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Corporate board heterogeneity and operations cost in the industrials sector of the Johannesburg Stock Exchange

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ABSTRACT

This study explores the influence of corporate board diversity on operational costs in South Africa's industrial sector, focusing on companies listed on the Johannesburg Stock Exchange (JSE). The research examines the relationship between board diversity in terms of gender, ethnicity, nationality, age, and operational costs, which significantly affect a firm's profitability. By applying a positivist research methodology involving deductive reasoning, the study analyzes the causal effect of board diversity using quantitative data from a 10-year panel dataset, covering 2014 to 2023, of 26 JSE-listed industrial firms' annual reports. The findings confirm that nationality and age diversity do not significantly impact operational costs, although operating expenses are positively influenced by board members aged between 50 and 59 years, indicating that this age range is associated with increased operating expenses. Among other insights, the study suggests that board diversity influences operating costs, though the effect is nuanced and depends on the specific composition of the board. The research emphasizes the importance of operational costs in maintaining profitability, recommending that firms seek an optimal balance of board diversity and operational efficiency. It also advocates that board member selection should prioritize competence and experience over identity politics.

Contribution/Originality: This study contributes to the existing literature by examining the impact of board diversity on operational costs in South Africa's industrials sector, a context rarely explored. The study uses panel regression to reveal that specific age and racial compositions significantly influence costs, offering insights for governance policies.

1. INTRODUCTION

The bottom line is usually the endgame for most business operations, regardless of the nature of the operation across sectors or industries. However, when the operations of a business do not result in performance and profitability, operational efficiency is questioned. One of the major motives for profitability is the overall company cost per period because it affects the profit arrived at before tax, regardless of the revenue generated (Anshar, 2023; James & Luke, 2014; Rusdiyanto et al., 2021). Another major contribution to profitability is the attributable costs determinants, which directly or indirectly lead to revenue generation, such as costs on inventory management, warehousing, transportation, sourcing, production, and packaging, which have been captured as operational costs (Ding, 2023; Hugos, 2024; Richards & Grinsted, 2024) an aspect of operation management (Krajewski & Malhotra, 2022).

These costs, in addition to the risks and opportunities, must be heavily managed by the operational managers under the oversight of strategic management and the guidance of the board of directors for business profitability

(Akinsola, 2025; Ogbari et al., 2024; Osuma, Nzimade & Simon-Ilogho, 2025). Alongside management, the board of directors plays a crucial role in the decision-making process for companies on a strategic level (Godos-Díez, Cabeza-García, Alonso-Martínez, & Fernández-Gago, 2018) and this has proven to be beneficial and necessary in facilitating the realization of corporate strategies. In achieving corporate strategies, the directors also help in mitigating or eliminating potential roadblocks and challenges that arise during certain periods with their experience, foresight, diversity, and advisory functions (Subasi, Rava, & D'Lima, 2025). Thus, boards are a focal and essential part of the strategic management and control involvement of companies heading in the direction of overall objectives. Hence, the qualities of the members of the board matter when a board is assembled.

One of the qualities that is usually considered in the selection and integration of board members is diversity (Butler, 2012; Ferreira, 2010). Diversity has recently been a valuable attribute to groups, especially considering the variety and richness of options available in contribution, experience, perspective, and ideas during decision-making (Islam, French, & Ali, 2022; Osiregbmhe, 2017). This variety of perspectives always ultimately results in careful judgment and high-quality selection of the course of action. Hence, these benefits can also be seen when there is diversity on the board of firms (Fernández-Temprano & Tejerina-Gaite, 2020; Hakovirta, Denuwara, Bharathi, Topping, & Eloranta, 2020; Prudêncio, Forte, Crisóstomo, & Vasconcelos, 2021). Studies in the past have examined the variation of board attributes and their individual or collective influence on the bottom line of the firms' view of decision quality in investment, social responsibility, human resources management, and performance. Few have considered their influence on operational efficiency and cost-effectiveness (Barker, Hofer, & Dobrzykowski, 2024; Ibidunni, Ufua, Okorie, & Kehinde, 2020).

Therefore, this study examines corporate board diversity and operational costs in an important sector in South Africa, which is the industrial sector. The study seeks to investigate a variety of qualities in the boards of companies listed on the Johannesburg Stock Exchange and how such qualities impact operational costs, which are captured and disclosed in financial statements. Therefore, the null hypothesis is as follows:

H0: Board diversity does not have any significant effect on the operational costs of firms in the industrial sector of the Johannesburg Stock Exchange.

The remainder of the article starts with a review of prior literature in section two. The literature review discusses. Section three addresses the methodology, measurement of variables, and model specifications. The fourth section captures the results, interpretation, and discussion of findings, and the study ends with a conclusion, recommendations, and contribution in the fifth section. Figure 1, the conceptual model, depicts the causal relationship between corporate board diversity and operational costs.

