



ESG investment enhanced with Industry 5.0: The introduction of conceptual framework

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Abstract. ESG investing has become rampant, especially after the disasters caused our environmental, social, and governance dilemmas. With the calling from the United Nations to meet 17 SDGs by 2030, sustainable investments like ESG investing have tried to align their investment plan with SDGs. However, there were revealed that ESG reports or information offered by rating agencies are diversified, inconsistent, and non-transparent, furthermore, different methodologies and non-standardized frameworks result in variation in ESG reporting. Emerging technologies like Industry 5.0 are believed to improve the situation by delivering more transparent, instantaneous, accessible, human-centric, and objective reporting for ESG investing decision-makers. A conceptual framework has been designed to depict the ideal situation when alternative ESG reporting is processed automatically by technologies, including a customized ESG report with features enhanced by Industry 5.0 technologies.

Keywords: ESG investing, GRI, AI, Industry 5.0, Alternative ESG

1 Introduction

1.1 Overview

ESG stands for environment, social, and governance. The objective of ESG is to capture all the non-financial risks and opportunities identified through daily business operations. Greenhouse gas emissions, water, and land pollution are the examples categorized under the environment pillar. Health, safety, and staff wellness are the concerns of the social pillar. Governance is about directors and policies to strengthen corporate governance [1].

ESG originated from the idea of Socially Responsible Investing (SRI) about 200 years ago [2], because of a series of environmental and social scandals, ESG was coined in a landmark study at the “Who Care Wins” conference in 2005 [3]. ESG has been a popular topic since the United Nations called all the nations to meet SDGs 17 and 169 specific targets to be achieved by 2030 [4]. Hence, ESG has gained much momentum, which has impacted investors’ perception of risk and their subsequent investment actions. The effect is even more prominent in ESG achievers than losers because institutional investors normally view the best-in-class positive screening [5]. The inclusion of

ESG criteria become part of the ESG investment making and has even attracted investors like pension funds and insurance companies as institutional investors. Green bonds and ESG-themed exchange-traded funds (ETFs) have also emerged in the market aftermath [6]. There have been records showing that ESG-themed megatrend investors were prepared to sacrifice about 30-50bps of their annual return to meet their sustainability targets, with the belief that higher transaction costs may be reduced in the future [7].

Although ESG is one of the popular sustainability measurement tools developed voluntarily by global rating agencies like MSCL, the demand from shareholders has doubled in the last two decades [8]. Furthermore, the pandemic has emphasized the significance of ESG [9]. ESG reporting is an effort to demonstrate firms' commitment to ESG initiatives except greenwashing [10], yet, there were challenges faced by the ESG user such as data inconsistency, wrong benchmarks, and wrong imputation [11]. No unified reporting framework is another factor affecting scalable and comparable information. This is because more ESG index providers have designed their index to evaluate ESG performance [12]. As of 2016, we have at least 125 ESG ratings data providers [13], ESG ratings can vary due to different methodologies [14]. The current evaluation of ESG performance is not objective due to relying upon scoring from various experts as analysts [15]. Hence, concerns about inaccurate ESG policies are surfacing, result increasing expectations from investors on verifiable ESG factors [16].

Although 54% of the global respondents have considered sustainable investing to be fundamental in their investment activities, 53% of the global participants claimed that poor quality and supply of ESG information were the greatest hindrances to implementing sustainable investing [17]. Sustainability in the West is driven by the bottom-up approach, the non-government approach. In emerging countries like Asia, sustainability is driven by a top-down approach enforced by the governments [18]. Hence, digitalized technologies are believed to resolve the aforementioned challenges. Features like data mining and predictive analytics which artificial intelligence (AI) can deliver sustainable investing, for consistent and streamlined reporting can be achieved via blockchain [10].

With challenges like lack of standardization, data verification, data privacy, cybersecurity, and subjective analysis, many investors have turned to digital technologies like AI and blockchain [19]. The problems that arise from the conventional way of preparing ESG ratings are human experts who may exercise subjective judgment and apply different methodologies. Instances like higher scores have been assigned to larger companies due to being resourceful in filling out the questionnaires provided by rating agencies [20]. A leading financial institution may be assigned with higher ratings resulting in biases [21]. Hence, the innovation of financial technologies has stirred up the existing mode of ESG ratings [21].

