Centinaio 2024). The increasing prominence of waste in global sustainability reporting frameworks underscores its strategic importance and the need for tailored empirical research on waste disclosure and its drivers. Additionally, our focus on two understudied board characteristics—tenure and cultural diversity—addresses recent calls (Baker et al. 2020; Ali et al. 2025) to analyze other types of board diversity beyond gender diversity in relation to corporate sustainability and transparency and responds to ongoing regulatory and societal attention to gender and cultural representation in corporate governance, thereby enhancing the practical relevance of the findings.

Drawing on a panel dataset of 832 large firms worldwide from 2011 to 2020, our results show that board tenure is positively associated with the extent of waste disclosure. Furthermore, we find that gender and cultural diversity strengthen this relationship, although the combined effect of both diversity dimensions is slightly smaller than the sum of their individual effects. These results are robust to changes in methodological specifications. Notably, the results also show that the COVID-19 crisis increased waste disclosure during the study period.

To our knowledge, this is the first study to empirically test the direct effect of board tenure on waste management disclosure and to theorize and demonstrate how this relationship is contingently influenced by two distinct forms of board diversity (gender and culture), considering the possible counter-effects postulated by our multi-theoretical framework. In doing so, our study uniquely contributes to the corporate governance and sustainability reporting literatures by "unpeeling the onion" of board composition (Hillman 2015), thus responding to the call to examine how interactions among board characteristics affect their impact on environmental disclosures. We also contribute

to the sustainability literature by developing an index to measure waste management disclosure based on internationally recognized frameworks and guidelines, extending previous approaches that typically rely on limited indicators such as the amount of waste generated or recycled (e.g., da Rosa et al. 2015; Adler et al. 2022; Gull et al. 2022, 2023; Shahab et al. 2022).

Following this introduction, the Section 2 provides a brief overview of the current state of waste management reporting worldwide. The theoretical framework and hypothesis development are presented in the Section 3. The empirical design of the research is then described in the Section 4. The Section 5 presents the results of the empirical analysis, and the Section 6 presents those of the complementary analysis. The Section 7 discusses the theoretical and practical implications of the findings, and the Section 8 summarizes the main conclusions of the research and suggests some avenues for further research.

2 | Waste Management Reporting: An Overview

As companies are increasingly expected to demonstrate environmental accountability and transparency, corporate waste management information disclosure has become a growing part of the global sustainability reporting agenda (Adler et al. 2022; Ha and Mansi 2023; Bogdan et al. 2025). Among the most influential frameworks shaping such disclosures is the Global Reporting Initiative (GRI), which has progressively refined its standards to include detailed guidance on waste-related metrics (Maia et al. 2021; Lejárraga-García et al. 2024; Bai et al. 2025). Specifically, GRI 306: Waste (2020) encourages companies to disclose waste generation, composition, treatment and final disposal to promote comparability and support informed decision-making by stakeholders. It includes five disclosures for organizations to report on the waste-related impacts of their activities, both in their operations and throughout their value chain, and how they manage these impacts (both by preventing waste generation and by managing waste that cannot be avoided). The standard emphasizes the quantitative aspects of waste management and its qualitative implications, urging companies to move from a linear to a circular economy logic in managing material flows. This reflects a broader shift from mere compliance-oriented reporting to strategic communication of environmental performance.

In June 2023, the International Sustainability Standards Board (ISSB) issued the first two sustainability disclosure standards: IFRS S1, with general requirements, and IFRS S2, with specific guidance on climate change disclosure. The proposed disclosures in these standards include qualitative information about waste management policies and strategies and various metrics related to waste management (e.g., IFRS S2 Climate-related Disclosures—Appendix B: Industry-based disclosure requirements, Volume B38—Waste Management). In addition, the Sustainability Accounting Standards Board (SASB), now under the auspices of the IFRS Foundation, provides industry-specific guidance on waste management disclosures. The SASB Waste Management Standard (version 2023) outlines metrics for companies in the waste management industry, including hazardous waste management, recycling and resource recovery, and activity metrics. These standards are designed to improve the transparency and comparability of sustainability reporting across the waste management industry.

At the regulatory level, recent European Union (EU) developments have further increased the importance of waste disclosure. The EU Taxonomy Regulation and the Corporate Sustainability Reporting Directive (CSRD), which builds on and replaces the Non-Financial Reporting Directive (NFRD), establish mandatory sustainability disclosure requirements for many companies. These frameworks explicitly require disclosure of information on resource use and circularity, including waste prevention, reuse, and recycling. In addition, the European Sustainability Reporting Standards (ESRS) developed by the European Financial Reporting Advisory Group (EFRAG) operationalize these requirements to ensure consistency, reliability, and future comparability. Specifically, ESRS E5 addresses resource management and the circular economy.

These frameworks indicate a paradigm shift in which waste management is no longer a peripheral issue, but a key component of companies' environmental stewardship, risk management, and legitimacy strategies across jurisdictions (Albitar et al. 2024; Mesjasz-Lech 2025). However, despite these advances, empirical evidence shows that companies are not very forthcoming with information on waste management (Abd-Mutalib et al. 2021; Adler et al. 2022; Wulansari and Adhariani 2023).

3 | Theoretical Framework, Literature Review, and Hypothesis Development

3.1 | Theoretical Framework

Previous research (e.g., Rao and Tilt 2016; Gangi et al. 2023; Paolone et al. 2023) has used a multi-theoretical approach, combining different theories, to study the impact of board characteristics on environmental disclosure. In line with this body of work, our study draws on Upper Echelons Theory (UET), Resource Dependence Theory (RDT), and the Resource-Based View (RBV) as the main theoretical underpinnings to explain the effect of board characteristics on waste management disclosure. Furthermore, to delve into the impact of board tenure, gender diversity, and cultural diversity on waste disclosure, we turn to entrenchment theory, gender socialization theory (GST), and imprinting theory, respectively, as a complement to these main theoretical frameworks. These perspectives offer additional insight into how board composition can impact the disclosure of corporate waste management practices.

UET (Hambrick and Mason 1984) posits that directors' demographic characteristics shape their cognitive styles, influencing how they interpret strategic issues and make decisions. As a result, board composition, particularly in terms of tenure, gender, and cultural background, affects how firms perceive and respond to environmental challenges (Hambrick 2007). RDT (Pfeffer and Salancik 1978) states that a firm's tangible and intangible resources determine its performance. From this perspective, the board of directors provides firms with valuable resources and capabilities that enhance their ability to achieve competitive advantage (Hillman and Dalziel 2003). In this view, directors' tenure enhances their ability to advise and provide

resources through accumulated firm-specific knowledge and stakeholder networks (Patro et al. 2018; Sun and Bhuiyan 2020), while gender and cultural diversity strengthen the human and relational capital of the board (Haque and Jones 2020; Cormier et al. 2022), bringing different perspectives to decision-making and improving governance quality (Katmon et al. 2019). RBV complements these perspectives by emphasizing that sustainable competitive advantage arises from valuable, rare, inimitable, and non-substitutable resources (Barney 1991). In this context, director tenure and board diversity influence its advisory and resource provision role (Katmon et al. 2019; García-Sánchez, Ortiz-Martínez, et al. 2023), allowing firms to address complex issues such as sustainability and environmental reporting (Katmon et al. 2019; Haque and Jones 2020).

From the entrenchment theory perspective (Beasley 1996), board composition may generate an entrenchment effect, whereby directors take advantage of information asymmetry to make decisions that do not align with shareholder interests, resulting in poor governance (Lizares 2022). According to this view, director tenure can result in greater inflexibility and resistance to change, causing directors to distance themselves from innovative approaches (Golden and Zajac 2001; Sun and Bhuiyan 2020). According to GST (Gilligan 1982), through education, women and men internalize society's gender-specific expectations and stereotypes, which shape their attitudes, perspectives, and interests (Eagly and Crowley 1986; Eagly and Johannesen-Schmidt 2001; Carter 2014). As women have been socialized to be compassionate and caring (Moreno-Ureba et al. 2022), they are more likely to be concerned about environmental and social issues than men (Ben-Amar et al. 2017; Liu 2018; Konadu et al. 2022; Oyewo et al. 2025). Based on this theory, women directors will act in accordance with these internalized traits (Atif et al. 2020; Nadeem et al. 2020; Gull et al. 2022), and therefore, greater gender diversity on boards will promote a long-term and stakeholder orientation (Issa and Bensalem 2023), thus encouraging environmental initiatives and disclosure. Finally, imprinting theory (Stinchcombe 2013) posits that early experiences leave a lasting impression on individuals, influencing their future decisions, including those made as board members (Marquis and Tilcsik 2013), which in turn affect corporate governance, board power dynamics, and risk-taking behavior. From this perspective, the ethical orientation of boards can be influenced by the country of origin of directors and their cultural tolerance for issues such as corruption and social and environmental problems, thereby impacting risk management and governance (Abbas et al. 2025).

3.2 | Board Tenure and Waste Management Disclosure

Board tenure refers to the length of time a director has served on a firm's board (Katmon et al. 2019; Sun and Bhuiyan 2020). As mentioned earlier, the UET suggests that tenure influences individuals' cognitive framing. Thus, how directors perceive strategic opportunities and challenges is influenced by their career trajectories (Hambrick and Mason 1984), which in turn affects how their firms perceive and respond to environmental challenges (Hambrick 2007). Furthermore, tenure fosters a feeling of connection between individuals and their firms (Garrido-Ruso et al. 2023), leading directors to associate their reputation with that of their firm. From this perspective, long-serving directors may have a deeper understanding of environmental issues and long-term sustainability goals (Hambrick 2007), which facilitates the implementation of environmental policies and disclosure of environmental information (Cormier et al. 2022; Bella and Pratama 2025; Gallego-Álvarez and Rodriguez-Dominguez 2025). In turn, this would allow them to enhance their reputation by signaling their commitment to addressing the most important challenges facing the planet.

Similarly, from the RDT and RBV perspectives, longer board tenure enables directors to develop firm-specific expertise, establish internal networks, and gain insight into stakeholder expectations—all of which can bolster the board's advisory and monitoring capabilities (Huang and Hilary 2018; Patro et al. 2018; Bella and Pratama 2025). Thus, directors' tenure brings valuable resources (e.g., knowledge, experience, and networks) to the board that are instrumental in shaping the firm's sustainability strategy (Kyaw et al. 2017; Paolone et al. 2023; Bella and Pratama 2025; Gallego-Álvarez and Rodriguez-Dominguez 2025) and promoting corporate transparency (Muttakin et al. 2015).

According to these theoretical frameworks, longer tenure increases directors' involvement in strategic decisions (Carpenter and Westphal 2001; Ben-Amar et al. 2013), reduces information asymmetry (Rutherford and Buchholtz 2007), and improves disclosure quality (Donoher et al. 2007; Chan et al. 2013). Thus, long-serving directors' greater experience and knowledge are expected to enhance waste performance and disclosure. However, entrenchment theory suggests that long-serving directors may become complacent, risk-averse, or resistant to change, especially in evolving fields such as sustainability (Ben-Amar et al. 2013; Patro et al. 2018). From this perspective, long-tenured directors may prioritize short-term goals or personal agendas over corporate transparency, thereby hindering ESG reporting and performance (Bella and Pratama 2025). Consequently, long-term director tenure may hinder innovation and responsiveness in waste disclosure practices (Sun and Bhuiyan 2020).

As indicated earlier, to our knowledge, no prior study has examined the impact of board tenure on waste disclosure, and the limited empirical evidence on the effect of board tenure on corporate sustainability and ESG reporting is inconclusive (Gallego-Álvarez and Rodriguez-Dominguez 2025). Some studies report a positive effect of board tenure on environmental performance (Harjoto et al. 2015; Shabbir et al. 2020; Paolone et al. 2023; Gallego-Álvarez and Rodriguez-Dominguez 2025), while others find either negative (Handajani et al. 2014) or insignificant effects (De Villiers et al. 2011; Hafsi and Turgut 2013; Walls and Hoffman 2013; Burke et al. 2019). Moreover, Patro et al. (2018) distinguish between independent and insider directors and find that for the former, board tenure and sustainability performance are nonlinearly related, while for the latter, there is no significant relationship between board tenure and sustainability performance. Concerning sustainability disclosure, the evidence is also mixed. Rao and Tilt (2016) and Khan, Khan, and Saeed (2019) find a positive association between tenure and sustainability disclosure in Australia and Pakistan, respectively, while Khan, Khan, and Senturk (2019) report a nonsignificant

effect in the same country. Aladwey et al. (2022) show that tenure increases the likelihood of assurance for sustainability reports of UK-listed firms. More recently, Arslan et al. (2023) demonstrated that longer board tenure improves the quality of environmental disclosures, while Bella and Pratama (2025) showed that the impact of board tenure on sustainability reporting varies depending on the institutional context of each country.

