

Managing Networked Boards and Sustainable Value Creation: Evidence from Malaysia's Shariah-Compliant Companies

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ABSTRACT

Governance networks are formed through board interlocks that may influence the diffusion of sustainability-related information, norms and strategic practices between companies. Yet, the sustainability implications of network positioning remain uncertain, especially in institutional contexts characterised by competing governance expectations. This study investigated the relationship between board network centrality and ESG performance among Shariah-compliant Malaysian public listed companies from 2019 to 2023. Utilising the Social Network Theory, the study examined how different dimensions of board network centrality related to sustainability outcomes. Based on panel data from 186 companies, the analysis employed fixed-effects and correlated random-effects estimations to separate short-term variation in network position from long-run structural embeddedness. The results revealed a temporal-structural duality. Short-term increases in brokerage positions were associated with lower ESG outcomes, suggesting coordination challenges and governance strain. In contrast, companies that remained persistently positioned as brokers exhibited significantly higher ESG performance over time, indicating the long-term value of structural embeddedness. Within-company effects of degree, eigenvector and closeness centrality were insignificant. The findings suggested that governance networks created sustainability value not through temporary increases in connectivity, but through persistent structural embeddedness over time.

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1. INTRODUCTION

Environmental, Social and Governance (ESG) performance is no longer an incidental reporting process but an essential element of company valuation, regulation and capital allocation. Meta-evidence shows that ESG engagement is associated with improved long-term company performance and lower risk exposure (Friede et al., 2015). More recent literature has highlighted the role of institutional investors and governance-related mechanisms in shaping corporate sustainability outcomes (García-Sánchez, Rodríguez-Ariza, et al., 2020; Velte, 2023). Despite this, existing research continues to focus mainly on board composition rather than the relational structure of boards.

Malaysian Shariah-compliant public listed companies operate within a dual governance framework. Alongside conventional capital market regulations, these companies are also required to comply with Shariah screening criteria administered by the Securities Commission Malaysia (Securities Commission Malaysia [SC], n.d.). This environment brings together ethical, financial, and regulatory expectations within a single corporate governance setting. In this context, ESG performance reflects not only companies' responsiveness to sustainability concerns, but also their capacity to balance market-based accountability with Shariah-oriented ethical principles (Boudawara et al., 2023; Muhamad et al., 2022). This dual governance arrangement therefore offers a distinctive institutional setting for examining whether board network centrality supports or constrains sustainable value creation.

In this study, sustainable value creation was operationalised through ESG performance. ESG scores reflect companies' ability to create long-term environmental, social, and governance value while maintaining organisational legitimacy and stakeholder trust. Consistent with contemporary sustainability governance literature, ESG performance was therefore treated as an observable manifestation of sustainable value creation.

The Social Network Theory suggests that strategic advantages of the actors in organisations were attributed to their structural location in networks (Bonacich, 1987; Freeman, 1978). Board interlocks created information, norm, and strategic practices transfer networks in the context of corporate governance (Larcker et al., 2013). Empirical evidence is also available indicating that centrality in networks positively influenced corporate performance including disclosure quality and sustainability engagement (Harjoto & Wang, 2020). However, not all dimensions of centrality were expected to produce similar sustainability outcomes. The four centrality measures captured different structural characteristics of board networks. Degree centrality reflected the number of direct board connections, eigenvector centrality captured prominence within influential network clusters, betweenness centrality indicated brokerage between otherwise disconnected actors, and closeness centrality represented the ease with which information can travel across the network (Freeman, 1978). Brokerage relationships may enhance access to different information, yet they may also generate coordination expenses and agency issues (Burt, 1992; Oehmichen et al., 2017).

Hence, management of the sustainability and board networks has recently revealed that the two were theoretically intricate. The central boards can assist in transferring ESG practices, although excess of brokerage can lower accountability or cause strategic fragmentation (Harjoto & Wang, 2020; Shu et al., 2024). Moreover, cross-country analysis has revealed that network effects were situational (Carney et al., 2020).

While Islamic finance and ESG research has largely focused on performance, disclosure or Shariah governance mechanisms within this distinctive regulatory environment, the structural embeddedness of boards into director networks remains understudied (Alam et al., 2023; Boudawara et al., 2023; Muhamad et al., 2022). This was salient as board interlocks may influence the diffusion of sustainability-related information and governance expectations among companies facing dual regulatory and ethical constraints.

A further limitation concerns the tendency to conflate between-company structural positioning with within-company temporal dynamics. Panel data studies caution that failing to distinguish these two sources of variation may lead to biased inference (Bell & Jones, 2015). The correlated random effects approach therefore allowed this study to separate persistent network embeddedness from short-term positional changes.

In this respect, the study examined the relationship between board network centrality and ESG performance among 186 Malaysian Shariah-compliant corporations from 2019 to 2023. This study broke down the structural embeddedness and temporal variation by using four measures of centrality (degree, eigenvector, betweenness and closeness) created on interlocking director networks and having fixed effects with Mundlak correction. This study avoided the risk of generalisation because it focused on SCPLCs and contributed institutionally specific information to the literature on sustainability governance.

The research contributes to the existing body of knowledge in three ways. First, it separated the types of centrality instead of conceptualizing board networks as homogenous relational capital. Second, it provided an example of an emerging market economy working in a dual governance system. Third, it enhanced the empirical modelling process by separating within and between effects, which made it possible to clarify whether ESG responsiveness was a structural positioning or network dynamics.

2. LITERATURE REVIEW

2.1 Board Interlocks and Organisational Outcomes

Board interlocks are not a new field of research in corporate governance literature. Directors who are on more than one board also build inter-organisational relationships that facilitated information dissemination, reputation signalling, and strategic orientation (Larcker et al., 2013; Mizruchi, 1996). In the context of the Social Network Theory (SNT), these relationships were explained as influence mechanisms but not mere descriptive ties (Borgatti & Halgin, 2011; Freeman, 1978).

Early studies have emphasized access to resources and environmental protection (Hillman & Dalziel, 2003; Pfeffer & Salancik, 1978), and the results showed a positive relationship between director networks and the performance of companies. But later studies had cast doubt on the ability to observe dilution and overcommitment by directors (Fama & Jensen, 1983; Ferris et al., 2003). Interlocks may be viewed as strategic awareness and impaired independent monitoring (Oehmichen et al., 2017). This literature as such represented an inherent paradox in that networks can provide informational benefits but can also introduce coordination and agency costs.

