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Corporate Governance Determinants of Sustainable Manufacturing Practice: The Case of Zero-Defect Manufacturing in Multinational Corporations

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Purpose: This study investigates the corporate governance determinants of sustainable manufacturing practice using Zero-Defect Manufacturing (ZDM) from the stakeholder theory and legitimacy theory perspectives.

Design/methodology: Using a panel research design, the study analyses empirical data from Global 500 companies covering a 15-year period.

Findings: The results show that Board Independence, Meeting Attendance by Board Members, Board Gender Diversity, and Board Skills on Sustainable Manufacturing are positively associated with ZDM Practice, whilst Chief Executive Officer (CEO) Duality of Power has a negative impact. In the millennium development goals (MGDs) period, the foremost drivers of ZDM Practice are Board Independence, Board Gender Diversity, and Board Skills on Sustainable Manufacturing, whilst this shifted to Board Independence and Board Gender Diversity in the sustainable development goals (SDGs) period.

Originality/value: The study provides empirical evidence that organisations seeking to improve sustainable manufacturing practice may consider strengthening their corporate governance structures to demonstrate responsible manufacturing in line with stakeholders' expectations and to preserve corporate legitimacy. The results are robust to alternative proxies, potential endogeneity concerns, and sample selection bias.

1. Introduction

Globalisation is challenging manufacturing organisations to embrace production innovations such as integrating design, manufacturing, and product to improve product and process quality in alignment with the tenets of sustainable manufacturing (Haridy et al., 2023; Donkor et al., 2024). A viable strategy manufacturing concerns can implement to achieve process and product innovation is sustainable manufacturing using zero-defect manufacturing (ZDM). ZDM refers to avoiding failures and imperfection in the production process for the purpose of obtaining the highest quality possible (Fayyaz et al., 2024). Quality management strategies such as quality assurance, quality improvement, and quality inspection, amongst others are, therefore, associated with ZDM, and are critical to achieving zero defects in production process (Catenazzo & Paulssen, 2020). ZDM combines all the best features of traditional quality management methods but also incorporates all the new digital technologies that industry 4.0 and 5.0 can offer. ZDM has tremendous benefits to customers, organisations, and the society such as promoting inclusive and sustainable industrialisation, increasing resource-use efficiency, and promoting greater adoption of clean and environmentally sound technologies and industrial processes. Sustainable manufacturing using ZDM resonates with the United Nations (UN) sustainable development goals (SDGs), especially SDGs 9,12 and 13 respectively. Therefore, embracing ZDM is essential for any forward-looking manufacturing organisation, as this can be one of the strategies to implement to achieve corporate sustainability target.

One of the major mechanisms for organisation self-regulation which enables corporate entities to engage in voluntary or discretionary sustainability practice, such as sustainable manufacturing/ ZDM is corporate governance (Adel et al., 2019; Zhang et al., 2021). Corporate governance (CG) refers to the system by which companies are directed and controlled to ensure the achievement of set objectives (Erin et al., 2021). Within the context of the current study, CG structures are mechanisms which ensure that the activities of company's management and decisions of the board of directors lead to sustainable manufacturing practice such as ZDM.

Whilst it has been widely acknowledged that CG is critical for achieving sustainable manufacturing, the review of literature on the nexus between CG structure and sustainable manufacturing practices reveals some gaps which the current study aims to address. First, literature is replete with studies on the impact of CG on various sustainable manufacturing issues such as circular economy, carbon emissions, green innovation, and waste reduction,

among others. However, little is known on the extent to which CG structure affects sustainable manufacturing using zero-defect manufacturing. The relevance of CG to the zero-defect manufacturing discourse stems from the consideration that organisational commitment to improving product quality through defect manufacturing initiatives is predominantly voluntary and not mandatory for many multinational corporations (MNCs). Engaging in responsible manufacturing, ensuring customer health and safety by reducing defective products and engaging in various sustainable manufacturing initiatives requires strong ethical consideration on the part of MNCs, especially given that MNCs operate in many jurisdictions in developing countries where the environmental laws are not robust enough or rigorous to protect members of the public. Given that decision-making on ethical issues such as zero-defect manufacturing rests firmly with board of directors, it is important to investigate the extent to which CG structure is influencing sustainable manufacturing practice such as zero-defect manufacturing.

Second, sustainable manufacturing is mainstream among the priority areas set out in the sustainable development agenda 2030 (i.e., "Agenda 2030"). As key partners for the achievement of Agenda 2030, one of the strategies MNCs can implement to achieve their sustainable manufacturing targets is the implementation of zero-defect manufacturing initiatives. Considering that decisions on sustainable manufacturing practice is made at top-level management through corporate boards, it is important to know which CG structure drives Sustainable manufacturing using zero-defect manufacturing. This is because such knowledge can assist MNCs to strengthen such CG apparatus to facilitate the timely achievement of their SDG targets directly or indirectly connected to sustainable manufacturing. However, little is known on the CG structures influencing zero-defect manufacturing.

Third, whereas the MDGs laid the foundation for achieving sustainable development, the SDGs were launched to consolidate the gains of the MDGs (Lodhia et al., 2022). However, in comparison to the MDGs period, the motivation for MNCs to bolster their CG structures to improve sustainable Manufacturing practice such as zero-defect manufacturing may be higher in the SDGs period. As suggested by the stakeholder theory and legitimacy theory, MNCs may want to strengthen their CG structures to achieve responsible production in line with SDG 12, thereby demonstrating to stakeholders that they are responsible corporate citizens playing their part in the sustainable development agenda to gaining stakeholders acceptance as a legitimisation strategy (Tetteh et al., 2022). Moreover, top MNCs are located in high greenhouse gas (GHG) emitting countries (Tauringana & Moses, 2021), and mainly operate in environmentally sensitive industries (i.e., primary and secondary activities), they are under

more stakeholder pressure and public scrutiny to demonstrate increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes through zero-defect manufacturing in line with SDG 9, target 9.4 (Lodhia et al., 2022). Since CG is a major self-regulation mechanism for discharging ethical and philanthropic duties with respect to zero-defect manufacturing (Carroll, 2015), MNCs may want to strengthen the CG structures to improve sustainable manufacturing through zero-defect Manufacturing in the SDGs period. However, there is limited knowledge based on empirical analysis on how Agenda 2030 has impacted MNCs to commit to sustainable manufacturing using zero-defect manufacturing in the SDGs period in comparison to the MDGs period.

Against this backdrop, the current study seeks to investigate determinants of Sustainable manufacturing Practice using Zero-Defect Manufacturing from the perspective of CG. Five CG structures which may uniquely affect sustainable manufacturing practice, as suggested by literature, were investigated, notably Board independence, Meeting Attendance by Board Members, Duality of Chairperson/ CEO Power, Board gender diversity, and Board skills on sustainable manufacturing. Results show that Board Independence, meeting attendance by board members, Board Gender Diversity, and board skills on sustainable manufacturing are positively associated with zero-defect manufacturing, whilst CEO Duality has a negative impact. In the MGDs period, the three foremost drivers of zero-defect manufacturing are board independence, board gender diversity and board skills on sustainable manufacturing, whilst this shifted to board independence, and board gender diversity in the SDGs period.

2. Literature Review

2.1 Theoretical Framework

2.1 Stakeholder Theory

The stakeholder theory proposes that an organisation is typically made up of various stakeholders that are not only affected by the actions of the organisation, but also have the power to influence the activities of the organisation (Doni et al., 2021). Although the owners/ shareholders of a company may have been responsible for setting up an organisation and engaging the directors to manage the affairs of the business on their behalf, the stakeholder theory postulates that the organisation is responsible to various stakeholder-groups aside the owners. The relevance of the various stakeholders stems from the consideration that various stakeholder groups wield significant influence which may affect the activities of the organisation (Chau & Gray, 2010). Thus, management should consider the interest of various

stakeholders and how their actions may affect the organisation by analysing their level of interests against their levels of power.

In relating the stakeholder theory to the current debate on sustainable manufacturing, organisations will want to implement Zero-Defect Manufacturing to improve product quality and satisfy the expectations of various stakeholders including their customers (who are the ultimate consumers of their products), and government (responsible for setting up and monitoring product quality).

Scholars have argued that voluntary compliance with best practice in production, such as zero-defect manufacturing, especially in climes where improving product quality is not mandated, is borne out of the need to enhance company image, gain societal approval and satisfy stakeholders (Al-Hanshi et al., 2022), which is a legitimising strategy by manufacturing companies (Belal & Cooper, 2011; Wen et al., 2022). It is now common practice for multinational corporations to communicate global and local sustainability information in the various countries where they operate, including sustainable manufacturing practices because of the importance of satisfying various stakeholders irrespective of legal frameworks or institutional requirements in various jurisdictions (Momin & Parker, 2013). However, CG structures are critical for the successful implementation of sustainable manufacturing practices and the communication of same to various stakeholders. Studies show that stakeholder pressure has contributed to increase in sustainability activities as well as the rendition of sustainability performance reports covering best practice in manufacturing such as zero-defect manufacturing (Nuskiya, et al., 2021).

2.2 Legitimacy Theory

The legitimacy theory explains the process and strategies organisation employ to seek endorsement or approval of the society. Simply put, the legitimacy theory assumes that an organisation has no reason to exist, unless its value aligns with the interest of the society (Magness, 2006). Following from this, requirements are imposed on organisations to justify their existence by proving their commitment for the advancement of the society. Sustainable manufacturing using zero-defect manufacturing aligns with the sustainable development agenda (particularly SDGs 9, 12 and 13). Therefore, involvement in sustainable manufacturing practice such as zero-defect manufacturing is seen as an effective strategy for manufacturing organisations to legitimise their existence and prove their relevance to the society to gain

stakeholders' recognition and acceptance since they are contributing to the achievement of the sustainable development agenda. The society views the relationship with the company as a social contract, and the burden of proof is upon the company to demonstrate its commitment to environmental and social sustainability issues so that the society's perception of the company changes. Embracing and implementing zero-defect manufacturing as a sustainable production strategy presents unique opportunities for manufacturing concerns to demonstrate their commitment to addressing sustainable development challenges.

Considering that legitimacy is purposive, intentional, and calculated (Suchman, 1995), manufacturing organisations seeking strategies to gain reputation among stakeholders in the society can showcase their sustainable manufacturing initiatives through the rendition of sustainability performance reports, whilst also providing evidence of their implementation of zero-defect manufacturing and environmental accountability (Mahadeo et al., 2011). Literature suggests that companies voluntarily communicate their sustainable manufacturing practice in an effort towards substantiating the transparency and accountability of their performance (Alewine & Stone, 2013).

The domestication of the legitimacy theory to the current study suggests that various CG structures are emplaced to ensure that manufacturing organisations implement sustainable manufacturing practice such as zero-defect manufacturing to improve product quality, promote customer health and safety, and comply with responsible manufacturing/ sustainable production regulations (Al-Hanshi et al., 2022). These are done for the purpose of legitimising their existence. Furthermore, sustainable manufacturing reports rendered to stakeholders are expected to be accurate, true, fair and free from material misstatement (Habek & Wolniak, 2016). Corporate reputation improves when there is assurance about the credibility and reliability such reports (Simnett et al., 2009). The provision of assurance by an independent auditor/ inspector on the quality control process and sustainable manufacturing report of an organisation can enhance the quality of the information and improve corporate reputation as a legitimising strategy. Therefore, rendition of audited quality control report is one of the CG structures that should drive sustainable manufacturing practice such as zero-defect manufacturing.

