

Purnamasari, Pupung; Umiyati, Indah

Article

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Greenwashing and financial performance of firms: the moderating role of internal audit quality and digital technologies

Pupung Purnamasari^a and Indah Umiyati^b

^aAccounting Department, Faculty of Economics and Business, Bandung Islamic University, Bandung, Indonesia; ^bAccounting Department, Sutaatmadja Economic Science Institute, Subang, Indonesia

ABSTRACT

Greenwashing (GW) is a common business strategy employed by modern-day firms to realize sustainability and financial goals. However, the puzzle of whether GW and underlying conditions essential to improve the financial performance (FP) remains unresolved. This study aims to empirically investigate the impact of GW on FP by operationalizing internal audit quality and digital technologies as moderators. The data of non-financial Indonesian firms between 2018 to 2022 were drawn and analyzed using generalized method of moments (GMM) technique. The findings indicate that GW has a significant positive effect on FP. The results also confirmed a significant positive moderating effect of internal audit quality on the relationship between GW/FP whereas digital technologies exhibit an insignificant positive effect on the nexus between GW/FP. Our findings contribute to validating the implementation of GW blended with internal audit quality and digital technologies to improve the sustainability and financial portfolios of the firms located in emerging economies.

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SUBJECTS

Finance; Business, Management and Accounting; Environmental Economics

1. Introduction

Over the past few decades, increasing environmental pressure has pushed business entities to improve their environmental, social, and governance (ESG) performance which contributes to the financial performance (FP) of firms (Berrone et al., 2017; Berrone and Gomez-Mejia, 2009; Delmas and Montes-Sancho, 2010). The prevailing environmental initiatives of the firms are communicated with potential stakeholders through sustainability reports to fulfill regulatory compliance, legitimize green image, and optimize FP (Cerin, 2002; Kim, 2019; Ozili, 2023). Ironically, these sustainability claims continue facing criticism due to the greenwashing (GW) practices of the firms that often damage the corporate image, undermine ESG narratives, increase the cost of capital, and face boycotts from customers (ESMA, 2023). The FP of the firms involved in GW practices further reduces when investors start scrutinizing them before making investment decisions (Amel-Zadeh and Serafeim, 2018; Mervelskemper and Streit, 2017). Modern-day investors are skeptical about the safety of their financial portfolios by carefully analyzing the ESG performance of the firms yet, the GW practices of the firms deny access to reliable and comparable ESG data further lowering their trust in the firms (Guo et al., 2018; Hain et al., 2022; Lashitew, 2021; Pinney et al., 2019). To restore declining corporate image and investors' confidence, the global corporate giants i.e., British Petroleum (BP), Chevron, ConocoPhillips, Exxon, and Shell spend billions of dollars every year which is suppressing their FP (Rahman and Nguyen-Viet, 2023).

GW refers to false, unreliable, and categorically dubious statements about the sustainability of a firm's products, services, and overall business practices (Peterdy, 2023). A few seminal and novel studies conferred that GW has emerged as a delusional organizational strategy to communicate sustainability performance with existing and future stakeholders (Delmas & Burbano, 2011; Torelli et al., 2020). Firms

CONTACT Pupung Purnamasari pupung@unisba.ac.id Accounting Department, Faculty of Economics and Business, Bandung Islamic University, Bandung, Indonesia

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involved in GW employ unethical business tactics to aggressively communicate higher sustainability performance instead of rendering actual efforts to improve their ESG matrices (Bowen and Aragon-Correa, 2014; Kim and Lyon, 2015). Despite such cynical maneuvering, the FP of the firms continues indicating downward trends as the stakeholders have become more skeptical about these sustainability assertions (Walker and Wan, 2012). This has unlocked a new discussion for corporates, policymakers, and researchers to explore whether GW affects the FP of firms since it is unintentional in some organizations (Peterdy, 2023).

The stream of literature investigating the impact of GW on the FP of firms continues to develop and remains inconclusive for two main reasons. First, there is no mutually agreed approach among the scholars to characterize firms as fully GW corporates as the conceptual coverage of GW is broad (Seele & Gatti, 2017). Second, the findings of previous studies are contradictory and limited and the extant literature calls for further expansion of the relationship between GW and FP (Lyon & Montgomery, 2015). A few authors noticed a negative relationship between GW and FP (Walker & Wan, 2012) while some reported an insignificant impact on FP of firms (Testa et al., 2018). Most of the scholars view environmental regulations to discourage firms from GW, some view these regulations as the value-added to the businesses (Petrescu et al., 2020). To others, GW may positively affect FP in the corporate citizenship field and simultaneously negatively impact employees' job roles (Schons & Steinmeier, 2016). The findings of a recent study have also confirmed that GW practices of high-earnings management firms increase the stock price risk (Liu et al., 2024). The positive association between GW and FP of firms is also validated by Li et al. (2023) in Chinese non-financial firms which can be lowered by imposing strict environmental regulations and media coverage (Sun & Zhang, 2019). Another study in this context exhibited similar findings by conceptualizing GW as ESG performance and its negative effect on earnings management moderated by the civil law code (Pathak & Gupta, 2022). Following the complications in the conceptual understanding of GW, it is argued that GW varies based on the contingent factors and the conditions employed to explore its effect on FP.

Taking together the complications associated with the GW perspective and the challenges faced by empirics in developing a universally accepted measurement model, it is inferred that GW and its effects on the FP of firms should be estimated through additional factors (Szabo & Webster, 2021). Over the years, several strategies and frameworks have been developed to represent GW such as selective and limited disclosure to compress internal data, overstated and or over-promising ESG matrices (Marquis et al., 2016). Some scholars used key performance indicators (KPIs) of green practices employed for green communication and compared them with ESG ratings to identify GW (Testa et al., 2018). The comparison of KPIs and ESG ratings revealed an overlap in self-reported data by the firms involved in GW. The multifaceted nature of GW leads to predict that the internal audit quality and modern digital technologies [big data analytics (BDA), Internet of Things (IoT), and Cloud] may improve the GW and FP of the firms. Generally, effective internal audit quality evaluates and maintains the equilibrium between environmental KPIs and ESG ratings of firms (Kai et al., 2022). Simultaneously, novel digital technologies leverage BDA, IoT, and Cloud-based services to detect and verify the mismatch in the actual ESG performance reported in sustainability. This will allow firms to reduce their GW practices to restore stakeholders' confidence which will realize financial benefits for them (Xu et al., 2024). The above discussion leads us to propose that the nexus between GW and FP is moderated by internal audit quality and digital technologies.