Recent studies have shifted away to structural location in governance networks as opposed to interlock presence. Centrality measurement not only identified the existence of ties, but it also displayed the variation in the degree of influence, brokerage, and embeddedness among actors (Harjoto & Wang, 2020; Larcker et al., 2013; Shu et al., 2024). This theoretical development provided possibilities of uncovering the impacts of network architecture on strategic performance, such as sustainability.

2.2 Board Networks and ESG Performance

The conceptualisation of ESG performance is becoming a result-based activity that is governed and not a secondary reporting activity (García-Sánchez, Hussain, et al., 2020; Velte, 2023). The institutional preferences were converted to organisational strategy by the governance systems (Aguilera et al., 2007). It is in this spirit that board networks might turn out to be a source of propagation of sustainability norms.

The empirical evidence is suggestive and not conclusive. Harjoto and Wang (2020) found that greater board network centrality was associated with stronger ESG performance, while Shu et al. (2024) similarly documented a positive relationship between board network positioning and ESG performance. Nonetheless, according to the findings of other studies, relational centrality may be linked to symbolic and not substantive sustainability engagement (W. Zhao et al., 2022). There was also some cross-market evidence that institutional regimes were important to network effects (Carney et al., 2020).

This line of research has two characteristics. To begin with, centrality was usually theorized as a unidimensional construct that ignored the actual process of relationship. Second, the majority of the studies employed static models without differentiating structural and temporal variation. In the absence of this differentiation, network effects can be overvalued or misunderstood.

Recent reviews have highlighted the importance of governance-related actors and institutional investors in shaping corporate sustainability outcomes (Velte, 2023). In addition, cross-market evidence indicates that sustainability outcomes are shaped by institutional conditions and investor networks (Ioannou & Serafeim, 2023; C. Jin et al., 2024; van der Zwan & van der Heide, 2024). Together, these studies reinforce the importance of examining sustainability governance beyond internal company characteristics.

2.3 Multidimensional Centrality Effects

Centrality is not a concept of one dimension. The various measures of centrality represent structurally diverse mechanisms that can have varying governance implications. Degree centrality indexes measure the relational width and exposure to various boards. Empirical studies have shown recently that the higher the relational vulnerability, the more access to sustainability knowledge and benchmarking can be obtained (Harjoto & Wang, 2020; Shu et al., 2024). However, excessive connectivity can cause coordination issues and ineffectiveness of monitoring, particularly when directors are in more than one outside board role (Fernández Méndez et al., 2015; Liu & Liu, 2023).

Eigenvector centrality indexes were members of central groups of central actors. Companies that were connected to extremely central actors were found on embedded prestige positions (Bonacich, 1987). Recent studies on sustainability governance have indicated that corporations incorporated in central governance clusters were more congruent with the changing disclosure norms (Harjoto & Wang, 2020; Yin et al., 2025). However cohesive clustering can also facilitate conformity and strategic homogeneity which can be a barrier to innovativeness in sustainability practices.

Closeness centrality represents the efficiency of networks as far as reachability is concerned. Facing the dynamic ESG norms and regulatory demands, shorter geodesic distances might be a possible way to enhance the adaptive capabilities. The recent panel research in the emerging economies has shown that those companies that had greater reachability abilities were more likely to respond to the change in the sustainability reporting requirements (Harjoto & Wang, 2020; Shu et al., 2024). Nevertheless, empirical studies on the topic of the closeness centrality of governance networks were still lacking.

Betweenness centrality is a measure of brokerage of structural holes (Burt, 1992). Recent research is becoming more and more aware of the heterogeneous governance impacts of brokerage. Despite the fact that bridging roles might enhance resilience to various sustainability practices (Shu et al., 2024), it might also worsen the cohesive monitoring and cognitive overload (Liu & Liu, 2023).

Prior review evidence suggests that the consequences of board interlocks are context-dependent (Yoon, 2021). Thus, it cannot be assumed that the sustainability impact of brokerage was always positive.

These current studies have suggested that the ESG performance of companies can be not only related to the connectivity but also to the structural role in the networks of governance.

2.4 Network Governance in Emerging and Regulated Contexts

Network effects are determined by institutional contexts. This situation might be offset by social relations in emerging markets in the context of less formal enforcement (X. Jin et al., 2016; Khanna & Palepu, 2010). Formal governance requirements may have the effect of compensating the peripheral role of social embeddedness in highly regulated settings.

Malaysia is a hybrid form of governance that incorporates traditional capital market regulation and the Islamic financial regulation. The reporting of sustainability has grown by a large margin in the recent years and ESG standards are now incorporated in listings requirements. Such networks may possibly strengthen normative isomorphism but it was not clear how much networks influence governance at the periphery.

The results of cross-country research has indicated that institutional pressures were reinforced by the effects of centrality (Gözübüyük et al., 2020). It was yet to be determined whether this is true of Shariah-compliant companies in dual governance frameworks.

2.5 Shariah-Compliant Governance and Sustainability

The Shariah compliant public listed companies have a dual governance structure that incorporated the traditional capital market regulation and the Islamic ethical filtering. The nested system brought normative requirements into the financial governance. The recent literature on Islamic finance has drawn more and more to the issue of sustainability alignment in Shariah compliant companies suggesting that ESG considerations may converge with the maqasid al-shariah objectives of social welfare and risk management (Boudawara et al., 2023; Muhamad et al., 2022).

Most prior studies in the Shariah governance literature have concentrated on disclosure practices, governance mechanisms, financial outcomes, or the role of Shariah supervisory structures (Mohd Zain & Abdullah, 2025). Although sustainability-related issues have received increasing attention, existing evidence remains largely centred on reporting behaviour and institutional arrangements rather than the relational positioning of directors within governance networks (Boudawara et al., 2023; Muhamad et al.,

2022). Consequently, the implications of board network embeddedness for sustainability outcomes in Shariah-compliant companies remained insufficiently understood.

The sustainability disclosure was also increasingly strict in the regulated emerging markets of Malaysia, over the past five years, and it had established the formal governance requirements. Recent studies have indicated that institutional harmonization and regulatory alignment was gaining momentum in the sustainability integration of the ASEAN markets (Handoyo & Anas, 2024). Informal relational capital through director interlocks may, in this context, either facilitate or create coordination problems readily when the formal governance was challenged by the dual compliance issues.

The connection between structural brokerage and Shariah governance was therefore an open empirical question. Embeddedness might contribute either to long-term sustainability fit by reputation-building or to short-term brokerage tension by dealing with two institutional logics.