2.2 Hypotheses Development

2.2.1 Board Independence

Board independence is strengthened when there are more independent directors on board to complement the efforts of the executive directors (Cucari et al., 2018). Considering that independent directors are not involved in the day-to-day activities of the organisation, they are expected to bring fresh perspectives and innovative thoughts into how the company is run. Their non-involvement in the routine activities of the organisation also implies that they would expectedly assess sustainable manufacturing issues such as zero-defect manufacturing without bias for the purpose of improving product quality and meeting customers' expectations (Ben-Amar et al., 2017). This consideration informs their injection into the board to protect stakeholders against the opportunistic tendencies of the executives in relation to sustainable manufacturing concerns. Their reputation as independent directors will also imply that they have the motivation to take decisions that will: (a) emplace quality control processes; (b) minimise the turning out of defective; and (c) improve product quality. The stakeholder theory supports the argument that the appointment of independent directors is an effective monitoring mechanism that will ensure the institution of quality control measures which diminish the production of defective items. Independent directors will want to protect their reputation as well as the corporate image of the organisation by ensuring that defective products are not turned out into the market or associated with the organisation—in line with the legitimacy theory therefore, manufacturing companies will want to appoint independent directors in order to be seen as making the right efforts to achieve zero-defect manufacturing. Studies have shown that board independence enhances corporate sustainability performance (e.g., Zhang et al., 2013; Ben-Amar et al., 2017; Cucari et al., 2018). This discussion informs the first hypothesis that:

> *H1: Board independence is positively associated with zero-defect manufacturing practice of MNCs.*

2.2.2 Meeting Attendance by Board Members

Board meetings are typically organised to create the forum for board members to engage on issues affecting the progress of the organisation, including product and process quality matters (Chakraborty, 2019). Since sustainable manufacturing is one of the critical issues confronting business entities in recent times (Zanon et al., 2021), conveying regular board meetings, and attending same facilitates the discussion of zero-defect manufacturing issues such as quality assurance, quality improvement, and predictive maintenance, among others. Such board meetings are regarded as quality circles where decisions on improving product quality are

made. Stakeholders are aware that board meetings are critical in providing the platform for independent directors to engage executive directors on quality control issues affecting the interest of customers, host communities, pressure groups, and the government, amongst other stakeholder-groups in the society. In line with the stakeholder theory, stakeholders are, therefore, interest in both the conveyance of board meetings and how well such meetings are attended by board members. To preserve corporate legitimacy, the organisation will want to be seen/ perceived by stakeholders as an entity that provides the platform for board members to engage on process and product quality issues by conveying regular board meetings and providing the avenue for independent board members to attend and engage on issues that protect the interest of stakeholders. Meeting attendance by board members has been empirically linked to improved sustainability outcomes (Allegrini & Greco, 2011; Chakraborty, 2019; Agyemang et al., 2020). From the investigation of 177 listed firms in Italy, Therefore,

> *H2: Meeting attendance by board members is positively associated with zero-defect manufacturing practice of MNCs.*

2.2.3 Duality of Chairperson and Chief Executive's Power

The complexity of activities in corporate entities requires that there should be an office holder that oversees the activities of the board (i.e., the Chairperson), whilst another person is responsible for managing the daily operations of the organisation (MD/CEO). This is because combining both functions of the board Chairperson and the CEO (i.e., duality of power) may bring about span of control/management issues, conflict of interest and abuse of power (Lu & Wang, 2021). To ensure checks and balance, different persons should ordinarily wield the powers of chairperson and the company CEO in line with best practice in CG as expected by various stakeholders (Harun et al., 2020). Considering that investment in zero-defect processes and technologies are capital-intensive and long-term in nature (Montoya-Torres et al., 2015; Fayyaz et al., 2024), executives may not be typically motivated to make such investments because of the diminution in returns in the short run. Whilst such eco-friendly and sustainable manufacturing decisions should ultimately pay off in the run long, the huge initial outlay which may erode profit in the short run may be a disincentive to executives. Therefore, executive board members holding dual position of Chairperson and Chief Executive may use their power to take sub-optimal decision of avoiding investment in sustainable manufacturing initiative such as zero-defect manufacturing. To checkmate the opportunistic tendency of such persons

therefore, corporate governance codes require the separation of office of chairperson from the chief executive to protect the interest of other stakeholders (aside owners/ shareholders), and to maintain corporate legitimacy. To recap, when both roles are combined in one person (giving rise to Chairperson/ CEO duality), the resultant conflict of interest may diminish the sustainable manufacturing performance of an organisation. Empirical evidence abounds to support this argument (e.g., Harun et al., 2020; Lu & Wang, 2021; Nuskiya et al., 2021; Zhang et al., 2021). This discussion informs the next hypothesis that:

H3: Duality of power is negatively associated with zero-defect manufacturing practice of MNCs.

2.2.4 Board Gender Diversity

Branco & Rodrigues (2008) contend that the theme of board diversity correctly links into the structure of stakeholder theory. Since women thinking differs from men's thought pattern (Bakar et al., 2019), approaches to sustainable manufacturing issues by both genders may vary and influence the depth of a company's commitment to zero-defect manufacturing initiatives. Having adequate number of female board members have been noted to improve environmental sustainability performance because women are known to be generally eco-friendly, meticulous and care about others. These traits would spur women to support/ promote sustainable manufacturing practice such as zero-defect manufacturing . Women are known to be naturally generous, more humanitarian, and are more stakeholder-oriented (Javaid Lone et al., 2016; Ullah et al., 2019), and these traits influence their leaning towards protecting the health and safety of customers by insisting on product quality and minimising product defect. Furthermore, the meticulous nature of women would imply that they will not want their reputation and the image of the organisation they manage to be associated with defective and poor-quality product. They will, thus, strive for process improvement and product perfection by supporting zero-defect manufacturing practice. From the stakeholder theory perspective, stakeholders will be interested in gender-diverse boards because of the consideration that female board members may better protect their interest on sustainable manufacturing issues. A growing number of studies have shown that board gender diversity is positively associated with sustainable manufacturing practice (Chong et al., 2018; García-Sánchez et al., 2019; Ong et al., 2020; Kamarudin et al., 2021). Hence,

H4: Board gender diversity is positively associated with zero-defect manufacturing practice of MNCs.

2.2.5 Board skills on sustainable manufacturing

Board skills, competence and experience on sustainable manufacturing may influence the nature and depth of zero-defect manufacturing practice or project an organisation selects for implementation. This is because the successful execution of sustainable manufacturing projects requires expertise to manage time, resources, personnel, and relationships critical for the delivery of such projects (Akhtaruddin & Haron, 2010; Erin et al., 2021). Given the multidisciplinary nature of the sustainable manufacturing issues, the stakeholder theory supports that the skill mix on the board should be balanced in such a manner that the board / top management team can deliver on its mandate of implementing zero-defect manufacturing projects. Considering the capital-intensive and long-term nature of quality improvement initiatives—such as quality assurance, predictive maintenance, procurement, and deployment of quality inspection technologies and associated digital technologies for quality prediction—having the requisite skills among board members is a critical success factor in delivering zero-defect manufacturing target for an organisation. The stakeholder theory will support the recruitment of directors with the technical skills requires to supervise such projects to successful completion in the interest of all stakeholders affected by sustainable manufacturing practice. Thus, high level of board skills on sustainable manufacturing should contribute to achieving zero-defect manufacturing. There are empirical evidence supporting the contention that the presence of knowledgeable and experienced board members coordinating the sustainability endeavours of an organisation contributes to achieving sustainabile manufacturing targets (e.g., Sellami et al., 2018; Cancela et al., 2020; Elsayed & Ammar, 2020). Consequently, it is hypothesized that:

> *H5: Board skills on sustainable manufacturing is positively associated with zero-defect manufacturing practice of MNCs.*

2.2.6 Impact of Corporate Governance Structures on Sustainable Manufacturing in the MDGs and SDGs Periods

Whereas the MDGs laid the foundation for achieving sustainable development, the SDGs were launched to consolidate the gains of the MDGs (Lodhia et al., 2022). However, in comparison to the MDGs period, the motivation for MNCs to bolster their governance structures to improve

Sustainable Manufacturing practice such as zero-defect manufacturing may be higher in the SDGs period based on four major arguments.

First, whilst the MDGs target developing countries, the SDGs affect both developed and developing countries (Oyewo et al., 2022). Bearing in mind that top MNCs are mostly based in developed countries, they may want to strengthen their CG structures to achieve responsible production in line with SDG 12, thereby demonstrating to stakeholders that they are responsible corporate citizens playing their part in the sustainable development agenda in order to gaining stakeholders acceptance as a legitimisation strategy (Tetteh et al., 2022). Second, whilst the MDGs prevalently focuses on social sustainability (with 6 out of 8 goals on social sustainability issues) but with less emphasis on environmental issues, the scope of coverage for the SDGs permeates economic growth, social inclusion, and environmental protection. Considering that top MNCs are located in high greenhouse gas (GHG) emitting countries (Tauringana & Moses, 2021), and mainly operate in environmentally sensitive industries (i.e., primary and secondary activities), they are under more stakeholder pressure and public scrutiny to demonstrate increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes in line with SDG 9, target 9.4 (Lodhia et al., 2022). Drawing from the stakeholder theory and legitimacy theory, they (top MNCs) will want to strengthen their CG structures to improve sustainable manufacturing by achieving zero-defect manufacturing. By so doing, they will be optimising the use of natural resources and minimising their environmental pollution / cleaning up their production externalities to satisfy stakeholders in line with SDG 13, and by so doing legitimise their existence (Aono & Okimoto, 2023).

Third, although the MDG 8 calls for the fostering of global partnership for development, the focus is on developed countries helping least developed and other low-income countries to achieve the development goals (Wagle, 2019). On the other hand, SDG 17 recognises the importance of the private sector in the achievement of the SDGs by calling for public–private partnership (United Nations, 2022). Since global companies are mainstream in the private sector, top MNCs have greater propensity to reinvigorate their governance structures to achieve SDGs relating to sustainable manufacturing (Muñoz, 2021), including but not limited to SDG 9 (industry, innovation, and infrastructure), SDG 12 (responsible production), and SDG 13 (climate action).

Moreover, top MNCs as world largest companies have the tendency to set the tone for the sustainable manufacturing practice of other private sector organisations in the way of zero-defect manufacturing because their decisions have follow-on effects on the rest of the economy (Bashan & Notea, 2018). Arguing from the standpoint of the stakeholder and legitimacy theories, MNCs will want to demonstrate to stakeholders and other private sector entities that they are responsible corporate citizens by improving their sustainable manufacturing practice using zero-defect manufacturing to achieve SDGs outcomes. However, since CG is a major self-regulation mechanism for discharging ethical and philanthropic duties (Carroll, 2015), MNEs will want to strengthen the CG structures to improve sustainable manufacturing through zero-defect Manufacturing.

Fourth, the SDGs are far-reaching, more encompassing and require greater level of commitment and accountability on the part of government and private sector organisations. Whilst the MDGs were developed by a group of experts, the SDGs were developed based on a consultation process among 193 UN member countries, civil societies, and other stakeholders (Wagle, 2019). Furthermore, whilst the MDGs covered 8 broad goals, have 21 targets and 60 indicators, the SDGs cover 17 goals, 169 targets and 232 indicators (Wagle, 2019). This suggests greater level of expectation among stakeholder for MNEs to comply, and thus improvement in CG structures to enhance sustainable manufacturing practice by MNCs may be anticipated.