Inconclusive empirical findings and competing theoretical predictions—specifically, the potential benefits of long tenure in terms of expertise and firm-specific knowledge (RDT and UET) versus the risk of entrenchment and resistance to innovation (entrenchment theory)—suggest that board tenure embodies the interplay between knowledge accumulation and independence (Huang and Hilary 2018). Consequently, the relationship between board tenure and waste management disclosure, a key component of environmental disclosure, is complex. Consequently, we adopt an approach that reflects the ambiguity in the literature and allows for an empirically grounded test without assuming a particular direction of effect (H1), while also proposing two directional hypotheses (H1a and H1b) and remaining empirically open. Thus, we propose the following hypotheses to test the effect of board tenure on firms' waste management disclosure:

H1. *There is a significant relationship between board tenure and waste disclosure.*

H1a. *Board tenure is negatively associated with waste disclosure.*

H1b. *Board tenure is positively associated with waste disclosure.*

3.3 | The Moderating Effect of Board Gender and Cultural Diversity

Strong corporate governance, such as board diversity, can offset the entrenchment effect of long-term director tenure and improve ESG disclosure by aligning directors' decisions with the interests of stakeholders (Bella and Pratama 2025). Diversity provides the board with a heterogeneous set of values, knowledge, backgrounds, and skills, which enhances its creativity and ability to solve problems and attract resources (Katmon et al. 2019) and brings new perspectives to board deliberations (Gallego-Álvarez and Rodriguez-Dominguez 2025). In this respect, directors' gender and cultural background are key drivers of differences in directors' abilities and behaviors (Gangi et al. 2023), which in turn influence their decisions and preferences (Ali et al. 2025).

The impact of board gender diversity on corporate sustainability has been widely studied (Amorelli and García-Sánchez 2021; Xu et al. 2025). According to UET, gender diversity brings new perspectives to board deliberations (García-Sánchez, Ortiz-Martínez, et al. 2023). From this perspective, women directors have different cognitive styles, values, and ethical orientations, which improve the board's understanding of stakeholder concerns and environmental issues (Atif et al. 2020; García-Sánchez et al. 2025) and influence risk-taking behavior (Yu and Liu 2024). Indeed, women directors tend to be more sensitive to social and environmental concerns, have higher moral standards, and be more risk-averse than men directors (Amorelli and García-Sánchez 2021; Ali et al. 2025). Consequently, women directors are more likely to promote socially responsible practices and policies and ensure higher compliance with environmental regulations (Nielsen and Huse 2010; García-Sánchez, Monteiro, et al. 2023; Zhu et al. 2024).

In a similar vein, according to the GST, the aforementioned cognitive styles, values, and ethical attitudes of women directors stem from their education (Eagly and Johannesen-Schmidt 2001; García-Sánchez, Ortiz-Martínez, et al. 2023; Yu and Liu 2024). Women have been taught to be compassionate and caring toward others (Oyewo et al. 2025). These internalized altruistic traits promote pro-environmental behavior among women directors (García-Sánchez, Ortiz-Martínez, et al. 2023; Yu and Liu 2024; Zhu et al. 2024; Gallego-Álvarez and Rodriguez-Dominguez 2025) and therefore favor environmental initiatives and sustainability disclosure (Yu and Liu 2024; Oyewo et al. 2025).

From an RDT and RBV perspective, women directors contribute unique human and relational capital, fostering a stakeholder-oriented, socially responsible board (Khan, Khan, and Saeed 2019; Gull et al. 2023; Ali et al. 2025). These perspectives also suggest that women directors bring environmental knowledge and expertise, broadening the board's perspective, open-mindedness, and connections. This promotes a deeper understanding of stakeholders' interests and favors corporate transparency (Muttakin et al. 2015; Dodd et al. 2022). Women directors also improve the governance quality and the board's ability to oversee corporate reporting (Katmon et al. 2019; Gull et al. 2023).

Empirical research generally supports a positive relationship between board gender diversity and corporate responsibility and sustainability disclosure. Overall, previous research documents a positive effect of board gender diversity on corporate sustainability (Martínez et al. 2022; García-Sánchez, Monteiro, et al. 2023; Centinaio 2024; Zhu et al. 2024; Gallego-Álvarez and Rodriguez-Dominguez 2025). An effect confirmed by the meta-analyses conducted by Byron and Post (2016), Khlif and Achek (2017), Velte (2022), and Ali et al. (2025).

Again, most empirical studies support the positive impact of board gender diversity on sustainability disclosure (Barako and Brown 2008; Harjoto et al. 2015; Liao et al. 2015; Al-Shaer and Zaman 2016; Ibrahim and Hanefah 2016; Ben-Amar et al. 2017; Cabeza-García et al. 2018; Katmon et al. 2019; Pucheta-Martínez and Gallego-Álvarez 2019; Tingbani et al. 2020; Wasiuzzaman and Wan Mohammad 2020; García-Sánchez et al. 2024). Furthermore, Amran et al. (2014) report a positive impact of board gender diversity on sustainability disclosure quality, while Temiz and Acar (2023) show that board gender diversity mitigates the inhibiting effect of a country's secrecy culture on sustainability disclosure.

In terms of waste management, recent studies indicate that gender-diverse boards are linked to reduced waste production and increased recycling rates (Shahab et al. 2022; Gull et al. 2023; Issa and In'airat 2025). Furthermore, these studies

suggest that superior waste performance leads to greater transparency (Benjamin et al. 2023). Regarding waste management disclosure specifically, Ahsan et al. (2024) and Bai et al. (2025) document a positive relationship between board gender diversity and waste management disclosure. However, Abd-Mutalib et al. (2021) found no significant effect of board gender diversity on e-waste management disclosure by Malaysian listed companies.

Based on the above discussion, it is plausible that gender diversity may influence the effect of board tenure on waste management disclosure by bringing fresh insights and reinforcing the sustainability focus of long-serving directors and, therefore, we hypothesize that gender diversity positively moderates the relationship between board tenure and waste management disclosure. Thus, the following hypothesis is stated:

H2. *Board gender diversity positively moderates the relationship between board tenure and waste disclosure.*

In addition to directors' gender, their cultural background is another important characteristic that influences board performance (Katmon et al. 2019; Martínez-Ferrero et al. 2021; Gangi et al. 2023; Gallego-Álvarez and Rodriguez-Dominguez 2025). The decisions that directors make and the way in which they exercise their advisory and oversight functions may vary according to their own heritage, background, values, and convictions (Haniffa and Cooke 2002; Muttakin et al. 2015; Dodd et al. 2022; Abbas et al. 2025). In this regard, Beji et al. (2021) show that the presence of foreign directors on the board is positively related to the firm's environmental performance and community involvement.

According to UET, cultural identity shapes directors' perceptions of environmental and social issues, influencing board-level decision-making (Haniffa and Cooke 2002; Muttakin et al. 2015; Dodd et al. 2022; Aliani et al. 2024). In a similar vein, imprinting theory posits that the unique cultural values of the directors' hometowns are imprinted on their personalities, influencing their judgment and permanently shaping their subsequent actions within the boardroom, thereby impacting firm strategy and performance (Abbas et al. 2025). Thus, from both perspectives, directors' personalities and values are influenced by their cultural roots, which shape their worldview (Fitzsimmons 2013; Martínez et al. 2022; Aliani et al. 2024; Abbas et al. 2025). In this regard, directors from environmentally conscious countries with strict environmental protection policies could integrate these standards into their governance practices, resulting in improved environmental performance and disclosure. Meanwhile, directors from less environmentally conscious countries could allow for more permissive environmental pollution practices, thus hindering environmental disclosure (Abbas et al. 2025).

From the perspective of RDT and RBV, cultural diversity brings diverse values, talents, and experiences to the board (Katmon et al. 2019; Martínez et al. 2022; Ali et al. 2025), which enhances the board's knowledge base, stakeholder orientation, and external connections (Khan, Khan, and Saeed 2019; Dodd et al. 2022; Gangi et al. 2023; Aliani et al. 2024). Accordingly, directors from culturally diverse backgrounds improve the quality of board governance (i.e., the advisory and supervisory functions performed by this body), which can promote a higher degree of ESG information disclosure (Dodd et al. 2022; Aliani et al. 2024). Furthermore, greater cultural diversity enhances a board's ability to understand the needs and demands of different stakeholders, which can positively affect environmental reporting (Gallego-Álvarez and Rodriguez-Dominguez 2025).

As far as we are aware, no prior study has examined the impact of board cultural diversity on waste disclosure, and there is limited empirical evidence on its impact on corporate sustainability (Aliani et al. 2024; Gallego-Álvarez and Rodriguez-Dominguez 2025). Most studies support a positive relationship between board cultural diversity and corporate sustainability performance (Post et al. 2011; Che Ahmad and Osazuwa 2015; Muttakin et al. 2015; Harjoto et al. 2019; Martínez-Ferrero et al. 2021; Dodd et al. 2022; Martínez et al. 2022; Gangi et al. 2023), including waste management performance (Gull et al. 2023). However, the few studies on sustainability disclosure provide mixed evidence, with some studies reporting a positive effect (Che Ahmad and Osazuwa 2015; Ibrahim and Hanefah 2016; Khan, Khan, and Senturk 2019; Khan, Khan, and Saeed 2019; Aliani et al. 2024; Ali et al. 2025), while others find no significant relationship (Zaid et al. 2020) or even a negative one (Katmon et al. 2019). These inconclusive findings may indicate that the impact of board cultural diversity on waste management disclosure, a key component of environmental disclosure, may vary across institutional contexts and industries.

Therefore, our theoretical foundations and the limited, contradictory evidence regarding the role of board cultural diversity in shaping sustainability disclosure suggest that cultural diversity on the board may interact with director tenure, moderating its effect on waste management disclosure, though caution should be exercised when assuming a directional effect. Accordingly, we formulate a hypothesis to test whether cultural diversity acts as a significant moderator in the relationship between board tenure and waste disclosure without predicting the nature or direction of the interaction, while again, to remain empirically open, we also propose two directional hypotheses.

H3. *Board cultural diversity moderates the relationship between board tenure and waste disclosure.*

H3a. *Board cultural diversity negatively moderates the relationship between board tenure and waste disclosure.*

H3b. *Board cultural diversity positively moderates the relationship between board tenure and waste disclosure.*

Figure 1 depicts the hypothesized relationships.

4 | Methods

4.1 | Sample

The population selected to test the research hypotheses corresponds to the world's leading companies in stock market capitalization. These companies have the necessary resources and capabilities to implement projects contributing to major environmental challenges (e.g., Gull et al. 2023; García-Sánchez

et al. 2025). The analysis of these companies is typically conducted from an international perspective, considering large global companies, as this allows for a broader and more heterogeneous study sample that enriches the results obtained (Gull et al. 2024). This heterogeneity is particularly relevant in our analysis when studying board diversity and the decisions they can make regarding waste management disclosure (Shahab et al. 2022).

In terms of time, we have chosen the period from 2011 to 2020. During this decade, waste management has made significant progress worldwide, with a growing emphasis on resource efficiency, recycling, and reducing waste generation. Countries have strengthened policies, including regulatory changes and economic instruments, to divert waste from landfills to recycling and recovery. There is also a global trend to increase recycling and composting and to explore waste-to-energy solutions (Gull et al. 2022).

Following numerous studies (e.g., Trinh et al. 2023; Albitar et al. 2024), including those mentioned above, we selected the Refinitiv database to access detailed information on these large companies' governance and waste management. This database was formerly Thomson Reuters and is now part of LSEG (London Stock Exchange Group). This ESG database is the most comprehensive in the market, covering over 80% of global market capitalization. In addition to its usefulness in academia, its ESG data is used by various professionals in the financial sector for portfolio analysis, equity research and other purposes. Information about more than 12,000 public and private companies in 76 countries is available. This information is based on published data compiled by ESG specialists and then audited and standardized. Access to the information is available on a commercial subscription basis.

The analysis sample was selected using the usual scientific criteria summarized in Figure 2. First, companies with available ESG information, according to Refinitiv, were selected. These were identified using the ESG Coverage Flag equal to the True search filter. In total, 11,373 companies were identified. The ESG information and economic-financial variables needed to estimate the models designed in the following section for 2011–2020 were downloaded.

Next, the second scientific criterion was applied by eliminating companies that did not have information on any of the variables required for the empirical analysis. In this respect, the sample consisted of 2933 companies (21,226 observations). Finally, the third criterion was applied to configure a balanced panel of data in order to analyze the evolution of the relationships of interest over the selected period. For this purpose, we dropped the companies without data from 2011 to 2020. Thus, the final sample corresponds to a balanced panel of 832 companies (8320 observations). A more detailed description of the sample is reflected in Section 5.1, where the descriptive statistics of the main variables of this research are presented. Figure 3 depicts the sample description.