Companies that intend to implement digitalization will affect their ESG performance by increasing governance performance, eliminating agency costs, and improving social scores and reliable reporting [22][10]. Through the integration of digital devices and IT functions, the processes and performance of innovations of the organizations are subsequently supported by the technologies [23]. It is confirmed that digital technology can improve sustainability performance like the ESG [24].

Industry 5.0 can create a more human-centric, sustainable, and resilient industry according to the European Union [25]. The purpose of Industry 5.0 is to shift the focus

from individual technologies to a systematic approach and integrate ESG through technology[26]. Besides this, Industry 5.0 is believed to enhance ESG reporting [27]. Although these emerging technologies can strengthen integration, and information exchange and address authenticity problems, the application for Industry 5.0 is awaiting to be explored [28]. Furthermore, studies about the impact of technologies like the Internet of Things (IoT), AI, blockchain, and big data on ESG data and performance are limited [10][22]. Therefore, this article will contribute by creating a conceptual model for ESG investing based on Industry 5.0 technologies.

The structure of the article is designed as follows: Section 2 covers literature reviews about the framework for ESG disclosure, ESG investing, emerging technologies, and alternative ESG ratings; Sections 3 and 4 depict the framework for sustainable investing with introductions of a few constructs; end the article with the conclusion in section 5.

2 Literature Review

A separate discussion topic will be discussed in this section with a focus on different literature reviews on the titles of 2.1 Framework for ESG Disclosure, 2.2 ESG Investing, 2.3 Emerging Technologies, and 2.4 Alternative ESG Ratings.

2.1 Framework for ESG Disclosure

ESG has become very popular and has been one of the most common terms widely used around the world in all kinds of situations from climate change to reform justice. In addition, there will be increasing ESG disclosures and reporting demanded from listed companies, resulting in abundant sustainability. Besides that, regulators are also increasingly moving toward codifying ESG performance[29]. ESG practice has helped firms become more accessible to financing facilities like trade credit, reduce information gaps, and strengthen operational efficiency and risk mitigation [30]. However, the challenges of ESG data that may affect the effectiveness of ESG information due to data inconsistency, wrong benchmarking, and computations of ESG data are questionable [11]. Some firms may even grab the opportunities to reduce fines and penalties from the prosecutors by coinciding with the official antitrust investigations by initial new CSR efforts [31]. As such, it is essential to select an appropriate reporting framework and Integrated Reporting is one of the recognized frameworks to report ESG disclosure [32].

A new type of ESG rating provider has replaced human research analysts, especially during the last few stages of data analysis and rating generation, additionally, the new framework Sustainability Accounting Standards Board (SASB) has been applied consistently, causing alternative ESG ratings have gained much attention recently, which is very contrast to the traditional model, as rating agencies are mainly accountable for the scoring. Yet, little research has been done to uncover the difference between alternative ESG ratings and traditional ESG ratings [21]. Besides SASB, the Global Reporting Initiative (GRI) framework is one of the most widely used frameworks in ESG today. GRI has covered various topics to reflect the different requirements and needs

of the divergent industries. About 73% of the world's 250 largest companies have utilized GRI for sustainability reporting and disclosures [33]. To develop a more comprehensive global standard for sustainability disclosure, the new International Sustainability Standards Board (ISSB) was also launched by the International Financial Reporting Standards Foundation (IFRS) [34]. The arisen of multiple frameworks with similar goals can be challenging for users, we still lack common standards as the benchmark for measuring sustainability-related information, according to the European Commission [35]. Lack of agreed standards may trigger major greenwashing at the corporate reporting level, and it could also happen to asset managers as well as corporate level results in misallocation of funds [36].