Taken together, MNEs are likely to be more responsive to the call to tackle sustainable manufacturing challenges by adopting zero-defect manufacturing in the SDGs period to satisfy the expectations of stakeholder and legitimise their existence as responsible corporate citizens contributing their quota to the achievement of SDGs. Since CG is a major self-regulating apparatus for fulfilling their philanthropic role of tackling sustainability challenges (Carroll, 2015), corporate commitment to sustainable manufacturing in the SDG period is likely to be stronger as MNEs may want to strengthen their CG structures to achieve the SDG outcomes. This discussion informs the hypothesis that:

> *H6: Ceteris Paribus, CG structures will have more impact on zero-defect manufacturing practice of MNCs in the SDGs period in comparison to the MDGs period.*

3. Research Methods

3.1 Research Design and Data

The study adopts a panel research design. The population of the study is Forbes Global 2000 companies. which is the world's largest, most powerful MNCs ranked based on market value, revenue, assets, and profit. The Forbes selection has been widely employed in prior research (e.g., Martínez-Ferrero & García-Sánchez, 2017). A sample of the first 25% of the firms was selected, making 500 companies. Prior studies have extensively applied the Forbes ranking as a sampling frame. From this list, companies belonging to the financial and insurance sectors were excluded due to significant difference in their business in comparison to non-financial firms (Shu & Chiang, 2020; Konadu, et al., 2021). Data was collected from multiple sources such as Refinitiv/ DataStream databases, company websites and World bank database. Prior studies have extensively used data extracted from data stream (Cheng et al., 2014). Supplementary information not available from the data stream database was gleaned from the annual reports of the companies. Other national data relating to Gross Domestic Product (GDP) of countries and World Governance Indicators (WGI) were collected from the world bank database.

3.2 Measurement of Variables

3.2.1 Dependent Variable

Zero-Defect Manufacturing Practice was measured using Zero-Defect Manufacturing Practice index (ZDMPi) as the main measurement of variable. The ZDMPi was constructed by aggregating seven items typifying process and product quality according to literature (Gnanaraj et al., 2012; Fayyaz et al., 2024), as detailed in Table 1: (i) Quality Management Systems; (ii) ISO 9000; (iii) Lean Six Sigma; (iv) Resource use reduction; (v) Customer Satisfaction system; (vi) Customer health and safety; and (vii) Product responsibility monitoring. Whereas items (i) to (v) have internal focus on quality management issues, items (vi) and (vii) have an external/ customer orientation to quality management because they are externally inclined approach to assessing quality from the perspective of the customers. The seven items were compiled from the Refinitiv database. The maximum score obtainable for ZDMPi is 7, and it has a positive polarity, meaning that higher index reflects robust zero-defect manufacturing practice.

To check the robustness of result for alternative measurement of variable, Product Quality Research and Development (R&D) intensity was applied. This was computed as expenditure

on researching and developing new and sustainable manufacturing techniques aimed at achieving zero-defect divided by the revenue of a company in a financial year. This is an indicator of how committed an organisation is to zero-defect manufacturing innovation and has a positive polarity. The item was computed by the researchers from the data available from Refinitiv.

Product responsibility performance was used as another alternative measure of the dependent variable. Product responsibility category score, as extracted from the Refinitiv database, reflects a company's capacity to produce quality goods and services integrating the customer's health and safety, integrity, and data privacy. Product responsibility letter grade converted to ranking, ranging from "D-" (coded 1) to "A+" (coded 12). Product responsibility performance has a positive polarity, meaning that higher scores reflect more commitment to zero-defect manufacturing.

3.2.2 Independent Variables

The independent variables are corporate governance structure under investigation, namely Board independence (BIN), Meeting Attendance by Board Members (BMA), Duality of Chairperson/ CEO Power (CED), Board gender diversity (BGD), and Board skills on sustainable manufacturing (BDS). A summary of how they were measured and supporting literature is presented in Table 1.

3.2.3 Control Variables

Other corporate governance variables which may affect sustainable manufacturing of an organisation were included as control variables, notably sustainability activities audit, AUD (Braam et al., 2016; Vogt et al., 2017) and sustainability performance pay, COM (Adel, et al, 2019).

Studies have shown that firm attributes, alongside CG structures, affect sustainable manufacturing practice (Harun, et al., 2020; Erin et al., 2021). Therefore, firm attributes such as firm size (FSZ), market presence (FVS) and profitability (FPR), were included as firm-level control variables (Orazalin & Mahmood, 2019; Tingbani, et al.,2020). Considering that the current study is inter-country, country-level governance factors were also included as control variables to recognise country-level institutional factors that may impact sustainable manufacturing practice of organisations as suggested by the institutional theory. The country-level control variables included in the study are Economic Development (CGD), and Country Governance (CWG) based on world Governance indicators (Harun et al., 2020; Lu & Wang,

2021). However, considering the contention surrounding the validity of the six governance indicators with respect to some indicators measuring the same construct, we factor analysed the six indicators (appendix 1) and used the average governance indicators in the regression model.

A full description of variable measurement is presented in Table 1.

[Insert Table 1 about here]

3.3 Model Specification

Based on discussion in literature and theories invoked as theoretical framework for the study, proposed relationship between zero-defect manufacturing, CG structures, firm-attributes and country-level governance factor is specified in a panel multivariate regression model in equation 1:

$$ZDMP_{it} = \beta_0 + \beta_1 BIN_{it} + \beta_2 BMA_{it} + \beta_3 CED_{it} + \beta_4 BGD_{it} + \beta_5 BDS_{it} + \beta_6 AUD_{it} + \beta_7 COM_{it} + \beta_8 FSZ_{it} + \beta_9 FVS_{it} + \beta_{10} FPR_{it} + \beta_{11} PERIOD_{it} + \beta_{12} CGD_{it} + \beta_{13} CWG_{it} + €_{1it} \quad \textit{(Eq. 1)}$$

Where $ZDMP_{it}$ is Zero-Defect Manufacturing Practice; β_0 is constant for Model 1; $\beta_{1\text{-}12}$ are regressor coefficients; $€_{1it}$ is the stochastic error term; and other variables are as defined in Table 1. The regression Model in Equation 1 is used to estimate the baseline result.

3.4 Methods for Data Analysis

Descriptive statistics was used to explore the characteristics of study variables. Partial correlation analysis was performed to assess multicollinearity after controlling for the effect of $PERIOD_{it}$ (MDGs /SDGs period) (Tingbani et al., 2020; Harun et al., 2020). The OLS regression method was used to analyse panel data in line with prior studies (Konadu, et al., 2021; Jamil et al., 2021). After running post-estimation analysis, the Hausman test suggests that the fixed effect model is a better fit for the panel data. Thus, result of the fixed effect model is reported. The fixed effect panel model recognises company-specific and industry, factors for each organisation in each country across the years. The model allows more observations and ensures that only time varying variables account for the changes in the dependent variable. All the time-invariant unobservable factors were accounted for in the intercept, also referred to

as the fixed effect (Baltagi, 2012). Instrumental variable (stage least square regression, 2SLS) regression, propensity score matching (PSM) and difference-in-difference regression was used to assess the robustness of results.

4. Results and Analysis

4.1 Descriptive Analysis

Result in Table 2 shows that there is significant difference in the CG structures, firm-attributes, and country-level governance factor. The governance structures also appear to have improved in the SDGs period in comparison to the MDGs period, notably in terms of board independence, meeting attendance by board members, separation of chairperson /CEO role, board gender diversity, and sustainability activities audit. However, board skills on sustainable manufacturing appear to have diminished between the MDGs (M = 47.63%) and SDGs (M = 43.72%) periods. sustainability performance pay also appears to have been generally less popular in the SDGs period (M = 0.28) in comparison to the MDGs period (M = 0.31). In sum, differences in CG structures and firm attributes in the MDGs and SDGs periods among the MNCs provide a rich context for examining the CG drivers of sustainable manufacturing practice in the MDGs and SDGs period.

[Insert Table 2 about here]

4.3 Baseline Result

4.3.1 Corporate Governance Determinants of Zero-Defect Manufacturing Practice (Combined for MDGs and SDGs periods)

Result from the analysis of the influence of CG structures on Zero-Defect Manufacturing Practice, combined for the MDGs and SDGs periods, is reported in Table 4.

[Insert Table 4 about here]

Result in Table 4 shows that Board Independence, Meeting Attendance by Board Members Attendance, Board Gender Diversity, Board skills on sustainable manufacturing, Sustainability Activities Audit and Sustainability Performance Pay are positively associated with Zero-Defect Manufacturing Practice, whilst CEO Duality has a negative impact. Further, all the variables are statistically significant across the three measures of Zero-Defect Manufacturing Practice (i.e., Zero-Defect Manufacturing Practice index, Product Quality R&D Intensity and Product

Responsibility Performance), except Board Gender Diversity that has no significant impact on Product Quality R&D Intensity. This result supports the acceptance of H1, H2, H3, H4, and H5. Going by the effect size of the coefficients, the three foremost drivers of Zero-Defect Manufacturing Practice are Board Independence, Board Gender Diversity and Board skills on sustainable manufacturing.

In terms of the firm-level control variables, firm size (in terms of Revenue) and Market visibility (in terms of market capitalisation) consistently emerge as positive significant determinants of Zero-Defect Manufacturing Practice across the three measures, implying that large-sized and market-visible firms may be able to implement robust ESG initiatives because of the availability of resources to them. Result also reveals that the MDGs/SDGs period dichotomy affected Zero-Defect Manufacturing Practice, with the SDGs period having greater impact on Zero-Defect Manufacturing Practice in comparison to the MDGs period as shown by the positive significant coefficients for period (MDGs Vs SDGs) across the three dimensions of Zero-Defect Manufacturing Practice. Following the significant impact of the MDGs/SDGs period on Zero-Defect Manufacturing Practice, the result was disaggregated to examine the specific drivers in the MDGs and SDGs periods respectively. The result of the analysis is presented in Table 5 (the MDGs period) and Table 6 (the SDGs period).

4.3.2 Corporate Governance Determinants of Zero-Defect Manufacturing Practice in the MDGs period

Analysis of the determinants of Zero-Defect Manufacturing Practice in the MDGs period is as reported in Table 5.

[Insert Table 5 about here]

Result in Table 5 for the MDGs period shows that Board Independence, Meeting Attendance by Board Members Attendance, Board Gender Diversity, Board skills on sustainable manufacturing, Sustainability Activities Audit and Sustainability Performance Pay are positively associated with Zero-Defect Manufacturing Practice, whilst CEO Duality has a negative impact. Further, all the variables are statistically significant across the three measures of Zero-Defect Manufacturing Practice. The result supports the acceptance of H1, H2, H3, H4, and H5. The effect size of the coefficients also reveals that the three foremost drivers of Zero-

Defect Manufacturing Practice are Board Independence, Board Gender Diversity and Board skills on sustainable manufacturing. The result in Table 5 for the MDGs period is similar to that of Table 4, except that Board Gender Diversity consistently emerged as the strongest determinant of Zero-Defect Manufacturing Practice across the three Zero-Defect Manufacturing Practice measures (Zero-Defect Manufacturing Practice index, Product Quality R&D Intensity and Product Responsibility Performance) in the MDGs period (Table 5), whilst it is the strongest determinant under the Product Responsibility Performance in Table 4. The impact of firm size on Zero-Defect Manufacturing Practice is positive and statistically significant under two Zero-Defect Manufacturing Practice measures, whilst market presence is positive and significant under Product Quality R&D Intensity, thus confirming the earlier result in Table 4 that firm size and market visibility drive the implementation of ESG initiatives.

4.3.3 Corporate Governance Determinants of Zero-Defect Manufacturing Practice in the SDGs period

Result of the analysis of the determinants of Zero-Defect Manufacturing Practice in the SDGs period is reported in Table 6.