4.2 | Models and Methodology

The empirical models designed to test the research hypotheses are reflected in Equations (1), (2a) and (2b). These equations correspond to mathematical models that analyze the dependency relationship between a dependent variable, Y, and several independent and control variables, X (Wooldridge 2010). The dependent variable in this study corresponds to companies' disclosure practices of waste management information. At the same time, board tenure and diversity (cultural and gender) are considered explanatory variables of interest to predict the behavior of the

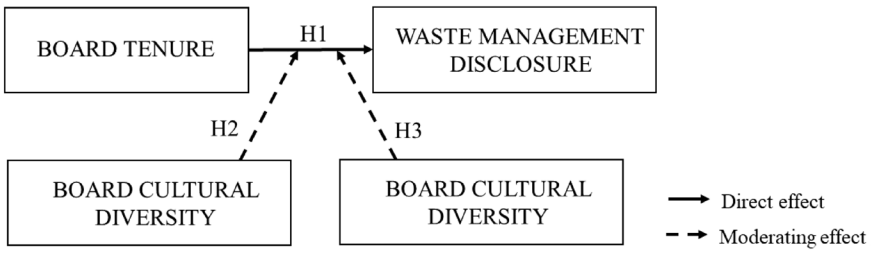

FIGURE 1 | Research model.

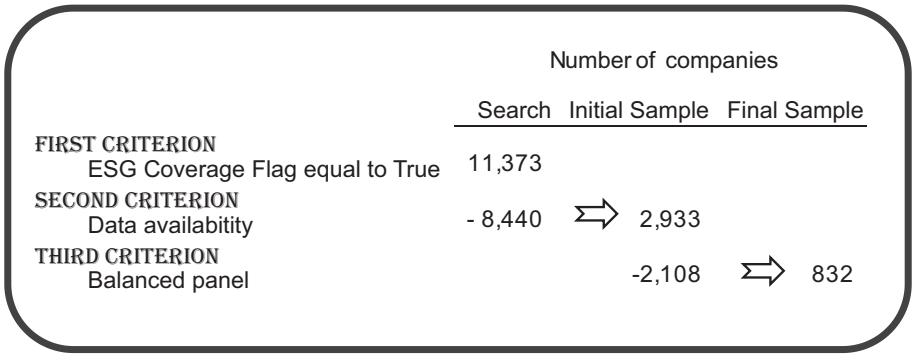

FIGURE 2 | Sample selection process.

FIGURE 3 | Sample description by WM discloures.

analyzed companies. β corresponds to the regression coefficients, parameters that measure the influence of the independent and control variables.

More specifically, Equation (1) allows us to test hypotheses H1a and H1b regarding the effect of board tenure on waste disclosure. In this regard, if $\beta_1 > 0$, our results confirm hypothesis H1b, which states that board tenure positively affects waste disclosure. In contrast, if $\beta_1 < 0$, we confirm the negative relationship proposed in hypothesis H1a.

$$\mathbf{WMdiscl}_{i,t} = \beta_0 + \boldsymbol{\beta_1}\mathbf{BoardTenure}_{i,t-1} + \beta_2 \mathrm{CulturalDiv}_{i,t-1} + \beta_3 \mathrm{GenderDiv}_{i,t-1} + + \beta_n \sum_{n=4}^{26} Control_{n,t-1} + \varepsilon_{it} + \eta_i \quad (1)$$

Equation (2a) is designed to test the hypothesis regarding the moderating effect of board gender diversity on the influence of board tenure on the disclosure of waste management information (H2). In contrast, Equation (2b) allows testing the moderating effect of board cultural diversity on such a relationship (H3). The positive hypotheses H2 and H3b are

confirmed in both cases, assuming that $\beta_1 > 0$ and $\beta_4 > 0$ in Equations (2a) and (2b), respectively. Hypothesis H3a is confirmed if $\beta_1 > 0$ and $\beta_4 < 0$, indicating a negative moderating role of board cultural diversity on the effect of board tenure on waste management disclosure.

$$\mathbf{WMdiscl_{i,t}} = \beta_0 + \boldsymbol{\beta_1}\mathbf{BoardTenure_{i,t-1}} + \beta_2 \text{CulturalDiv}_{\text{i,t-1}} + \beta_3 \text{GenderDiv}_{\text{i,t-1}} + \boldsymbol{\beta_4}\mathbf{BoardTenure} * \mathbf{GenderDiv_{i,t-1}} + \beta_n \sum_{n=5}^{27} Control_{n,t-1} + \varepsilon_{\text{it}} + \eta_{\text{i}} \quad (2a)$$

$$\mathbf{WMdiscl_{i,t}} = \beta_0 + \boldsymbol{\beta_1}\mathbf{BoardTenure_{i,t-1}} + \beta_2 \text{CulturalDiv}_{\text{i,t-1}} + \beta_3 \text{GenderDiv}_{\text{i,t-1}} + \boldsymbol{\beta_4}\mathbf{BoardTenure} * \mathbf{CulturalDiv_{i,t-1}} + \beta_n \sum_{n=5}^{27} Control_{\text{n,t-1}} + \varepsilon_{\text{it}} + \eta_{\text{i}} \quad (2b)$$

Since the WMdiscl variable is a numeric variable that corresponds to a score associated with the percentage of items that the company discloses regarding the management of the waste-related impacts of its activities and those throughout its value chain, the methods used to estimate Equations (1), (2a), and (2b) are based on linear regressions with fixed and random effects for panel data. In addition, to ensure robust results, we used another regression approach that allows us to control for the ordinal nature of the WMdiscl absolute score in Section 5.3.

Moreover, dependency models in the economic field are characterized by the endogeneity problem, which refers to the fact that the effect of the independent variable cannot be interpreted causally because it includes unobserved causes, such as the fact that there is causality between the explanatory variables and the dependent variable. This study controls endogeneity using a lag in the independent, moderator, and control variables (García-Sánchez et al. 2025). In addition, to ensure robust results, it is possible to use different techniques like instrumental variables or dynamic models of panel data, such as the Arellano-Bond estimator, a Generalized Method of Moments (GMM) estimator. In this study, causality is associated with control variables such as size and ROA, among others, so GMM is more appropriate than using instrumental variables for our independent variables. In this vein, following Blundell and Bond (1998), we employ a two-step GMM estimation system that uses lagged levels and differences as instruments. The process involves two steps: first, the variables are differenced to eliminate individual fixed effects, and second, lagged levels and differences of the variables are used to instrument the differenced equations. On the other hand, the multicollinearity resulting from the inclusion of interacted variables is corrected by the use of centered variables.

4.3 | Variables

The dependent variable *WMdiscl* is a self-developed score based on the international frameworks of major organizations around the world and the recommendations of the GRI, SASB, and EFRAG regarding the material information companies should disclose about their waste management activities and waste impacts. The disclosure proposals of previous international organizations provide answers to the following questions: What is meant by significant impacts related to waste, what measures has the company designed to prevent the generation of waste and to manage the significant impacts of the waste generated, what is the composition of the waste generated, what are the recovery operations used to avoid disposal, and what are the disposal operations.

After specifying the disclosure requirements, we first draft eight items related to the previous question. The first item allows us to determine whether companies report on their potential and actual impacts related to the waste they generate. The second is whether companies report on waste management and initiatives to prevent waste generation. The third to fifth items are specific in that it is possible to know the amount of waste generated by weight and the amount destined for disposal, in total and by type. Item 6 relates to the segmental disclosure of previous waste indicators by hazardous or non-hazardous material and/or economic activity. Item 7 measures whether disposal activities were carried out at the company's facilities or off-site. The last item identifies whether knowing the waste management information in the supply chain is possible.

We then identified whether or not downloading information from Refinitiv has a value in the variables associated with each item. In this sense, we have created eight dummy variables associated with each item (WM1 to WM8), which take the value 1 if the company discloses information in this respect and 0 otherwise. Finally, the score WMdiscl is constructed based on the sum of the 8 dichotomous variables. Its absolute value reflects the number of items each company discloses about waste management. In addition, we use the relative score, which measures the proportion of items reported by each company. Table 1 shows the items analyzed and the proposed scores.

This approach complements those used in previous literature, which have mainly focused on using variables related to waste generated or recycled as a proxy for companies' disclosure practices (e.g., da Rosa et al. 2015; Adler et al. 2022; Shahab et al. 2022; Gull et al. 2023).

BoardTenure is the main independent variable. Following Patro et al. (2018), among others, it corresponds to a numerical variable measuring the average tenure of directors on the board. This measure avoids the limitations of some diversity indices, such as the Simpson and Shannon diversity indices. For example, the Simpson Diversity Index, which focuses primarily on tenure dominance, means that a few managers with dominant tenures can significantly reduce the value of the Simpson Index, even if other tenures are higher. The Shannon Diversity Index shows an inability to account for temporal distribution, the impact of sample size, and its sensitivity to rare tenures. It also does not directly quantify the high frequency of a given tenure.

The moderating variables, *CulturalDiv* and *GenderDiv*, are defined following Gangi et al. (2023) and correspond to the proportion of directors whose cultural background is not the same as that characterizing the location of the company's headquarters, and the proportion of female directors. The moderating effect is analyzed by interacting the independent variables

TABLE 1 | Composition of the WMdiscl score.

Items		Points
WM1. Significant potential and actual impacts related to waste generated		1
The company reports on the amount, type and nature of waste generated by its activities.		
WM2. Management of waste and the impacts of waste		1
The organization reports on initiatives to prevent the generation of waste. The organization reports on the management of impacts, indicating whether they are managed directly by the organization or by a third party (with an indication of the control process)		
WM3. Waste generated		1
The company reports the amount of waste generated by weight (metric tons).		
WM4. Waste generated that is not destined for disposal		1
The company reports the amount of waste generated that has been reused by weight (metric tons), indicating whether it has been reused, recycled, or otherwise recovered.		
WM5. Waste for disposal		1
The company reports the amount of waste generated that is destined for disposal by weight (metric tons), indicating whether it was landfilled, incinerated (with or without energy recovery), or otherwise disposed of.		
WM6. Waste broken down by composition or type of waste		1
The information for items WM3, WM4 and WM5 is presented broken down by composition or type of waste. Breakdown criteria: hazardous or non-hazardous; by materials; and/or by economic activity.		
WM7. Reuse and Disposal Activities		1
For items WM4 and WM5, the company reports whether the reuse or disposal operations were performed at the company's own facilities or off-site.		
WM8. Waste management in the supply chain		1
The company reports on the amount, type, and nature of waste generated in the value chain.		
Absolute value (Total items reports)	WMdiscl $n=8; i=1$ a $i=8$	$\sum_i^n WMi$
Relative value (Proportion of items reports, %)	WMdiscl $n=8; i=1$ a $i=8$	$\sum_i^n \frac{WMi}{n}$

with the moderator variables: *BoardTenure*CulturalDiv* and *BoardTenure*GenderDiv*.

The control variables proposed to avoid biased results are associated with the company's resources and capabilities, external and internal monitoring mechanisms, and institutional pressures. These variables have been identified according to previous studies such as Gull et al. (2023, 2024) or Bai et al. (2025). In this sense, control variables related to firm resources and capabilities are related to firm size, age, investment, profitability, and leverage, and environmental performance. The latter are expected to be positively associated with waste management disclosure due to their significant influence on strategic choices and competitive advantage, as they often have more financial resources and established networks that allow them to invest in areas such as sustainability reporting (García-Sánchez et al. 2025). In the case of environmental performance, since the work of Clarkson et al. (2008), scholars know that the higher the level of sustainability in the organization, the greater the transparency to obtain the economic benefits associated with this leadership.

Regarding external and internal monitoring mechanisms, papers such as Bai et al. (2025) and Shahab et al. (2022) have shown that companies with the strongest corporate governance mechanisms disclose more information about waste generation and management. These strongest corporate governance mechanisms are associated with (i) boards with a higher presence of independent directors, higher activity levels, an absence of CEO duality, and the existence of a sustainability committee; (ii) the presence of institutional investors in ownership; (ii) a higher number of financial analysts following the company; and the hiring of an assurance service provider.

Concerning the institutional variables, different papers have observed the undoubtedly positive impact of regulation, culture and religion on sustainability disclosure practices (Du et al. 2014; García-Sánchez et al. 2016, 2024). In the case of COVID-19, the variable identifies the short-term impact of the pandemic on sustainability, with an expected reduction in environmental pressures (i.e., emissions and land use, among others).

However, it should be noted that the OECD (2021) has also estimated a long-term impact, which will reduce these pressures of between 1% and 3%. According to economic theories, this reduction has a positive impact on environmental performance and favors related disclosures.

Table 2 shows the definition and measurement of the independent control variables included in the empirical models. Additionally, the ordinal variables Country, Industry and Year are included to control for other unobservable factors at the country, industry, and period levels.

5 | Results and Discussion

5.1 | Descriptive Statistics

Figure 4 shows the average annual evolution of the dependent, independent, and moderator variables proposed for the analysis. In this respect, interannual growth can be observed in the waste management information provided by companies. This trajectory is similar to that of gender diversity on the board of directors. The board of directors' cultural diversity and the tenure of this body show a stable situation throughout the period. It can also be seen that the year of the appearance of the COVID-19 pandemic did not modify these trends.

Table 3 shows the average of the main variables based on the country of origin of the companies that make up the analysis sample. In this regard, companies from Greece, Hungary, Israel, Finland, Poland, Taiwan and Colombia report more than 60% of the items analyzed. While those whose headquarters are located in Thailand, Spain, Turkey, France, Cyprus, Italy, Portugal, Russia, Brazil, Germany, USA and India, between 50% and 60%.

Table 4 shows the means, standard deviations, and Pearson correlation coefficients for all the variables used to estimate Equations (1), (2a), and (2b).