2.2 ESG Investing

There have been different acronyms for sustainable investing. It could be ESG investing, socially responsible investing (SRI), and impact investing [37]. Normally investors have a long-term perspective, besides considering ESG, investors are also concerned about the overall health and stability of the financial market, and SRI is the broad term to consolidate conventional financial perspective with the agendas toward social and environmental objectives [38]. SRI originated from the Quaker movement and religious group of the 20th Century, with an emphasis on ethical activities. ESG appears as a wider scope in investment analysis, with a combination of different dimensions of financial and nonfinancial risk, and opportunities [39]. For a normative attempt to increase the morality of investing into a speculative practice of valuation, ESG has been transformed from SRI [40]. On the contrary, impact investing is different from normal investing and it aims to bring positive changes in environmental and social perspectives, besides achieving financial profitability objectivity [19]. The scope of impact investing is much narrower compared to ESG investing, which is always correlated with market returns [41]. Nevertheless, investors generally would still prefer companies they are investing in that have met targeted financial objectives and have embedded risks and opportunities with ESG practices [29].

ESG investing is the integration of environmental, social, and governance factors in decision-making for investment, and it has attracted institutional investors from pension funds and insurance companies. Besides that, green bonds and ESG-themed exchange-traded funds (ETFs) were also invented after the development of ESG investing [6]. With the widespread of Sustainable Development Goals (SDGs) in the global economic system, for practicality, ESG investing has included ESG principles as well as SDGs in the business process [42]. Through technology and social media, people all over the globe are aware of the world's problems. Compared with Generation Xers reporting 54% and baby boomers reporting 42%, 64% of the millennials feel that ESG considerations are important in their sustainability investing decisions [41].

2.3 Emerging Technologies

To understand the birth of Industry 5.0, we must appreciate the industrialization revolution in history. The first Industrial Revolution happened at the end of the 18th century

whereby water and steam were the basic resources used in production. With the beginning of conveyor belts used in the processes of mass production, the Revolution has moved to the second stage. The third evolution arose from the invention of digital technology and information systems. The advanced level of automation and digitalization, which was believed to have started in Germany, has further created an entire eco-system value chain that encompasses artificial intelligence, the Internet of Things, cybersecurity, robots, simulation, and any other information technology tools one can imagine to work in integration, which is the idea of Industry 4.0 [43]. Industry 4.0 is the digitalization with embedded sensors in all the components of a product [44]. Industry 5.0 is the latest and emerging technology meant to overcome the weaknesses of Industry 4.0 which has neglected the human side of interaction [26]. Automatic data collection from supply chains from multiple industries, mass processing of data, authenticity in transactions, and the wonders of producing real-time reporting, and generating insightful information are the characteristics of Industry 5.0 supporting ESG [45].

Additionally, Industry 5.0 addresses the problem of ESG disclosure through standardization and customizability which are being built into the system [28]. Nevertheless, besides depending on smart technologies to accelerate ESG investment, other credentials are critical enough to increase the volume of ESG investments which are advanced infrastructure for telecommunications, competent staff in digitalization, accessibility, and innovation of smart technologies [46]. More green financing such as incentivizing the deployment of green energy and the implementation of emission taxation is also well recommended to foster more ESG investment [47]. Besides the adoption of new technologies, the level of education and financial development can be influenced by policymakers to boost sustainable investing like ESG-themed ETFs [48].

2.4 Alternative ESG Ratings

Even though firms may have diligently reported ESG disclosures in their reports and company own websites, there are still challenges and hindrances faced by the various ESG data users as stakeholders when comes to the application of ESG data. Problems like data inconsistency, different standards of benchmarking, and diverted methods of data computation, are all factors that trigger data comparison difficulties and challenges [49]. With the advancement of AI and machine learning, the Alternative ESG rating provider with algorithms has replaced human rating providers. Alternative ESG rating providers started from a Silicon Valley-like culture and are led by experts like computer engineers, coders, and AI [21]. To supplement the financial information, the algorithm experts have searched sources from the Internet to provide insightful sustainability information as the presence of “Alternative data” [50]. Hence, more objective ratings have been created based on AI, resulting in alternative ESG rating providers producing more objective sustainability information [51].

3 Methodology

The objective of this research is to design a conceptual framework for ESG investing with Industry 5.0 technologies as the emerging technology to strengthen ESG reporting

by alternative ESG reporting and customized ESG reporting for asset managers for their better sustainable investing decision-making.