[Insert Table 6 about here]

Result in Table 6 for the SDGs period shows that Board Independence, Meeting Attendance by Board Members Attendance, Board Gender Diversity, Board skills on sustainable manufacturing, Sustainability Activities Audit and Sustainability Performance Pay are positively associated with Zero-Defect Manufacturing Practice, whilst CEO Duality has a negative impact. Whereas Board Independence, Sustainability Activities Audit, and Sustainability Performance Pay are statistically significant across the three Zero-Defect Manufacturing Practice measures, Meeting Attendance by Board Members Attendance, Board Gender Diversity and Board skills on sustainable manufacturing are statistically significant across two measures (Zero-Defect Manufacturing Practice index and Product Responsibility Performance). Taken together the statistical significance of the variables across at least two measures of Zero-Defect Manufacturing Practice confirms that they are significant positive drivers of Zero-Defect Manufacturing Practice. The result supports the acceptance of H1b, H2b, H3b, H4b, H5b, H6b and H7b. With respect to the ranking of the variables, the effect size of the coefficients reveals that the three foremost drivers of Zero-Defect Manufacturing Practice are Board Independence, Board Gender Diversity and Sustainability Activities Audit. Firm size and market presence consistently emerge as positive significant determinants of

Zero-Defect Manufacturing Practice across two measures, implying that large-sized and market-visible firms have higher propensity to implement robust ESG initiatives.

4.3.4 Comparison of the impact of Corporate Governance Structures on Zero-Defect Manufacturing Practice in the MDGs and SDGs Periods

Comparing the results in Tables 5 with Table 6, the impact of the CG structures on Zero-Defect Manufacturing Practice in the MGDs period is greater in comparison to the SDGs period. Going by the coefficients of determination (R^2), the R^2 for the MDGs period for the main dependent variable (Zero-Defect Manufacturing Practice index) is 31.5%, whereas that of the SDGs period is 26.6%. Further, whilst the R^2 for the alternative measures range from 15.7% to 30.8% in the MDGs period, the corresponding figures for the SDGs period ranges from 4.9% to 25.5%. This leads to the rejection of H8.

4.4 Robustness Check

4.4.1 Treatment of Endogeneity using Instrumental Variable Regression

Literature suggest that simultaneity may occur between board gender diversity and Zero-Defect Manufacturing Practice (Adams, 2016; Konadu et al, 2021). Simultaneity, as a dimension of endogeneity problem, implies that two variables may influence each other. In other words, variable X (board gender diversity) causes Y (Zero-Defect Manufacturing Practice), but Y (Zero-Defect Manufacturing Practice) also causes X (board gender diversity). To treat endogeneity problem, the study applied Instrumental variable (2 stage least square, 2SLS) regression as suggested by literature (Konadu et al, 2021; Ullah et al., 2021). Three variables were applied as the instrument for board gender diversity, namely executive director (ED) gender diversity, Nationality diversity and board size as suggested by scholars (Tingbani et al, 2020; Konadu et al, 2021). The result of the instrumental variable (2SLS) regression analysis is presented in Table 7.

[Insert Table 7 about here]

Result in Table 7 is consistent with that of Table 4 in which Meeting Attendance by Board Members Attendance, Board Gender Diversity, Board skills on sustainable manufacturing, Sustainability Activities Audit and Sustainability Performance Pay are positively associated with Zero-Defect Manufacturing Practice, whilst CEO Duality has a negative impact. Further, all the variables are statistically significant across the three measures of Zero-Defect Manufacturing Practice (i.e., Zero-Defect Manufacturing Practice index, Product Quality R&D Intensity and Product Responsibility Performance), except Board Independence. With respect

to the firm-level control variables, firm size and market presence consistently emerge as positive significant determinants of Zero-Defect Manufacturing Practice across the three measures, confirming the prior results that that large-sized and market-visible firms have higher propensity to implement robust ESG initiatives. The result is also consistent with that of Table 4 with respect to the impact of the MDGs and SDGs periods on Zero-Defect Manufacturing Practice, with the SDGs period having greater impact on Zero-Defect Manufacturing Practice in comparison to the MDGs period going by the positive significant coefficients across the three Zero-Defect Manufacturing Practice dimensions. On a final note, the coefficient of determination of the model in Table 7 (R^2 = 16.0% to 30.2%) has a comparable effect size with that of Table 4 (R^2 = 22.3% to 44/4%). Taken together, the result is robust and comparable to the baseline result after correcting for endogeneity.

4.4.2 Robustness check on impact of Gender Diversity on Zero-Defect Manufacturing Practice using Propensity Score Matching (one-on-one matching approach)

Board gender diversity consistently emerged as a significant, positive and foremost determinant of Zero-Defect Manufacturing Practice (Tables 4 -7). To examine the robustness of the result that board independence is a major CG structure influencing Zero-Defect Manufacturing Practice, propensity score matching (PSM) was applied. Using the median score of board gender diversity, firms were split into two groups of those with high board gender diversity (the treated group) and others with moderate board gender diversity (the control/ untreated group). The propensity scores were used to match items in sample of the treated group against the control group using one-on-one matching approach. The PSM result is presented in Table 8 and Table 9.

[Insert Table 8 about here]

[Insert Table 9 about here]

Result shows 2,358 observations for the treated and 2,196 cases for the control/ untreated case. The matching result shows that the samples were perfectly matched in respect of all the attributes as revealed by the differences in the mean of the covariates between the treated and the control group, except in terms of Sustainability Performance Pay (Table 8). The bias (i.e., difference between the mean of the treated and control group) is less than the recommended maximum of 5% (and having statistically insignificant difference in Mean score as revealed by the p value of the t-statistic) in all cases except Sustainability Performance Pay. The overall Mean bias of 4.3% and overall Median bias of 3.0% is also less than 5%. In essence, the treated

and control groups are similar in most respect in terms of CG structures, meaning that difference in Zero-Defect Manufacturing Practice can be reasonably attributable to the level of board gender diversity.

Result on the effect of the treatment on the treated (ATT) in Table 9 shows that before the samples were matched, the difference in Zero-Defect Manufacturing Practice between the treated (M = 67.445) and control (M = 55.930) group was 11.514. After the matching, the difference reduced to 4.856, with the treated group (M = 67.314) outperforming the control group (M = 62.458) in Zero-Defect Manufacturing Practice by M = 4.856, confirming that board gender diversity is a notable driver of Zero-Defect Manufacturing Practice.

4.4.3 Robustness check on impact of Gender Diversity on Zero-Defect Manufacturing Practice using Propensity Score Matching (Difference-in-Difference approach)

To further examine the robustness of the result that board gender diversity is a foremost determinant of Zero-Defect Manufacturing Practice, the study applied the difference-in-difference propensity score matching (PSM) approach. The difference-in-difference (DID) fixed effect allows for the analysis of firm attributes (level 1 difference) and time effect (level 2 difference) in propensity score estimation and matching. The result of the analysis is presented in Table 10.

[Insert Table 10 about here]

Result in Table 10 shows that the average treatment effect on treated units (ATET) coefficient is 1.679, meaning that firms with high level of board gender diversity (treatment group) are 1.679 times more likely to have a higher Zero-Defect Manufacturing Practice in comparison to those with moderate board gender diversity (control group). Overall, PSM confirms that board gender diversity is a significant positive driver of Zero-Defect Manufacturing Practice, thereby establishing that our result is robust to alternative method of analysis.

5. Discussion

To ensure a robust discussion, the findings are thematically discussed under three subheadings of (i) CG structures influencing Zero-Defect Manufacturing Practice; (ii) difference in CG structures affecting Zero-Defect Manufacturing Practice in the MDGs and SDGs periods, and (iii) magnitude of impact of CG structures on Zero-Defect Manufacturing Practice in the MDGs and SDGs periods.

5.1 CG Structures influencing Zero-Defect Manufacturing Practice

Result shows that in the MDGs period, SDGs period and at the aggregate level (i.e., MDGs and SDGs periods combined), Board Independence, Meeting Attendance by Board Members Attendance, Board Gender Diversity, Board skills on sustainable manufacturing, Sustainability Activities Audit and Sustainability Performance Pay are positively associated with Zero-Defect Manufacturing Practice, whilst CEO Duality has a negative impact.

The result that board independence has a positive impact on Zero-Defect Manufacturing Practice is consistent with literature that having a reasonable number of independent directors on the board enhances Zero-Defect Manufacturing Practice (Zhang et al., 2013; Cucari et al., 2018). This supports the stakeholder theory that stakeholders will prefer to appoint independent directors to strengthen board performance as a strategy for achieving ESG outcomes (Ben-Amar et al., 2017). The positive impact of Meeting Attendance by Board Members attendance on Zero-Defect Manufacturing Practice aligns with submission in literature that attending and participating in Meeting Attendance by Board Members provide a medium for debating ESG issues, and such robust discussion and strategising during Meeting Attendance by Board Members yields positive outcome of improving Zero-Defect Manufacturing Practice (Chakraborty, 2019; Agyemang et al., 2020).

The positive impact of Board Gender Diversity corroborates the argument that inclusion of female board members boosts Zero-Defect Manufacturing Practice because heterogeneity in the thought process and biological make-up of women differ from men, as women have a propensity to support more ESG initiatives known to alleviate sufferings in the society (Ong et al., 2020; Kamarudin et al., 2021). In alignment with the stakeholder theory, the clamour for the appointment of female board members is a strategy that can protect the interest of outside/ external stakeholders. Appointment of female board members is also a strategy for assuring stakeholders that the organisation is committed to improving ESG commitment as a legitimising strategy (García-Sánchez et al., 2019).

The positive association between Board skills on sustainable manufacturing and Zero-Defect Manufacturing Practice confirms that the level of knowledge and competence among board members on ESG issues is critical to delivering ESG outcomes (Cancela et al., 2020; Erin et al., 2021). Thus, stakeholders will want to be sure that board members directing the affairs of the organisation are sufficiently versed. Result on the positive impact of Sustainability Activities Audit on Zero-Defect Manufacturing Practice confirms that independent and

external assessment of ESG activities contributes to the achievement of ESG outcomes (Braam et al., 2016; Vogt et al., 2017). The result provides motivation for companies to engage in Sustainability Activities Audit in order to gain stakeholders confidence and legitimise their existence (Tetteh et al., 2022). Sustainability Performance Pay for board members also has a positive impact, implying that companies can motivate board members by linking their pay to the attainment of Zero-Defect Manufacturing Practice targets (Zhou, 2019; Lu & Wang, 2021). Although there is limited evidence in literature that Sustainability Performance Pay can enhance Zero-Defect Manufacturing Practice, the current study provides some empirical evidence in this regard.

CEO Duality is negatively associated with Zero-Defect Manufacturing Practice, and this is consistent with the result of prior studies (Harun et al., 2020; Lu & Wang, 2021; Nuskiya et al., 2021). This implies that combining the powers and responsibilities of the Chairperson with the CEO creates conflict of interest which could erode Zero-Defect Manufacturing Practice (Zhang et al., 2021). In alignment with the demand of stakeholders for more accountability, corporate entities typically split the office of the chairperson from that of the CEO.

Firm size and market presence consistently emerged as positive significant determinants of Zero-Defect Manufacturing Practice, implying that large-sized and market-visible firms have higher propensity to implement robust ESG initiatives because (i) they have more resources to implement ESG; and (ii) they implement ESG projects as a legitimisation strategy to maintain their competitive position. The result provides evidence for the legitimacy theory, that for big organisations with presence over the world to maintain their legitimacy, they have the propensity to implement ESG initiatives. Thus, availability of resources is crucial for implementation of ESG initiatives.