2.6 Literature Gap

Although the literature on board interlocks and sustainability governance was increasingly growing, it still had certain blind spots that needed to be filled. The existing literature has not investigated simultaneous measurement of multiple centralities in ESG situations and much less did it attempt to differentiate between structural embeddedness and positional change. Last but not the least, the existing literature remained concentrated on the developed world and did not give a lot of references to the regulated emerging markets and Shariah-compliant business cultures that were typified by two sets of governance expectations. These aspects demanded a more precise approach that will help understand the role of relational positioning in sustainable value creation better.

2.7 Research Gap and Research Question

Existing research has demonstrated that board networks influenced sustainability outcomes, yet three limitations remain. First, prior studies frequently treat network centrality as a single governance construct despite the distinct mechanisms represented by degree, eigenvector, closeness, and betweenness centrality. Second, existing evidence rarely distinguished between persistent structural embeddedness and short-term changes in network position, creating ambiguity regarding the temporal nature of network effects. Third, evidence from dual-governance environments remained limited, particularly among Shariah-compliant companies operating under both capital-market and religious governance expectations. Accordingly, this study investigated whether different dimensions of board network centrality influenced ESG performance and whether these effects differed between short-term positional changes and long-term structural embeddedness.

3. THEORETICAL FRAMEWORK AND HYPOTHESIS

3.1 Conceptual framework

According to the Social Network Theory, the conceptualisation of this research was that ESG performance was a direct relationship of board network centrality in a formalised interlocking directorate network. This conceptual framework took the structural location of governance networks as a predictor of sustainability performance rather than focusing on internal board structures (Borgatti & Halgin, 2011;

Freeman, 1978). Interlocked directors in more than one board created network forms that affected information availability, reputation visibility, as well as strategic visibility between companies.

These four measures of centrality were identified as degree, eigenvector, closeness, and betweenness in the conceptual framework. All these measures singled out a different structural property of network location. Degree centrality quantified the relational range as well as direct visibility to other boards. Eigenvector centrality denoted structural location within notable clusters. Centrality of proximity quantified network accessibility and information efficiency. Betweenness centrality referred to mediation in separated actors (Bonacich, 1987; Burt, 1992). It was postulated that these four measures influenced ESG performance by organising the ways in which the companies interpreted and reacted to shifting sustainability requirements.

It is important to note that this conceptual framework had a hypothesis of a direct correlation between the centrality of the board network and the ESG performance. Theoretical explanations of this direct relationship were informational diffusion, reputation visibility, and brokerage diversity, which, however, were not conceptualised as mediating variables. The study examined the ESG performance as the empirical organisational performance of structural location in governance networks.

A distinction between the temporal and structural levels of the empirical level was also incorporated in the framework. Network embeddedness had the potential to generate cumulative informational and reputational benefits with time, and a shift in network location within a shorter time frame might be associated with coordination and adjustment costs. In order to draw a line between structural positioning and temporal variation, the analysis isolated the within-company variation and the between-company variation based on the correlated random effects approach (Bell & Jones, 2015).

Lastly, the relationship was placed in a institutional context that was Shariah compliant. Malaysian Shariah compliant public listed companies have a dual standard of governance which is a combination of capital market regulation and Shariah screening standards. This is a multi-level institutional structure that acted as the boundary condition where the network effects were understood in not as a statistical control. Figure 1 shows the conceptual framework to be discussed in this study.

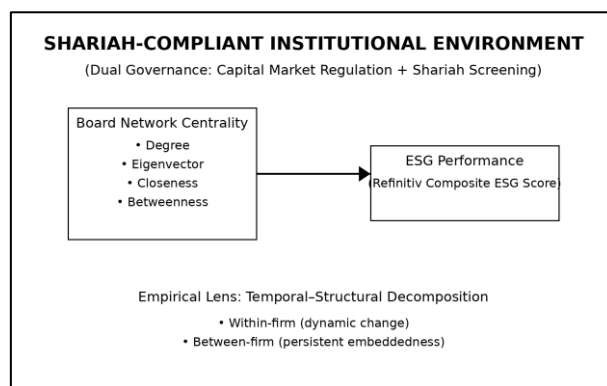


Fig. 1. Conceptual Framework

3.2 Board Networks and Sustainable Corporate Outcomes

The Social Network Theory suggests that organizational actors obtain strategic advantage by exercising their structural location in relational networks (Burt, 1992; Freeman, 1978). Under corporate governance, interlocking directorates were a networked system of governance, where information, norms and strategic practices were exchanged amongst companies (Larcker et al., 2013). These multiple boards were reputational cues, governance routines and policy innovations that were communicated by directors thereby affecting organizational decision making processes beyond the company.

ESG engagement was also being perceived as a governance-based strategic deliverable in the sustainability literature, and not a compliance-based reaction (García-Sánchez et al., 2020; Velte, 2023). Boards based in thick inter-company networks can have first-mover advantages in knowledge of sustainability, regulation, and benchmarking practices among peers. Empirical evidence shows that board interlocks constituted disclosure quality, innovation diffusion, and strategic convergence (Harjoto & Wang, 2020; Larcker et al., 2013; Shu et al., 2024). However, network centrality was connected to ESG outcomes in a process that has a complicated theoretical basis.

Centrality is a concept that is multidimensional. The degree centrality is a degree of the number of direct ties which is an indication of exposure to information flow. Eigenvector centrality represented the concept of influence within highly connected groups, which means prestige in highly connected groups. Closeness centrality is a measure of the effectiveness of the accessibility of the total network by the company. Betweenness centrality represented the force of brokerage between otherwise unconnected groups (Bonacich, 1987; Freeman, 1978).

In spite of the fact that centrality may be a good aspect of access to information, brokerage activities were associated with coordination costs and higher agency risks (Burt, 1992). The structural holes directors might have contradictory commitments and lower monitoring efficacies, which can neutralise the ESG implementation. The recent cross-country evidence has revealed that institutional and governance aspects were predetermining sustainability payoff of board networks (Shu et al., 2024).

The governance environment of the Malaysian Shariah was a special context. Companies have to fulfil Shariah screening requirements as well as the traditional capital market conditions, and ethical limitations were introduced into the financial management. The strategic fit and normative compliance were captured in sustainability outcomes within this environment. The spread of responsible behaviour can be achieved through networked boards, but excessive dependence on the brokerage functions may induce governance fragmentation in the two-regulatory environment.

This study therefore proposed that different dimensions of centrality may exhibit heterogeneous relationships with ESG performance.

3.3 Hypothesis Development

Social Network Theory conceptualised organisational outcomes as contingent upon the structural position of actors within relational systems (Borgatti & Halgin, 2011; Freeman, 1978). Board interlocks were a network of governance that facilitated strategic information, behavioural norms and reputation indicators. Different measures of centrality described different structural processes, hence, it was not likely that their impact on ESG performance would be comparable.