3.1 Conceptual Framework

Since SDGs become globalized, ESG has become part of the business strategy and review processes to align with SDG targets. With the innovation of technology like AI, two different types of ESG investments have come into play. ESG investment could be acquiring or financing smart technologies such as AI to improve ESG and business activities systematically[52]. Whereas, the other type of ESG investment implies making ESG investment decisions on smart technologies like AI and blockchain [53]. For the development of ESG investment in the age of AI, more financing is required for research and development, and share of science-intensive, advanced technology and innovative products [46]. For effective sustainable investment, a conceptual framework has been designed to propose the ESG disclosure or index that could be produced by digitalized technology to reduce subjective judgment, variation, and inconsistency. With the implementation of Industry 5.0, an asset manager can enjoy the benefit of customized ESG reporting with more security, accessibility, and traceability including predictive and interactive reporting.

4 Results and Discussion

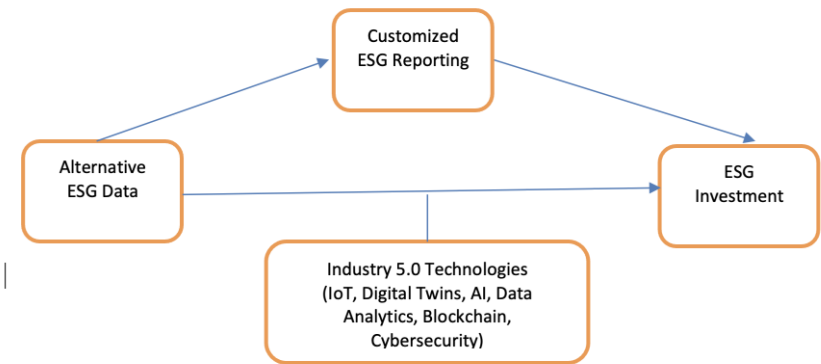


Fig. 1. Conceptual Framework

4.1 Alternative ESG Data (Independent Variable)

Although existing methodologies and models can identify and abstract ESG-related information through publicly available information, the quality of the information is either non-objective or conflicting. Hence, the users of the ESG data such as asset owners and asset managers are recommended to substitute traditional data with alternative data, while concurrently keeping watch on AI solutions due to governance and ethical challenges [54].

ESG rating agencies play the role of providing an assessment of the company's performance by evaluating ESG performance through credentials. The rampant expansion of ESG investing has led to more financial products offered to investors[55]. However, the quality of ESG data can be an issue such as ambiguous or incomplete information resulting in inconsistent findings [56]. Alternative data has therefore replenished the weakness found in traditional ESG data by delivering more transparent, visible operational data of the companies. Natural language processing (NLP) is one of the innovations which has led to AI-based systems. The amalgamation of AI with ESG criteria has shown improvement in investment decision-making [6]. Higher expenditure spent on information and communication technology has been correlated with increased investment in ESG. On the contrary, the negative performance of ESG investing has been affected by higher consumption of energy [47].

4.2 Customized ESG Reporting (Mediating Variable)

To ensure ESG disclosure is authentic; functions like retrospective to prospective and real-time reporting, different reports based on customization, and extended reporting with multitier supply chains are the features of Industry 5.0. Customization of ESG reports can articulate more insightful information with relevant regulations, alternative assessment, and data comparison, which make them possible from Industry 5.0 technologies [28].

4.3 Industry 5.0 Technologies (Moderating Variable)

AI is one of the foundations for the digitalization growth in the industry [57]. It is believed machine learning (ML) and AI can process large volumes of data efficiently by producing timely, reliable, comprehensive data and analytics products [54]. A sound development of AI-controlled platforms can also integrate ESG factors into the investment process [58]. Besides that, AI also has the features of market trend projections, and recommendation of trading signs[59]. Together with cyber-physical systems and the Internet of Things (IoT), ESG practices are run based on smart technology under the control of AI [60]. Besides this, AI can analyze Big Data related to ESG, which forms the basis for collecting more reliable and complete sustainability information internally and externally[61].

Blockchain originated from the realm of cryptocurrencies and has the function of recording every transaction to resolve the issues of safety and data privacy [19]. The

benefit of blockchain is to ensure data or information is consistent and transparent. Besides that, Blockchain and IoT can work together to collect ESG data automatically and ensure security, transparency, and traceability during data collection and ESG disclosure [62]. With the collaboration of AI and blockchain, their potential can be double folded by reducing their limitation through evaluation, risk management, and shareholder engagement [19]. As a result, ESG investment has been enhanced through AI by experiencing improved decision-making, and the application of blockchain can improve governance, data sharing, privacy, transparency, accessibility, accountability of ESG data, and reporting [63][64].