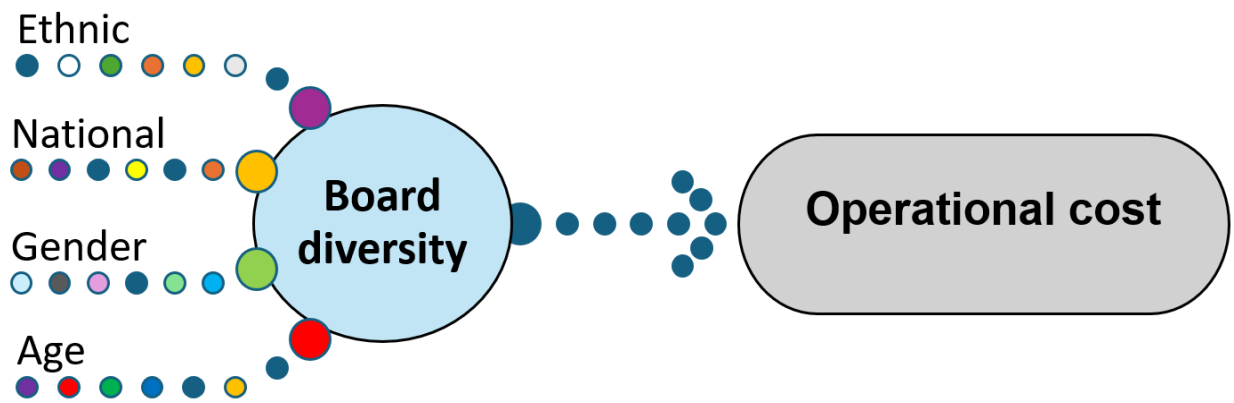

Figure 1. Conceptual model of examination.

2. LITERATURE REVIEW

Several studies have identified the role played by the board (Bovie, Smith, & Turner, 2021; Hakovirta et al., 2020; Islam et al., 2022; Prudêncio et al., 2021; Squires & Elnahla, 2020) and some have identified its influence trickles down

to the operational level (Abdullah & Ismail, 2013; Alabede, 2016). For instance, Alabede (2016) suggested that board diversity has a strong positive relationship with operating performance and moderates the influence of governance on operating performance. The work of Alabede (2016) represented diversity on the board with gender diversity (the representation of females), while capturing board size and emphasizing agency theory as its theoretical framework.

Some other studies have also identified the influence of the board in other aspects of business activities, especially the impact of diversity on financing and financial reporting (Aksoy & Yilmaz, 2023; Dobbin, & Jung 2011; Tawiah, Gyapong, & Wang, 2024). The work of Aksoy and Yilmaz (2023) and Tawiah et al. (2024) both investigated the impact of diversity on the board in different locations in Turkey and South Africa, respectively. Specifically, Aksoy and Yilmaz (2023) examined the impact on the cost of debt financing, emphasizing the mitigating impact of board gender diversity on agency costs and investment finance. They also opined on the need for more chairwomen and women directors on boards because it is less risky and they are charged less for debt financing than men. Opines that females should increase on board.

Several other empirical studies depicting the impact of board diversity on several key aspects of business, particularly operations, efficiency, and performance, are discussed in the empirical review. All these studies have illustrated the impact diversity on the board has on business. Although diversity has been seen as a good board quality, there is also evidence that it results in conflict, communication barriers, and could lead to cooperation interference (Dobbin, & Jung 2011). Therefore, the following empirical review discusses the impact of board diversity on two major themes, which are firm financial and operational performance.

This next section of the empirical review examines studies that have investigated the impact of board diversity on financial performance because financial performance is an important measurement of the overall firm performance that is impacted by operational costs (Istan et al., 2021).

2.1. Board Diversity on Financial Performance

The work of Marimuthu and Kolandaisamy (2009) showed that ethnic diversity had a significant impact on financial performance.

Together with the earlier stated studies that revealed the insignificant effect of board diversity, the work of Ujunwa, Okoyeuzu, and Nwakoby (2012), Abdullah and Ismail (2013) and Cheong and Sinnakkannu (2014) did not capture other aspects of diversity, like culture and educational diversity. They all had varying methods of analysis (see Table 3) and results with Ujunwa et al. (2012) revealing negative effects of ethnic, gender and national diversity, while Abdullah and Ismail (2013) revealed negative effects of age and gender diversity and in agreement with Cheong and Sinnakkannu (2014), a positive effect for ethnic diversity.

2.2. Board Diversity on Firm Market Value

The studies of Zvinowanda, Mafini, and Beneke (2024); Hassan, Marimuthu, and Johl (2015) and Do (2023) investigated the impact of board diversity on the value of firms in the form of national diversity (in South Africa) and ethnic diversity (in Malaysia & Australia), respectively, with the first two studies showing negative influences of board diversity and the last showing a positive influence. The results from Do (2023) show that ethnic diversity has a positive effect on pay-to-performance sensitivity, especially for firms that suffer from agency problems and firms with CEOs of different ethnicities from the directors. Here again, the agency problem, which is associated with agency theory, is mentioned (Alabede, 2016).

Aside from financial-based performance, studies like Harjoto, Laksmana, and Yang (2019) have investigated the impact of board diversity on other non-financial-based performance, which will be discussed under the subsequent sub-headings. Harjoto et al. (2019) examined the influence of board diversity on corporate social responsibility (CSR) performance, but in this case, unlike the prior reviewed studies, they investigated the educational background of the board members alongside nationalities, and their results showed a positive impact.

Table 1. Summary of empirical review.