3.4 Degree Centrality and ESG Performance

The degree centrality was used to measure the extent of direct connections maintained by a board. Direct relational exposure leads to the spread of information and alignment of norms according to Social Network Theory (Freeman, 1978). The actors in high connected structural positions were subjected to repeated exposure, which increased the chances of practise transfer and behavioural alignment (Granovetter, 1985).

Direct relational exposure to other boards in governance networks increased awareness of the sustainability reporting standards, frameworks, and integration of the ESG. Empirical research has also shown that those corporations that were involved in bigger interlock networks exhibited higher levels of disclosure and governance congruence (Larcker et al., 2013). Other more modern sustainability research has indicated that ESG practices were spreading out of governance networks instead of company-level sustainability initiatives (Gawusu et al., 2025; D. Zhao et al., 2025).

The existence of the constraint effects was however recognised by the Social Network Theory as well. The more the degree of relational exposure, the more the complexity of coordination and relational burdens (Burt, 2007). Board relationships can result in reduced check and balances as boards become over connected. The result was therefore the presence of benefits of informational exposure compared to coordination burdens.

As diffusion of ESG expectations in emerging markets was growing rapidly, direct connectivity was expected to increase the level of sustainability alignment.

H1: Board degree centrality is positively associated with ESG performance.

3.5 Eigenvector Centrality and ESG Performance

Eigenvector centrality is a measure of embeddedness in large influential clusters. In comparison to degree centrality, eigenvector centrality was used to measure the quality of connections and network position (Bonacich, 1987).

The embeddedness view holds the view that, when the actors belong to cohesive and powerful clusters, then they are more likely to have a high level of normative alignment due to frequent engagement (Granovetter, 1985). Within such environments reputational interdependence existed and the difference between practices that were dominant and ones that were not became more noticeable. Consequently, boards that were situated in powerful network cores can be more willing to internalise dominant sustainability standards.

Recent ESG studies support this mechanism, showing that companies with more central or well-connected boards tended to exhibit stronger ESG performance and governance alignment (Harjoto & Wang, 2020; Shu et al., 2024). Related evidence suggests that board interlock centrality can facilitate access to external market information and strategic knowledge (Srinivasan et al., 2018). Reputational incentives to integrate ESG may be increased in the presence of embeddedness in a powerful set of people in the Shariah-compliant environment of Malaysia, where both ethical screening and the transparency of governance were in place.

Regulated markets were more prone to homogeneity encouraged by dense clusters, but ESG convergence fosters compliance and is unlikely to discourage innovation.

H2: Board eigenvector centrality is positively associated with ESG performance.

3.6 Closeness Centrality and ESG Performance

Closeness centrality determines the effectiveness of an actor to access other network members using shortest paths (Freeman, 1978). The actors who are highly central in terms of closeness were those who were more reachable and had lesser informational distance.

Diffusion perspectivewise, it was possible to identify emergent governance practices and changes in regulations at a faster rate due to the short distance of the paths (Borgatti & Halgin, 2011). ESG standards have changed quite quickly in the recent years and the regulatory scrutiny and disclosure requirements have increased. Companies that were effective in accessing information that was available throughout the network were thus better placed to adapt in appropriate period.

The empirical sustainability research has demonstrated that governance structures that supported the rapid flow of information were associated with a higher ESG responsiveness (Velte, 2023). Centrality of proximity enhanced accessibility of structure without always creating a strain of brokering or cohesive force implying a potentially beneficial consistency to sustainability responsiveness.

H3: Board closeness centrality is positively associated with ESG performance.

3.7 Betweenness Centrality and ESG Performance

Given the competing theoretical arguments concerning informational benefits and coordination costs, the direction of the relationship remains ambiguous. Betweenness centrality captured brokerage roles in inter-organisational networks through the degree to which a board linked otherwise disconnected clusters (Burt, 1992). Brokerage role actors were able to gain access to a variety of information sources and mediated the heterogeneous perspectives of governance between companies.

From a social network perspective, structural holes highlight a basic trade-off between brokerage and network cohesion (Burt, 2007). Brokers have the advantage of having access to varied information and a higher level of strategic freedom, yet they might be less integrated into the cohesion of systems of monitoring that strengthen shared norms and collective accountability. The implication of this duality in governance environments was that the establishment of informational benefits by the brokerage can be achieved and coordination complexity can be generated as well.

In the sustainability contexts, brokerage roles can subject the companies to a wider scope of ESG practices and governance practices across the industries. Simultaneously, the process of handling heterogeneous expectations in detached clusters can add a strain of coordination. Empirical data has also indicated that the impact of brokerage on the results of companies were context-specific and not always positive (Kwon et al., 2020).

With this theoretical contradiction between informational advantage and coordination complexity, it was unclear what the connection between betweenness centrality and the ESG performance was.

H4: Board betweenness centrality is associated with ESG performance.

4. RESEARCH DESIGN AND EMPIRICAL STRATEGY

4.1 Sample and Data

The study concentrated on the Malaysian Shariah-compliant public listed companies (SCPLCs) in the year 2019 onwards to 2023. The sample was identified as per the categorization of Shariah compliance by the Securities Commission Malaysia in order to have homogeneity of institutions in a dual governance structure. The original panel comprised of 186 companies and 930 company-year observations. Due to missing values in selected control variables, the estimation sample used in the multivariate analyses was reduced to 920 observations through listwise deletion.

The period in question captured post-regulatory improvement phase of ESG reporting in Malaysia, as well as, adoption of sustainability disclosure practices swiftly in reaction to better listing requirements. The emphasis on SCPLCs in and of itself minimised the institutional heterogeneity and eliminated generalisation outside of the regulatory framework that is being studied.

Board interlock data set was gathered by hand using annual reports. Measurements of centrality in a network were computed in the UCINET software package. To compare the centrality values in various dimensions and avoid scale differences, the centrality values were normalised (z-score transformation).

The ESG performance measure was obtained by means of the Refinitiv composite ESG score. Composite ESG measures are widely used in empirical sustainability research (Friede et al., 2015). Financial controls used to eliminate resource capacity and capital structure were company size (log of total assets) and debt (leverage).

4.2 Empirical Model Specification

The empirical specification at the baseline was given as:

$$ESG_{it} = \beta_1 Centrality_{it} + \beta_2 Controls_{it} + \lambda_t + \alpha_i + \varepsilon_{it}$$

where α_i captured unobserved company-specific heterogeneity and λ_t denoted year fixed effects.