The main task of IoT is to ensure data exchange between devices in real-time is robust, autonomous, and secure, resulting in real-time monitoring, better decision-making support, and early detection and alertness of environment-related disasters. In collaboration with 5G mobile networks, IoT can even contribute to smart transportation and logistics systems [65]. Hence, AI is an advanced technology for greater data analysis which will benefit investors from the existing data that may be subjective and biased. AI is therefore the catalyst of solution providers for greater analysis of material data. Through AI and ML, they can identify patterns from large historical data to make projections and discover new opportunities and threats [10].

For better analysis and data interpretation to identify trends, patterns, and insights, data analytics can provide the solution by statistical and quantitative methods, which may include other techniques like regression analysis and time series analysis [58]. Digital twins mimic virtual physical processes, which can produce ESG reports immediately that are customizable, transparent, and accessible to different users [66]. Therefore, none of the technologies can work in a silo, although AI is the chief technology to collaborate and partner with other technologies, each of them has different features and characteristics to make the whole process of ESG data collection, disclosure, reporting to final sharing of their pertinent information to different stakeholders in a smooth, safe and secure way.

4.4 ESG Investment (Dependent Variable)

The concept of traditional investment is rather linear and short-term perspective. Environment issues like climate change, water scarcity, and failure of governance are the targets ESG tries to mitigate. Sustainable investing is considered the solution to resolve the issues and its implementation has been growing yet challenging, especially implementation. Therefore, the roles of technology and alternative data become critical to stimulate further growth in sustainable investing including more involvement from the governors [35]. An estimated 30.3 trillion of sustainable assets have been invested globally. Since the last two years, the growth of sustainable investment has been 20%, which is about USD21.9 trillion in assets under management (AUM) across developed countries like Europe, Canada, Japan, Australia, and New Zealand [67]. After getting the customized ESG reporting or ESG scores or indexes, there are a few popular strategies that investors can refer to as part of their ESG investing strategies; best-in-class screening, norm-based screening, exclusionary screening, ESG integration, sustainability-themed investing, impact/community investing, and corporate engagement [68].

5 Conclusion

ESG investing has become a mainstream market practice in most of the financial markets across OECD countries, however, the Committee on Financial Markets (CMF) has discovered that ESG investing has suffered from the weaknesses of non-transparency, comparability difficulty, and quality of data since 2019. Besides that, the lack of adequacy to disclose the calculation of the ratings and matrix being constructed into the ESG ratings is ambiguous [69]. Therefore, it is recommended that the financial authorities consider available facilities to monitor ESG rating providers, as well as support greater transparency of methodologies used for ESG ratings [70].

We expect that the application of advanced technologies like Industry 5.0 will enhance the experiences of ESG investors, promoting more ESG investment due to better accessibility of data, standardization, transparency, real-time, stricter privacy and data security control of ESG information including customized ESG reporting. Nevertheless, AI is an emerging technology and the ethical governance over its development and application is still under development to identify its potential issues [71]. Hence, regular audits and assessments of the technologies deployed in the ESG investment are strongly recommended to avoid biases designed into the system [72].

Furthermore, if proper governance is in place to safeguard data privacy, users of the product have more confidence in it. For example, due to poor data management, Facebook and Amazon are vulnerable to risky exposure. On the other hand, Apple is well-positioned due to having stronger policies for governance [73]. Therefore, by upgrading from Industry 4.0 to Industry 5.0, we believe these technologies can deliver better value to the different stakeholders. The involved technologies can complement each other and work in collaboration in harmony and systematically, furthermore, with the suggested conceptual framework in this study, users like ESG investors can rely the alternative ESG reporting which is more timely, transparent, trustworthy, reliable, standardized, customized, interactive, objective and more insightful information. Meanwhile, we expect more involvement from the governors to address the potential ethical issues of AI especially, including its risks and opportunities. With the common adoption of these technologies into sustainability reporting, human biases including speculation will gradually be reduced and mitigated. More frameworks for sustainability like ESG will try to align with SDGs as the global common target and the gaps of differences in methodology will be reduced.

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