5.2 | Main Results

Table 5 shows the results of estimating Equations (1), (2a) and (2b) using linear regression with fixed (fe) and random (re) effects. The Hausman test with a p-valor <0.05 indicates that the fixed effects model is the most optimal from an econometric point of view, so the results for this effect methodology are discussed. The relationships are depicted in Figure 5, the linear tendency graph allows us to observe the positive impact of BoardTenure, GenderDiv, CulturalDiv and their interactions on WMDiscl score.

The coefficient of the *BoardTenure* variable is positive and significant in all estimated models. Specifically, focusing on Equation (1), *BoardTenure* has a direct positive impact of $\beta_1 = 0.00402$, which is significant at the 99% confidence level. These results allow us to accept hypothesis H1b, which proposed the existence of a positive association between board tenure and the disclosure of information on waste management.

Additionally, we observe that the *CulturalDiv* and *GenderDiv* variables are positive and significant in all estimations. Referring to Equation (1) (fe), the significant effect of *CulturalDiv* is $\beta_2 = 0.00416$, with a confidence level of 95%. In the case of *GenderDiv*, the effect is $\beta_3 = 0.00643$, significant at the 99% confidence level.

The results of Equation (2a) also show the positive and significant impact of the *BoardTenure* and *GenderDiv* variables already discussed. In addition, the interaction between the two produces an amplifying effect on the impact of board tenure on waste disclosure ($\beta_4 = 0.000231$), at the 99% confidence level, which allows us to accept hypothesis H2 regarding the positive moderating effect of board gender diversity on the relationship between board tenure and waste disclosure.

Focusing on Equation (2b), the individual positive effect of *BoardTenure* and *CulturalDiv* on waste disclosure is maintained., observing that the effect of the interaction between *BoardTenure* and *CulturalDiv* is $\beta_4 = 0.000103$, significant at a 90% confidence level. This result suggests that board cultural diversity interacts with board tenure by strengthening its positive effect on waste disclosure. This finding leads us to accept hypothesis H3b, which states that board cultural diversity positively moderates the relationship between board tenure and waste disclosure.

Rearding the control variables, those companies with the best environmental performance (*EnvPerf*), age (*logAge*), and size (*logTA*), as well as those that have a CSR subcommittee (*CSRcomm*) and assure their non-financial or sustainability information (Assurance) are the most likely to disclose waste information. This effect is also related to the legal pressure on environmental issues (*ERRI*) and the presentation of sustainability information (*EU*), as well as to the effect of the COVID-19 pandemic. Conversely, the most profitable companies (*ROA*) and those located in countries with a predominantly masculine and individualistic culture are less likely to disclose information about their waste management practices and impacts.

5.3 | Robustness Analysis

To test the robustness of our results, Panel A of Table 6 presents the estimates of Equations (1), (2a) and (2b) for the absolute value of the variable *WMdiscl*, using the ordinal regression methodology for panel data. This approach allows us to consider a categorical dependent variable that can take eight cardinally ordered values. The results obtained confirm those discussed in the previous section, guaranteeing that the results are robust to variations in the methodological specifications.

Endogeneity, a common econometric problem in the business field, can manifest itself in several ways as reverse causality, the presence of unobserved variables, and sample selection bias. Our previous estimations included the use of one-period lag instruments to control the bidirectional influence of the dependent and independent variables (reverse causality). In addition, to reinforce our findings, we present the results of the system GMM estimations as a robust procedure to control for endogeneity in

TABLE 2 | Variable definition.

Variable	Definition
Independent and moderating variables	
BoardTenure	Average length of service of board members on the board
GenderDiv	Borad gender diversity measured by the proportion of female directors on the board
CulturalDiv	Board cultural diversity measured by the proportion of directors whose cultural background is not the same as that characterizing the location of the company's headquarters
Control variables	
EnvPer	Refinitiv score that reflects the environmental performance of the firm
logAge	Firm age measured by logarithm of age
logTA	Firm size measured by logarithm of total assets
Invest	Monetary volume of annual investments
ROA	Economic profitability of the firm as measured by the ratio of net income to total assets
Leve	Debt level of the company
II	Presence of institutional investors as measured by the number of votes they hold
Analysts	The number of financial analysts who follow the company
Bactivity	Board activity measured by the number of annual meetings in the year
Bindep	Board independence measured by the proportion of independent directors on the board
CEOduality	Dummy that takes the value 1 if the CEO also serves as the chairperson of the board, and 0 otherwise
CSRComm	Dummy that takes the value 1 if the board has a dedicated sustainability subcommittee and 0 otherwise
Assurance	Dummy that takes the value 1 if the company has engaged the services of an assurance provider for non-financial or sustainability reporting., and 0 otherwise
COVID	Dummy that identifies the effects of the COVID-19 Pandemic in 2020
ERRI	Environmental Regulatory Regime Index
EPI	Environmental Performance Index
EU	Dummy indicating the mandatory reporting of environmental information for companies located in EU member states due to the NFRD Directive.
Religion	Religious dimension of the company's country of origin measured by the percentage of religious people
CultInd	Hofstede's dimension of individualism that characterizes the national culture of the company's country of origin (Hofstede 1980)
CultMasc	Hofstede's dimension of masculinity that characterizes the national culture of the company's country of origin (Hofstede 1980)

Panel B of Table 6, as explained in Section 4.2. The results obtained are quite similar to the previous ones, confirming that there is no bias in our findings.

On the other hand, fixed effects models in panel data consider unobserved variables that do not change over time, controlling for endogeneity provoked by omitted variables by using within-group variation. Moreover, we conduct a change analysis to confirm the absence of omitted variable bias in our findings. By this approach we test a causal relationship to infer that x (independent variables) cause y (dependent variables), contrasting these three conditions: (i) y follows x; (ii) y changes when x changes; and (iii) there is no other cause that could eliminate this relationship. In this vein, the first three columns of Panel C allow us to confirm the above conditions, reinforcing the robustness of our previous evidence.

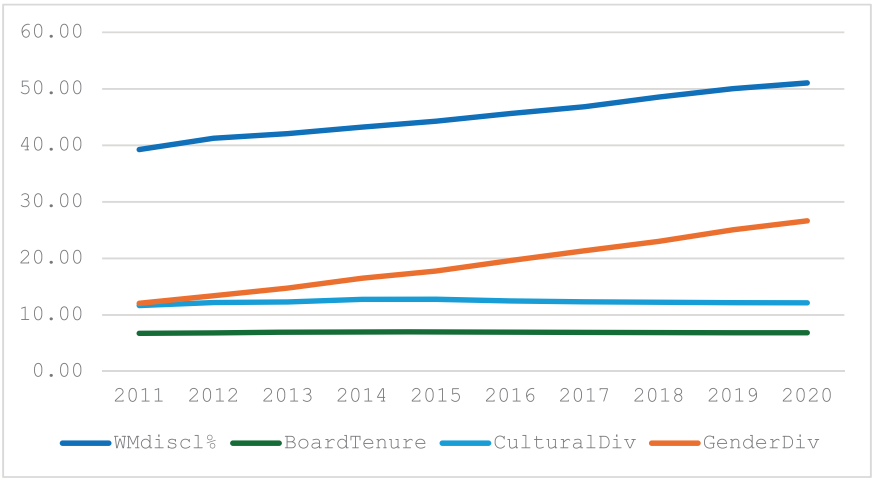

FIGURE 4 | WM disclosures and board tenure and diversity.

To address endogeneity caused by sample selection bias, we have re-estimated our baseline equations, incorporating Propensity Score Matching (PSM). This procedure aims to overcome endogeneity associated with sample selection bias that implies that firms without diversity boards ("without treatment") may be systematically different from firms with diversity boards ("treatment"), and therefore the factors affecting board diversity may also be correlated with waste disclosure practices, our dependent variable. The last three columns of Panel B reflect the re-estimation of the baseline equations using the PSM-matched sample of firms, thereby strengthening previous results.

6 | Complementary Analysis

From a theoretical perspective, examining the interplay between board gender and cultural diversity allows for understanding the nuanced and potentially non-linear dynamics through which board diversity shapes director decision-making and, ultimately, corporate sustainability disclosure practices. While both forms of diversity are individually associated with broader perspectives, greater sensitivity to stakeholder concerns, and a greater propensity to challenge dominant logic (Ali et al. 2025; Gallego-Álvarez and Rodriguez-Dominguez 2025), their simultaneous presence can create complex interpersonal and cognitive dynamics within the boardroom (Lau and Murnighan 2005). Thus, the intersection of gender and culture may not simply produce additive effects but may alter the underlying mechanisms through which board members interpret environmental responsibilities and prioritize transparency in areas such as waste management. While gender-diverse boards may be more attuned to social and environmental issues due to greater community orientation and ethical sensitivity, culturally diverse boards may facilitate responsiveness to a broader range of institutional and stakeholder expectations in different jurisdictions. However, the interaction of these two forms of diversity can also pose challenges regarding communication, coordination and consensus building. As highlighted by the faultline model (Lau and Murnighan 2005), when demographic characteristics align along multiple dimensions (e.g., gender and culture), subgroup formation and identity-based polarization can occur, potentially undermining group cohesion and decision-making effectiveness. In the context of complex, technical, and often contentious issues such as waste management disclosure, these tensions may undermine the ability of diverse boards to act decisively and transparently.

To delve into the effect of board gender and cultural diversity on waste disclosure, we develop Equation (3), which proposes a model that includes the interaction of the variables *CulturalDiv* and *GenderDiv*. If $\beta_4 > 0$, it would indicate that boards with greater cultural and gender diversity would disclose more waste information than those characterized by only one type of board diversity. If $\beta_4 < 0$, the results would indicate that the combined effect of both board diversity attributes is less than that produced by each of them considered in isolation.

$$\mathbf{WMdiscl_{i,t}} = \beta_0 + \boldsymbol{\beta_1}\mathbf{BoardTenure_{i,t-1}} + \beta_2 \mathrm{CulturalDiv}_{i,t-1} + \beta_3 \mathrm{GenderDiv}_{i,t-1} + \boldsymbol{\beta_4}\mathbf{CulturalDiv} * \mathbf{GenderDiv_{i,t-1}} + \beta_n \sum_{n=5}^{27} Control_{n,t-1} + \varepsilon_{it} + \eta_i \quad (3)$$

The results in Table 7 (Panel A in Equation (3)) show that the positive effect of the *CulturalDiv* and *GenderDiv* variables on the *WMdiscl* variable is reduced, as the effect of the interaction is negative and significant at the 99% confidence level. The negative interaction coefficient indicates that the joint effect of board gender and cultural diversity on waste disclosure is smaller than the sum of their individual effects. This finding suggests that while each form of board diversity independently enhances its ability to oversee and promote waste disclosure, their simultaneous presence may not always produce synergistic benefits. One possible explanation lies in the complexity and potential for communication challenges that may arise when multiple dimensions of diversity coexist. High levels of demographic heterogeneity may increase cognitive diversity and foster richer deliberation. However, they may also create coordination difficulties, reduce cohesion, or generate divergent priorities and interpretive frameworks within the board (Van Knippenberg and Schippers 2007). Thus, the effectiveness of board diversity may

TABLE 3 | Variables mean description by country.

Country	WMdiscl (%)	WMdiscl (total items)	BoardTenure (year)	GenderDiv (%)	CulturalDiv (%)
AUSTRALIA	32.84	2.63	5.91	22.64	6.80
AUSTRIA	32.81	2.63	6.75	25.99	12.69
BELGIUM	39.53	3.16	7.66	25.26	16.81
BRAZIL	52.61	4.21	6.70	9.33	7.49
CANADA	44.24	3.54	8.16	20.92	23.47
CHILE	42.50	3.40	8.38	12.71	4.57
CHINA	30.18	2.41	5.72	6.79	4.17
COLOMBIA	60.83	4.87	5.58	7.99	0.00
CYPRUS	56.25	4.50	3.62	21.11	18.89
CZECH REPUBLIC	40.63	3.25	4.59	11.79	12.13
DENMARK	37.32	2.99	6.63	22.43	30.87
FINLAND	63.52	5.08	5.23	34.20	27.95
FRANCE	56.30	4.50	7.21	34.81	21.93
GERMANY	51.25	4.10	6.14	25.13	14.77
GREECE	73.75	5.90	3.95	5.27	4.86
HONG KONG	42.50	3.40	9.54	12.00	10.62
HUNGARY	66.88	5.35	7.85	12.34	8.93
INDIA	50.00	4.00	8.41	9.93	5.37
INDONESIA	34.27	2.74	5.42	5.54	20.08
IRELAND	30.13	2.41	7.00	22.48	27.04
ISRAEL	63.75	5.10	7.39	10.69	3.91
ITALY	56.02	4.48	5.36	25.60	7.89
JAPAN	46.58	3.73	5.91	5.67	0.49
LUXEMBOURG	37.50	3.00	6.96	17.58	77.16
MALAYSIA	30.63	2.45	8.22	15.62	13.65
MEXICO	42.08	3.37	15.92	9.82	1.99
NETHERLANDS	45.50	3.64	5.83	24.76	43.59
NEW ZEALAND	18.75	1.50	5.87	22.44	15.21
NORWAY	47.03	3.76	4.77	39.88	18.95
PHILIPPINES	45.75	3.66	12.49	12.97	8.16
POLAND	62.81	5.03	4.31	15.71	12.88
PORTUGAL	55.42	4.43	5.86	11.40	12.18
RUSSIAN FED.	53.28	4.26	5.06	5.91	9.86
SINGAPORE	37.97	3.04	6.91	12.00	9.67
SOUTH AFRICA	36.93	2.95	6.73	24.11	9.60
SOUTH KOREA	48.37	3.87	3.57	3.48	0.00
SPAIN	56.56	4.53	8.01	20.04	11.72

(Continues)

TABLE 3 | (Continued)

Country	WMdiscl (%)	WMdiscl (total items)	BoardTenure (year)	GenderDiv (%)	CulturalDiv (%)
SRI LANKA	23.75	1.90	13.20	7.56	0.00
SWEDEN	46.67	3.73	7.90	32.72	17.85
SWITZERLAND	49.09	3.93	7.08	16.63	51.94
TAIWAN	62.25	4.98	8.35	8.27	2.94
THAILAND	58.00	4.64	5.47	7.95	2.08
TURKEY	56.50	4.52	6.97	11.77	3.21
UNITED KINGDOM	33.62	2.69	5.86	22.27	14.53
UNITED STATES	50.33	4.03	8.60	23.16	4.94

depend on the board's ability to integrate different perspectives and constructively manage potential frictions. These findings support the view that diversity is not inherently beneficial but context-dependent and shaped by internal board dynamics and governance processes.