To investigate the impact of GW on the FP of firms under internal audit quality and digital technologies, this study focuses on Indonesian non-financial firms. Recently, the country has restructured its ESG taxonomy to encourage all of its societal stakeholders including businesses by minimizing GW practices and showing commitment to achieving net zero carbon emissions by 2050 (PwC, 2023). This will allow us to deliver four important contributions. First, this study unpacks the GW practices and their impact on the FP of non-financial firms in an emerging economy which contributes to the existing stream of literature that differs from previous studies that largely focus on GW in developed countries (Testa et al., 2018; Walker & Wan, 2012). Second, the current research investigates the impact of GW on FP under the moderating factors of internal audit quality and digital technologies which contributes to proposing novel techniques to accurately estimate GW. Third, previous studies have identified the limitations of conceptual and theoretical models in understanding the characteristics of institutions engaged in GW (Li et al., 2023). Our study expects to fill this research gap by

classifying the attributes of the institutions involved in GW and their impact on FP. Fourth, we contribute to developing a contingent model that can be used to effectively reduce GW and optimize the FP of firms by enhancing the quality of internal audits and leveraging novel digital technologies.

The rest of the study proceeds as follows. Section two presents conceptual understanding, theoretical and empirical literature on GW followed by methodological strategies used to undertake this research in section three. The results of this study are explained and discussed in section four. Finally, the conclusion, implications, limitations, and recommendations for future studies are reported in [Section 5](#).

2. Literature review

2.1. Background of GW

GW originated from ‘whitewashing’ which simply means to cover something. Ever since GW was first introduced by the American environmentalist Jay Westerveld in 1986 (Becker-Olsen and Potucek, 2013), it has been in action in firms to artificially manage their reputation and cover existing environmental situations (Akturan, 2018). GW also refers to misleading customers about environmental practices and/or the environmental benefits of the products and services offered by the firms (TerraChoice, 2007). The empirics have used the Oxford English Dictionary to define GW as ‘organizations portraying better environmental image by spreading false information’ (Furlow, 2010; Ramus & Montiel, 2005; Vos, 2009). A few other scholars used ‘Greenpeace’ [non-governmental organizations (NGO)] to describe GW and conceptualized it as ‘the deceptive actions of firms to mislead consumers about their environmental practices and environmental benefits of using their products and services’ (Delmas & Burbano, 2011). Some studies specified that firms are considered GW when their acts are deliberated (Mitchell & Ramey, 2011). The different definitions, contexts, and perspectives of GW have trended over the years among researchers (Sundarasan et al., 2024).

To understand the characteristics of GW, it is essential to analyze the factors that motivate firms to GW. This study argues that firms engage in GW primarily to reduce stakeholders’ environmental pressure and establish organizational legitimacy. The sustainability reports and ESG disclosures aim to fulfill the key stakeholders’ information requirements (Veltri & Silvestri, 2020). Hence, the quality of sustainability reporting is an exceptional indicator of a legitimate and environmentally responsible firm. The findings of past studies have determined that stakeholders are dissatisfied with the sustainability performance and reporting approaches of firms due to inconsistency and the lack of full disclosure (Silva et al., 2019). Further, the variance in sustainability reports exists due to excessive stakeholders’ pressure on firms pushing them to manipulate environmental performance. The firms actively engage in the manipulation of sustainability reports to avoid environmental scrutinization by regulators, alter public perception, and ignore the environmental impacts of the business through regular business activities. The firms with low sustainability performance suffer from bad corporate image, appear incredible, and are subject to regulatory action as well as are likely to engage in GW (Moses et al., 2020). Thereby, it is inferred that firms having low-quality sustainability reports use GW as a covering business strategy to reduce stakeholders’ pressure and warrant socially responsible corporates (Delmas & Burbano, 2011).

Although there is no unified definition of GW, most of the studies analyzing the drivers of GW commonly agree that excessive environmental and social marketing is done by firms to achieve organizational legitimacy (Berrone & Gomez-Mejia, 2009; Prakash, 2002; Weaver et al., 1999). The Firms operating in the current capitalist economies leverage corporate social responsibility (CSR) as a decoupling strategy to gain legitimacy (Fleming & Jones, 2013). A few firms have shown some success in symbolical management and the creation of public relations without taking any environmental action which has allowed them to establish legitimacy (Palazzo & Scherer, 2006). Hence, firms overstate their green narratives simply by employing unconventional business tactics to gain legitimacy and intentionally mislead their stakeholders (Patriotta et al., 2011). Organizational legitimacy is crucial for firms to acquire various resources and develop strong partnerships with their stakeholders (Aldrich & Fiol, 1994; DiMaggio & Powell, 1983; Oliver, 1991). Alternatively, firms’ active green communication improves their reputation and increases sales, and acceptance of high-priced products which eventually increases firms’ financial

portfolios (Baum, 2012). Thus, the benefits associated with achieving organizational legitimacy are a clear indicator of why these days many firms are involved in GW (Deephouse, 1999).

2.2. Theoretical framework and research hypotheses

To understand the impact of GW on FP and the moderating role of internal audit quality and digital technologies, this study developed a conceptual framework following the fundamentals of agency theory (Figure 1). Agency theory outlines the risk sharing among individuals or groups (agents and owners), which mainly exists due to different goals (Wilson, 1968). According to the logic of this theory, the managers (agents) of the business entities are under tremendous pressure from the owners due to different expectations pushing them to employ uncommon strategies to reduce internal and external pressure (Eisenhardt, 1989). Contextually, the factors of stakeholders' environmental pressure and organizational legitimacy surge motivate firms to employ GW practices. Previous studies have also deployed agency theory to explain the relationship between GW and the characteristics of the firms involved in such practices and conferred that firms' sustainability reporting hinges on numerous organizational factors (Fama & Jensen, 1983). Effective internal control may allow firms to reduce the agency cost incurred in ESG reporting and sustainability disclosures (Ghitti et al., 2023). Furthermore, an agency conflict between owners and their agents (managers) arises while establishing organizational legitimacy through CSR activities which is likely to motivate agents to be involved in GW (Masulis & Reza, 2015).

GW firms are known to employ excessive green communication to reduce stakeholders' pressure and gain legitimacy (Mohammed et al., 2024). According to Delmas and Burbano (2011), configuring different levels (high/low) of green communication and green practices generates different green approaches namely 'GW', which emphasizes green communication and ignores improving the performance of the environment, 'silent green', focuses to improve the performance of environment through green practices and ignores green communication aspect, 'vocal green', simultaneously focuses on improving environmental performance and green communication, and 'silent brown', ignoring both green communication and environmental performance improvement. Among these strategies, 'GW' significantly lowers the agency cost as compared to 'vocal and silent green' approaches. The firms have experienced increasing pressure from the stakeholders to represent better environmental and social pressure (Hoffman, 1999). Despite the clear financial benefits of 'being green', firms' environmental approaches have negatively affected their FP (Friedman, 1970; Hart & Ahuja, 1996; King & Lenox, 2001; Porter & Van der Linde, 1995).