4.3 Fixed Effects Estimation

The estimation of panel data also had the issue of time-invariant unobserved heterogeneity which may be correlated with explanatory variables. In case this correlation existed, then pooled OLS and random effects estimators were not consistent (Wooldridge, 2010). In order to specify the right specification, the Hausman test was performed to compare the fixed and random effects models (Hausman, 1978).

The Hausman test rejected the null hypothesis of no systematic difference between the fixed-effects and random-effects estimators, indicating that the explanatory variables were correlated with unobserved company-specific effects. This was why fixed effects estimation was preferable because it eliminated the heterogeneity that was time-invariant using within-transformation (Baltagi, 2021).

Clustering of standard errors at company level was done to counter heteroskedasticity and serial correlation among panels. Cluster-robust variance estimators were also advocated in the corporate panel contexts whereby residues can be within-company dependent (Arellano, 1987).

Year dummies were added to control them against macroeconomic shocks, regulatory adjustments and institutional developments related to ESG to all companies at the same time. Omission of year effects might have resulted in the attribution of time-varying macro shocks to network properties of companies.

4.4 Correlated Random Effects (Mundlak) Decomposition

Although the fixed effects model did not explicitly distinguish between long-term structural positioning and short-term fluctuations, the difference between the two was captured in within-company variation. According to the Social Network Theory, persistent embeddedness was a quite different mechanism compared to temporary changes in network centrality.

In order to differentiate these elements, this study used a correlated random-effects specification that succeeded (Mundlak, 1978). The method generalised the traditional random-effects model by including company-specific means of time-varying independent variables, and in that way, broke down within-company variations in the deviation to between-company structural positioning:

$$ESG_{it} = \beta_w(Centrality_{it} - \overline{Centrality}_i) + \beta_b\overline{Centrality}_i + \beta_2Controls_{it} + \lambda_t + u_i + \varepsilon_{it}$$

The model used correlated random-effects framework to differentiate between dynamic changes and structural positioning by including company-specific means of the time-varying centrality measures. Formally, ESG performance was defined as a variable of centrality deviation of mean of centrality at the company-level, company-level centrality mean, control variables, and year fixed effects.

With these company-level averages added, it was possible to break down the overall effect into within-company and between-company. The within effect measured variations in the connection to ESG performance of a company over time in relation to changes in the network position of that company. Conversely, the between effect indicated whether there were systematically different sustainability results of companies that held enduring central structural positions.

The specification was an alternative to the traditional fixed-effects models that were flexible when the research problem needed to interpret both temporal dynamics and cross-sectional structural differences at the same time (Bell & Jones, 2015).

4.5 Cross-Sectional Dependence and Robustness

Cross-sectional dependence can also arise with panel data on interdependent companies, which was a result of common shocks, or network spills. Traditional cluster-robust standard errors failed to capture this issue fully (Hoechle, 2007).

In order to enhance robustness, Driscoll-Kraay standard errors were used. This estimator was resistant to heteroskedasticity, serial correlation, and wide-scale cross-sectional dependence in medium time dimension panels (Driscoll & Kraay, 1998). The analysis minimised possible inference bias due to correlated error structures by reporting both cluster-robust and Driscoll-Kraay corrections.

4.6 Model Diagnostics and Specification Tests

An extensive diagnostic test was performed to determine the right panel estimator and to make sure that the statistical inference corresponds to the econometric requirements and to the theory of governance. Table 1 summarises the findings.

Table 1 Summary of Diagnostic Tests

Test	Statistic	p-value	Interpretation
Hausman test	$\chi^2(7) = 58.10$	0.0000	FE preferred over RE
F-test (all $u_i = 0$)	$F(185, 727) = 25.04$	0.0000	Company effects significant
Intra-class correlation (ρ)	0.8902	–	89% variance due to company effects
Modified Wald test	$\chi^2(186) = 54,436.88$	0.0000	Heteroskedasticity present
Wooldridge test	$F(1, 184) = 37.078$	0.0000	First-order autocorrelation present
Pesaran CD test	$CD = 0.723$	0.470	No cross-sectional dependence
Hansen test (GMM)	$\chi^2(1) = 9.10$	0.003	Instrument validity rejected

The Hausman specification test provided strong support for the fixed-effects estimator. It rejected the null hypothesis that the difference between the random-effects (RE) estimator and the FE estimators was not systematic ($\chi^2(7) = 58.10$, $p < 0.001$). This result showed that the regressors were correlated with unobserved company-specific effects, thus making the RE estimator inconsistent (Baltagi, 2021; Hausman, 1978; Wooldridge, 2010). This conclusion was further confirmed by the estimated correlation between unobserved effects and the explanatory variables, $\text{corr}(u_i, Xb) = 0.1474$. Such correlation can be theoretically quite possible in the context of governance: it was hardly possible that board structures, relational capital and embedded institutional norms were randomly distributed among companies. In this light, the FE estimator was embraced as the main method of empirical analysis.

It was also remarkable how large the intra-class correlation coefficient was. The 0.8902 estimated ρ indicated that about 89 percent of the overall change in the ESG performance was time-invariant company specific and not time-varying company specific. Table 1 indicates that this heterogeneity was confirmed by the joint significance test of company effects ($F(185, 727) = 25.04$, $p < 0.001$). This trend was informative, and not problematic, through the governance-theoretical perspective. Corporate governance mechanisms were entrenched in organisational practices, ownership patterns, regulatory placement and board composition patterns that developed over time. A high ρ was thus more of structural embeddedness and not a statistical artefact. Within this context, the within-estimator was not only a technical choice but a theoretically coherent approach because it separated the effects of the changes in board network centrality

and governance features with the institutional structures that were still present on a company-by-company basis.

Diagnostic tests also pointed to the violations of classical error assumptions. The Modified Wald test was a strong reject of homoskedasticity ($\chi^2(186) = 54,436.88$, $p < 0.001$), and the Wooldridge test was a strong evidence of a first-order serial correlation between companies ($F(1, 184) = 37.078$, $p < 0.001$), as in Table 1. These trends were consistent with inertia and path dependence forms of governance. Sustainability initiatives, board realignment, and strategic risk management adjustments typically evolve over time rather than occurring instantaneously. All fixed-effects models were estimated using company-level clustered robust standard errors to support valid inference in such circumstances, and to be consistent in the presence of arbitrary heteroskedasticity and intra-cluster serial correlation.

The lack of cross-sectional dependence was also an indicator of the identification strategy. Pesaran CD ($CD = 0.723$, $p = 0.470$) did not reject the null hypothesis of cross-sectional independence. Although the companies were interconnected, the statistical evidence of contemporaneous correlation across panel that will bias the coefficient estimates was lacking. This implied that the effects that were observed were more likely to be conducted at company level than systemic shocks.