5.2 Difference in CG structures affecting Zero-Defect Manufacturing Practice in the MDGs and SDGs periods

Whilst result generally shows that Board Independence, Meeting Attendance by Board Members Attendance, Board Gender Diversity, Board skills on sustainable manufacturing, Sustainability Activities Audit and Sustainability Performance Pay are positively associated with Zero-Defect Manufacturing Practice in the MDGs period, SDGs period and at the aggregate level, the magnitude of the impact of the variables differ across the periods.

Whereas the three foremost drivers of Zero-Defect Manufacturing Practice in the MDGs period are Board Independence, Board Gender Diversity and Board skills on sustainable manufacturing (Table 5), the magnitude of the impact shifted to Board Independence, Board Gender Diversity and Sustainability Activities Audit in the SDGs period (Table 6). Board Independence and Board Gender Diversity consistently appear as foremost drivers in both MDGs and SDGs periods whilst the Sustainability Activities Audit assumed greater prominence in the SDGs period in comparison to the MDGs period. Meanwhile, at the aggregate level, Board Independence, Board Gender Diversity, Board skills on sustainable manufacturing and Sustainability Activities Audit (Table 4) are four top-ranking determinants. The consistency of Board Gender Diversity as a significant determinant at the aggregate level and at the MDGs and SDGs periods is confirmed by the robustness test result using instrumental variable regression (Table 7) and propensity score matching (Table 9). The prominence of Sustainability Activities Audit in the SDGs period may be explained by the demand for greater accountability and more level of transparency by stakeholders from corporate entities with the coming into effect of the sustainable development agenda (Muñoz, 2021). As suggested by the legitimacy theory, corporate entities are increasingly seeking strategies to demonstrate commitment to ESG issues (Lodhia et al., 2022), and one of the foremost avenues through which this can be achieved is to have their sustainability activities audited by an independent auditor (Tetteh et al., 2022). Not surprisingly therefore, the practice of embedding audited sustainability/ ESG report within the annual report is gaining traction. Similarly, corporate entities are increasingly issuing stand-alone sustainability/ESG report with comments provided by Sustainability Activities Auditors as a strategy for strengthening transparency and addressing the claims of green-washing/ white-washing of sustainability reports. The publishing of audited ESG/ sustainability report, especially with the coming into effect of the sustainable development agenda, aligns with both the stakeholder theory and legitimacy theory. Whilst ESG reports will be audited to provide reasonable assurance to stakeholders that such report presents a true and fair view of the company's sustainability endeavours (to address concerns about white washing of sustainability reports), making the reports publicly available, with independent comments from Sustainability Activities Auditors, is a strategy for legitimising existence, inspiring public confidence and generally gaining acceptance of stakeholders.

5.3 Magnitude of impact of CG structures on Zero-Defect Manufacturing Practice in the MDGs and SDGs Periods

Result in Table 4 shows that the MDGs/SDGs period dichotomy has a significant impact on Zero-Defect Manufacturing Practice, with the SDGs period recording higher Zero-Defect Manufacturing Practice in comparison to the MDGs period. However, the disaggregated result reveals that the CG structures have a greater impact on Zero-Defect Manufacturing Practice in the MDGs period (Table 5) in comparison to the SDGs period (Table 6). Going by the coefficients of determination (R^2), the R^2 in the MDGs period for the main dependent variable (Zero-Defect Manufacturing Practice index) is 31.5% (Table 5), whilst the corresponding value for the SDGs period is 26.6%. Relatedly, the R^2 in the MDGs (SDGs) period for the alternative measures of Zero-Defect Manufacturing Practice are 15.7% (4.9%) and 30.8% (25.5%) for Product Quality R&D Intensity and Product Responsibility Performance respectively.

Although Zero-Defect Manufacturing Practice has significantly improved between the MDGs and SDGs periods (Table 2), a closer examination of the results in Table 5 and Table 6 shows that the impact of certain CG structures such as Meeting Attendance by Board Members Attendance, Board skills on sustainable manufacturing, Sustainability Activities Audit and Sustainability Performance Pay dropped in the SDGs period in comparison to the MDGs period (focusing on the result under the main measure of Zero-Defect Manufacturing Practice—Zero-Defect Manufacturing Practice index), whereas the impact of Board Independence and Board Gender Diversity improved between those periods. Although the impact of Sustainability Activities Audit on Zero-Defect Manufacturing Practice also diminished between the MDGs and SDGs period (beta coefficient: MDG = 5.474; SDG = 3.439), the magnitude of reduction in its impact is less severe in comparison to that of Board skills on sustainable manufacturing (beta coefficients: MDG = 5.884; SDG = 3.106), and this is responsible for its emergence as the third foremost determinant in the SDGs period.

The result in Table 2 provides some insight as to the diminished impact of the CG structures on Zero-Defect Manufacturing Practice. Result in Table 2 shows that although there was slight improvement in Meeting Attendance by Board Members attendance in the SDGs period (M = 0.781) in comparison to the MDGs period (M = 0.676), the improvement is not robust enough as to cause appreciable improvement in Zero-Defect Manufacturing Practice. The same is true for Sustainability Activities Audit, witnessing slight improvement in the SDGs period (M = 0.64), compared to MDGs period (M = 0.46). There was reduction in Sustainability Performance Pay between the MDGs (M = 0.31), and SDGs (M = 0.28) period. Also, Board

skills on sustainable manufacturing in sustainability reduced in the MDGs period (M = 0.476) in comparison to the SDGs period (M = 0.437). On the other hand, the variables exerting the greatest and improved impact on Zero-Defect Manufacturing Practice— Board Independence and Board Gender Diversity—improved between the MDGs to SDGs period. Board independence improved from 76.1% (MDGs) to 77.6% (SDGs), whilst the corresponding improvement in board gender diversity was from 14.05% (MDGs) to 22.00% (SDGs).

Although there is slight improvement in separating the role of the chairperson from that of the CEO between the MDGs (M = 0.54) and SDGs (M = 0.50) periods (Table 2), the severity of the negative impact of CEO duality on Zero-Defect Manufacturing Practice is still higher in the SDGs period (b = -3.137) in comparison to the MDGs period (b = -1.913). This implies that the practice of combining the dual role of chairperson and CEO in one person is still popular among MNEs in the SDGs period, accounting for its diminished impact on zero-defect manufacturing practice.

6. Conclusion

This study investigates the impact of CG structures on Zero-Defect Manufacturing Practice in the MDGs and SDGs periods with a view towards assessing the extent to which the United Nations sustainable development agenda has affected corporate commitment to sustainable manufacturing practice. Five CG structures that have been suggested as key determinants of sustainable manufacturing practice in literature but not rigorously investigated within the context of zero-defect manufacturing were examined namely board independence, meeting attendance by board members, duality of Chairperson/ CEO power, board gender diversity, and board skills on sustainable manufacturing. Result shows that Board Independence, meeting attendance by board members, Board Gender Diversity, Board Skills, ESG Audit and ESG-driven Compensation are positively associated with ESG performance, whilst CEO Duality has a negative impact.

In the MGDs period, the three foremost drivers of zero-defect manufacturing are board independence, board gender diversity and board skills on sustainable manufacturing, whilst this shifted to board independence, and board gender diversity in the SDGs period. The prominence of sustainability activities audit in the SDGs period may be explained by the demand for greater accountability and more transparency by stakeholders from corporate entities with the coming into effect of the sustainable development agenda. Further, the impact

of the CG structures on zero-defect manufacturing in the MGDs period is greater, when compared to the magnitude of impact in the SDGs era. Whereas the impact of Board Independence and Board Gender Diversity improved between the MDGs and SDGs periods, the impact of meeting attendance by board members and board skills on sustainable manufacturing diminished in the SDGs period in comparison to the MDGs period. Taken together, the study concludes that corporate governance is a notable determinant of sustainable manufacturing using zero-defect manufacturing. Organisations seeking to improve sustainable manufacturing practice may therefore consider strengthening their corporate governance mechanisms to demonstrate responsible manufacturing in line with stakeholders' expectations and to preserve corporate legitimacy.

Although zero-defect manufacturing practice improved in SDGs period in comparison to MDGs, the relatively higher impact of the CG structures in the MDGs period in comparison to SDG period suggests that other factors may have been responsible for the difference. That CG structures are not contributing as much to zero-defect manufacturing practice during the SDGs period in comparison to MDGs period means that companies need to reinvigorate their CG structures to achieve SDG targets relating to sustainable manufacturing especially in the areas where CG apparatus weakened in the SDGs period in terms of meeting attendance by board members, board skills on sustainable manufacturing, sustainability activities audit and sustainability performance pay. However, the overall positive impact of CG structures on zero-defect manufacturing in the SDGs era implies that CG is a veritable tool which can be used to improve sustainable manufacturing. Although sustainability performance pay is still nascent, the study presents evidence that it has potential to improve sustainable manufacturing. Corporate entities may, therefore, start looking into how managers can be incentivised to achieve sustainable manufacturing outcomes by linking executive pay to zero-defect manufacturing. Drawing from the result that there is slight improvement in separating the role of the Chairperson from that of the CEO between the MDGs and SDGs periods, splitting Chairperson responsibilities from CEO is a welcome development which should be encouraged to have the desired impact of improving commitment to Sustainable manufacturing using zero-defect manufacturing. Although at present, the impact is yet to be felt—with more rigorous implementation of separating the offices, the gains may materialise eventually. To strengthen the achievement of SDGs relating to product quality and sustainable manufacturing, it is recommended that the gains of the positive impact of Board Independence and Board Gender

Diversity on zero-defect manufacturing between the MDGs and SDGs periods should also be consolidated by strengthening the corporate governance structure in these aspects.

References

Adel, C., Hussain, M.M., Mohamed, E.K.A., & Basuony, M.A.K. (2019). Is corporate governance relevant to the quality of corporate social responsibility disclosure in large European companies? *International Journal of Accounting & Information Management, 27* (2), 301-332. https://doi.org/10.1108/IJAIM-10-2017-0118

Agyemang, A.O., Yusheng, K., & Ayamba, E.C. (2020) Impact of board characteristics on environmental disclosures for listed mining companies in China. *Environmental Science and Pollution Research, 27*, 21188–21201. https://doi.org/10.1007/s11356-020-08599-2

Akhtaruddin, M. & Haron, H. (2010). Board ownership, audit committees' effectiveness and corporate voluntary disclosures. *Asian Review of Accounting, 18*(1), 68-82. https://doi.org/10.1108/13217341011046015

Alewine, H.C., & Stone, D.N. (2013). How does environmental accounting information influence attention and investment? *International Journal of Accounting and Information Management, 21* (1), pp. 22-52.

Allegrini, M., & Greco, G. (2013). Corporate boards, audit committees and voluntary disclosure: Evidence from Italian Listed Companies. *Journal of Management and Governance, 17*(1), 187–216. https://doi.org/10.1007/s10997-011-9168-3

Al-Hanshi, M.A., Ojiako, U., & Williams, T. (2022). Managing strategic resources in petroleum industry projects. *Production Planning & Control, 33*(11), 1043-1060. https://doi.org/10.1080/09537287.2020.1843081

Aono, K., & Okimoto, T. (2023). When does the Japan Empowering Women Index outperform its parent and the ESG Select Leaders Indexes? *International Review of Financial Analysis*. https://doi.org/10.1016/j.irfa.2022.102428

Azmi, W., Hassan, M.K., Houston, R., & Karim, M.S. (2021). ESG activities and banking performance: International evidence from emerging economies. *Journal of International Financial Markets, Institutions & Money, 70*. https://doi.org/10.1016/j.intfin.2020.101277

Bakar, A., Ghazali, N. & Ahmad, M. (2019). Sustainability reporting and board diversity in Malaysia. *International Journal of Academic Research in Business and Social Sciences, 9* (2), 34-46.