Earlier studies adhered that firms' environmental activities lead to higher agency costs by increasing their operational costs (Aldy & Stavins, 2012; Stern, 2008). A few other studies in a similar context linked

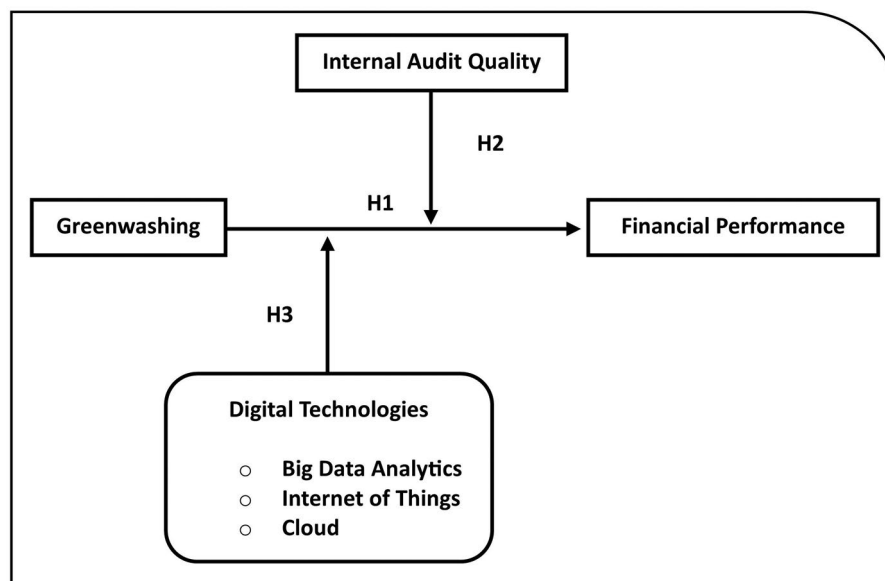


Figure 1. Theoretical model.

the environmental initiatives of firms to declining financial portfolios (Fisher-Vanden & Thorburn, 2011). The increasing stakeholders' environmental pressure puts managers in a dilemma of whether to operate in an environmentally responsible fashion or respond to stakeholders' (owners) profit maximization demand (Dahlmann & Grosvold, 2017). Managers start using GW as an effective strategy to reduce tension between shareholders' demand and market environmental pressure when they deem that being green is not creating shared values for them (Bowen, 2014; Ramus & Montiel, 2005). A few seminal studies on the relationship between GW and FP of firms have recommended resolving stakeholders' demand and environmental pressure through a symbolic decoupling strategy also known as GW (DiMaggio & Powell, 1983; Lyon & Maxwell, 2011; Oliver, 1991). This symbolic GW strategy is characterized as a less substantive action that serves as a shield for the firms to avoid being penalized by the regulators as well as confirm stakeholders' requirements (Weaver et al., 1999; Zott & Huy, 2007). However, such decoupling approaches influence firms' reputation and legitimacy as the firms in certain environments have different expectations (Fombrun, 2001). Thus, through GW firms may reduce stakeholders' pressure and establish environmental legitimacy without applying any changes in regular business activities or additional investments in environmental initiatives.

GW is also labeled as a better signaling approach to notify interested parties to gain insight into desired environmental information through observable signals. Despite increasing concern about environmental performance, it is difficult and practically challenging for the stakeholders to assess firms' actual green practices and environmental performance. This is due to a lack of stakeholders' knowledge about the environmental management standards followed and green technologies adopted by the firms (Lyon & Maxwell, 2011). Since firms' environmental responsibility information is delivered through green communication, it is relatively easier for the firms to attract customers and investors allowing them to legitimize their environmental image (Lyon & Montgomery, 2015; Testa et al., 2015). The failure to incorporate an effective green communication strategy imposes a 'brown' label on firms despite maintaining higher environmental performance (Delmas & Grant, 2014). The findings of a past study have confirmed that firms that fail to establish an active green communication approach may face declining FP and reduced shareholders' value (Testa et al., 2018). Contextually, GW attributed as an effective green communication approach works as a charm for the firms to appear as environment-friendly business entities to stakeholders, achieve legitimacy, and acquire more resources and support to maximize their FP (Jones & Wicks, 1999). This leads us to propose the first hypothesis (H1) of this study.

H1. GW approach has a positive impact on the FP of firms.

2.3. Moderating effect of internal audit quality

Agency theory contends that following the positivist approach, the conflict between agents and principals in the perception of risk can be minimized by corporate governance which limits agents' self-serving behavior (Eisenhardt, 1989). Considering GW practices as the agents' self-serving behavior to minimize stakeholders' environmental pressure and gain legitimacy, principals view it as a risk to firms' reputations as well as FP. Hence, effective corporate governance particularly, internal audit may reduce tensions related to risk between managers and owners. Internal audit quality (IAQ) coupled with successful internal control allows firms to achieve organizational goals by rendering a systematic approach to risk management (El Gharbaoui & Chraïbi, 2021; Stewart & Subramaniam, 2010). Scholars have described AIQ as the next frontier of organizational survival, development, and sustainability (Hoai et al., 2022). IAQ is basically a component of corporate governance that influences the GW and FP of firms (Ghitti et al., 2023). Various aspects of corporate governance namely board size, board independence, and IAQ are positively associated with firms' environmental performance, GW behavior, and FP (Chakraborty & Yilmaz, 2017; Miroshnychenko et al., 2019; Yu et al., 2020). Generally, ESG disclosures of firms are unaudited leading us to predict that an effect IAQ will ensure that ESG disclosures comply with regulatory requirements and fulfill stakeholders' needs which eventually will increase the FP of firms (Lu & Wang, 2021). Hence, the second research hypothesis (H2) is as follows;

H2: IAQ moderates the relationship between GW and FP of firms.

2.4. Moderating the role of digital technologies

Agency theory asserts that the length of the contract fosters agents' and principals learning behavior and encourages employing modern digital technologies (DTs) to overcome information asymmetry (Eisenhardt, 1989). Importing Seele and Gatti's (2017) multi-construct of GW, it is argued that firms concerned with minimizing stakeholders' pressure and maintaining legitimacy may leverage modern DTs [big data analytics (BDA), Internet of Things (IoT), and Cloud (CLOUD)] to effectively communicate sustainability (ESG) information. Past studies have vigorously implemented DTs and reported their effectiveness in increasing environmental and FP, reputation, and compromised image of firms due to GW practices (Ahmad et al., 2019; Ali et al., 2022; Zhang et al., 2023). Since negative consequences of GW are subjective and manageable as some firms in emerging countries are not accused of GW due to limited availability of information (Su et al., 2016). Further, the interaction of a few external stakeholders is minimal, ESG disclosures are only accessible through sustainability reports and corporate websites, and the firms' environmental information is complex and require specialist knowledge to fully understand and evaluate (Carlson et al., 1993; Du et al., 2007). Therefore, leveraging DTs may allow firms to understand environmental information requirements, understand the nature of different stakeholders, and customize sustainability reports to fulfill diverging stakeholders' needs which alternatively will allow firms to continue GW and maximize their FP. Thus, the third research hypothesis (H3) is as follows;