S/N	Authors	Location	Coverages	Dependent variables	Estimators	Result
1	Alabede (2016)	241 UK FTSE 350 firms	2009 – 2011	Operating performance	OLS,	Positive sig.
2	Aksoy and Yilmaz (2023)	211 Firms in Turkey	2016 - 2020	Debt finance cost	GMM	Positive sig.
3	Tawiah et al. (2024)	192 firms in South Africa	2014 - 2018	Accounting Disclosures	2-SLS, GMM	Positive sig.
4	Carter, D'Souza, Simkins, and Simpson (2010)	641 firms in the US	1998-2002	Finance Performance	F.E.-OLS & 3-SLS	Insignificant
5	Guest (2019)	1,906 US Firms	1996 – 2011	Board Monitoring outcomes	OLS	Negative sig.
6	Abdullah and Ismail (2013)	100 Malaysian Firms	2007 – 2017	Firm performance	Multivariate analysis	Negative, negative, and positive sig. For gender, age, and ethnicity, respectively.
7	Marimuthu and Kolandaisamy (2009)	100 Malaysian Firms	2000 – 2006	Financial performance	OLS	Insignificant
8	Cheong and Sinnakkannu (2014)	634 Malaysian Firms	2005 – 2009	Firm performance	Multivariate analysis, Fixed effect	Positive sig.
9	Zvinowanda et al. (2024)	South Africa	2013 - 2022	Shareholder value creation	Regression	U-shape
10	Hassan et al. (2015)	Malaysia		Market value	Regression	Negative sig.
11	Do (2023)	859 Australian Firm	2007 - 2017	Pay-to-performance sensitivity	Regression	Positive sig.
12	Harjoto et al. (2019)	879 firms in the US	2000-2013	CSR performance	Univariate & Multivariate analysis	Positive sig.
13	Benjamin et al. (2020)	S&P 500 firms	2010-2015	Sustainable supply chain	Ordered-Probit Regression	Positive sig
14	Jin et al. (2024)	1,570 firms from the S&P 500	2008 – 2020	Supply chain	Ordinary Least Squares	Positive sig.
15	Klerk and Singh (2021)	Australia		Health care supply chain	Regression	Positive sig.
16	Ramly et al. (2015)	102 Banks from Malaysia, Singapore, Thailand, Indonesia, and the Philippines	1999-2012	Bank operational efficiency	Tobit regression	Negative sig.
17	Ekadah and Mboya (2012)	44 Kenyan Bank	1998-2009	Operating performance	Stepwise regression	Insignificant
18	Ali et al. (2021)	806 firms in China	2009-2017	Firm efficiency	Tobit regression and two-step system GMM	Positive Sig
19	Kimanzi et al. (2020)	87 housing co-operatives	Mixed method	financial structure & operating efficiency	Multiple linear regression	Negative Sig.
20	Ujunwa et al. (2012)	122 listed Nigerian Firms	1991 -2008	Firm performance	Fixed effect on Generalised Least Squares regression	Negative Sig.

2.3. Board Diversity and Influence on Operational Costs

There is evidence to show that board diversity influences operational activities too and this evidence is seen in Benjamin, Mansi, and Pandey (2020) and Jin, Li, and Zhang (2024) as the former examined gender diversity and board independence, while the latter examined gender diversity and board ethnicity, respectively; both showed the positively significant impact of board diversity. In addition, Klerk and Singh (2021) examined board diversity and operation, but examined the healthcare operation in Australia and across the world and observed that heterogeneity in the board impacts the governance of firms.

Table 1 presents a summary of empirical studies on board diversity, highlighting key findings, methodologies, and results related to financial performance, market value, and operational costs. In addition to operations management, other studies have demonstrated the impact of diversity on board performance concerning operational performance and efficiency, which will be discussed in the following subheading.

2.4. Board Diversity Influence on Operational Performance and Efficiency

Most of the reviewed studies covering board diversity and operational performance addressed gender diversity, and their results were mixed without consensus. For instance, A multinational study across five nations in Asia by Ramly, Sok-Gee, Mustapha, and Sapiei (2015) revealed a negative effect of diversity on bank efficiency using Tobit regression modelling, which agrees with Kimanzi, Mwangi, Ochieng, and Lishenga (2020). While Ali, Wang, Jebran, and Ali (2021), a Chinese study, showed a positive effect of board diversity on technical efficiency and total factor productivity, also with the Tobit regression. Ekadah and Mboya (2012), a study in Kenya, revealed a different result from the prior three, showing an insignificant effect of board diversity on operating performance.

From these reviews, most studies revealed that board diversity impacts operational performance, whether negative or positive, which aligns with the opinion of Ali et al. (2021), indicating that a diverse board can facilitate the integration of diverse knowledge, abilities, skills, experience, and expertise, thereby enhancing firms' efficiency. Prior studies considered only one dimension of diversity and overlooked others, with most focusing solely on gender diversity.

2.5. Theoretical Review

The majority of the examined studies captured by the Agency theory have reviewed the theoretical framework for their investigation because it explains the implications of agency costs and the role played by governance on the board. Studies like Carter et al. (2010) looked at employed agency, resource dependence, and human capital theories as frameworks. However, in the context of this study, the upper echelons and human capital theories are best aligned with this investigation. The human capital theory emphasizes the importance of a diversity of attributes such as skills, knowledge, experience, abilities, education, and training as valuable assets to an economy (Eide & Showalter, 2010). While the upper echelons theory posits that, based on the divergent characteristics of top management, the direction and success of the organization are traceable to their competencies, personalities, and experiences (Hambrick & Mason, 1984). The combination of these theories can explain the impact of board diversity on a firm's cost of operation.

3. METHODOLOGY

The study adopts a positivist viewpoint in its investigation with deductive reasoning while examining the causal effect of diversity on the corporate board on operational costs. The deductive reasoning approach is adopted because it is a problem-solving approach that deals with hypothesis development (Qizi & Qizi, 2023). A positivistic approach is applied because it fits to establish generalizable causal relationships between board diversity and operational expenses as a function of observable, measurable variables. It concludes logically from established premises, and it is a usable approach when dealing with quantitative data (Lieberman, 2023).

This methodology section summarizes the design employed, the choice of data collection and sources, as well as the sampling techniques used. Additionally, the model specifications are detailed before the data analysis is conducted.