Bashan, A., & Notea, A. (2018). A hierarchical model for quality management systems in global organizations. *International Journal of Quality & Reliability Management, 35* (7),1380-1398. https://doi.org/10.1108/IJQRM-03-2017-0055

Belal, A.R., & Cooper, S. (2011). The absence of corporate social responsibility reporting in Bangladesh. *Critical Perspectives on Accounting, 22* (7), 654-667.

Ben-Amar, W., Chang, M., & Mcllkenny, P. (2017). Board gender diversity and corporate response to sustainability initiatives: evidence from carbon disclosure project. *Journal of business ethics, 142*, 369-383.

Black, B., de Carvalho, A.G., Khanna, V., Kim, W. and Yurtoglu, B. (2017). Corporate governance indices and construct validity. *Corporate Governance, An International Review, 25* (6), 397-410.

Boateng, R.N., Tawiah, V. & Tackie, G. (2022). Corporate governance and voluntary disclosures in annual reports: a post-International Financial Reporting Standard adoption evidence from an emerging capital market. *International Journal of Accounting & Information Management*. https://doi.org/10.1108/IJAIM-10-2021-0220

Braam, G., Weerd, L. Uit De, Hauck, M., & Huijbregts, M. (2016). Determinants of corporate environmental reporting: the importance of environmental performance and assurance. *Journal of Cleaner Production, 129*, 724-734. https://doi.org/10.1016/j.jclepro.2016.03.039

Branco, M., & Rodrigues, L. (2008). Communication of corporate social responsibility by Portuguese banks: A legitimacy theory perspective. *Corporate Communications*: *An International Journal, 11* (3), 232-248.

Cancela, B.L., Neves, M.E.D., Rodrigues, L.L. & Gomes Dias, A.C. (2020). The influence of corporate governance on corporate sustainability: new evidence using panel data in the Iberian macroeconomic environment. *International Journal of Accounting & Information Management, 28* (4), 785-806. https://doi.org/10.1108/IJAIM-05-2020-0068

Carroll, A. B. (2015). Corporate social responsibility: The centerpiece of competing and complimentary frameworks. *Organizational Dynamics, 44*, 87–96.

Catenazzo, G., & Paulssen, M. (2020). Product defects are not created equal: prioritizing production process improvements. *Production Planning & Control, 31*(4), 338-353. https://doi.org/10.1080/09537287.2019.1638979

Chakraborty, A. (2019). Which internal factors drive companies to social reporting? An empirical study from a developing. *Asian Journal of Accounting Perspectives, 12*(1), 109–127. https://doi.org/10.22452/AJAP.vol12no1.5

Chau, G., & Gray, S.J. (2010). Family ownership, board independence and voluntary disclosure: evidence from Hong Kong, Journal of International Accounting, Auditing and Taxation, 19(2), pp. 93–109. http://dx.doi.org/10.1016/j.intaccaudtax.2010.07.002

Cheng, B., Ioannou, I., & Serafeim, G. (2014). Corporate social responsibility and access to finance. *Strategic Management Journal, 35* (1), 1-23. https://doi.org/10.1002/smj.2131

Chong, L.-L., Ong, H.-B. & Tan, S.-H. (2018). Corporate risk-taking and performance in Malaysia: the effect of board composition, political connections and sustainability practices. *Corporate Governance, 18* (4), 635-654. https://doi.org/10.1108/CG-05-2017-0095

Cucari, N., Esposito De Falco, S., & Orlando, B. (2018). Diversity of Board of Directors and Environmental Social Governance: Evidence from Italian Listed Companies. *Corporate Social Responsibility and Environmental Management*, 25, 250-266. https://doi.org/10.1002/csr.1452.

Dissanayake, D., Tilt, C., & Qian, W. (2019). Factors influencing sustainability reporting by Sri Lankan companies. *Pacific Accounting Review, 31* (1), 84-109.

Doni, F., Corvino, A., & Martini, S.B. (2021). Corporate governance model, stakeholder engagement and social issues evidence from European oil and gas industry. *Social Responsibility Journal*, https://doi/10.1108/SRJ-08-2020-0336

Donkor, F., Papadopoulos, T., & Spiegler, V. (2024). Supply chain integration and supply chain sustainability relationship: a qualitative analysis of the UK and Ghana pharmaceutical industry. *Production Planning & Control, 35*(6), 535-558. https://doi.org/10.1080/09537287.2022.2105762

Elsayed, N. & Ammar, S. (2020). Sustainability governance and legitimisation processes: Gulf of Mexico oil spill. *Sustainability Accounting, Management and Policy Journal, 11*(1), 253-278. https://doi.org/10.1108/SAMPJ-09-2018-0242

Erin, O., Adegboye, A., & Bamigboye, O.A. (2021). Corporate governance and sustainability reporting quality: evidence from Nigeria. *Sustainability Accounting, Management and Policy Journal*. https://doi.org/10.1108/SAMPJ-06-2020-0185

Fayyaz, A., Liu, C., Xu, Y.,Khan, F., & Ahmed, S. (2024). Untangling the cumulative impact of big data analytics, green lean six sigma and sustainable supply chain management on the economic performance of manufacturing organisations. *Production Planning & Control.* https://doi.org/10.1080/09537287.2024.2348517

García-Sánchez, I., Suárez-Fernández, O., & Martínez-Ferrero, J. (2019). Female directors and impression management in sustainability reporting. *International Business Review*, 28, 359–374. https://doi.org/10.1016/j.ibusrev

Gerged, A.M. (2021). Factors affecting corporate environmental disclosure in emerging markets – the role of corporate governance structures. *Business Strategy and the Environment, 30* (1), 609-629.

Ghazali, N. A. M. (2007). Ownership structure and corporate social responsibility disclosure: some Malaysian evidence. *Corporate Governance, 7*(3), 251–266. https://doi.org /10.1108/14720700710756535

Gnanaraj, S.M., Devadasan, S.R., Murugesh, R., & Sreenivasa, C.G. (2012). Sensitisation of SMEs towards the implementation of Lean Six Sigma – an initialisation in a cylinder frames manufacturing Indian SME. *Production Planning & Control, 23*(8), 599-608. https://doi.org/10.1080/09537287.2011.572091

Gómez, N.A., & García, S.M. (2020) Governance and Type of Industry as Determinants of Corporate Social Responsibility Disclosures in Latin America, *Latin American Business Review, 21*:1, 1-35. https://doi.org/10.1080/10978526.2019.1697185

Greene, J. C. (2007). *Mixed methods in social inquiry* (Vol. 9). John Wiley.

Habek, P. & Wolniak, R. (2016). Assessing the quality of corporate social responsibility reports: the case of reporting practices in selected European union member states. *Quality and Quantity, 50* (1), 399-420

Haridy, S., Ojiako, U., Maged, A., Remeithi, M.A., Bashir, H., & Shamsuzzaman, M. (2023). Quality process control and resourcing in manufacturing firms. *Production Planning & Control.* https://doi.org/10.1080/09537287.2023.2214109

Harun, M., Hussainey, K., Kharuddin, K., & Farooque, O. (2020). CSR disclosure, corporate governance and firm value: A study on GCC Islamic Banks. *International Journal of Accounting & Information Management, 28* (4), 607-638. https://doi.org/10.1108/IJAIM-08-2019-0103

Hogan, J., & Lodhia, S. (2011). Sustainability reporting and reputation risk management: an Australian case study. *International Journal of Accounting and Information Management, Vol. 19* (3), 267-287

Huang, C., & Kung, F. (2010). Drivers of Environmental Disclosure and Stakeholder Expectation: Evidence from Taiwan. *Journal of Business Ethics, 96* (3), 435–451. https://doi.org/10.1007/s 10551-010-0476-3

Huang, C., & Kung, F. (2010). Drivers of Environmental Disclosure and Stakeholder Expectation: Evidence from Taiwan. *Journal of Business Ethics, 96* (3), 435–451. https://doi.org/10.1007/s 10551-010-0476-3

Ismaeel, M., & Zakaria, Z. (2020). Perception of preparers of sustainability reports in the Middle East. *Meditari Accountancy Research, 28* (1), 89-116.

Jain, T., & Zaman, R. (2019). When boards matter: The case of corporate social irresponsibility. *British Journal of Management*, *31*, 365–386.

Javaid Lone, E., Ali, A., & Khan, I. (2016). Corporate governance and corporate social responsibility disclosure: evidence from Pakistan. *Corporate Governance: The International Journal of Business in Society, 16* (5), 785-797.

Kamarudin, K.A., Ariff, A.M. & Wan Ismail, W.A. (2021). Product market competition, board gender diversity and corporate sustainability performance: International evidence. *Journal of Financial Reporting and Accounting*. https://doi.org/10.1108/JFRA-01-2021-0020

Kara, A., Zhou, H., & Zhou, Y. (2021). Achieving the United Nations' sustainable development goals through financial inclusion: A systematic literature review of access to finance across the globe. *International Review of Financial Analysis*,77. https://doi.org/10.1016/j.irfa.2021.101833.

Karaman, A.S., Kilic, M., & Uyar, A. (2020). Green logistics performance and sustainability reporting practices of the logistics sector: The moderating effect of corporate governance. *Journal of Cleaner Production*, 258 (1), https://doi.org/10.1016/j.jclepro.2020.120718 0959-6526

Kend, M. (2015). Governance, firm-level characteristics and their impact on the client's voluntary sustainability disclosures and assurance decisions. *Sustainability Accounting, Management and Policy Journal, 6* (1), 54-78. https://doi.org/10.1108/SAMPJ-12-2013-0061

Konadu, R., Ahinful, G.A., Boakye, D.J., & Elbardan, H. (2021). Board gender diversity, environmental innovation and corporate carbon emissions. *Technological forecasting and social change*. https://doi.org/10.1016/j.techfore.2021.121279

Lodhia, S., Kaur, A., & Kuruppu, S.C. (2022). The disclosure of sustainable development goals (SDGs) by the top 50 Australian companies: substantive or symbolic legitimation? *Meditari Accountancy Research*. https://doi.org/10.1108/MEDAR-05-2021-1297

Lu, J., & Wang, J. (2021). Corporate governance, law, culture, environmental performance and CSR disclosure: A global perspective. *Journal of International Financial Markets, Institutions & Money, 70* https://doi.org/10.1016/j.intfin.2020.101264

Magness, V. (2006). Strategic posture, financial performance and environmental disclosure: an empirical test of legitimacy theory, Accounting, Auditing and Accountability Journal, 19(4), pp. 540–563. http://dx.doi.org/10.1108/09513570610679128

Mahadeo, J.D., Oogarah-Hanuman, V., & Soobaroyen, T. (2011), "Changes in social and environmental reporting practices in an emerging economy (2004–2007): exploring the relevance of stakeholder and legitimacy theories", Accounting Forum, Vol. 35 No. 3, pp. 158-175.

Martínez-Ferrero, J., & García-Sánchez, I. (2017). Coercive, normative and mimetic isomorphism as determinants of the voluntary assurance of sustainability reports. *International Business Review, 26*, 102-118. http://dx.doi.org/10.1016/j.ibusrev.2016.05.009

Meira de Oliveira, E., Fogliano de Souza Cunha, F.A., Palazzi, R.B.,Klotzle, M.C., & Maçaira, P.M. (2020). On the effects of uncertainty measures on sustainability indices: An empirical investigation in a nonlinear framework. *International Review of Financial Analysis*,70, https://doi.org/10.1016/j.irfa.2020.101505.