H3: *DTs moderate the relationship between GW and FP of firms.*

3. Research methods

The empirical environment of Indonesia offers an interesting perspective to investigate the relationship between GW and FP of firms under the moderating effects of AIQ and DTs for two main reasons. First, the Indonesian government through the Financial Services Authority [Otoritas Jasa Keuangan (OJK)] has legislated several regulations such as No. 51/POJK.03/2017 (POJK 51, Citation2017) and supplementary provision of OJK letter No. S-264/D.04/2020 in 2020 requires non-financial firms to strengthen their internal governance system by adopting sustainable practices and publishing a separate sustainability report (Rahmaniati & Ekawati, 2024). Second, the country has also started developing key infrastructure to promote the adoption of DTs (Trinugroho et al., 2022) to achieve the goals of 2025–2045 National Long Term Development Plans known as *Rencana Pembangunan Jangka Panjang Nasional* (RPJPN) by increasing sustainability and performance of non-financial firms through DTs (Amaliah et al., 2024). These developments offer an opportunity to empirically investigate whether GW (a sustainability communication/reporting strategy) improves the FP of non-financial firms under the moderating effect of IAQ and DTs.

3.1. Sample and data selection

The empirical analysis of this study started by sampling non-financial firms in Indonesia that are listed on the Indonesian Stock Exchange (IDX) from 2018 to 2022. The firm-level data of non-financial firms sampled in this study is obtained from IDX or Bursa Efek Indonesia (<https://www.idx.co.id/en/listed-companies/company-profiles>) which is recognized as an established and reliable source of data of listed non-financial Indonesian companies. The environmental data of these firms is drawn from companies' sustainability reports generally available in the annual reports or downloaded from their websites if published separately. Before finalizing the sample, the data from these sources are merged, and the following procedures are applied. The firm-year observations containing environmental disclosure are selected and the firms labeled as financial and insurance entities by OJK are dropped. The firms excused publicly accused of GW are also removed from the sample. We also employed additional measures to ensure the completeness of data by excluding firms with insufficient information required to develop the GW index, analyze FP, and control variables. The final sample is comprised of 2450 firm-year observations of 245 firms from 20 different industries. The composition of firms and their respective industries sampled in this study is presented in Table 1.

Table 1. Composition of firms and their industries of the selected sample.

Industry	2018	2019	2020	2021	2022	Total	%
Manufacturing	5	7	7	5	4	28	11.42
Wholesale and retail trade	2	4	6	7	5	24	9.79
Agriculture	3	5	2	7	3	20	8.16
Forestry and fishing	2	3	6	2	4	17	6.93
Mining and quarrying	4	5	2	2	2	15	6.12
Construction	3	2	3	1	4	13	5.30
Transportation and storage	1	3	3	4	2	13	5.30
Information and communication	2	1	3	3	3	12	4.89
Public administration and defense and social security	3	3	1	2	2	11	4.48
Education	2	1	1	3	4	11	4.48
Real estate	2	1	2	3	3	11	4.48
Accommodation	2	2	2	1	3	10	4.08
Food service activities	1	2	2	2	3	10	4.08
Other services	1	2	3	2	1	9	3.67
Business services	2	2	1	2	1	8	3.26
Human health	1	3	1	2	1	8	3.26
Electricity and gas	2	1	1	1	2	7	2.85
Water supply and sewerage	1	1	1	2	2	7	2.85
Waste management and remediation	1	1	1	1	2	6	2.44
Timber and furniture manufacturing	1	1	1	1	1	5	2.04

3.2. Experimental variables

3.2.1. Output variables

FP is the dependent variable and can be measured through different variables such as return on assets (ROA) return on equity (ROE) and Tobin's Q (Ali et al., 2023). Although a few emerging studies have recommended to estimate firm's FP through Tobin's Q due to its inclusiveness, we preferred estimating FP through ROA, as it is simple, easy to compute, frequently updates, and focuses on firms' operational efficiency (Dybvig & Warachka, 2015; Singh et al., 2018). Considering GW as an operational environmental strategy to achieve organizational sustainability, it is deduced that ROA is likely to represent the actual increase in firms' FP due to GW practices. Hence, FP of firms is measured through the proxy of ROA which is estimated as net income divided by total assets. Also, ROA is a commonly used in the recent studies measuring FP of non-financial firms we created this proxy to estimate the FP of the firms sampled in this study (Hoskisson et al., 1994; Li et al., 2023). To minimize the effect of outliers, we winsorized ROA on the 1st and 99th percentiles.

3.2.2. Independent variables

GW is an independent variable and was estimated by developing a GW index (GWI). Over the years, empirics have identified various forms of GW namely empty green claims and policies (Lyon & Montgomery, 2015), the intersection between green communication and poor environmental performance (Delmas & Burbano, 2011), and the difference between actual green practices and green communication of firms (Testa et al., 2018; Walker and Wan, 2012). This study considered GW as the difference between actual green practices and green communication which is calculated through the indices of green practices index (GPI) and green communication index (GCI). The high or low difference between the two indices determines the level of GW in the firms which assumes a higher difference between GPI and GCI will indicate higher GWI and more GW practices in the firms.

We followed a systematic and scientific approach to develop GWI following Li et al.'s (2023) criteria. First, we created a content analysis framework to estimate GPI and GCI by converting the environmental information disclosure of the sampled firms. This step was essential as there is no unified definition of GW, and no structured data are available to directly measure GW in Indonesia. The content analysis approach is used to explore and discuss the aims and attention of firms in the form of published annual reports (Weber, 1990). Accordingly, modern-day corporates have started using annual sustainability reports to explicitly disclose potential environmental information allowing researchers to develop interactive econometric models (Walls et al., 2011). Second, GPI and GCI were accurately captured by employing a two-step approach. The environmental information presented in the form of text, tables, and

captions in the sustainability reports are coded in the first step followed by the interpretation and conversion of these codes into GW information in the second step. This was a repetitive process as the researchers were required to go back and forth to ensure the accuracy of GPI and GWI. We conducted an in-depth literature review to identify the codes and themes of GPI and GCI and imported the information retrieved from sustainability reports. We also ensured that green practices information exhibits actual and actioned green initiatives and eliminated public statements or policies that are irrelevant to the routine business activities of the firms.

After identifying GPI and GCI items, we converted these coded items based on a sliding scale indicating the amounts and levels of green practices and communication of the firms. Altogether GPI contained 17 items and GCI comprised 18 items. The items used for developing both these scales are reported in Table 2.

The reliability and validity of the operationalized constructs were tested following the theoretical frontiers of GW. We assigned three junior researchers to re-evaluate the items based on actual/communicated value presented in the annual report and verify the statistical reliability. The results indicated that GPI and GCI items were reliable as Cronbach's alpha was 0.912 (Shrout & Fleiss, 1979). To ensure the validity of selected items, the coded items were matched with the literature and theories imported during the content analysis process (Nunnally & Bernstein, 1994). It was notable that the scale items of GPI and GCI truly represent the green practices and communication definitions and concepts prescribed in the empirical literature (Testa et al., 2018).