A model with a lagged dependent variable was estimated to overcome the possibility of dynamic endogeneity. The estimate of the fixed-effects specification with clustered standard errors revealed the moderate persistence of ESG performance ($\beta = 0.318$, $p = 0.003$). This trend concurred with the concept of structural embeddedness in the Social Network Theory where organisational practices emerged gradually as a result of repetitive interaction and enduring relational network (Borgatti & Halgin, 2011; Granovetter, 1985). When sustainability efforts were integrated into the governance practices, they were likely to exhibit continuity and not sudden change. This positive lagged coefficient was therefore expressed the path of dependence governance processes and not a manifest of mechanical inertia.

A robustness check was done by implementing a system GMM estimator. Even though the lagged ESG coefficient was positive and significant ($\beta = 0.849$, $p = 0.031$), and the Arellano-Bond tests did not reveal any second-order serial correlation ($AR(2)$: $z = 0.73$, $p = 0.468$), the null hypothesis of instrument validity was rejected by the Hansen test ($\chi^2(1) = 9.10$, $p = 0.003$), as demonstrated in Table 1. This brought into question the power of instruments and over-identification. In this regard, the directional persistence identified by the dynamic GMM results was confirmed, but the primary inference was drawn using the fixed-effects specification, with clustered standard errors, which was both econometrically sound and theoretically coherent.

In general, the evidence of the diagnosis in Table 1 confirmed the application of the fixed-effects estimator but also supported the theoretical argument of the study. The large company-specific variance, the continuity of the performance of ESG, and the lack of cross-sectional dependence were all indicative that sustainability outcomes are systemically entrenched in the company-level governance structures as opposed to being spurred by the temporary shocks. The empirical approach was thus not only econometrically justifiable but also theoretically based.

5. EMPIRICAL RESULTS

5.1 Descriptive Statistics and Preliminary Diagnostics

Table 2 Descriptive Statistics

Variable	Obs	Mean	SD	Min	Max
ESG	930	36.06	17.55	5.32	91.57
zdfnd	930	0.00	1.00	-0.84	4.21
zdfne	930	0.00	1.00	-0.27	7.07
zdfnb	930	0.00	1.00	-0.29	8.79
zdfnc	930	0.00	1.00	-1.51	1.95
lnfs	921	21.06	1.62	15.91	26.05
leverage	929	0.40	0.51	0	14.48

Table 2 reports the summary statistics for the full available sample of 930 company-year observations generated from 186 Malaysian Shariah-compliant listed companies over the 2019–2023 period. Descriptive statistics used the entire available sample, while multivariate estimations were limited to 920 observations after listwise deletion of missing control variables. The mean ESG score was 36.06 (SD = 17.55) and the dispersion was quite large (min = 5.32; max = 91.57). This dispersion implied that sustainability practices were not adopted homogenously in the Shariah-compliant section of the Malaysian capital market.

All measures of centrality of network were standardised (mean = 0; SD = 1). Interestingly, the centrality variables changed across and within companies as time went by. The within-company standard deviations were 0.50 (degree) to 0.92 (closeness) and indicated significant changes in the positions of the boards networks over the sample period. This difference justified the application of panel estimation and the reasons to separate structural and temporal elements in further analysis.

The average size of companies (ln total assets) was 21.06 (SD = 1.62), with a mean leverage of 0.40 (SD = 0.51), which suggested that there was a high level of heterogeneity in financial capacity among companies.

Table 3 Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) ESG	1.000						
(2) zdfnd	0.355***	1.000					
(3) zdfne	0.056*	0.504***	1.000				
(4) zdfnb	0.319***	0.554***	0.243***	1.000			
(5) zdfnc	0.031	0.268***	0.133***	0.132***	1.000		
(6) lnfs	0.622***	0.366***	0.138***	0.271***	0.189***	1.000	
(7) leverage	0.061*	0.118***	0.020	0.063*	0.104***	0.138***	1.000

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

The correlation (Table 3) showed that ESG had a positive relationship with degree centrality ($r = 0.355$, $p < 0.01$) and betweenness centrality ($r = 0.319$, $p < 0.01$), but the associations with eigenvector centrality and closeness centrality were not as strong. The company size presented the best bivariate correlation with ESG ($r = 0.622$, $p < 0.01$), indicating that resource endowment was a significant element in sustainability performance. Variance inflation factors were not high (mean VIF = 1.37; maximum = 2.06), which meant that no multicollinearity was observed.

Even though such bivariate correlations provided some initial understanding, they failed to account for unobserved company-specific heterogeneity. Hence, the analysis below was based on fixed-effects estimation.

5.2 Fixed effects estimation

Table 4 Fixed Effects Estimates

Variables	Degree	Eigenvector	Betweenness	Closeness
Centrality	0.267	-0.269	-0.725**	-0.386
lnfs	1.419*	1.460*	1.262	1.412*
leverage	0.309*	0.290	0.342*	0.329*
Year FE	Yes	Yes	Yes	Yes

Variables	Degree	Eigenvector	Betweenness	Closeness
Within R ²	0.665	0.666	0.670	0.665
N	920	920	920	920

Notes: ** $p < 0.05$, * $p < 0.10$

Table 4 contains the estimates of company fixed-effects using company-clustered standard errors and year dummies. The F-test was highly significant in rejecting the null hypothesis that company effects were jointly zero and hence the necessity to control time-invariant heterogeneity. The Hausman test also supported the fixed-effects specification.

The within R² across specifications was 0.665 to 0.670, which implied that the model could explain about two-thirds of the within-company variation in ESG performance. Year dummies were always positive and had a significant value ($p < 0.001$), which indicated a systematic increase in the ESG scores during the sample period, probably due to the tightening of regulations and the increasing institutional focus on sustainability reporting.

Concerning the most important explanatory variables, the degree centrality did not have a statistically important within-company effect ($\beta = 0.267$, $p = 0.638$). Eigenvector centrality was also insignificant ($\beta = -0.269$, $p = 0.117$). These results indicated that the short-term variations in relational breadth or embeddedness in influential clusters could not generate instantaneous changes in ESG performance after the company-specific characteristics have been considered.

In contrast, betweenness centrality had a statistically significant negative within effect ($\beta = -0.725$, $p = 0.019$). The increase of standard deviation of the brokerage position by one standard deviation correlated with a decrease in the ESG score by about 0.73 points. This finding suggested that the short-term time-varying shifted to brokerage activities can bring about coordination complexity or strain on monitoring, which limited sustainability performance. The within effect of closeness centrality was insignificant ($\beta = -0.386$, $p = 0.561$).