The positive and statistically significant coefficient on the COVID-19 variable suggests that companies increased the amount of waste information disclosed during the pandemic. While caution is warranted in attributing causality in observational settings, this pattern may reflect a heightened awareness of corporate social and environmental responsibility in systemic disruption (Aibar-Guzmán et al. 2023). As noted by Hantoko et al. (2021) and Sarkodie and Owusu (2021), the pandemic led to a notable increase in medical and packaging waste and increased public scrutiny of sanitary conditions in workplaces and supply chains. In this context, corporate transparency on waste management may have become more salient as a matter of regulatory compliance and as a means of demonstrating accountability to stakeholders concerned with health risks and environmental protection. Moreover, various national and supranational recovery frameworks, particularly in the EU, explicitly emphasized sustainability and ecological transition as guiding principles for post-pandemic economic recovery (Sharma et al. 2021). It is, therefore, plausible that firms perceived increased disclosure on environmental issues, including waste management, as consistent with the broader institutional discourse and expectations that emerged during the COVID-19 crisis.

In this sense, to determine which characteristics of the board of directors have played a greater role in this regard, Equation (4) has been designed. Under the reference BoardVariables (a term used to refer to the variables *BoardTenure*, *CulturalDiv* and *GenderDiv*), it interacts with the COVID-19 variable.

$$\mathbf{WMdiscl_{i,t}} = \beta_0 + \boldsymbol{\beta_1}\mathbf{BoardTenure_{i,t-1}} + \beta_2 \mathrm{CulturalDiv}_{i,t-1} + \beta_3 \mathrm{GenderDiv}_{i,t-1} + \boldsymbol{\beta_4}\mathbf{BoardVariables} * \mathbf{Covid19_{i,t-1}} + \beta_n \sum_{n=5}^{27} Control_{n,t-1} + \varepsilon_{it} + \eta_i \quad (4)$$

The results in Table 7 (Panel B in Equation (4)) show that the positive effect of the variables *BoardTenure*, *CulturalDiv* and *GendeDiv* on the disclosure of waste management information is enhanced during the COVID-19 pandemic period. This pattern may reflect that experienced and diverse boards (i.e., those with longer firm-specific tenure and greater cognitive plurality) are more able to interpret complex, evolving stakeholder expectations and mobilize organizational resources to communicate sustainability efforts in times of crisis effectively. These findings are consistent with extant research highlighting the value of board diversity and experience in navigating uncertainty and promoting organizational resilience (Lins et al. 2017). Nevertheless, we interpret these results cautiously, recognizing the need for longitudinal and qualitative research to elucidate further how and why board-level characteristics shape disclosure responses under conditions of systemic shock.

7 | Discussion

7.1 | Research Implications

Concerning the effect of board tenure on waste management disclosure, and given the inconclusive empirical evidence and conflicting theoretical perspectives, we proposed two competing hypotheses. Our results provide robust support for H1b, revealing a statistically significant and positive relationship between board tenure and waste disclosure. This result is consistent with prior evidence on the positive relationship between board tenure and sustainability reporting (Rao and Tilt 2016; Khan, Khan, and Saeed 2019) and is theoretically consistent with both UET, RDT, and RBV. These frameworks suggest that longer-tenured directors are better equipped to grasp the complexity of sustainability issues and advocate for their disclosure due to their accumulated firm-specific knowledge, stakeholder insights, and strategic expertise. More specifically, our findings suggest that tenure not only enhances the cognitive framing of environmental challenges (Sun and Bhuiyan 2020; Paolone et al. 2023), consistent with UET, but also strengthens the board's resource provision and advisory capabilities (Patro et al. 2018; Katmon et al. 2019), as posited by RDT and RBV.

Confirming H1b over H1a is a valuable theoretical contribution, especially in a literature stream where director tenure is often viewed with skepticism due to potential entrenchment effects

TABLE 4 | Correlations and descriptive statistics.

N.	Variable	Mean	Std. error	1	2	3	4	5	6	7	8	9	10	11	12
1	WMdiscl	45.22	23.74	1											
2	BoardTenure	6.90	3.09	0.03***	1										
3	CulturalDiv	12.31	19.42	0.03***	−0.07***	1									
4	GenderDiv	19.02	13.63	0.06***	−0.03***	0.17***	1								
5	EnvPerf	23.96	8.43	0.50***	0.03***	0.07***	0.17***	1							
6	logAge	3.55	0.84	0.10***	0.15***	−0.16***	−0.01	0.15***	1						
7	logTA	16.34	1.62	0.20***	0.00	0.09***	0.09***	0.39***	0.07***	1					
8	ROA	5.57	7.95	0.00	0.06***	0.02	0.03**	−0.02*	−0.03***	−0.17***	1				
9	Leve	0.78	0.56	−0.04***	−0.08***	0.03***	−0.14***	−0.11***	0.00	−0.07***	0.03***	1			
10	Invest	376.80	321.50	0.03***	−0.05***	−0.01	−0.10***	−0.02	0.02	0.06***	0.03***	0.33***	1		
11	II	82.30	33.43	0.00	−0.07***	−0.05***	−0.07***	−0.10***	−0.01	−0.09***	0.01	0.03***	0.02**	1	
12	Analysts	17.31	8.63	0.21***	0.05***	0.16***	0.07***	0.30***	−0.05***	0.45***	0.11***	−0.01	0.10***	−0.08***	1
13	Bactivity	10.04	5.58	0.05***	−0.22***	−0.11***	−0.11***	0.02	0.02	0.12***	−0.11***	0.04***	0.02**	0.03***	−0.12***
14	Bindep	50.67	38.59	0.08***	−0.08***	0.12***	0.26***	0.13***	−0.09***	0.11***	−0.01	−0.07***	−0.03***	−0.06***	0.10***
15	CEOduality	0.68		−0.09***	−0.21***	0.08***	0.00	−0.11***	−0.07***	−0.15***	−0.02	0.06***	−0.03**	0.01	−0.16***
16	CSRcomm	0.87		0.21***	−0.05***	0.01	0.07***	0.32***	0.13***	0.15***	−0.04***	−0.05***	−0.02*	−0.05***	0.08***
17	Assurance	0.61		0.33***	−0.08***	0.07***	0.09***	0.44***	0.10***	0.29***	−0.04***	−0.06***	0.00	−0.02*	0.17***
18	COVID-19	10.00		0.08***	−0.01	0.00	0.19***	0.08***	0.06***	0.04***	−0.08***	0.01	0.00	0.00	−0.06***
19	EU	20.30		0.14***	−0.02**	0.22***	0.36***	0.17***	−0.02	0.05***	−0.02	−0.05***	−0.04***	−0.01	0.03**
20	ERRI	0.92	0.69	0.03***	−0.03***	0.21***	0.32***	0.12***	0.03***	0.03***	−0.04***	−0.29***	−0.16***	−0.04***	0.01
21	EPI	60.85	8.94	0.03***	−0.13***	0.23***	0.12***	0.06***	−0.05***	0.05***	−0.05***	−0.11***	−0.05***	−0.02*	0.05***
22	Religion	75.57	16.58	−0.01	0.20***	0.17***	0.27***	−0.02*	−0.20***	−0.10***	0.12***	0.12***	−0.04***	−0.05***	0.13***
23	CultInd	66.68	22.09	−0.06***	0.09***	0.13***	0.44***	0.06***	−0.04***	−0.04***	0.02**	−0.31***	−0.21***	−0.12***	0.00
24	CultMasc	59.79	21.47	−0.05***	−0.05***	−0.28***	−0.36***	−0.05***	0.25***	0.08***	−0.08***	−0.07***	−0.03**	0.05***	−0.16***

(Continues)

TABLE 4 | (Continued)

N.	Variable	Mean	Std. error	13	14	15	16	17	18	19	20	21	22	23	24
1	WMdiscl	45.22	23.74												
2	BoardTenure	6.90	3.09												
3	CulturalDiv	12.31	19.42												
4	GenderDiv	19.02	13.63												
5	EnvPerf	23.96	8.43												
6	logAge	3.55	0.84												
7	logTA	16.34	1.62												
8	ROA	5.57	7.95												
9	Leve	0.78	0.56												
10	Invest	376.80	321.50												
11	II	82.30	33.43												
12	Analysts	17.31	8.63												
13	Bactivity	10.04	5.58	1											
14	Bindep	50.67	38.59	−0.07***	1										
15	CEOduality	0.68		0.07***	0.06***	1									
16	CSRcomm	0.87		0.02*	0.06***	−0.04***	1								
17	Assurance	0.61		0.07***	0.07***	0.01	0.25***	1							
18	COVID-19	10.00		0.08***	0.07***	0.03***	0.06***	0.07***	1						
19	EU	20.30		0.01	0.12***	0.00	0.01	0.16***	0.18***	1					
20	ERRI	0.92	0.69	−0.10***	0.03***	−0.03***	0.04***	−0.02**	0.00	0.18***	1				
21	EPI	60.85	8.94	0.05***	−0.01	0.05***	−0.02*	−0.01	0.00	0.25***	0.64***	1			
22	Religion	75.57	16.58	−0.22***	0.25***	0.04***	−0.07***	−0.10***	0.00	0.07***	−0.30***	−0.29***	1		
23	CultInd	66.68	22.09	−0.24***	0.20***	−0.03***	0.03***	−0.12***	0.00	0.02	0.62***	0.20***	0.21***	1	
24	CultMasc	59.79	21.47	0.08***	−0.17***	−0.03***	0.05***	−0.02	0.00	−0.27***	−0.03***	0.01	−0.48***	−0.08	1

Note: Correlation coefficient does not give a standard error on the correlation. Instead, it gives the p-value from a test of $b = 0$ in a linear regression, which is also a test of zero correlation. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE 5 | Results with linear regression.