The sustainability reports are rated based on the level of green practices and green communication of sampled firms. GPI was estimated by taking the average value of items representing yearly green practices while GCI was calculated through the average of the items representing green communication in a particular year. The standardized difference between GPI and GCI allowed us to estimate GWI. To calculate the standardized values of GPI and GCI, we subtracted the sample mean values and divided it with sample standard deviation values following the Baum et al. (2006) approach. This led us to compare the indices and estimate the difference between green practices and green communication (Li et al., 2023). The statistical formula to measure GWI is presented in Equation (1).

$$GWI_{it} = \frac{(GCI_{it} - \bar{GCI})}{\sigma_{GCI}} - \frac{(GPI_{it} - \bar{GPI})}{\sigma_{GPI}} \quad (1)$$

GCI_{it} and GPI_{it} represent the GCI and GPI of firm i and t are the year, \bar{GCI} and \bar{GPI} are the sample mean values, and σ_{GCI} and σ_{GPI} are the standard deviation values of GCI and GPI.

3.2.3. Moderating variables

IAQ and DTs are applied as the moderating variables and are estimated through the proxies of the IAQ index (IAQI) and DTs ranking of the countries. To estimate IAQ, we created IAQI following the procedures prescribed by the World Bank (2018). We used six items to assess internal audit key performance indicators (IAKPIs) of sampled firms and ranked them based on the availability of relevant internal audit functions within the firm (score '0' represents no implementation of IAKPIs while '6' indicates that relevant IAKPIs are implemented). IAKPIs comprised of external indicators, planning, budgeting, staffing, impact, and the quality of internal audit.

DTs are estimated through the proxy of Indonesia's yearly ranking taken from the World Digital Competitiveness Ranking issued by the IMD World Competitiveness Centre (IMDCC). The global economies are ranked by IMDCC based on their capacity and readiness for DTs to accelerate economic, business, social, and regulatory transformation. IMDCC uses several indicators to globally assess and rank the countries based on the level of implementation of DTs (BDA, IoT, CLOUD, and artificial intelligence) and reviews how different countries have revamped economic, business, social, and government landscapes through DTs. We downloaded Indonesia's yearly ranking (between 2018 and 2022) from IMCDD to estimate the moderating effect of DTs on the relationship between GW and FP.

Table 2. Operationalized items of GPI and GCI.

Variables	Measurements	Maximum score
Green practices	Environmental performance	(36)
	Consumption of materials	(0–6)
	Consumption of water	(0–6)
	Treatment and recycling of effluents and wastes	(0–6)
	Preservation of biodiversity and ecology	(0–6)
	Treatment and control of gases	(0–6)
	Investment and spending on the environment	(3)
	Investment and spending on innovation, R&D, and sustainability of the environment	(0–1)
	Spending on the ramification of wastes	(0–1)
	Spending on environmental management and prevention	(0–1)
	Managing environmental supply chains	(4)
	Assessing suppliers' environmental effect	(0–1)
	Selection of new suppliers following environmental standards	(0–1)
	Terminations of suppliers with highly negative environmental impact	(0–1)
	Minimizing suppliers' environmental impact employing environmental assessment	(0–1)
	Green production	(4)
	Details of how products and services minimize environmental impact	(0–1)
	Adoption of green technologies and green products to reduce environmental impact	(0–1)
	Manufacturing and the sale of eco-friendly products	(0–1)
	Recycling of materials and sold products	(0–1)
Green communication	Green vision and strategy pledge	(3)
	SMART sustainability objectives and KPIs	(0–1)
	Environmental approach, culture, and policies	(0–1)
	Designated environment management team	(0–1)
	Sustainability profile	(5)
	Strategy to comply with environment-related rules, regulations, and standards	(0–1)
	Externally audited disclosure of environmental performance	(0–1)
	Disclosure of environmental performance following global reporting standards	(0–1)
	Winning green awards	(0–1)
	Information on how a firm's operation, products and services affect environment	(0–1)
	Environmental actions	(5)
	Adoption of green human resource management and training for employees	(0–1)
	The presence of a response team and specialized programs in case of environmental incidents	(0–1)
	Policies to reward and penalize compliance with environmental rules	(0–1)
	Internally certified environmental programs	(0–1)
	Regular reviews and self-assessment of environmental performance	(0–1)
	Stakeholders' environmental engagement	5
	Engaging government and public agencies	(0–1)
	Collaboration with NGOs	(0–1)
	Global environmental agreements	(0–1)
	Engagement with suppliers and other stakeholders	(0–1)
	Communication with investors	(0–1)

3.2.4. Control variables

Following the review of past studies, we controlled the firm size (SIZE), leverage (LEV), market-to-book ratio (MB), intangible assets (INTAN), ownership concentration (TOP5), and ownership type (OWN) (Ghitti et al., 2023; Li et al., 2023). Generally, large firms enjoy more resources and better business opportunities compared to small firms and are able to achieve economies of scale by gaining more capital investments. We used the natural logarithm of market capitalization to calculate SIZE. LEV is estimated by the ratio of total debt divided total assets of firms; MB is the logarithm of market capitalization divided by the book value of equity. INTAN is calculated by the natural logarithm of total intangible assets and is known to affect the FP for firms. TOP5 is used as a proxy to estimate ownership concentration as it potentially influences the FP of firms. The evidence suggests Top5 improves FP as the firms with the higher number of shareholders are extra careful in evaluating the investment decisions allowing firms to overcome managers' short-sighted tendencies (Li et al., 2023). OWN is estimated through a dummy variable to separate firms based on their privately owned and/or state-owned enterprises. The findings of previous studies concluded that state-owned firms are equipped with more resources and support and are likely to exhibit higher FP compared to private entities (Li et al., 2023). The experimental variables used in this study are presented in Table 3.

3.3. Econometric models

The hypotheses of this study are tested by selecting relevant econometric models that fit our panel data. We performed the Hausman Test to validate the selection of our econometric model. The results of the

Table 3. Experimental variables.

Variables	Type	Symbol	Effect	Source	Measurements
Greenwashing	Independent	GW	±	Asset4	It is measured through the greenwashing index (GWI) which is the difference between firms' green practices index (GPI) and green communication index (GCI).
Financial performance	Dependent	FP	±	The World Bank	It is measured by the ratio of net income divided by total assets.
Internal audit quality	Moderator	IAQ	±	World Bank	IAQ is estimated by IAQ index (IAQI), score '0' represents no implementation of IAKPIs while '6' indicates that IAKPIs are implemented.
Digital technologies	Moderator	DTs	±	IMDCC	It is measured by the Digital Competitiveness annual ranking.
Firm size	Control	SIZE	±	World Bank	Natural log. of market capitalization.
Leverage	Control	LEV	±	World Bank	It is the ratio of total debt divided total assets.
Market to book ratio	Control	MB	±	World Bank & ADB	Log. of market capitalization divided by book value of equity.
Intangible assets	Control	INTAN	±	Worldscope	Log. Of total intangible assets.
Ownership concentration	Control	TOP5	±	Worldscope	'0' represents 1 or less than one shareholder; '1' is more than 1 shareholder.
Ownership type	Control	OWN	±	Worldscope	'0' privately owned firms; '1' government-owned firms.