3.1. Design, Data, Population, and Sample

Quantitative data were collected from secondary sources as the annual reports of the listed companies examined in the industrials sector of the Johannesburg Stock Exchange (JSE) across the period from 2014 to 2023 (10 years). Twenty-six (26) firms out of a population of forty-two listed industrial firms were examined. The choice of 26 firms was based on the data consistency criterion covering ten years of data from 2014 to 2023, as some firms did not provide sufficient data on board age and race/ethnicity, probably because of the sensitivity of the subject. A panel data collection for analysis was employed using an Excel sheet as a collection portfolio because of the cross-section and time-period combinations. The basis for using panel data is that it can capture changes over time and also provide information about firm-specific factors that could influence operating costs. By using a 10-year perspective, the study aims to capture short- and long-term effects and trends and present a balanced view of how corporate board diversity has evolved over the last 10 years.

As of November 2024, the number of companies listed in the JSE industrials sector was forty-two as a total population. A criterion-based sampling approach was adopted, using a criterion to eliminate companies based on data availability consistency across the determined eleven years (2014-2024).

3.2. Model Specifications and Measurement of Variables

A simple linear model was adopted from a similar study in Alabede (2016), which examined the effect of board diversity and corporate governance on the operating performance of the UK FTSE 350 firms. The first model in the work of Alabede (2016) was stated as follows:

$$Operating\ performance_{i,t} = \beta_0 + \beta_1 OUD_{i,t} + \beta_2 BSIZE_{i,t} + \beta_3 AUCOM_{i,t} + \beta_4 BDV_{i,t} + \beta_5 LogFMZ_{i.t} + \beta_6 DEBT_{i.t} + \beta_7 BMET_{i,t} + \beta_8 BHS_{i.t} + \beta_9 LogMVE_{i,t} + \beta_{10} LagROA_{i.t} + \beta_{11} INDSECT_{i,t} + \varepsilon_{i,t}$$

By making modifications to the model to fit the distinct variables and objectives of this present study, it is kept in line with past studies but also allows for the investigation of the distinct context of South African firms on the Johannesburg Stock Exchange (JSE). The reason for the lag on ROA is to capture the previous year's ROA, while the current year ROA in Alabede (2016) was to proxy for operating performance. While the log was done on firm size and market value of equity in Alabede (2016) to prevent outliers and skewness because they are large numbers, in the adaptation of the model to this study, the log will be applied to large numbers, and the lag will be ignored because this study is not attempting to achieve the same objective as Alabede (2016).

Their model is based on a simple linear model with the basic causal expression Y F(x), expandable to Y = F (x1, x2, x3…). Y represents the dependent variable, and x1, x2, and x3 represent the independent variables. The incorporated research dependent and independent variables result in an expression as thus:

OPRNSit = F(GenDiv, EthDiv, NatDiv, AgeDiv).

The inclusion of the control variables and the expansion of the expression to a linear model, inclusive of intercept, coefficients, and error terms, is expressed as follows:

$$OPRNS_{i,t} = \alpha_0 + \beta_1 GenDiv_{i,t} + \beta_2 EthDiv_{i,t} + \beta_2 NatDiv_{i,t} + \beta_2 AgeDiv_{i,t} + \gamma_1 FirmSize_{i.t} + \gamma_2 Profit_{i.t} + \gamma_3 BrdSize_{c,t} + \varepsilon_{c,t}$$

Where α, β, γ represent the intercept, coefficients of independent and control variables, respectively. While $_{it}$ represents panel data depiction (cross-section and time series), and ε represents the error term.

Table 2. Representation of variables.

S/N	Type	Variable abbreviations represent…
1	Dependent variable	SCC_{it} is the operational cost of the examined listed companies from 2014 to 2024 (Panel data)
2	Independent variable	$GenDiv_{it}$ is the gender diversity of the examined listed companies from 2014 to 2024 (Panel data)
3	Independent variable	$EthDiv_{it}$ is the ethical diversity of the examined listed companies from 2014 to 2024 (panel data)
4	Independent variable	$NatDiv_{it}$ is the national diversity of the examined listed companies from 2014 to 2024 (Panel data)
5	Independent variable	$AgeDiv_{it}$ is the age diversity of the examined listed companies from 2014 to 2024 (Panel data)
6	Control variable	FirmSize is the firm size of the examined listed companies from 2014 to 2024 (Panel data)
7	Control variable	$Profit_{it}$ is the profitability of the examined listed companies from 2014 to 2024 (Panel data)
8	Control variable	$BrdSize_{it}$ is the Board size of the examined listed companies from 2014 to 2024 (Panel data)

Table 2 outlines the measurement of variables, defining operational cost proxies (TOE, COGS), diversity metrics (gender, ethnicity, nationality, age), and control variables (firm size, profitability, board size) with their respective operationalizations. The model is shown below.

$$OPRNS_{i,t} = \alpha_0 + \beta_1 GenDiv_{i,t} + \beta_2 EthDiv_{i,t} + \beta_2 NatDiv_{i,t} + \beta_2 AgeDiv_{i,t} + \gamma_1 FirmSize_{i.t} + \gamma_2 Profit_{i.t} + \gamma_3 BrdSize_{i,t} + \varepsilon_{i,t}$$

Operation cost (OPRNS) is further broken down into two separate dependent variable proxies in total operational expense (TOE) and cost of goods sold (COGS), which require separate models because of the two dependent variable representations. Ethnic diversity (EthDiv) is also broken into five separate proxy representations in ethnicity representations (EthRep), Black to total number of races (BRatio), White to total number of races (WRatio), Indian/Asian to total number of races (IARatio), and coloured to total number of races (CRatio). The ethnicity representations (EthRep) are an ordinal depiction of diversity, where the presence of one ethnicity is depicted as 1, and when there are two, three, and four ethnicities in the board, they are depicted as 2, 3, and 4, respectively. These depictions express the ordinal levels of diversity, implying that 1 means the least diverse age category representation in the board and 4 means the most diverse age category representation in the board.