	Equation (1)		Equation (2a)		Equation (2b)	
	fe	re	fe	re	fe	re
	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
	(std.error)	(std.error)	(std.error)	(std.error)	(std.error)	(std.error)
BoardTenure	0.00402	0.00387***	0.000443*	0.000955*	0.00291**	0.00286**
(BT)	(0.00129)	(0.00116)	(0.00065)	(0.00050)	(0.00142)	(0.00127)
CulturalDiv	0.000416**	0.000306*	0.000437**	0.000328*	0.000227*	0.000292*
(CD)	(0.000203)	(0.000183)	(0.000203)	(0.000183)	(0.000093)	(0.00068)
GenderDiv	0.000643***	0.000717***	0.000868*	0.000543*	0.000643***	0.000712***
(GD)	(0.000243)	(0.000229)	(0.000499)	(0.000175)	(0.000243)	(0.000229)
BT*GD			0.000231***	0.000193***		
			(6.65e-05)	(6.37e-05)		
BT*CD					0.000103*	9.51e-05*
					(5.37e-05)	(5.09e-05)
EnvPerf	0.00448***	0.00580***	0.00437***	0.00573***	0.00449***	0.00581***
	(0.000404)	(0.000379)	(0.000405)	(0.000379)	(0.000404)	(0.000379)
logAge	0.0618***	0.0251***	0.0637***	0.0254***	0.0592***	0.0241***
	(0.0113)	(0.00641)	(0.0113)	(0.00641)	(0.0114)	(0.00644)
logTA	0.0330***	0.0152***	0.0322***	0.0150***	0.0330***	0.0153***
	(0.00686)	(0.00375)	(0.00685)	(0.00375)	(0.00686)	(0.00375)
ROA	−0.000703***	−0.000611**	−0.000724***	−0.000631**	−0.000702***	−0.000609**
	(0.000258)	(0.000253)	(0.000258)	(0.000253)	(0.000258)	(0.000253)
Leve	−8.70e-06	−8.33e-06	−8.95e-06	−9.00e-06	−8.41e-06	−8.35e-06
	(1.12e-05)	(8.48e-06)	(1.12e-05)	(8.48e-06)	(1.12e-05)	(8.48e-06)
Invest	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
II	−0.000370	0.000119	−0.000358	0.000120	−0.000362	0.000120
	(0.000472)	(0.000178)	(0.000471)	(0.000178)	(0.000472)	(0.000178)
Analysts	−0.000920	0.000127	−0.000958	9.10e-05	−0.000963	9.06e-05
	(0.000560)	(0.000480)	(0.000559)	(0.000480)	(0.000560)	(0.000480)
Bactivity	−0.000753	−0.000305	−0.000723	−0.000285	−0.000757	−0.000309
	(0.000566)	(0.000535)	(0.000565)	(0.000534)	(0.000565)	(0.000534)
Bindep	5.29e-05	8.07e-05	5.45e-05	8.18e-05	5.29e-05	8.04e-05
	(6.27e-05)	(6.12e-05)	(6.26e-05)	(6.11e-05)	(6.26e-05)	(6.11e-05)
CEOduality	0.00473	0.00136	0.00421	0.00122	0.00429	0.00101
	(0.00577)	(0.00550)	(0.00577)	(0.00549)	(0.00578)	(0.00550)
CSRcomm	0.0287	0.0286	0.0277	0.0278***	0.0286***	0.0286***
	(0.00716)	(0.00694)	(0.00716)	(0.00694)	(0.00716)	(0.00694)

(Continues)

TABLE 5 | (Continued)

	Equation (1)		Equation (2a)		Equation (2b)	
	fe	re	fe	re	fe	re
	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
	(std.error)	(std.error)	(std.error)	(std.error)	(std.error)	(std.error)
Assurance	0.0147**	0.0246***	0.0144**	0.0245***	0.0146**	0.0245***
	(0.00600)	(0.00572)	(0.00600)	(0.00571)	(0.00600)	(0.00572)
COVID-19	0.0172***	0.0228***	0.0174***	0.0231***	0.0175***	0.0231***
	(0.00510)	(0.00502)	(0.00509)	(0.00501)	(0.00510)	(0.00502)
EU	0.0219***	0.0275***	0.0212***	0.0269***	0.0220***	0.0273***
	(0.00614)	(0.00601)	(0.00614)	(0.00601)	(0.00614)	(0.00601)
ERRI		0.0368*		0.0367*		0.0376*
		(0.0215)		(0.0216)		(0.0216)
EPI		−0.00105		−0.00102		−0.00111
		(0.00106)		(0.00106)		(0.00106)
Religion		5.87e-05		0.000131		7.66e-05
		(0.000609)		(0.000610)		(0.000610)
CultInd		−0.00187***		−0.00187***		−0.00188***
		(0.000537)		(0.000538)		(0.000538)
CultMasc		−0.000676*		−0.000660*		−0.000675*
		(0.000388)		(0.000388)		(0.000388)
Constant	0.121	0.0886	0.156	0.106	0.140	0.0993
	(0.405)	(0.107)	(0.404)	(0.107)	(0.405)	(0.107)
Country, industry and year controlled in re models. Year controlled in fe models.						
R-square	0.095***	0.253***	0.097***	0.251***	0.096***	0.252***
Hausman test	159.92***		163.19***		148.93***	

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

(Beasley 1996; Patro et al. 2018; Sun and Bhuiyan 2020). In particular, despite arguments warning that prolonged director tenure can compromise independence (Sun and Bhuiyan 2020) and hinder the adoption of new practices and policies (Golden and Zajac 2001), our findings reveal that director tenure brings valuable resources (e.g., knowledge, experience, and networks) to the board, which are essential for developing the firm's sustainability strategy (Kyaw et al. 2017; Paolone et al. 2023). Our findings suggest that tenure is an asset in promoting environmental transparency, especially about waste management practices. While previous studies have reported mixed results, the clarity of our findings in an international context may reflect growing regulatory and stakeholder pressures that compel board members to remain informed and strategically proactive, thereby countering the risk of stagnation typically associated with longer tenure (Rao and Tilt 2016; Huang and Hilary 2018; Patro et al. 2018).

Consistent with hypothesis H2, our results further show that board gender diversity positively moderates the relationship between board tenure and waste disclosure. Specifically, the positive effect of tenure is significantly amplified in boards with greater gender diversity. This interaction effect underscores the ability of gender-diverse boards to more effectively leverage the experiential capital acquired through long tenure, thereby enhancing transparency in environmental reporting. Our findings are consistent with recent evidence linking gender-diverse boards to improved environmental outcomes, such as reduced waste generation and increased recycling (Shahab et al. 2022; Gull et al. 2023; Issa and In'airat 2025), as well as a broader body of literature reporting a positive relationship between board gender diversity and sustainability disclosure quality (Harjoto et al. 2015; Ben-Amar et al. 2017; Katmon et al. 2019; Pucheta-Martínez and Gallego-Álvarez 2019; Tingbani et al. 2020; Wasiuzzaman and Wan Mohammad 2020; Temiz and Acar 2023; Centinaio 2024; García-Sánchez et al. 2025). Regarding waste disclosure, our findings align with those of Ahsan et al. (2024) and Bai et al. (2025), who also identified a positive impact of board gender diversity on waste disclosure.

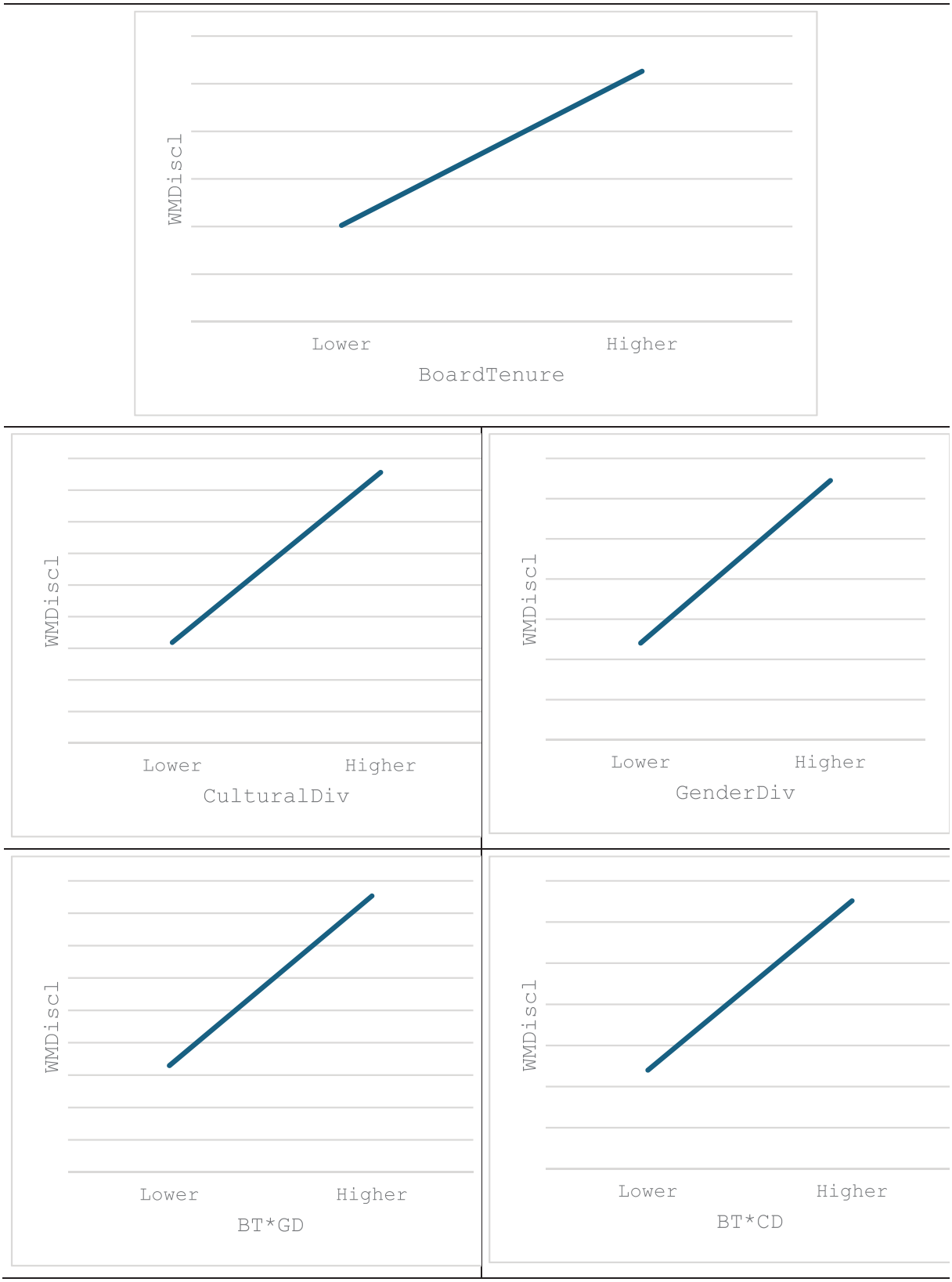

FIGURE 5 | Linear tendency regression for Equations (1), (2a) and (2b).

However, our findings contrast with those of Abd-Mutalib et al. (2021), who found no statistically significant impact of board gender diversity on e-waste disclosure in Malaysia. This divergence may be due to contextual factors (Bella and Pratama 2025): our international sample captures institutional diversity, while Abd-Mutalib et al. (2021) focused only on Bursa Malaysia-listed firms, which operate in a more specific regulatory, cultural, and institutional environment that may limit the influence of board diversity (da Rosa et al. 2015; Ali et al. 2025).

TABLE 6 | Robust results.

Panel A. Robust results with ordinal regression			
	Equation (1)	**Equation (2a)**	**Equation (2b)**
	coeff.	**coeff.**	**coeff.**
	(std.error)	**(std.error)**	**(std.error)**
BoardTenure	0.0369***	0.00664*	0.0266**
(BT)	(0.0111)	(0.0044)	(0.0122)
CulturalDiv	0.00297*	0.00322*	0.00323*
(CD)	(0.00179)	(0.00179)	(0.00054)
GenderDiv	0.00795***	0.00518**	0.00791***
(GD)	(0.00219)	(0.0054)	(0.00219)
BT*GD		0.00202***	
		(0.000611)	
BT*CD			0.000990**
			(0.000488)
EnvPerf	0.0537***	0.0530***	0.0538***
	(0.00368)	(0.00369)	(0.00368)
logAge	0.252***	0.257***	0.241***
	(0.0644)	(0.0646)	(0.0646)
logTA	0.183***	0.181***	0.184***
	(0.0378)	(0.0379)	(0.0378)
ROA	−0.00595**	−0.00614**	−0.00590**
	(0.00246)	(0.00246)	(0.00246)
Leve	−0.000119	−0.000126	−0.000120
	(8.38e-05)	(8.39e-05)	(8.39e-05)
Invest	5.33e-11*	5.40e-11**	5.35e-11*
	(0.000)	(0.000)	(0.000)
II	0.000843	0.000867	0.000867
	(0.00179)	(0.00180)	(0.00179)
Analysts	−0.000894	−0.00123	−0.00126
	(0.00468)	(0.00468)	(0.00468)
Bactivity	−0.00412	−0.00392	−0.00419
	(0.00512)	(0.00512)	(0.00512)
Bindep	0.000606	0.000619	0.000607
	(0.000581)	(0.000581)	(0.000581)
CEOduality	0.00755	0.00586	0.00405
	(0.0519)	(0.0519)	(0.0519)
CSRcomm	0.301***	0.293***	0.302***
	(0.0672)	(0.0673)	(0.0673)

(Continues)

TABLE 6 | (Continued)

Panel A. Robust results with ordinal regression			
	Equation (1)	**Equation (2a)**	**Equation (2b)**
	coeff.	**coeff.**	**coeff.**
	(std.error)	**(std.error)**	**(std.error)**
Assurance	0.199***	0.198***	0.199***
	(0.0543)	(0.0543)	(0.0543)
COVID-19	0.238***	0.241***	0.240***
	(0.0476)	(0.0476)	(0.0476)
EU	0.301***	0.296***	0.299***
	(0.0577)	(0.0577)	(0.0577)
ERRI	0.375*	0.374*	0.383*
	(0.220)	(0.220)	(0.220)
EPI	−0.0111	−0.0107	−0.0117
	(0.0108)	(0.0109)	(0.0108)
Religion	0.00194	0.00267	0.00209
	(0.00621)	(0.00623)	(0.00621)
CultInd	−0.0176***	−0.0176***	−0.0176***
	(0.00549)	(0.00550)	(0.00549)
CultMasc	−0.00604	−0.00588	−0.00603
	(0.00396)	(0.00397)	(0.00396)
Country, industry and year controlled			
Log-likelihood	−9120.07***	−9114.61***	−9118.01***
Panel B. Robust results with system GMM models			
	Equation (1)	**Equation (2a)**	**Equation (2b)**
	coeff.	**coeff.**	**coeff.**
	(std.error)	**(std.error)**	**(std.error)**
BoardTenure	0.0385*	0.0454**	0.0208**
(BT)	(0.0199)	(0.0205)	(0.0040)
CulturalDiv	0.00759***	0.00759***	0.0381***
(CD)	(0.00155)	(0.00153)	(0.00491)
GenderDiv	0.00902***	0.0104***	0.0121***
(GD)	(0.00227)	(0.00564)	(0.00240)
BT*GD		0.00152**	
		(0.00025)	
BT*CD			0.00459***
			(0.000572)
EnvPerf	0.0531***	0.0524***	0.0515***
	(0.00429)	(0.00430)	(0.00476)