Hausman Test confirmed that the implementation of the fixed effect model ($p < 0.05$) compared to the random effect model. Thus, the hypotheses (H1, H2, and H2) are tested by following fixed-effect regression models.

$$ROA_{it} = \beta_0 + \beta_1 GWI_{it} + \beta_2 Controls_{it} + Industry + Year + \varepsilon_{it} \quad (2)$$

$$ROA_{it} = \beta_0 + \beta_1 GWI_{it} + \beta_2 IAQ_{it} + \beta_3 GWI_{it} \times IAQ_{it} + \beta_4 Controls_{it} + Industry + Year + \varepsilon_{it} \quad (3)$$

$$ROA_{it} = \beta_0 + \beta_1 GWI_{it} + \beta_2 DTs_{it} + \beta_3 GWI_{it} \times DTs_{it} + \beta_4 Controls_{it} + Industry + Year + \varepsilon_{it} \quad (4)$$

In Equations (2)–(4), ROA_{it} is the dependent variable and is the proxy of FP; GWI_{it} is an independent variable and is the proxy of GW. IAQ_{it} and DTs_{it} are the moderating variables and are the proxies of internal audit quality and digital technologies; $Controls_{it}$ are the control variables (SIZE, LEV, MB, INTAN, TOP5, and OWN), i and t represents industry and year; ε_{it} represents the error term.

3.4. Data analysis procedures

It is critical to optimize the validity and reliability of the results by employing relevant approaches during data analysis process. Since our datasets are time-based panel data, there is a risk of causality and endogeneity issues which are likely to influence our findings (Blundell & Stephen, 1998). To analyze our panel data, we used generalized method of moments (GMM) regression technique, as it allows resolving endogeneity and heterogeneity problems in self-aggregated data. Additionally, to ensure that our variables are free of mechanical problems and datasets are superior, we conducted Sargan and Arellano-Bond tests and observed that our instrumental variables do not exhibit autocorrelation which delineates that GMM regression is relevant for data analysis.

4. Findings and discussion

Table 4 reports the descriptive statistics of experimental variables, i.e. GWI, FP, IAQI, and DTs. It is observed that predictors, output, and moderating variables have positive mean and standard deviation values and a meaningful peak distribution indicating positive trends in GWI, FP, AIQ, and DTs. An index value of 27.81 indicates the highly influential effect of GWI and 10.23 confers the lowest effect of GWI from the panel of selected financial, internal audit, and digital technologies indicators of Indonesian non-financial firms and experience a positive effect of means and standard deviation values of GWI. Additionally, an increase in GWI, AIQI, and DTS is projected to enhance the FP of firms.

The correlation between the variables of this study is presented in Table 5. A careful overview of the correlation matrix reveals a positive correlation between ROA, GWI, AIQI, and DTs. Particularly, the

Table 4. Descriptive statistics.

Variables	N	Mean	Median	Std. dev	Minimum	Maximum	Skewness	Kurtosis	Jarque-Bera
ROA	2422	1.81	2.06	0.85	1.23	2.75	0.238	1.462	1.385
GWI	2418	24.28	23.55	2.15	10.23	27.81	0.441	2.720	7.629
AIQI	2432	2.15	2.32	0.48	1	6	-0.118	0.112	0.368
DTs	2440	52	53	4.54	45	56	12.421	3.183	10.608
SIZE	2438	321.45	448.36	81.96	286.72	563.65	-1.527	52.084	67.755
LEV	2440	2.35	2.49	0.21	0.18	3.56	-0.145	0.545	0.535
MB	2440	1.78	1.94	0.55	1.36	2.67	-0.146	0.314	0.539
INTAN	2425	0.61	0.74	0.17	0.15	1.05	-0.360	0.458	0.326
TOP5	2425	0.67	0.69	0.27	0.23	0.98	-0.065	0.414	0.267
OWN	2440	554.36	559.25	92.05	424.18	674.76	-1.436	63.173	78.844

Table 5. Correlation between experimental variables.

Variables	ROA	GWI	AIQI	DTs	SIZE	LEV	MB	INTAN	TOP5	OWN
ROA	1.0									
GWI	0.10***	1.00								
AIQI	0.24***	0.22**	1.00							
DTs	0.13*	0.22**	0.16*	1.00						
SIZE	0.18**	0.24**	0.36***	0.21***	1.00					
LEV	0.16***	0.17**	0.26**	0.28**	0.30**	1.00***				
MB	0.09***	0.06***	0.30*	0.38***	0.46***	0.57**	1.00			
INTAN	0.28*	0.52*	0.57**	0.45***	0.42**	0.57*	0.37*	1.00		
TOP5	0.21***	0.47*	0.33***	0.10*	0.18**	0.31*	0.28**	0.44*	1.00	
OWN	0.18*	0.25**	0.35***	0.23**	0.36*	0.48	0.31	0.38	0.37*	1.00

*Determines significance at a level of 10%. **Determines significance at a level of 5%. ***Determines significance at a level of 1%.

Table 6. VIF test results.

Variables	VIF	1/VIF
ROA	0.86	1.162
GWI	1.23	0.813
AIQI	1.13	0.848
DTs	0.79	1.265
SIZE	0.64	1.562
LEV	0.61	1.639
MB	0.81	1.234
INTAN	0.82	1.219
TOP5	0.77	1.298
OWN	1.12	0.892
Mean VIF	0.878	

correlation between ROA and GWI, and AIQI is significant and positive whereas, weak and insignificant between ROA, GWI, and DTs. This leads us to partially support our propositions of positive changes in FP due to GW, AIQI, and DTs. The correlation between AIQI and TOP5 and OWN is also significant and positive leading us to confer that the number of shareholders and ownership type of firms are likely to exhibit an effective internal audit system which may increase the FP of firms. It is also notable that the intercorrelation between GWI, SIZE, LEV, MB, and INTAN is positive establishing that GWI can be used as a tool to enhance the FP of firms. Further, the correlation matrix indicates that econometric models do not suffer from multicollinearity issues which was verified by conducting Variance Inflation Factor (VIF) test. The findings of VIF test are presented in Table 6. It is notable that VIF coefficients are below the recommended threshold ($VIF > 10$) confirming that the regressions models are not likely to contain multicollinearity problems.