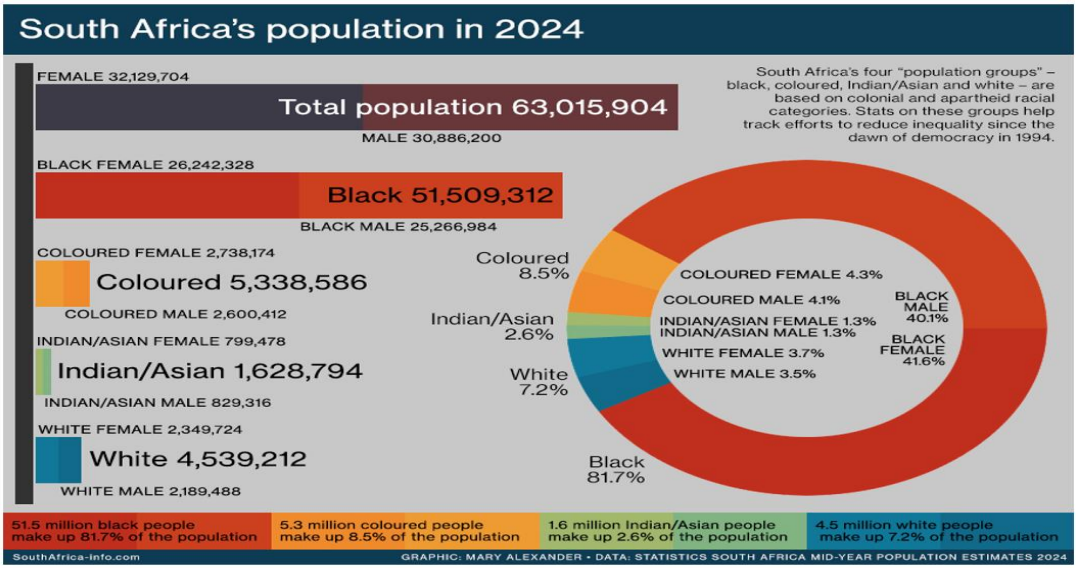

Figure 2. The standard ethic/racial classification of the South African population.
Source: South Africa Gateway (2025).

Figure 2 depicts South Africa's standard racial/ethnic classification (Black, White, Coloured, Indian/Asian), contextualizing the study's analysis of board ethnic diversity.

In addition, age diversity was categorized into five groups because four age categories were selected based on the most common age groups among board members in South African firms. The age categories included 30-39 (Thirties), 40-49 (Forties), 50-59 (Fifties), and above 60 years (Above Sixty). Age diversity was also represented by the collective presence of any of these age groups on the board. For example, when only one category is present, it is indicated as 1; when two, three, or four categories are present, they are indicated as 2, 3, or 4, respectively. This method of depiction is similar to that used for EthRep. Additionally, profitability (Profit) was divided into two subcategories: return on revenue (ROR) and return on assets (ROA).

Gender diversity was not represented with a female-to-male ratio because it also references the male population when it is represented by the female-to-total gender population on board. It could also not be represented by 1's and 2's for males and females, respectively, because there are only two genders, and this representation may be limited in variety.

Models one and two are shown as follows.

$$TOE_{i,t} = \alpha_0 + \beta_1 GenDiv_{i,t} + \beta_2 EthRep_{i,t} + \beta_2 BRatio_{i,t} + \beta_2 WRatio_{i,t} + \beta_2 IARatio_{i,t} + \beta_2 CRatio_{i,t} + \beta_2 NatDiv_{i,t} + \beta_2 AgeDiv_{i,t} + \beta_2 Thirties_{i,t} + \beta_2 forties_{i,t} + \beta_2 Fifties_{i,t} + \beta_2 AbvSixty_{i,t} + \gamma_1 FirmSize_{i.t} + \gamma_2 ROR_{i.t} + \gamma_2 ROA_{i.t} + \gamma_3 BrdSize_{i,t} + \varepsilon_{i,t}$$

$$COGS_{i,t} = \alpha_0 + \beta_1 GenDiv_{i,t} + \beta_2 EthRep_{i,t} + \beta_2 BRatio_{i,t} + \beta_2 WRatio_{i,t} + \beta_2 IARatio_{i,t} + \beta_2 CRatio_{i,t} + \beta_2 NatDiv_{i,t} + \beta_2 AgeDiv_{i,t} + \beta_2 Thirties_{i,t} + \beta_2 forties_{i,t} + \beta_2 Fifties_{i,t} + \beta_2 AbvSixty_{i,t} + \gamma_1 FirmSize_{i.t} + \gamma_2 ROR_{i.t} + \gamma_2 ROA_{i.t} + \gamma_3 BrdSize_{i,t} + \varepsilon_{i,t}$$

Table 3. Measurement of variables.