(Continues)

TABLE 6 | (Continued)

Panel B. Robust results with system GMM models			
	Equation (1)	**Equation (2a)**	**Equation (2b)**
	coeff.	**coeff.**	**coeff.**
	(std.error)	**(std.error)**	**(std.error)**
logAge	0.318***	0.298***	0.412***
	(0.115)	(0.114)	(0.111)
logTA	0.150*	0.123	0.104
	(0.0889)	(0.0970)	(0.0889)
ROA	−0.000554	−0.000725	0.000409
	(0.00132)	(0.00133)	(0.00137)
Leve	0.000277***	0.000272***	0.000247***
	(1.83e-05)	(1.82e-05)	(1.91e-05)
Invest	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
II	0.00710**	0.00739**	−0.00325
	(0.00349)	(0.00362)	(0.00338)
Analysts	−0.0319***	−0.0335***	−0.0272***
	(0.00478)	(0.00472)	(0.00499)
Bactivity	0.00215	0.000402	0.00160
	(0.00285)	(0.00284)	(0.00277)
Bindep	0.00145***	0.00149***	0.00146***
	(0.000403)	(0.000399)	(0.000404)
CEOduality	−0.0530	−0.0391	−0.0811*
	(0.0495)	(0.0494)	(0.0438)
CSRcomm	0.121	0.165*	0.176*
	(0.0916)	(0.0938)	(0.0939)
Assurance	0.556***	0.528***	0.479***
	(0.0690)	(0.0691)	(0.0706)
COVID-19	0.0403**	0.0508**	0.0271
	(0.0195)	(0.0199)	(0.0194)
EU	−0.0236	−0.0200	−0.00989
	(0.0553)	(0.0549)	(0.0581)
ERRI	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
EPI	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Religion	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)

(Continues)

TABLE 6 | (Continued)

Panel B. Robust results with system GMM models			
	Equation (1)	**Equation (2a)**	**Equation (2b)**
	coeff.	**coeff.**	**coeff.**
	(std.error)	**(std.error)**	**(std.error)**
CultInd	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
CultMasc	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Country, industry and year controlled			
Wald chi	1484.33***	1443.10***	1079.85***
Arellano-Bond test for AR(2)	Pr > z = 0.241	Pr > z = 0.243	Pr > z = 0.234
Hansen test of overid. restrictions	Prob > chi2 = 0.520	Prob > chi2 = 0.472	Prob > chi2 = 0.529

Panel C. Robust results with change models and Propensity Score Matching (PSM)						
	Change model			**PSM**		
	Equation (1)	**Equation (2a)**	**Equation (2b)**	**Equation (1)**	**Equation (2a)**	**Equation (2b)**
	coeff.	**coeff.**	**coeff.**	**coeff.**	**coeff.**	**coeff.**
	(std.error)	**(std.error)**	**(std.error)**	**(std.error)**	**(std.error)**	**(std.error)**
BoardTenure	0.0350***	0.0248**	0.0242*	0.0649***	0.0653***	0.0244**
(BT)	(0.00962)	(0.0106)	(0.0125)	(0.0158)	(0.0205)	(0.0019)
CulturalDiv	0.00380**	0.00210***	0.00387*	0.00352*	0.00360*	0.00361*
(CD)	(0.00151)	(0.000295)	(0.00151)	(0.00196)	(0.00193)	(0.00196)
GenderDiv	0.00609***	0.00610***	0.00184**	0.00139**	0.00139**	0.0123**
(GD)	(0.00177)	(0.00177)	(0.00061)	(0.00067)	(0.00067)	(0.00580)
BT*CD		0.000939**			0.00134*	
		(0.000403)			(0.00055)	
BT*GD			0.000656***			0.00211***
			(0.000186)			(0.000794)
EnvPerf	0.0523***	0.0525***	0.0520***	0.0379***	0.0379***	0.0371***
	(0.00302)	(0.00302)	(0.00302)	(0.00482)	(0.00482)	(0.00482)
logAge	0.426***	0.403***	0.431***	0.281**	0.282**	0.332**
	(0.0830)	(0.0836)	(0.0831)	(0.129)	(0.131)	(0.131)
logTA	0.186***	0.187***	0.183***	0.217***	0.217***	0.208***
	(0.0505)	(0.0505)	(0.0505)	(0.0764)	(0.0765)	(0.0764)
ROA	−0.00437**	−0.00436**	−0.00445**	−0.00872***	−0.00872***	−0.00882***
	(0.00190)	(0.00190)	(0.00190)	(0.00298)	(0.00298)	(0.00297)
Leve	2.04e-05	2.46e-05	1.97e-05	1.78e-05	1.78e-05	2.89e-05
	(8.73e-05)	(8.73e-05)	(8.73e-05)	(0.000189)	(0.000189)	(0.000188)

(Continues)

TABLE 6 | (Continued)

Panel C. Robust results with change models and Propensity Score Matching (PSM)						
	Change model			PSM		
	Equation (1)	Equation (2a)	Equation (2b)	Equation (1)	Equation (2a)	Equation (2b)
	coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
	(std.error)	(std.error)	(std.error)	(std.error)	(std.error)	(std.error)
Invest	5.38e-11	5.59e-11	5.47e-11	2.54e-10	2.54e-10	2.55e-10
	(0.000)	(0.000)	(0.000)	(1.12e-10)	(1.12e-10)	(1.12e-10)
II	−0.00618*	−0.00609*	−0.00615*	−0.00876*	−0.00876*	−0.00840*
	(0.00357)	(0.00357)	(0.00357)	(0.00480)	(0.00480)	(0.00480)
Analysts	−0.0106**	−0.0111***	−0.0107**	−0.00890	−0.00889	−0.00858
	(0.00424)	(0.00424)	(0.00424)	(0.00628)	(0.00629)	(0.00628)
Bactivity	−0.00271	−0.00271	−0.00262	−0.00573	−0.00573	−0.00548
	(0.00364)	(0.00364)	(0.00365)	(0.00590)	(0.00590)	(0.00589)
Bindep	0.00106**	0.00107**	0.00107**	−0.000204	−0.000205	−0.000198
	(0.000474)	(0.000474)	(0.000474)	(0.000704)	(0.000704)	(0.000703)
CEOduality	0.0208	0.0169	0.0200	−0.0196	−0.0196	−0.0241
	(0.0439)	(0.0439)	(0.0439)	(0.0829)	(0.0829)	(0.0828)
CSRcomm	0.333***	0.331***	0.329***	0.343***	0.343***	0.349***
	(0.0547)	(0.0547)	(0.0548)	(0.0841)	(0.0841)	(0.0840)
Assurance	0.153***	0.152***	0.152***	0.126*	0.126*	0.124*
	(0.0447)	(0.0447)	(0.0447)	(0.0695)	(0.0695)	(0.0694)
COVID-19	0.117***	0.121***	0.118***	0.122**	0.122**	0.124**
	(0.0413)	(0.0413)	(0.0413)	(0.0586)	(0.0588)	(0.0586)
EU	0.117**	0.118**	0.115**	0.209***	0.209***	0.200***
	(0.0480)	(0.0480)	(0.0481)	(0.0593)	(0.0594)	(0.0594)
Constant	−2.351***	−2.221**	−2.260**	−1.790	−1.793	−1.569
	(0.878)	(0.880)	(0.881)	−1.324	−1.330	−1.325
Year controlled						
R-square	0.170***	0.171***	0.169***	0.121***	0.121***	0.118***

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

In this regard, it is important to recognize that the effectiveness of board diversity in shaping sustainability disclosure is likely to be context-dependent (Ali et al. 2025). Our sample includes firms from developed and emerging markets, which differ significantly in regulatory stringency, stakeholder expectations, and normative environmental pressures. Drawing on institutional theory (DiMaggio and Powell 1983), female directors are better positioned to advocate for environmental transparency in developed markets, characterized by mature institutional frameworks and stronger sustainability mandates. In contrast, in emerging markets, institutional gaps, weaker enforcement mechanisms, and limited stakeholder scrutiny may dampen the impact of board gender diversity (García-Sánchez et al. 2025). These institutional asymmetries help explain the variation in findings across jurisdictions, as well as the contrasting results reported in studies such as Abd-Mutalib et al. (2021), and support the notion that institutional embeddedness is an important moderating factor in the relationship between board composition and sustainability outcomes, particularly in the understudied area of waste disclosure (Adler et al. 2022; Wulansari and Adhariani 2023; Ali et al. 2025; Bai et al. 2025).

This finding theoretically strengthens the combined explanatory power of UET and GST by demonstrating that socially constructed values and ethics directly impact the environmental priorities of long-tenured directors (Oyewo et al. 2025). Furthermore, our findings align with the tenets of RDT and RBV. The former emphasizes how board diversity improves a firm's ability to access critical resources, including stakeholder legitimacy (Gull et al. 2023). In turn, RBV posits that the interplay

TABLE 7 | Complementary results: Equation (3) and (4).

Panel A. Equation (3)

	Linear regression		Ordinal
	fe	re	Regression
	coeff.	coeff.	coeff.
	(std.error)	(std.error)	(std.error)
BoardTenure	0.00413***	0.00395***	0.0377***
(BT)	(0.00129)	(0.00116)	(0.0111)
CulturalDiv	0.00108***	0.000790***	0.00796***
(CD)	(0.000290)	(0.000269)	(0.00261)
GenderDiv	0.00104***	0.00102***	0.0110***
(GD)	(0.000272)	(0.000260)	(0.00249)
CD*GD	−0.0000284***	−0.0000211**	−0.000216***
	(8.83e-06)	(8.62e-06)	(8.25e-05)
EnvPerf	0.00446***	0.00579***	0.0536***
	(0.000404)	(0.000379)	(0.00368)
logAge	0.0653***	0.0261***	0.264***
	(0.0113)	(0.00643)	(0.0647)
logTA	0.0330***	0.0154***	0.185***
	(0.00685)	(0.00376)	(0.0379)
ROA	−0.000663**	−0.000583**	−0.00573**
	(0.000258)	(0.000254)	(0.00246)
Leve	−9.97e-06	−9.12e-06	−0.000127
	(1.12e-05)	(8.49e-06)	(8.38e-05)
Invest	0.000	0.000	5.36e-11*
	(0.000)	(0.000)	(0.000)
II	−0.000392	0.000117	0.000828
	(0.000471)	(0.000178)	(0.00180)
Analysts	−0.000892	0.000129	−0.000848
	(0.000559)	(0.000480)	(0.00468)
Bactivity	−0.000664	−0.000234	−0.00350
	(0.000566)	(0.000535)	(0.00512)
Bindep	4.91e-05	7.75e-05	0.000574
	(6.26e-05)	(6.11e-05)	(0.000581)
CEOduality	0.00450	0.00130	0.00690
	(0.00577)	(0.00550)	(0.0519)
CSRcomm	0.0291***	0.0289***	0.304***
	(0.00715)	(0.00694)	(0.0673)
Assurance	0.0143**	0.0245***	0.198***
	(0.00600)	(0.00572)	(0.0543)

(Continues)

TABLE 7 | (Continued)

Panel A. Equation (3)

	Linear regression		Ordinal
	fe	re	Regression
	coeff.	coeff.	coeff.
	(std.error)	(std.error)	(std.error)
COVID-19	0.0164***	0.0224***	0.233***
	(0.00510)	(0.00502)	(0.0476)
EU	0.0242***	0.0293***	0.320***
	(0.00618)	(0.00605)	(0.0581)
ERRI		0.0361*	0.368*
		(0.0216)	(0.220)
EPI		−0.00107	−0.0113
		(0.00106)	(0.0109)
Religion		−5.13e-05	0.000809
		(0.000611)	(0.00624)
CultInd		−0.00190***	−0.0179***
		(0.000538)	(0.00550)
CultMasc		−0.000697*	−0.00627
		(0.000388)	(0.00397)
Constant	0.103	0.0879	
	(0.404)	(0.107)	
Country, industry and year controlled in re models. Year controlled in fe models.			
R-square	0.097***	0.250***	
Log-likelihood			−9116.636***

Panel B. Equation (4)