Out of the control variables, company size tended to show a positive correlation with ESG performance, with slight variance in the extent of statistical significance across the models. Leverage had a weak positive relationship with some of the specifications, but the effect lacked consistent robustness.

In general, the fixed-effects estimates indicated that the dimensions of network centrality did not have the same implications; brokerage positions had different implications on sustainability performance.

5.3 Decomposing structural and temporal effects: correlated random effects

Table 5 Mundlak Decomposition (Betweenness)

Variable	Coefficient
Within (zdfnb)	-0.656**
Between (mean_zdfnb)	7.885***
lnfs	3.900***
leverage	0.407
Year FE	Yes
N	920

Notes: *** $p < 0.01$, ** $p < 0.05$

In order to decouple persistent structural positioning and short-term fluctuations, Table 5 presents the correlated random-effects (Mundlak) decomposition of betweenness centrality. Within-company effect was negative, and statistically significant ($\beta = -0.656$, $p = 0.035$), which supported the fixed-effects finding that the growth of brokerage position was negatively related to ESG performance.

Conversely, the between-company element showed a reverse trend. The mean of betweenness centrality at the company level was positive and very significant ($\beta = 7.885$, $p < 0.001$). Companies that were continuously placed as intermediaries had significantly greater ESG ratings. One standard deviation of mean betweenness centrality had a relationship with a 7.9-point shift in ESG performance.

The contrasting signs of the within and between coefficients revealed a temporal-structural duality in board brokerage. While temporary increases in brokerage were associated with lower ESG performance, persistent brokerage positions were associated with substantially higher ESG performance. Such duality could not be observed through a standard fixed-effects specification.

5.4 Robustness to cross-sectional dependence

Table 6 Driscoll–Kraay Robustness (Betweenness)

Variable	Coefficient
zdfnb	-0.725***
lnfs	1.262***

Variable	Coefficient
leverage	0.342
Within R ²	0.669
N	920

Note: *** $p < 0.01$

Since there was a likelihood of common shocks and network spillovers, Driscoll-Kraay standard errors were used to overcome cross sectional dependence. The strength of the effect values as in Table 6 confirmed the negative value of betweenness centrality ($\beta = -0.725$, $p = 0.001$). The size of the coefficient was the same as the one with the fixed-effects model, and statistical significance was increased after the correction of the cross-sectional dependence.

This robustness test further increased confidence that the negative time effect of brokerage cannot be explained by correlated disturbances or macro-level shocks, but rather reflected a substantive within-company dynamic.

5.5 Summary of Hypotheses Testing

Table 7 Summary of Hypotheses Testing

Hypothesis	Hypothesised Relationship	Primary Empirical Result	Decision
H1	Board degree centrality is positively associated with ESG performance.	Positive but statistically insignificant in the fixed-effects model ($\beta = 0.267$, $p = 0.638$).	Not supported
H2	Board eigenvector centrality is positively associated with ESG performance.	Negative but statistically insignificant in the fixed-effects model ($\beta = -0.269$, $p = 0.117$).	Not supported
H3	Board closeness centrality is positively associated with ESG performance.	Negative but statistically insignificant in the fixed-effects model ($\beta = -0.386$, $p = 0.561$).	Not supported
H4	Board betweenness centrality is associated with ESG performance.	Significant negative association in the fixed-effects model ($\beta = -0.725$, $p = 0.019$).	Supported (negative association)

Table 7 provides a summary of the inferences across all hypotheses based on fixed-effects estimates (from Table 4). The results showed that the association linking board network centrality to ESG performance varied across centrality dimensions. Specifically, controlling for company-specific heterogeneity extinguished any statistical significance of degree on ESG performance as well as eigenvector and closeness centrality. As such, H1, H2 and H3 were not supported.

In contrast, H4 was supported because betweenness centrality exhibited a statistically significant association with ESG performance. The coefficient was negative, indicating that short-term increases in brokerage positions were associated with lower ESG performance. The next Mundlak decomposition refined this result further, demonstrating that the negative relationship was confined to within-company time series variation while persistent between-company brokerage led to increased ESG performance. Taken together, these findings suggested that brokerage should be viewed as more than a simple network position. Its influence appears to depend on the extent to which brokerage roles were maintained over time and become embedded within a company's governance structure.

6. DISCUSSION

The findings provided a subtle account of the effect of board network structures on sustainability performance amongst Malaysian Shariah-compliant companies. Instead of the linear concept of a network advantage, the evidence showed that the governance implications of centrality were based on structural positioning and temporal stability. This difference narrowed the gap in existing assumptions in the Social Network Theory and corporate governance studies.

The findings highlighted the limits of assuming that all dimensions of board centrality generated equivalent sustainability benefits. While prior studies often conceptualised network centrality as a uniformly advantageous governance resource, the present findings suggested that the governance implications of network position were considerably more heterogeneous.

The lack of statistically significant within-company effects on degree and eigenvector centrality indicated that the gradual increase in relational breadth or embeddedness may not necessarily result in better ESG performance. Degree centrality measures the number of direct ties (Freeman, 1978), whereas eigenvector centrality measures the closeness to influential actors (Bonacich, 1987). Previous research in the field of governance tended to equate such embeddedness with greater reputational visibility and higher-quality disclosure (Gulati & Westphal, 1999; Harjoto & Wang, 2020). Nonetheless, the current results suggested that informational access in itself was not enough to create quantifiable sustainability gains when considering the company-specific heterogeneity was held constant.

In terms of the Social Network Theory, access must be supplemented by absorptive capacity and institutional alignment (Borgatti & Halgin, 2011; Granovetter, 1985). Formal screening mechanisms and ethical supervision may limit the marginal benefits of the additional network exposure in Shariah-compliant companies, which already predetermined the governance arrangements. In these institutional circumstances, relational breadth can also act as symbolic embeddedness rather than as an active force in ESG transformation (Aguilera et al., 2007; Silva et al., 2025). Recent ESG governance literature also

cautions that, even where connected, a normative or regulated environment did not necessarily result in sustainability performance (Shu et al., 2024; D. Zhao et al., 2025).

The most significant findings were associated with centrality of betweenness. This result was consistent with the non-directional expectation proposed in H4, which recognised competing theoretical arguments regarding the informational benefits and coordination costs of brokerage positions. The fixed-effects and Driscoll-Kraay estimations indicated an adverse within-company correlation between brokerage and ESG performance. Consistent with the structural holes perspective, brokerage can provide strategic advantages by connecting actors that are otherwise disconnected (Burt, 1992). Meanwhile, the introduction of coordination complexity and conflicting demands was brought about by brokerage (Oehmichen et al., 2017). Directors in bridging roles were likely to experience cognitive overload and divided attention in monitoring, especially when working across heterogeneous institutional domains. Prior evidence also suggests that multiple board appointments can constrain directors' monitoring capacity (Ferris et al., 2003).