S/N	Abbrev.	Variables	Definition (In the context of the study)	Measurement
1	OPRNS	Operations cost	The cost involved in operational activities periodically	1. COGS 2. Total Operating Expense (TOE)
2	GenDiv	Gender diversity	In this context, it is defined as the female-to-total gender ratio	Female / Male + Female
3	EthDiv	Ethnic diversity	The variety of ethnicities on the board of a corporate organization.	1. Black ratio 2. White Ratio 3. Coloured Ratio 4. Indian/Asian Ratio 5. EthRep (number of different ethnicities on board 1,2,3,4)
4	NatDiv	National diversity	The variety of foreign nationals on the board of a corporate organization	Number of foreign nationalities on the board
5	AgeDiv	Age diversity	Age variation on the board of companies in a group range of 10 years (e.g., 30 – 39 years)	The total number of age groups is found on the board individually and in combined representation.
6	FirmSize	Firm size	The capacity of assets available to the company for use (operational and strategic).	Total assets
7	Profit	Profitability	Profit made after tax deduction (PAT)	4.1 Returns on Assets (ROA) = PAT/ Total Assets 4.2 Return on Revenue (ROR) = PAT/Total Assets
8	BrdSize	Board size	The total number of board members	Number of Board members

Table 3 presents the operational definitions and measurement methods for all variables, including dependent (operational cost proxies), independent (board diversity metrics), and control variables (firm size, profitability, board size).

4. DATA ANALYSIS AND RESULT INTERPRETATION

The study examines the influence of board diversity on the cost of operations in the industrials sector in South Africa by employing the panel regression method in ordinary least squares (OLS). The OLS was conducted for both dependent variables (COGS and TOE) as seen in the specified models. The Hausman test was used to determine whether fixed or random effects were appropriate, as seen in Table 4a and 4b.

Table 4a. Hausman test for total operational cost.

Test summary		Chi-sq. statistic	Chi-Sq. d.f.	Prob.
Cross-section random		25.095	16	0.068
Cross-section random effects test comparisons:				
Variable	Fixed	Random	Var(Diff.)	Prob.
GENDIV(-1)	-0.172	0.015	0.037	0.332
ETHREP(-1)	-0.339	-0.242	0.005	0.169
BRATIO(-1)	-0.803	-0.389	0.021	0.004
WRATIO(-1)	0.452	0.344	0.014	0.359
IARATIO(-1)	0.901	0.791	0.259	0.829
CRATIO(-1)	7.608	7.516	1.822	0.946
NATDIV(-1)	-0.0005	-0.002	0.0001	0.870
AGEDIV(-1)	-0.127	-0.103	0.0007	0.388
THIRTIES(-1)	0.095	0.034	0.0005	0.008
FORTIES(-1)	0.079	0.076	0.0003	0.845
FIFTIES(-1)	0.196	0.205	0.0003	0.637
ABVSIXTY(-1)	0.022	0.027	0.0003	0.806
(LOG(FIRMSIZE)-1)	0.459	0.677	0.006	0.005
ROR(-1)	0.468	0.019	0.016	0.0004
ROA(-1)	-0.316	-0.013	0.024	0.051
BRDSIZE(-1)	-0.105	-0.098	0.0002	0.634

Table 4a reveals the Hausman test for the first dependent variable (TOE) and the proxy of operational cost. The table probability result shows a probability value of 0.0682 (above 0.05 significance), indicating that the random effect is the most appropriate. Therefore, the random effect is referred to as the fixed effect based on this result for TOE.

Table 4b. Hausman test for the cost of goods sold.

Test summary		Chi-sq. statistic	Chi-Sq. d.f.	Prob.
Cross-section random		53.91	16	0.000
Cross-section random effects test comparisons:				
Variable	Fixed	Random	Var(Diff.)	Prob.
GenDiv(-1)	0.342	0.237	0.037	0.589
EthRep(-1)	-0.284	-0.042	0.005	0.000
Bratio(-1)	0.904	0.807	0.021	0.503
Wratio(-1)	0.962	0.916	0.014	0.690
IARatio(-1)	-1.274	-2.554	0.260	0.012
Cratio(-1)	4.216	2.577	1.826	0.225
Nat Div(-1)	0.049	0.076	0.000	0.010
Age Div(-1)	0.116	0.141	0.000	0.381
Thirties(-1)	-0.061	-0.124	0.000	0.006
Forties(-1)	0.033	0.006	0.000	0.123
Fifties(-1)	0.120	0.106	0.000	0.450
AbvSixty(-1)	0.108	0.095	0.000	0.468
(Log(FirmSize)-1)	0.281	0.662	0.00	0.000
ROR(-1)	-0.143	-0.693	0.016	0.000
ROA(-1)	-0.051	0.329	0.024	0.014
BrdSize(-1)	-0.070	-0.053	0.000	0.256

Table 4b reveals the Hausman test for the second dependent variable (COGS), which is another proxy for operational cost. The table's probability result shows a probability value of 0.000 (below 0.05), indicating that the fixed effect is the most appropriate. Therefore, the fixed effect is referred to as the random effect based on this result for COGS.

The results for the ordinary least squares for both TOE (random effect) and COGS (fixed effect) are revealed in Table 5. Both dependent variables and firm size were logged based on the model specifications because of the large figures involved in billions that could cause outliers and skewness. In addition, all the independent and control variables were lagged according to the model specifications because this approach captures the effect of previous years' independent variable conditions on the current or present years' dependent variable outcomes.

Table 5. Regression table.