	Linear regression (fe)		
	coeff.	coeff.	coeff.
	(std.error)	(std.error)	(std.error)
BoardTenure	0.00373***	0.00399***	0.00389***
(BT)	(0.00130)	(0.00129)	(0.00129)
CulturalDiv	0.000421**	0.000468**	0.000419**
(CD)	(0.000203)	(0.000205)	(0.000203)
GenderDiv	0.000644***	0.000640***	0.000735***
(GD)	(0.000243)	(0.000243)	(0.000247)
BT*COVID-19	0.00277*		
	(0.00157)		
CD*COVID-19		0.000421*	
		(0.000233)	

(Continues)

TABLE 7 | (Continued)

Panel B. Equation (4)

	Linear regression (fe)		
	coeff.	**coeff.**	**coeff.**
	(std.error)	**(std.error)**	**(std.error)**
GD*COVID-19			0.000690**
			(0.000335)
EnvPerf	0.00445***	0.00446***	0.00446***
	(0.000404)	(0.000404)	(0.000404)
logAge	0.0629***	0.0624***	0.0608***
	(0.0113)	(0.0113)	(0.0113)
logTA	0.0323***	0.0326***	0.0328***
	(0.00687)	(0.00686)	(0.00686)
ROA	−0.000704***	−0.000687***	−0.000714***
	(0.000258)	(0.000258)	(0.000258)
Leve	−8.54e-06	−8.46e-06	−8.84e-06
	(1.12e-05)	(1.12e-05)	(1.12e-05)
Invest	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
II	−0.000373	−0.000381	−0.000382
	(0.000472)	(0.000472)	(0.000472)
Analysts	−0.000927*	−0.000891	−0.000874
	(0.000560)	(0.000560)	(0.000560)
Bactivity	−0.000731	−0.000751	−0.000734
	(0.000566)	(0.000566)	(0.000566)
Bindep	5.35e-05	5.18e-05	4.59e-05
	(6.26e-05)	(6.26e-05)	(6.27e-05)
CEOduality	0.00486	0.00462	0.00433
	(0.00577)	(0.00577)	(0.00578)
CSRcomm	0.0283***	0.0288***	0.0290***
	(0.00716)	(0.00716)	(0.00716)
Assurance	0.0144**	0.0144**	0.0144**
	(0.00600)	(0.00600)	(0.00600)
COVID-19	−0.00163	0.0223***	0.0357***
	(0.0118)	(0.00584)	(0.0103)
EU	0.0219***	0.0233***	0.0229***
	(0.00614)	(0.00619)	(0.00616)
Constant	0.133	0.127	0.129
	(0.405)	(0.405)	(0.405)
Year controlled			
R-square	0.095***	0.095***	0.095***

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

of gender diversity and tenure creates a unique, inimitable organizational capability that leads to superior sustainability outcomes (Khan, Khan, and Saeed 2019; Bai et al. 2025). Thus, in line with our multi-theoretical framework, we demonstrate that tenure enables more informed and consistent decision-making and that gender diversity introduces heterogeneity in cognitive frameworks, risk assessments, and stakeholder responsiveness (García-Sánchez et al. 2025). Consequently, our findings suggest that gender diversity amplifies the effect of board tenure by fostering a more deliberative, inclusive, and adaptive board dynamic (Buallay et al. 2022).

Finally, regarding board cultural diversity, our results confirm H3b, showing that board cultural diversity significantly moderates the positive relationship between board tenure and waste disclosure. These results suggest that the benefits of director tenure are greater on culturally diverse boards, where experiential knowledge intersects with cognitive framework heterogeneity linked to diverse cultural perspectives, producing a more nuanced, globally attuned approach to sustainability reporting (Cormier et al. 2022; Aliani et al. 2024; Ali et al. 2025). This finding is consistent with the work of Ibrahim and Hanefah (2016) as well as Khan, Khan, and Senturk (2019); Khan, Khan, and Saeed (2019). Furthermore, it aligns with the tenets of UET and imprinting theory by demonstrating that the cultural environments directors experience early in life create lasting cognitive frames that shape their interpretation of and response to complex issues such as waste management. Similarly, it aligns with the tenets of RDT and RBV by showing that cultural diversity enriches the board's knowledge base and improves the integration of sustainability into governance processes (Katmon et al. 2019; Martínez et al. 2022). Importantly, the interaction effect suggests that cultural heterogeneity could mitigate potential drawbacks of long tenure, such as strategic rigidity or insularity, by introducing pluralistic perspectives and enabling more context-sensitive responses to stakeholder demands (Dodd et al. 2022; Abbas et al. 2025).

Beyond board characteristics, our control variables provide additional insight into the firm-level determinants of waste disclosure. Firms with stronger environmental performance, greater organizational maturity (as proxied by firm age), and larger asset bases are more likely to report on waste-related issues. These patterns suggest that environmentally proactive, well-established, and large firms are better equipped to integrate sustainability goals and develop robust reporting systems. These findings are consistent with Benjamin et al. (2023), who reported a positive relationship between environmental performance and disclosure, and Abd-Mutalib et al. (2021), who found a similar relationship for firm size. In addition, dedicated CSR subcommittees and external assurance for sustainability reports are positively associated with waste transparency, consistent with Bai et al. (2025). These mechanisms strengthen the institutionalization of sustainability governance and lend credibility to non-financial reporting.

Finally, the role of institutional and contextual factors is noteworthy (da Rosa et al. 2015; Ali et al. 2025). Companies operating in jurisdictions with more stringent environmental regulatory requirements (ERRI) and within the EU disclosure framework are more likely to disclose waste information. This underscores the critical role of legal and normative pressures in shaping corporate transparency (Mesjasz-Lech 2025; García-Sánchez, Ortiz-Martínez, et al. 2023). Interestingly, the positive association between the COVID-19 pandemic and waste disclosure may reflect a heightened societal awareness of sustainability and a shift in stakeholder expectations in times of global crisis (Aibar-Guzmán et al. 2023).

In summary, this study offers a significant theoretical contribution by providing an integrative perspective that redefines the role of board tenure in sustainable governance. Contrary to the traditional view that links director tenure with rigidity and entrenchment risk, our findings demonstrate that the accumulated experience of long-tenured directors becomes a strategic resource that enhances environmental transparency, an effect that is further strengthened by gender and cultural diversity. This perspective expands the explanatory power of UET, RDT, and RBV by showing that the cognitive and relational capabilities of boards are not static but dynamically shaped by heterogeneity and institutional context. By incorporating regulatory factors and cultural contingencies, the study proposes a more complex, adaptive theoretical framework connecting experiential capital, diversity, and normative pressures to explain superior sustainability disclosure outcomes. In doing so, this study opens new avenues for researching how these interactions can optimize governance in global settings and respond to the growing demand for transparency.

7.2 | Practical Implications

From a practical perspective, our findings underscore the strategic importance of board tenure and diversity in promoting environmental transparency. While long tenure facilitates a deeper understanding of the company's operations and stakeholder pressures, gender and cultural diversity enrich these insights with complementary perspectives that amplify the benefits of tenure. This synergy is particularly evident in the context of waste disclosure, an area that is often underreported relative to other environmental areas (Abd-Mutalib et al. 2021; Adler et al. 2022; Wulansari and Adhariani 2023). Our findings suggest that the strategic appointment of women and culturally diverse directors can help companies realize the full potential of tenure-based experience for more meaningful sustainability reporting.

These findings are particularly relevant for multinational companies operating in complex institutional environments. In such contexts, the intersection of stable governance structures and diverse board profiles offers a unique advantage in meeting global sustainability standards. Firms seeking to enhance their environmental accountability would benefit from promoting longer board tenures alongside greater gender and cultural diversity, thereby improving both the quality and credibility of their sustainability disclosures. To this end, companies can promote stability in board member tenure and allow board members to retain their positions longer to pass on the experience gained through extended tenure. Additionally, companies can establish gender and cultural representation quotas on their boards, aligned with international best practices and sustainability frameworks. They can also implement transparent and

inclusive recruitment procedures to seek candidates who will enrich board cultural and gender diversity. Companies can also develop leadership programs and mentoring initiatives to prepare diverse professionals for board positions, and train current board members in intercultural communication and inclusive decision-making to maximize the benefits of board diversity. Finally, companies can include diversity KPIs into their sustainability reports to reinforce their strategic importance.

For policymakers, our findings can inform debates around governance reform, including discussions around board tenure limits and diversity mandates. Although tenure has traditionally been viewed with ambivalence (Patro et al. 2018; Sun and Bhuiyan 2020), our findings suggest that it can be a powerful driver of transparency in waste management information. While our results do not support prescriptive conclusions regarding optimal tenure or diversity quotas, they suggest that efforts to promote board diversity and ensure experiential continuity may support more meaningful sustainability disclosure. Based on our findings, regulators and policymakers could implement concrete measures, such as encouraging firms to set diversity targets, offering incentives to companies that demonstrate measurable improvements in board diversity, highlighting the value of directors' accumulated experience and strategic continuity, and including board cultural and gender diversity and director tenure metrics in sustainability reporting frameworks, such as the aforementioned ISSB standards or ESRS. Additionally, our waste disclosure index could serve as a model or checklist for standard-setting organizations worldwide, such as the ISSB and EFRAG, to refine their waste-related disclosure requirements.

Finally, our findings may also be relevant to scholars and practitioners beyond business and management, such as environmental scholars and regulators interested in understanding how corporate governance dynamics intersect with environmental disclosure practices.

8 | Conclusion

Waste management disclosure reflects a company's environmental impact and its alignment with circular economy principles, regulatory compliance, and stakeholder expectations for transparency (Gull et al. 2024; Mesjasz-Lech 2025). This study investigates the influence of board tenure on corporate waste disclosure and examines whether this relationship is moderated by board gender and cultural diversity. Based on a sample of 832 large firms operating in multiple countries, our results suggest that board tenure positively influences the extent of waste disclosure and that this effect is amplified in boards with greater gender and cultural diversity. These findings provide theoretical insights into how specific board characteristics shape environmental transparency in the relatively under-researched area of waste management (Adler et al. 2022; Wulansari and Adhariani 2023; Bai et al. 2025; Bogdan et al. 2025).

By disentangling this granular component of environmental disclosure (Ha and Mansi 2023; Centinaio 2024), our research provides a more holistic understanding of the interplay between board composition and sustainability disclosure. In particular, our findings underscore the importance of director tenure as a mechanism through which boards accumulate firm-specific knowledge, enhance strategic oversight, and strengthen disclosure practices. This positive effect is stronger when boards are demographically heterogeneous, which enriches their cognitive resources and expands their ability to interpret complex stakeholder demands and institutional pressures. In this sense, gender and cultural diversity may amplify the tenure's positive effects by fostering richer deliberation and broader perspectives in decision-making.

Overall, these findings support those of Shahab et al. (2022), Gull et al. (2023), and Bai et al. (2025) on the impact of board characteristics on corporate waste management and disclosure practices, and extend existing research on the impact of board composition on corporate sustainability and transparency in several ways. First, they reinforce the strategic role of corporate governance, and the board in particular, in promoting environmental accountability through more comprehensive waste disclosure (Ahsan et al. 2024; Bai et al. 2025). By identifying tenure, gender, and cultural diversity as mutually reinforcing drivers of waste disclosure, the study provides nuanced evidence of their potential synergistic effects. Second, our findings challenge the assumption of diminishing returns to board tenure (Beasley 1996) by demonstrating that longer-serving boards can enhance environmental transparency. Third, our findings contribute to the ongoing debate on the benefits and risks of board diversity (Martínez et al. 2022).

From a practical perspective, while the results establish statistical associations rather than causal mechanisms, they provide valuable insights for firms and policymakers seeking to improve environmental transparency. Companies seeking to improve the quality of their waste disclosure should take a more inclusive approach to board composition. Rather than focusing on tenure, gender or cultural diversity in isolation, governance strategies should consider how combinations of these characteristics can foster a board environment conducive to more credible and stakeholder-responsive sustainability reporting. This approach is particularly relevant given the generally low level of corporate disclosure on waste management. In this context, board characteristics such as tenure, gender, and cultural diversity can serve as levers to improve accountability and promote environmental stewardship (Wulansari and Adhariani 2023).

Notwithstanding its contributions, the study has several limitations that warrant caution and open avenues for future research. First, although we control for several firm-level characteristics, the possibility of endogeneity due to unobserved heterogeneity remains, potentially affecting the observed relationships. Second, the positive associations between board diversity and waste disclosure may partly reflect reverse causality, with environmentally proactive firms attracting diverse board members.

Future studies using longitudinal designs or instrumental variable approaches could help address these concerns. Further research could also examine additional board characteristics, such as functional background or age diversity, that may influence waste disclosure, independently or in interaction with tenure and demographic diversity. It would also be valuable to examine whether a threshold or "critical mass" of female or culturally diverse directors conditions the observed effects or

whether board tenure has nonlinear effects. Moreover, many countries have started to adopt mandatory gender quotas on boards that could affect disclosure practices. However, these laws have an application period that exceeds the analyzed time interval of this paper. In this vein, future research would incorporate natural experiments, allowing for a cleaner estimation of the causal effect of a board's diversity "shock" on subsequent waste disclosure practices, compared to a control group of firms not subject to the regulation. Finally, cross-national studies that control for institutional and cultural differences could deepen our understanding of how contextual factors affect the relationship between board composition and environmental transparency.

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