To test the hypotheses of this study, we conducted the GMM regression analysis (Table 7). The results of regression output (Model 1) confer that GWI has a significant positive effect on ROA confirming that H1 is supported ($\beta=0.031$, $p<0.01$). This finding supports the empirical findings of Li et al. (2023), Liu et al. (2024), Petrescu et al. (2020), and Schons and Steinmeier (2016) establishing that GW is employed as a business strategy to improve FP and stock price of firms. However, this result contradicts a few studies on GW (see, Pathak & Gupta, 2022; Testa et al., 2018) criticized GW as an unethical and controversial business strategy that may reduce the FP of firms.

The results (Models 2 and 5) confer that IAQI has a significant positive effect on the relationship between GWI and ROA confirming that H2 is also supported ($\beta=0.038$, $p<0.01$; $\beta=0.044$, $p<0.01$). This

Table 7. Results of regression analysis.

Variables	ROA model (1)	Model (2)	Model (3)	Model (4)	Model (5)
GWl → ROA	0.031*** (2.75)	0.054*** (3.54)	0.038*** (3.82)	0.065*** (5.61)	0.031*** (2.46)
<i>Moderators</i>					
IAQI		0.026*** (2.18)			0.032*** (2.89)
DTs			0.045 (4.38)	0.052 (4.67)	
<i>Moderating effect</i>					
GWl × IAQI		0.038*** (2.86)			0.044*** (3.14)
GWl × DTs			0.023 (1.92)	0.027 (1.97)	
<i>Control variables</i>					
SIZE	0.016*** (1.45)	0.021*** (1.67)	0.055*** (5.19)	0.037*** (3.04)	0.041*** (2.56)
LEV	0.009** (1.26)	0.008** (1.10)	0.014*** (1.28)	0.005** (1.15)	0.002*** (1.03)
MB	0.020* (1.33)	0.019* (1.62)	0.033* (1.66)	0.034** (1.83)	0.039** (2.07)
INTAN	0.048*** (3.16)	0.040*** (3.68)	0.053*** (4.42)	0.055*** (4.75)	0.062*** (6.63)
TOP5	0.008*** (0.89)	0.016*** (1.14)	0.022*** (1.67)	0.018*** (1.34)	0.013*** (1.02)
OWN	0.058*** (5.63)	0.052*** (5.87)	0.068*** (6.69)	0.073*** (7.41)	0.076*** (7.19)
Yearly effect	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
R ²	0.2732	0.4367	0.3241	0.2867	0.4485
Adjusted R ²	0.2678	0.4165	0.3017	0.2842	0.4321

*Determines significance at a level of 10%. **Determines significance at a level of 5%. ***Determines significance at a level of 1%.

result validates the findings of previous studies (El Gharbaoui & Chraibi, 2021; Ghitti et al., 2023; Stewart & Subramaniam, 2010) highlighting the significance of internal governance mechanism, corporate governance, and effective internal control in improving environmental and FP of firms. The regression coefficients in Models 2 and 4 are insignificant and positive ($\beta=0.023$, $p>0.01$; $\beta=0.027$, $p>0.01$) rendering that DTs are not a significant moderator of GWI/FP delineating that H3 was partially supported. This finding is consistent with the recent studies of Ahmad et al. (2019), Ali et al. (2022), and Zhang et al. (2023) highlighting the potential and benefits of employing BDA, IoT, and Cloud-based DTs to improve sustainability and financial portfolios of the firms.

The endogeneity issues between GW and FP are addressed following Hansen's (1982) GMM approach which allows detecting serial autocorrelation (AR). It is crucial to identify the factors related to FP rather than GW as the GW strategies of firms may experience changes in FP. Hence, addressing endogeneity issues avoids over-fitting problems in the theoretical model and ensures that explanatory variables (GW) are endogenous. We applied Li et al.'s (2023) GMM approach and used GWI's second and third-year lagged values to replace the missing external instrumental variables. We performed Hansen and Kleibergen–Paap tests to identify the valid instrumental variables. The findings confirmed that instrumental variables correlated with the regressed endogenous variables ($p<0.1$). This result verifies that our main findings are free of endogeneity issues. The results of GMM regression are presented in Table 8.

The robustness of our empirical results is further tested by alternate measures for the output variable (FP). We replaced ROA by Tobin's Q (TQ) which is estimated by a ratio between the book value of total assets—book value of shareholder's equity+market value of share-holder's equity and book value of total assets) and reperformed the regression analysis. The results reported in Table 9 confirm the accuracy of earlier findings (Table 7) as GWI represents a significant positive impact on TQ and both moderators (IAQI and DTs) exhibit a significant positive effect on GWI/TQ. The results of the moderating effect of DTs slightly diverge from earlier findings and a possible explanation is the difference in the effect of DTs on income and equity investment decisions. Indeed, the impact of modern DTs on the environmental and FP of firms in emerging economies is an interesting research domain and requires further investigation.

5. Conclusions

This study is motivated by the recent rise of GW trends implemented by modern-day firms to claim environmental sustainability and achieve financial goals (Ghitti et al., 2023). Considering the ambiguity

Table 8. Robustness checks (based on the endogeneity between GW and FP).

Variables	ROA model (1)	Model (2)	Model (3)	Model (4)	Model (5)
GW → ROA	0.036*** (3.62)	0.048*** (3.96)	0.068*** (4.72)	0.048*** (4.52)	0.424*** (3.57)
<i>Moderators</i>					
IAQI		0.035*** (3.07)			0.040*** (3.11)
DTs			0.026 (2.27)	0.042 (3.56)	
<i>Moderating effect</i>					
GW × IAQI		0.043*** (3.71)			0.058*** (4.53)
GW × DTs			0.031 (2.10)	0.036 (2.17)	
<i>Control variables</i>					
SIZE	0.025*** (3.42)	0.031*** (2.56)	0.068*** (6.28)	0.049*** (2.04)	0.052*** (3.68)
LEV	0.019** (2.35)	0.016** (2.22)	0.018*** (2.10)	0.015** (2.34)	0.028*** (3.17)
MB	0.023* (2.22)	0.028* (2.33)	0.045* (2.43)	0.042** (2.71)	0.048** (3.09)
INTAN	0.057*** (4.25)	0.052*** (4.57)	0.064*** (5.53)	0.063*** (6.68)	0.076*** (7.743)
TOP5	0.010*** (0.92)	0.012*** (1.36)	0.035*** (2.36)	0.028*** (2.12)	0.032*** (2.13)
OWN	0.068*** (6.74)	0.063*** (6.96)	0.079*** (7.70)	0.081*** (8.52)	0.085*** (8.20)
Yearly effect	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Kleibergen–Paap (<i>p</i> value)	0.001	0.001	0.000	0.000	0.001
Hansen's Test (<i>p</i> value)	0.128	0.162	0.183	0.195	0.175
<i>R</i> ²	0.3641	0.3356	0.4352	0.3787	0.5696

*Determines significance at a level of 10%. **Determines significance at a level of 5%. ***Determines significance at a level of 1%.