Methods	Random effect OLS	Fixed effect OLS
Dependent Variable	**Log(TOE)**	**Log(COGS)**
Variables	**R.E. (Coeff)**	**F.E. (Coeff)**
GENDIV(-1)	0.974(0.015)	0.503 (0.342)
ETHREP(-1)	0.104(-0.242)	0.085 (-0.284)
BRATIO(-1)	0.477(-0.389)	0.111 (0.904)
WRATIO(-1)	0.450(0.344)	0.042 (0.963)
IARATIO(-1)	0.642(0.791)	0.473 (-1.274)
CRATIO(-1)	0.051(7.510)	0.300 (4.217)
NATDIV(-1)	0.961(-0.002)	0.295 (0.049)
AGEDIV(-1)	0.287(-0.103)	0.244 (0.117)
THIRTIES(-1)	0.761(0.034)	0.589 (-0.061)
FORTIES(-1)	0.419(0.076)	0.730 (0.033)
FIFTIES(-1)	0.027(0.205)	0.200 (0.120)
ABVSIXTY(-1)	0.775(0.027)	0.253 (0.108)
LOG(FIRMSIZE)-1	0.000(0.677)	0.0047 (0.281)
ROR(-1)	0.970(0.019)	0.790 (-0.144)
ROA(-1)	0.984(-0.013)	0.938 (-0.051)
BRDSIZE(-1)	0.277(-0.099)	0.447 (-0.070)
Observations	208	208
R-Squared	0.45	0.93
Adj. R-squared	0.40	0.91
Prob(F-stat)	0.000	0.000
Durbin-Watson	2.12	2.52
Sig.	0.05***	0.05***

Note: "***" indicates statistical significance at the 0.05 level (5% threshold) in regression results.

From Table 5, all the probabilities and coefficients of the combined sixteen independent variables and control variables are revealed in the second and third columns. The results from the first model, specified on the effect of board diversity on total operating expense (TOE), showed that only CRATIO (Coloured ethnicity to total board member ratio), firm size, and board members in the fifties (50s) age bracket have significant probabilities in impacting total operating expense (TOE). All other measured independent and controlled variables had insignificant probabilities. This implies that these are the most influential board attributes to operational cost expressed as TOE. Considering the coefficients of these significant variables, board members in their fifties, those who are coloured, and the size of the firm all have a significant impact on the operating cost (expense).

The third column of Table 5 reveals the results from the panel regression of the second variable proxy of operational cost in COGS. The results showed that only WRATIO (white race to the total number of board members) and firm size are significant at the 0.05 threshold. This implies that the presence of white ethnicity (race) on the board has a significant influence on the cost of goods sold, and this also applies to the size of the firm, which is understandable.

A general observation from the results of both COGS and TOE proxies is that the size of the firm determines the operational cost in a positive direction. This means that under both examinations, the larger the firm's size, the

larger the cost of goods sold because of the positive coefficient in both results. In addition to this, the coefficient from the result reveals that WRATIO had a significantly positive influence on operational cost, which means that as the number of white directors increases, the more the cost of goods sold increases.

Based on all the results on the core diversity variables such as GenDiv, NatDiv, EthRep, and AgeDiv, it is safe to say that board diversity does not have a significant influence on the cost of operations of the examined companies. This means that we can accept the null hypothesis that was stated: "Board diversity does not have any significant effect on the operational cost of firms in the industrial sector of the Johannesburg Stock Exchange."

The R-squared and adjusted R-squared for both examinations show an adequate percentage of explanation of the variation in the outcomes of the dependent variable in business research. The R-squared value of 0.45 (45%) indicates a moderate level of explanation, which is considered adequate (Suleiman & Abdulkadir, 2022). Although the Hausman test for the first analysis suggested that the random effect should be preferred, the fixed effect had a higher R-squared value (see Table 6).

Table 6. R-squared representation.

Hausman test	**Probability**	**0.068**
	Fixed effect	Random effect
R-Square	0.90	0.45
Adjusted R-Square	0.88	0.40

The other examination with COGS had an ideal and preferable R-squared of 0.93 and an adjusted R-squared of 0.91, which is under the fixed effect result recommended by the Hausman test with a probability of 0.00.

5. EMPIRICAL FINDINGS AND DISCUSSIONS

The results from the empirical analysis suggest that diversity in the board varies in its influence over the operations of companies, which aligns with the varying results obtained from the works of Ekadah and Mboya (2012) and Alabede (2016), both examining operational performance but yielding different results. The analyses in one and two are based on two different model specifications, revealing that gender diversity in the board has no significant impact on operational costs. Gender diversity was represented by the ratio of female board members to the total number of board members. Consequently, this measure only reflects the female portion of the gender spectrum on the board, not the male. This finding implies that the volume of female presence on a firm's board does not influence cost-related aspects of firm operations. This conclusion is consistent with the work of Ekadah and Mboya (2012), although their study did not focus on operational costs.

The results from both analyses also reveal that board ethnicity or racial representation (diversity), as measured in this study, does not impact the cost of operations based on the insignificant results obtained. Despite the insignificant result obtained with EthRep, it is notable that the coefficient was a tangible negative value, which shows that if the probability were significant, then ethnic representation would result in a reduction in the cost of operations. Although the significance of the effect of the CRATIO on the cost of operation, as represented by Total Operating Expense (TOE) is an exception because it shows that an increased number of individuals of color on the board leads to a tangible increase in the cost of operations with a positive coefficient (7.51). Likewise, the second analysis revealed that WRATIO had a significant positive impact on operating cost with a high coefficient (0.96), which also means that an increase in the number of board members of the white race will lead to a tangible increase in the cost of goods sold (COGS) of firms. These increases in the cost of operation in both scenarios could be attributable to improved quality, efficiency, customer satisfaction, and increased environmental awareness, where cutting costs is secondary to green productivity in the industrial sector.

In the results, diversity in nationality and age in the boardroom shows no impact on the cost of operations based on the insignificant results obtained from both analyses. This therefore, implies that an increased variety of nationals

on the board of firms does not influence operating costs. Also, age diversity across the board does not impact the cost of operations. However, from the results of the individual age categories, on both analyses, the board members within the fifties (50s) age bracket (50 to 59 years) have a significant positive impact on the cost of operations. This implies that the board members within the 50 to 59 age bracket indirectly impact the increase in the cost of operating, represented by TOE and COGS. Although the probability reveals an insignificant impact of age diversity, the coefficient reveals a negative direction, which means that if the probability were significant, the diversity in board age would reduce the cost of operations.