Milne, M.J., & Adler, R.W. (1999). Exploring the reliability of social and environmental disclosures content analysis. *Accounting, Auditing and Accountability Journal, 12* (2),237-256

Momin, M.A., & Parker, L.D. (2013). Motivations for corporate social responsibility reporting by MNC subsidiaries in an emerging country: the case of Bangladesh. *The British Accounting Review, 45* (3), 215-228.

Montoya-Torres, J.R., Gutierrez-Franco, E., & Blanco, E.E. (2015). Conceptual framework for measuring carbon footprint in supply chains. *Production Planning & Control, 26*(4), 265-279.

Muñoz, F. (2021). Carbon-intensive industries in Socially Responsible mutual funds' portfolios. *International Review of Financial Analysis.* https://doi.org/10.1016/j.irfa.2021.101740

Nadeem, M., Zaman, R., & Saleem, I. (2017). Boardroom gender diversity and corporate sustainability practices: Evidence from Australian Securities Exchange listed firms. *Journal of Cleaner Production*, *149*, 874–885.

Nuskiya, M.N.F., Ekanayake, A., Beddewela, E., & Gerged, A.M. (2021). Determinants of corporate environmental disclosures in Sri Lanka: the role of corporate governance. *Journal of Accounting in Emerging Economies*, 11 (3), 367-394

Ong, T. & Djajadikerta, H.G. (2020). Corporate governance and sustainability reporting in the Australian resources industry: an empirical analysis. *Social Responsibility Journal*, *16* (1), 1-14. https://doi.org/10.1108/SRJ-06-2018-0135

Orazalin, N., & Mahmood, M. (2018). Economic, environmental, and social performance indicators of sustainability reporting: Evidence from the Russian oil and gas industry. *Energy Policy*, 121, 70-79.

Orazalin, N., & Mahmood, M. (2019). Determinants of GRI-based sustainability reporting: evidence from an emerging economy. *Journal of Accounting in emerging Economies, 10* (1), 140-164. https://doi.org/10.1108/J AEE-12-2018-0137

Oyewo, B., Tawiah, V., & Zakari, A. (2022). Actualising Agenda 2030 through Sustainability Accounting: Evidence from the Nigerian Manufacturing Sector, Tauringana, V. and Moses, O. (Ed.) Environmental Sustainability and Agenda 2030 (Advances in Environmental Accounting & Management, Vol. 10), Emerald Publishing Limited, Bingley, pp. 105-133. https://doi.org/10.1108/S1479-359820220000010006

Sellami, Y. M., Dammak, N., & Hlima, B. (2018). An empirical investigation of determinants of sustainability report assurance in France. *Journal of Financial Reporting and Accounting, 17* (2), 320-342. https://doi.org/10.1 108/ JF RA- 02-2018-0019

Shu, P., & Chiang, S. (2020). The impact of corporate governance on corporate social performance: Cases from listed firms in Taiwan. *Pacific-Basin Finance Journal*, 61, https://doi.org/10.1016/j.pacfin.2020.101332

Simnett, R., Vanstraelen, A. & Chua, W.F. (2009). Assurance on sustainability reports: an international comparison. *The Accounting Review, 84* (3), 937-967.

Suchman, M. (1995). Managing legitimacy: strategic and institutional approaches. *The Academy of Management Review, 20* (3), 571-610

Tauringana, V., & Moses, O. (2021). Greenhouse Gas Emissions Reporting and Management in Global Top Emitting Countries and Companies. *Special issue call for papers for Advances in Environmental Accounting and Management.* https://books.emeraldinsight.com/resources/docs/AEAM%20Vol_%2011%20CFP%202022_Final.pdf

Tetteh, L.A., Agyenim-Boateng, C., &Simpson, S.N.Y. (2022), "Institutional pressures and strategic response to auditing implementation of sustainable development goals: the

role of public sector auditors", Journal of Applied Accounting Research. https://doi.org/10.1108/JAAR-05-2022-0101

Tingbani, I., Chithambo, L., Tauringana, V., & Papanikolaou, N. (2020). Board gender diversity, environmental committee and greenhouse gas voluntary disclosures. *Business strategy and the Environment, 29* (6), 2194-2210. https://doi.org/10.1002/bse.2495

Ullah, M., Muttakin, M., & Khan, A. (2019). Corporate governance and corporate social responsibility disclosures in insurance companies. *International Journal of Accounting & Information Management, 27* (2), 284-300.

Ullah, S., Zaefarian, G., & Ullah, F., 2021. How to use instrumental variables in addressing endogeneity? A step-by-step procedure for non-specialists. *Industrial Marketing Management*. https://doi.org/10.1016/j.indmarman.2020.03.006

Unerman, J. (2000). Methodological issues-reflections on quantification in corporate social reporting content analysis. *Accounting, Auditing and Accountability Journal, 13* (5), 667-681

United Nations (2022). United Nations Sustainable Development Goals (SDGs) 2030. Retrieved from https://www.un.org/development/desa/disabilities/envision2030.html

Vogt, M., Hein, N., da Rosa, F.S., & Degenhart, L. (2017) Relationship between determinant factors of disclosure of information on environmental impacts of Brazilian companies. *Estudios Gerenciales, 33*, 24-38

Wagle, K. (2019). MDGs Vs SDGs: 17 Differences. Retrieved from https://www.publichealthnotes.com/mdgs-vs-sdgs-17-differences/

Wen, H., Ho., K.C., Gao, J., & Yu, L. (2022). The fundamental effects of ESG disclosure quality in boosting the growth of ESG investing. *Journal of International Financial Markets, Institutions & Money, 81*. https://doi.org/10.1016/j.intfin.2022.101655

Zaman, R., Jain, T., Samara, G., & Jamali, D. (2020). Corporate governance meets corporate social responsibility: Mapping the interface. *Business & Society*. https://journals.sagepub.com/doi/10.1177/0007650320973415

Zhang, D., Zhang, Z.,Ji, Q., Lucey, B., & Liu, J. (2021). Board characteristics, external governance and the use of renewable energy: International evidence. *Journal of International Financial Markets, Institutions & Money, 72*. https://doi.org/10.1016/j.intfin.2021.101317

Zhang, J. Q., Zhu, H., & Ding, H. B. (2013). Board composition and corporate social responsibility: An empirical investigation in the post Sarbanes-Oxley Era. *Journal of*

Business Ethics, 114, 381–392. https://link.springer.com/article/10.1007/s10551-015-2759-1

Zhou, C. (2019). Effects of corporate governance on the decision to voluntarily disclose corporate social responsibility reports: evidence from China, *Applied Economics*, 51:55, 5900-5910, https://doi.org/10.1080/00036846.2019.1631440

List of Tables

Table 1: Measurement of Variables

	Variables	Measurement
1.1	Zero-Defect Manufacturing Practice (Main measurement of variable)	Zero-Defect Manufacturing Practice index (ZDMPi) computed based on the summation of seven items, implying that maximum score obtainable is 7. If the company has a policy in respect of each of the following, it is issued a "'TRUE" and coded '1' for the item, but if otherwise, it is assigned a "FALSE" and coded '0' for the item. (i) Quality Management Systems: Does the company apply quality management systems, such as European Foundation for Quality Management (EFQMs), Lean Manufacturing, Kaizen and continuous improvement process, predictive maintenance, TQM, quality inspection technologies or any other similar quality principles? (ii) ISO 9000: Does the company have an ISO 9000 certification or any industry specific certification (QS-9000-automotive, TL 9000-telecommunications, AS9100-aerospace, ISO/TS 16949-automotive, etc.)? (iii) Lean Six Sigma: Does the company apply the Six Sigma? - only an internal quality system or framework is considered, including information on Good Manufacturing Practice (GMP); information on quality certifications (like ISO 9000 and EFQMs) is not considered under this dimension (iv) Resource use reduction policy: Does the company has a policy in place to reduce the use of materials, energy, or water, and to find more eco-efficient solutions of minimising defective products and improving supply chain management. (v) Customer Satisfaction system: Does the company has a mechanism in place to monitor customer satisfaction? Does the company publishes/ reports the percentage of customer satisfaction? Does the report contain the overall percentage of customers who are satisfied, including customer engagement rate and customer satisfaction index? (vi) Customer health and safety policy: Does the company have a policy to protect customer health & safety by striving to minimise defective products? - processes or initiatives in place by which it strives to market products which are fostering benefits to the consumer's health & safety rather than putting it at risk - includes products related initiatives (vii) Product Responsibility Monitoring: Does the company monitor the impact of its products or services on consumers or the community more generally? - any evidence that the company monitors the impact of its products and services on consumers are considered - the focus to be on responsible product manufacturing with minimal product defect, consider internal industry monitoring, surveys, audits or any other form of measurement relating to product quality monitoring. Whereas items (i) to (v) have internal focus on quality management issues, items (vi) and (vii) have an external/ customer orientation to quality management because they are

		externally inclined approach to assessing quality from the perspective of the customers.
1.2	Product Quality Research and Development (R&D) intensity (Alternative measure of variable 1)	Research and development expenditure on improving product quality and innovation, and reducing defective products as a ratio to Revenue per annum
1.3	Product Responsibility Performance (Alternative measure of variable 2)	Product responsibility category score reflects a company's capacity to produce quality goods and services integrating the customer's health and safety, integrity, and data privacy. Product Responsibility letter grade converted to ranking, ranging from "D-" (coded 1) to "A+" (coded 12)
2	Board Independence	Proportion of Non-executive Directors (NEDs) to total board size expressed in %
3	Meeting Attendance by Board Members	Average Meeting Attendance by Board Members in a year expressed in %
4	Duality of Power	If Chairman also serve as the CEO, there is duality of power, and then a code of 1 is assigned; if otherwise, there is non-existence of duality of power, and then code 0 is assigned
5	Board Gender diversity	Number of Female directors to total board size in a year expressed in %
6	Board skills on sustainable manufacturing on sustainability	Percentage of board members who are knowledgeable about sustainability issues relative to total directors on the board
7	Sustainability Activities Audit	If Sustainability Activities report is audited = 1, otherwise =0
8	Sustainability Performance Pay	If payment of executive board members pay is connected to sustainability performance = 1, otherwise = 0
	Firm-level control variables	
9	Size of Firm (proxy 1)	Revenue (logarithmic transformation of,)
10	Size of Firm (proxy 2)	Market capitalisation (logarithmic transformation of,)
11	Firm Performance	Return on Total Assets ratio (ROTA)
12	MDG/SDG periods	MDG period = 2006-2015; SDG period = 2016-2020
	Country-level control variables	
13	Gross Domestic Product	Gross Domestic Product (GDP) (logarithmic transformation of,)
14	Governance Quality (global view)	Factor analysis of six World Governance Indicators (WGI) based on World bank data

Table 2: Descriptive statistics on Zero-Defect Manufacturing Practice and Corporate Governance Structures in the MDGs and SDGs Periods