Table 9. Robustness checks (output variable: TQ).

Variables	Tobin's Q model (1)	Model (2)	Model (3)	Model (4)	Model (5)
GW → TQ	0.034*** (2.66)	0.046*** (3.14)	0.042*** (3.36)	0.057*** (4.44)	0.039*** (2.46)
<i>Moderators</i>					
IAQI		0.018*** (1.92)			0.022*** (1.75)
DTs			0.026*** (2.17)	0.031*** (2.67)	
<i>Moderating effect</i>					
GW × IAQI		0.033*** (2.37)			0.048*** (3.87)
GW × DTs			0.021*** (2.15)	0.029*** (2.35)	
<i>Control variables</i>					
SIZE	0.026*** (2.15)	0.029*** (2.47)	0.045*** (4.49)	0.036*** (3.54)	0.034*** (2.76)
LEV	0.011** (1.48)	0.018** (2.09)	0.020*** (2.17)	0.025** (3.02)	0.024*** (2.20)
MB	0.032* (2.11)	0.017* (1.04)	0.022* (1.19)	0.038** (2.43)	0.042** (3.17)
INTAN	0.033*** (2.36)	0.059*** (4.75)	0.058*** (4.48)	0.044*** (3.96)	0.066*** (5.45)
TOP5	0.028*** (1.44)	0.019*** (2.10)	0.027*** (1.84)	0.023*** (1.02)	0.016*** (0.95)
OWN	0.068*** (6.42)	0.062*** (6.18)	0.078*** (7.78)	0.082*** (8.21)	0.086*** (8.62)
Yearly effect	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
<i>R</i> ²	0.2857	0.4596	0.3691	0.3344	0.5267
Adjusted <i>R</i> ²	0.2915	0.4660	0.4089	0.3388	0.5385

*Determines significance at a level of 10%. **Determines significance at a level of 5%. ***Determines significance at a level of 1%.

in the concept and the impact of GW, it is difficult to estimate how firms may achieve their sustainability and financial goals (Schons & Steinmeier, 2016; Testa, et al., 2018; Walker & Wan, 2012). Accordingly, the objectives of this study are two-fold. First, to unpack the different concepts and definitions of GW and explore the underlying characteristics and motivations of firms employing it as an organizational strategy. Second, we propose a theoretical model based on the fundamentals of agency theory. The operationalized model consists of GW and the moderators of IAQ and DTs to investigate how firms may optimize their FP. The findings suggest that firms employ GW to reduce stakeholders' environmental pressure and establish organizational legitimacy. The empirical results suggest that GW may significantly

improve FP. Although the moderators of IAQ and DTs play a positive role in increasing FP, further investigation is required to validate these claims especially the role of DTs in GW and enabling FP offers an interesting research prospect (Kai et al., 2022).

5.1. Theoretical implications

The empirical findings of this research have numerous implications for theory. From a theoretical lens, we employ the fundamentals of agency theory to conceptualize GW as an organizational strategy to increase the FP of firms through the moderators of IAQ and DTs. We perform multiple statistical tests to authenticate the theoretical model which may serve as an extension of agency theory and validate its accuracy in investigating GW-FP nexus. This study also implicates the potential of agency theory in developing an integrated theoretical model covering various dimensions including IAQ and DTs allowing us to measure the impact of GW on FP under different conditions. This contributes to laying the foundation of a theoretical roadmap for future empirics looking to embark on the GW research domain. The relevance of conceptual framework to investigate the context of this study contributes to warranting the efficacy of agency theory as an organizational sustainability enabler.

5.2. Practical implication

The results of the present study also exhibit implications for managerial, policy, and regulatory considerations. This study establishes that GW can be used as an environmental communication strategy as well as a financial performance booster requiring business managers to fully understand and employ it within the businesses. The insight of this study does not endorse and encourage implementation of GW within the firms during their entire life cycle hence, managers should remain cautious before using GW as their next strategic move. Perhaps the usage of modern DTs namely BDA, IoT, Cloud, and artificial intelligence may allow managers to understand the existing sustainability information requirement and the stakeholders' (investors) trends. In the context of policy, the Indonesian government may improve its regulatory infrastructure to specify the conditions under which firms may use 'green' terminology to advertise, market, and promote their products and services and use it in their sustainability reports. The findings of this study also serve as a practitioner guide to identify the GW training programs for employees so that an effective internal audit is done by GW practicing firms before the publication of their sustainability reports. The financial consultants may find our results useful in recommending sustainable business strategies to the firms operating in developing countries.

5.3. Limitations and future research

The limitations of this study can be attributed to different factors. First, the theoretical model of this study is discussed and validated from critical and logical lenses however, the use of GWI to estimate GW, ROA to calculate FP, IAQI to measure IAQ, and IMDCC ranking to determine DTs is debatable as all these constructs contain many sub-dimensions and themes. Perspective researchers are encouraged to incorporate additional measurements such as economic and social dimensions in GW, corporate governance functions in IAQ, artificial intelligence in DTs, and alternate measures (ROE) for FP. Second, the research scope i.e., Indonesian context and panel data timelines (2018-2022) may increase controversies in the findings of our study as the FP particularly of manufacturing and production firms is affected by the recent Covid-19 pandemic. Future empirics are recommended to use a large sample covering more time duration so that the actual impact of GW on FP is truly measured. Third, the researchers have potentially resolved endogeneity and heterogeneity problems in self-reported data through the GMM regression approach yet, problems such as the Halo effect may still contaminate the findings of this study. Thereby, additional statistical approaches namely difference-in-difference, generalized, two-and three-stage least squares regression should be used to obtain robust findings.

Author contributions

Conceptualization, Pupung Purnamasari; methodology, Indah Umiyati; software, Pupung Purnamasari; data curation, Pupung Purnamasari; visualization, Pupung Purnamasari and Indah Umiyati; formal Analysis, Indah Umiyati; writing – original draft, Pupung Purnamasari and Indah Umiyati; resources, Indah Umiyati; review & editing and writing original draft, Pupung Purnamasari and Indah Umiyati; supervision, Indah Umiyati.

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ORCID

Pupung Purnamasari  <http://orcid.org/0000-0002-4974-740X>

About the authors

Dr. Pupung Purnamasari holds a Doctoral in Accounting and currently working as an associate professor at the Department of Accounting of the Faculty of Economics and Business, Bandung Islamic University. Besides her academic endeavors, she also serves as the head of Master in accounting.

Indah Umiyati holds a Master and currently serving as a lecturer at STIE Sutaatmadja Subang Indonesia. She is a prolific researcher in the area of accounting and finance.

Data availability statement

This research used secondary data which is accessible from Asset4, the World Bank, Asian Development Bank, IMDCC, and the Worldscope databases. The data associated with this article is also available on a request from corresponding author.

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