In addition to the main variables, control variables such as ROR, ROA, and board size reveal an insignificant impact on the cost of operations, given their probability, which is above 0.05. This implies that regardless of the return on revenue and assets in the present year, there would be no increase or decrease in the cost of operation in the following year. It means that the profitability (ROR and ROA) of the preceding year does not impact the cost of operations in the current year. Therefore, out of the independent variables examined, the profitability aspect (ROR and ROA) does not influence the total cost of operation for the examined firms. Additionally, the board size also shows no significant impact, which means that regardless of the increase or decrease in the size of the board, there would be no significant changes in the cost of operation. However, the only control variable that reveals a significant impact on the cost of operations is the size of the firms. The firm's size (FirmSize) in both analyses shows a significant positive impact on the cost of operations. This makes practical sense because the size of the firm usually dictates the level of risk in expenses that can be incurred on operations. After all, it is more feasible for larger firms with bigger assets at their disposal.

6. CONCLUSIONS AND RECOMMENDATIONS

Operational activities are usually described as the engine room for businesses, and the flow of finance is the gearing instrument that keeps the engine running. Operations include all activities, both direct and indirect, that source materials, process them, and deliver the products to end users (Hanaysha & Alzoubi, 2022). Monitoring the costs of these activities is essential because it is vital to the success and profitability of a business, which influences increased EPS and market value. Therefore, this study examined the operational costs of firms listed in the industrials sector of the Johannesburg Stock Exchange by investigating the impact of board diversity.

Given the extremely diverse society of South Africa, it was imperative to investigate the implications of diversity on the board of firms in the nation to see how these dimensions of diversity impact the cost of operation. This study was able to ascertain the impact of the various dimensions of diversity in the boards of firms on the cost of operations, covering twenty-six firms out of a population of 42 listed firms in that sector. The choice of 26 firms was based on the data consistency criterion covering ten years of data from 2014 to 2023. The data collected from their published annual reports was analyzed using fixed and random effects (OLS) based on the two models specified, respectively. The results revealed in all analyses that all the main representations of diversity, ethnic representation, national diversity, gender diversity, and age diversity, revealed an insignificant effect on the cost of operations.

This simply implies that diversity in the board of directors of listed industrial firms in the JSE does not impact the cost of operating these firms. The implications of this, when it comes to policies, are that it informs the unnecessary quota allocation of board members when it comes to board selection. It is recommended that board member selection should be based on competence and experience, without the politics of identity. The ideal should be that there is diversity in the board, but not born from identity politics, but based on competence, capacity, resource, and experience. Experience was one of the emphases in the results of age diversity, with both analyses revealing the impact of those in their fifties, which is an age bracket of balances between youth and experience. However, the study also highlights the impact of a few representations of racial/ethnical diversity, which also reveals how this dimension of diversity influences operating costs.

6.1. Contribution To Knowledge

This study contributes to the richness of the corporate governance literature by presenting an advanced analysis of the impact of board diversity on operational costs in South Africa's industrial sector, a context characterized by unique socio-economic forces and post-apartheid corporate reforms. By focusing on an emerging market often underrepresented in global governance literature, the research challenges Western-centric assumptions and emphasizes the importance of localized solutions. Compared to studies conducted in developed nations, where performance outcomes are linked to board diversity factors such as age or nationality, this study reveals that in South Africa's manufacturing industry, these dimensions have limited influence. Instead, it uncovers the subtle impact of specific demographic features: while broad diversity measures (e.g., nationality, age heterogeneity) had minimal or no effects, directors aged 50–59 and certain racial compositions (White and Coloured directors) had significant and substantial impacts on operating costs. The findings indicate that experience and localized racial relations, rather than diversity in general, are the primary factors influencing cost outcomes, highlighting the interplay between South Africa's historical inequalities and current governance practices.

Several empirical studies have examined board diversity with a variety of representations, but not many have analyzed board diversity variables across specific dimensions as done in this study. For instance, this study was able to examine ethnic diversity through various specific dimensions, including ethnic representation and the ratio of different individual races to the total number of board members. Additionally, the study analyzed age diversity using two dimensions: age bracket representations on the board and the ratio of each age bracket to the total board size. Furthermore, it assessed the impact of board diversity on operational costs, a relationship that has not been extensively explored in prior research, particularly within a developing nation in Africa, such as South Africa. Given the high level of diversity observed in South Africa's culturally diverse society, with various races and nationalities, the findings of this study offer valuable insights into how specific dimensions of board diversity influence operational costs. This research contributes to the existing literature by addressing the gap concerning board heterogeneity and operational costs in the industrial sector, a nexus that previous studies have not sufficiently explored. The robustness of these findings enhances the accuracy of measurement instruments and provides a more comprehensive understanding of the subject. Finally, this study offers insights relevant to Sustainable Development Goals five (SDG 5) and ten (SDG 10), which focus on gender equality and the reduction of inequalities, respectively. These insights are particularly pertinent to company, sectoral, regulatory, and national policies related to the selection of board members.

Finally, the research suggests paths for future research, including analyses of intersectional diversity (e.g., gender-age interactions) and longitudinal studies of how board composition affects cost-efficiency and innovation trade-offs. By crossing geographic and methodological divides, this study not only enriches global governance studies but also offers a template for optimizing board performance in the emerging world, where strategies for governance must reconcile global best practices and local realities.

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