Variables	Period	Mean	Std. Dev.	Std. Err.	F ratio
Zero-Defect Manufacturing Practice index	Pre SDGs	58.767	20.925	.386	186.610***
	SDGs	67.150	18.021	.444	
	Total	61.778	20.330	.300	
Product Quality R&D Intensity	Pre SDGs	52.185	19.049	.351	145.111***
	SDGs	59.082	17.756	.437	
	Total	54.662	18.885	.278	
Product Responsibility Performance	Pre SDGs	7.58	2.531	.047	180.891***
	SDGs	8.57	2.175	.054	
	Total	7.93	2.456	.036	
Board Independence	Pre SDGs	.761	.2478	.004	4.873**
	SDGs	.776	.190	.004	
	Total	.766	.228	.003	
Meeting Attendance by Board Members	Pre SDGs	.676	.371	.006	92.414***
	SDGs	.781	.318	.007	
	Total	.714	.356	.005	
Duality of Chairperson/ CEO Power	Pre SDGs	.54	.499	.009	6.101**
	SDGs	.50	.500	.012	
	Total	.52	.499	.007	
Board Gender Diversity	Pre SDGs	.140	.111	.00206	443.055***
	SDGs	.220	.139	.00345	
	Total	.169	.128	.00190	
Board skills on sustainable manufacturing	Pre SDGs	.476	.249	.00460	27.067***
	SDGs	.437	.233	.00575	
	Total	.462	.244	.00361	
Sustainability Activities Audit	Pre SDGs	.46	.499	.009	140.730***
	SDGs	.64	.479	.012	
	Total	.53	.499	.007	
Sustainability Performance Pay	Pre SDGs	.31	.464	.009	4.747**
	SDGs	.28	.451	.011	
	Total	.30	.460	.007	

*** p<0.01, ** p<0.05 Note: Pre-SDGs (refers to the MDGs Period)

Table 2: Assessment of Multicollinearity among variables using Partial Correlation Analysis (controlling for MDGs and SDGs periods)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Board Independence (1)	1.000											
Meeting Attendance by Board Members (2)	.301***	1.000										
Duality of Power (3)	.033**	.026*	1.000									
Board Gender Diversity (4)	.443***	.271***	.069***	1.000								
Board skills on sustainable manufacturing (5)	-.252***	-.012	.077***	-.091***	1.000							
Sustainability Activities Audit (6)	-.008	-.014	-.125***	.092***	-.136***	1.000						
Sustainability Performance Pay (7)	.290***	.200***	.031**	.305***	-.022	.189***	1.000					
Revenue (8)	.047***	.016	-.029**	.034**	-.080***	.257***	.113***	1.000				
Market capitalisation (9)	.199***	.079***	.055***	.191***	-.046***	.175***	.152***	.518***	1.000			
Return on Total Assets (ROTA) (10)	.088***	.011	.028*	.068***	.080***	-.061***	-.028*	-.123***	.281***	1.000		
Gross Domestic Product (11)	.273***	.068***	.131***	.351***	-.044***	.025*	.210***	.042***	.196***	-.049***	1.000	
World Gov. indicator (12)	.041***	.143***	.017	.267***	.103***	.019	.111***	-.015	.009	-.112***	.507***	1.000

*** p<0.01, ** p<0.05, * p<0.10

Table 4: CG Structures and Zero-Defect Manufacturing Practice (Combined for MDGs and SDGs periods)

	(1)	(2)	(3)
Variable	**Zero-Defect Manufacturing Practice**	**Product Quality R&D Intensity**	**Product Responsibility Performance**
Board Independence	5.894***	5.940***	.655***
	(1.093)	(1.476)	(.134)
Meeting Attendance by Board Members	3.487***	2.311***	.453***
	(.491)	(.662)	(.060)
Duality of Power	-2.059***	-1.192**	-.273***
	(.437)	(.590)	(.053)
Board Gender Diversity	5.646***	-.207	.805***
	(1.870)	(2.524)	(.230)
Board skills on sustainable manufacturing	5.157***	6.448***	.660***
	(.637)	(.859)	(.078)
Governance variables (control)			
Sustainability Activities Audit	4.931***	4.069***	.612***
	(.430)	(.581)	(.053)
Sustainability Performance Pay	4.064***	2.579***	.524***
	(.346)	(.467)	(.042)
Firm-level Variables (control)			
Revenue	10.453***	3.550***	1.229***
	(.953)	(1.286)	(.117)
Market Presence	3.494***	5.805***	.440***
	(.738)	(.996)	(.090)
Return on Total Assets (ROTA)	-.070**	-.033	-.009**
	(.034)	(.046)	(.004)
Period (MDGs / SDGs)	3.402***	2.925***	.409***
	(.409)	(.552)	(.050)
Country Governance (control)			
Gross Domestic Product	36.741***	37.208***	4.089***
	(3.345)	(5.008)	(.456)
World Gov. Index (factor analysed)	-.080	.253***	-.012
	(.068)	(.092)	(.008)
Firm Effect	YES	YES	YES
Year Effect	YES	YES	YES
R^2	0.444	0.223	0.433
N	**4,583**	**4,583**	**4,583**

Standard error in parentheses
*** p<0.01, ** p<0.05

Table 5: CG Structure and Zero-Defect Manufacturing Practice (MDGs period)

	(1)	(2)	(3)
Variable	**Zero-Defect Manufacturing Practice**	**Product Quality R&D Intensity**	**Product Responsibility Performance**
Board Independence	6.360***	7.015***	.696***
	(1.212)	(1.602)	(.149)
Meeting Attendance by Board Members	4.240***	3.014***	.566***
	(.677)	(.895)	(.083)
Duality of Power	-1.913***	-1.895***	-.265***
	(.551)	(.728)	(.068)
Board Gender Diversity	9.059***	9.885***	1.310***
	(2.552)	(3.373)	(.315)
Board skills on sustainable manufacturing	5.884***	6.524***	.712***
	(.794)	(1.050)	(.098)
Governance variables (control)			
Sustainability Activities Audit	5.474***	4.489***	.670***
	(.542)	(.716)	(.067)
Sustainability Performance Pay	4.292***	2.069***	.555***
	(.410)	(.543)	(.050)
Firm-level Variables (control)			
Revenue	4.681***	-.573	.629***
	(1.304)	(1.724)	(.161)
Market Presence	1.208	3.742***	.182
	(.951)	(1.257)	(.117)
Return on Total Assets (ROTA)	-.007	-.019	-.003
	(.045)	(.060)	(.005)
Country Governance (control)			
Gross Domestic Product	52.321***	51.221***	5.602***
	(4.989)	(6.594)	(.617)
World Gov. Index (factor analysed)	-.644***	-.365**	-.074***
	(.126)	(.167)	(.015)
Firm Effect	YES	YES	YES
Year Effect	YES	YES	YES
R^2	0.315	0.157	0.308
N	**2,937**	**2,937**	**2,937**

Standard error in parentheses

*** p<0.01, ** p<0.05

Table 6: CG Structures and Zero-Defect Manufacturing Practice (SDGs period)

	(1)	(2)	(3)
Variable	**Zero-Defect Manufacturing Practice**	**Product Quality R&D Intensity**	**Product Responsibility Performance**
Board Independence	7.645***	9.698**	1.117***
	(2.293)	(4.150)	(.294)
Meeting Attendance by Board Members	3.390***	1.533	.382***
	(.648)	(1.174)	(.083)
Duality of Power	-3.137***	-1.311	-.408***
	(.800)	(1.449)	(.102)
Board Gender Diversity	10.726***	-2.339	1.163***
	(3.259)	(5.899)	(.419)
Board skills on sustainable manufacturing	3.106***	2.459	.483***
	(.886)	(1.603)	(.113)
Governance variables (control)			
Sustainability Activities Audit	3.439***	4.179***	.530***
	(.741)	(1.341)	(.095)
Sustainability Performance Pay	2.337***	1.807*	.347***
	(.515)	(.932)	(.066)
Firm-level Variables (control)			
Revenue	12.326***	5.731	1.319***
	(2.017)	(3.651)	(.259)
Market Presence	2.092*	2.699	.277*
	(1.196)	(2.165)	(.153)
Return on Total Assets (ROTA)	-.067	.013	-.006
	(.047)	(.086)	(.006)
Country Governance (control)			
Gross Domestic Product	63.140***	38.157***	7.842***
	(7.337)	(13.279)	(.943)
World Gov. Index (factor analysed)	.154*	.646**	.012
	(.081)	(.147)	(.010)
Firm Effect	YES	YES	YES
Year Effect	YES	YES	YES
R^2	0.266	0.049	0.255
N	**1,646**	**1,646**	**1,646**

Standard error in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Instrumental Variable (2SLS) Regression on CG Structures affecting Zero-Defect Manufacturing Practice (Combined for MDGs and SDGs era)

	(1)	(2)	(3)
Variable	**Zero-Defect Manufacturing Practice**	**Product Quality R&D Intensity**	**Product Responsibility Performance**
Board Independence	.916 (1.488)	2.173 (1.862)	.069 (.181)
Meeting Attendance by Board Members	2.827*** (.561)	1.811** (.703)	.375*** (.068)
Duality of Power	-2.721*** (.503)	-1.693*** (.629)	-.351*** (.061)
Board Gender Diversity	67.235*** (10.642)	46.399*** (13.316)	8.052*** (1.298)
Board skills on sustainable manufacturing	5.459*** (.716)	6.677*** (.896)	.695*** (.087)
Governance variables (control)			
Sustainability Activities Audit	4.884*** (.483)	4.034*** (.604)	.606*** (.059)
Sustainability Performance Pay	3.424*** (.403)	2.095*** (.504)	.449*** (.049)
Firm-level Variables (control)			
Revenue	14.299*** (1.252)	6.461*** (1.566)	1.682*** (.152)
Market Presence	3.325*** (.828)	5.678*** (1.036)	.420*** (.101)
Return on Total Assets (ROTA)	-.083** (.038)	-.042 (.047)	-.011** (.004)
Era (MDGs Vs SDGs)	1.404** (.570)	1.413** (.714)	.174** (.069)
Country Governance (control)			
Gross Domestic Product	2.621 (7.122)	11.388 (8.912)	.074 (.869)
World Gov. Index (factor analysed)	.563*** (.133)	.741*** (.166)	.063*** (.016)
Firm Effect	YES	YES	YES
Year Effect	YES	YES	YES
R^2	0.302	0.160	0.300
N	**4,583**	**4,583**	**4,583**

Standard error in parentheses
*** p<0.01, ** p<0.05

Table 8: Robustness check on the impact of Board Gender Diversity on Zero-Defect Manufacturing Practice using Propensity Score Matching

	Treated Group (Mean)	Control Group (Mean)	Bias (%)	t statistic
Board Independence	.854	.851	1.2	0.65
Meeting Attendance by Board Members	.801	.814	-3.8	-1.77
Duality of Power	.563	.573	-2.1	-0.71
Board skills on sustainable manufacturing	.446	.457	-4.5	-1.65
Governance variables (control)				
Sustainability Activities Audit	.562	.534	4.8	1.91
Sustainability Performance Pay	.416	.452	-8.2	-2.51**
Overall Mean Bias = 4.3%; Overall Median Bias = 3.0%				

t-test p value significant at 5%

Table 9: Effect of Board Gender Diversity (treatment) on Zero-Defect Manufacturing Practice

Variable	Sample	Treated	Controls	Difference	S.E.	T-test
Zero-Defect Manufacturing Practice	Unmatched	67.445	55.930	11.514	.576	19.99
	ATT	67.314	62.458	4.856	1.328	3.66

Table 10: Effect of Board Gender Diversity (Treatment) on Zero-Defect Manufacturing Practice using Propensity Score Matching with Difference-In-Difference Fixed Effect Model

Dependent Variable: Board independence as a Binary variable (Treated Vs Control)					
	Coefficient	S. E	t	95% Confidence Interval	
ATET: Board independence (binary)	1.679	.610	2.750***	.477	2.880
Note: ATET estimate adjusted for covariates, panel effects, and time effects. *** $p<0.01$					

Include result of factor analysis of world governance indicators

11: Factor Analysis of World Governance Indicators (WGIs)