Brokerage can create a heightened governance tension in the Shariah-compliant environment. The boards have to strike a balance between commercial interests, religious adherence, and the emerging sustainability requirements. Temporary surges in the number of brokers can thus create adjustment costs that restricted ESG integration in the short term. These findings were consistent with recent findings that network centrality can generate both informational advantage and governance strain, which depended on the institutional setting (Blanco-Alcántara et al., 2019; Jamaludin et al., 2025).

Nevertheless, the correlated random-effects decomposition showed a structurally different pattern. The companies that continued to be brokers presented a much better ESG performance. The between-company effect of betweenness centrality was very strong and economically significant. The separation of changes in time and structural long-term positioning provided a valuable theoretical contribution.

Continued brokerage likely builds relational capital and reputational legitimacy over time (Burt, 2007; Granovetter, 1985). Continuous bridging roles can increase the access to various sustainability practices, regulatory expertise, and normative anticipations, which will contribute to the long-term incorporation of ESG norms. This interpretation is also consistent with an institutional perspective, whereby companies located in influential networks may face greater normative and reputational pressures (DiMaggio & Powell, 1983). Such pressures can also strengthen sustainability engagement over time rather than undermine it.

Recent ESG literature is beginning to appreciate the fact that the network effects were instantiated by institutional and temporal circumstances (Harjoto & Wang, 2020, 2024). The current results built on this perspective by demonstrating that brokerage returns had opposite impacts when it comes to a momentary shift or a structural place. Volatility in brokerage in the short-term can create a governance disruption, but long-term structural brokerage was an inherent network facility.

These dynamics were further contextualised by the consistently positive effects of the year. ESG scores increased significantly between 2019 to 2023, which was a time when regulatory focussed on sustainability disclosure intensified in Malaysia. Structurally central roles of brokerage, when institutional pressure was mounting, could expose them to new governance norms and regulatory demands (Shu et al., 2024; Yang et

al., 2024). In comparison, temporary adjustments in brokerage can lead to short-term friction in the process of meeting new standards.

Collectively, the findings dispelled the belief that the board connectivity would equally lead to improved sustainability performance. Rather, they displayed a time-based structural duality of network effects. In Shariah-compliant companies with two governance systems, the long-term nature of the brokerage position seemed to enhance sustainability integration, but the short-term nature of the position seemed to destabilise it.

This is one of the differences that added to the Social Network Theory, highlighting the importance of viewing network centrality in a dynamic way. It also pursued ESG governance studies by recognising structural brokerage as a long-term sustainability asset as opposed to a homogenously advantageous feature.

7. CONCLUSION

This paper examined the impact of board network management on the performance of Shariah-compliant public listed companies in Malaysia in terms of ESG performance between 2019 and 2023. Based on the Social Network Theory and using fixed-effects and correlated random-effects estimation, the findings indicated that network effects were characterised by a temporal-structural duality.

Short-term growth was negatively correlated with ESG performance, whereas companies that remained continuously embedded as brokers achieved much better sustainability results. These results showed that network benefits were not only the result of management connection, but of structural embeddedness stability. Short-term transitions to the brokerage can put pressure on coordination, whereas long-term brokerage was a strategic governance attribute. For regulators and boards, the findings implied that the sustainability value of governance networks emerged through stable and enduring inter-organisational relationships rather than temporary expansions of board connectivity.

The study transcended the notion of centrality being statically conceived in the literature on network governance by separating between within-company and between-company structural positioning. It showed that time change and long-term embeddedness can influence sustainability performance in conflicting ways. In a Shariah-compliant environment, sustainability integration seemed to be enhanced by sustained brokerage through a dual governance framework that integrated market regulation with ethical oversight.

The research had several limitations that could be considered in further research. Its emphasis on Malaysian Shariah-compliant companies limits generalisability, and its use of composite ESG scores may not be the most effective way to capture the subtleties of company-level sustainability. Future studies might increase the time of observation, disaggregate the elements of ESG, or compare studies in different institutional settings.

Overall, the results did not fully support the assumption that greater board connectivity consistently enhanced ESG performance. Instead, the sustainability effects of board networks depended on whether connectivity reflected persistent structural positioning or short-term positional change, offering a more refined understanding of relational governance in regulated capital markets.

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9. CONFLICT OF INTEREST STATEMENT

The authors declare that they have no financial or non-financial competing interests that could have influenced, or appeared to influence, the research, analysis, or conclusions reported in this manuscript.

10. AUTHORS' CONTRIBUTIONS

Mohd Fahmee Bahaudin: Conceptualisation, methodology, formal analysis, investigation, data curation, visualisation, and writing original draft; **Nor Balkish Zakaria:** Conceptualisation, methodology, supervision, validation, and writing review and editing; **Mohd Faizal Jamaludin:** Methodology, formal analysis, validation, and writing review and editing; **Marziana Madah Marzuki:** Conceptualisation, supervision, validation, and writing review and editing. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for the integrity of the work.

11. DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

During the preparation of this manuscript, the authors used an AI-assisted tool, solely to support language refinement, readability, clarity, and formatting in accordance with the journal's requirements. The tool was not used to generate or interpret the research data, perform the statistical analyses, or formulate the study's findings and conclusions. All AI-assisted outputs were critically reviewed, verified, and revised by the authors as necessary. The authors take full responsibility for the accuracy, originality, and integrity of the manuscript.

12. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

The data supporting the findings of this study were obtained from corporate annual reports publicly available through the Bursa Malaysia website and from the subscription-based LSEG Refinitiv database. Data obtained from LSEG Refinitiv are subject to the provider's licensing terms and therefore cannot be redistributed publicly by the authors. The derived dataset and supporting materials may be made available by the corresponding author upon reasonable request, subject to applicable licensing and data-use restrictions. No separate supplementary materials accompany this article.

13. ETHICS STATEMENT

This study relied exclusively on secondary archival data obtained from publicly available corporate annual reports and the licensed LSEG Refinitiv database. No human participants or animal subjects were recruited or directly involved, and the study did not include interviews, surveys, experiments, or the collection of private or sensitive personal information. Accordingly, institutional ethics approval and informed consent

were not required. All data were collected, processed, and reported in accordance with established standards of academic integrity and the applicable terms of use of the data sources.

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