Comparative ESG Rating Systems and Scope 3 Disclosure in Japan and Korea: Evidence from the Electronics Manufacturing Industry

Sunhee Suk[1*] and Dayeon Jang[2]

[1]Graduate School of Integrated Science and Technology, Nagasaki University, 1-14 Bunkyo Machi, Nagasaki City, Nagasaki Prefecture, Japan
[2]Department of Biological and Environmental Science, Dongguk University, 30 Pildong-ro 1-gil, Jung-gu, Seoul 04620, Republic of Korea
**Corresponding Author E-mail: suksunhee@nagasaki-u.ac.jp.*

ABSTRACT

This study examines selected ESG-related evaluation systems and Scope 3 disclosure practices in Japan and Korea, with a focus on the electronics manufacturing industry. As international sustainability disclosure frameworks such as ISSB and CSRD strengthen climate-related disclosure requirements, inconsistencies among ESG rating agencies and the comparability of Scope 3 emissions data have become increasingly important issues for investors, regulators, and corporations. This study compares selected ESG-related evaluation institutions in Japan and Korea, including JCR, R&I, KCGS, KRESG, and SUSTINVEST, and analyzes their environmental evaluation methodologies, governance structures, and disclosure approaches. In particular, the study proposes a comparative ESG divergence framework focusing on weighting, boundary setting, assurance practices, and transparency of evaluation systems. In addition, this study develops a Scope 3 disclosure index to assess the comprehensiveness of corporate climate-related disclosure. The framework is applied to four major electronics manufacturers: Panasonic, Sony, Samsung Electronics, and LG Electronics. The analysis identifies differences among the selected evaluation frameworks and corporate disclosures, particularly in their stated methodologies, disclosure boundaries, and assurance coverage. It does not estimate the causes of rating disagreement or convergence over time. The findings suggest that interpretation of ESG ratings requires attention not only to corporate environmental performance but also to institutional and methodological differences among rating systems. This study contributes to the growing literature on ESG governance and sustainable finance by providing a comparative perspective on ESG evaluation systems and Scope 3 disclosure practices in East Asia. The results also provide policy implications for improving transparency, comparability, and reliability in ESG disclosure and evaluation frameworks.

Keywords: ESG ratings/ Scope 3 disclosure/ Electronics industry/ Japan and Korea

1. INTRODUCTION

Over the past two decades, Environmental, Social, and Governance (ESG) factors have become increasingly important in global investment, corporate management, and sustainability governance [1, 2]. International initiatives such as the Principles for Responsible Investment (PRI), the Task Force on Climate-related Financial Disclosures (TCFD), and more recently the International Sustainability Standards Board (ISSB) and the European Union Corporate Sustainability Reporting Directive (CSRD) have accelerated the expansion of ESG disclosure and climate-related reporting requirements [3, 35, 36]. As a result, corporations are increasingly expected to disclose not only financial performance but also climate risks, carbon emissions, and sustainability-related governance practices.

Among ESG-related issues, greenhouse gas emissions disclosure has become particularly important due to the intensifying global climate crisis and the transition toward carbon neutrality [13]. In particular, Scope 3 emissions, which include indirect emissions occurring throughout corporate value chains, have emerged as one of the most challenging areas in sustainability disclosure [34]. Compared with Scope 1 and Scope 2 emissions, Scope 3 emissions are more difficult to measure, verify, and compare because they involve upstream suppliers, logistics, product use, and end-of-life treatment processes across complex global supply chains [34]. Nevertheless, international disclosure frameworks

increasingly emphasize Scope 3 disclosure because these emissions often account for the largest share of corporate carbon footprints, especially in manufacturing industries [34, 35].

At the same time, ESG rating agencies have gained significant influence in sustainable finance and investment decision-making. ESG ratings are widely used by institutional investors, financial institutions, and regulators to evaluate corporate sustainability performance and climate-related risks [10]. However, previous studies and market participants have pointed out that ESG ratings frequently differ across agencies, even for the same company [5, 6, 11, 12]. Such divergence may reduce transparency and comparability in sustainable finance markets and create uncertainty for investors and firms [5, 11, 12]. Recent discussions suggest that ESG rating divergence is not simply caused by differences in corporate sustainability performance, but also by methodological heterogeneity among rating agencies, including differences in weighting systems, evaluation boundaries, disclosure assumptions, assurance practices, and feedback mechanisms [5, 6, 11, 12].

Against this background, Japan and Korea provide an important comparative context for examining ESG evaluation systems and climate-related disclosure practices. Both countries have rapidly expanded ESG-related policies and disclosure frameworks in response to global sustainability governance trends, including the standard-setting work of the Sustainability Standards Board of Japan (SSBJ) and the Korea Sustainability Standards Board (KSSB) [22, 28]. At the same time, the two countries exhibit differences in ESG governance structures, rating systems, and regulatory approaches. In addition, electronics manufacturers in both countries play important roles in global supply chains and are highly exposed to Scope 3 emissions associated with product use and upstream supply networks.

This study examines ESG rating systems and Scope 3 disclosure practices in Japan and Korea, with a particular focus on the electronics manufacturing industry. Specifically, the study compares selected ESG-related evaluation institutions in both countries and analyzes methodological differences in environmental evaluation systems. In addition, the study develops a comparative ESG divergence framework and a Scope 3 disclosure index to assess the comprehensiveness and comparability of corporate climate-related disclosure. The analytical framework is applied to four major electronics manufacturers: Panasonic, Sony, Samsung Electronics, and LG Electronics.

This study contributes to the literature in three ways. First, it provides a comparative analysis of selected ESG-related evaluation systems in Japan and Korea by focusing on methodological divergence among rating agencies. Second, it proposes a comparative framework for understanding how weighting systems, evaluation boundaries, assurance practices, and transparency may be relevant to interpreting ESG rating outcomes. Third, it develops a Scope 3 disclosure index to evaluate the comprehensiveness of climate-related disclosure among major electronics manufacturers in East Asia. The findings contribute to ongoing discussions on ESG governance, sustainable finance, and the comparability of climate-related disclosure frameworks.

2. METHODOLOGY

2.1 Research Design

This study adopts a qualitative comparative case study approach to examine ESG rating systems and Scope 3 disclosure practices in Japan and Korea. The analysis focuses on the electronics manufacturing industry because it is highly exposed to global supply-chain risks, climate-related disclosure requirements, and Scope 3 emissions, particularly emissions associated with product use and upstream supply chains [30-33].

The study consists of two analytical components. First, it develops a comparative ESG divergence framework to examine why ESG evaluation outcomes may differ across rating agencies. Second, it constructs a Scope 3 disclosure index to assess the comprehensiveness and comparability of corporate climate-related disclosure among selected Japanese and Korean electronics manufacturers.

Figure 1 illustrates the overall research framework of this study. The analytical structure links the evolution of global ESG governance and sustainability disclosure frameworks with comparative

analyses of ESG rating systems and corporate Scope 3 disclosure practices in Japan and Korea. The framework also organizes methodological differences in ESG evaluation systems and climate-related disclosure practices that are relevant to comparability. The arrows indicate the analytical sequence, not tested causal relationships.

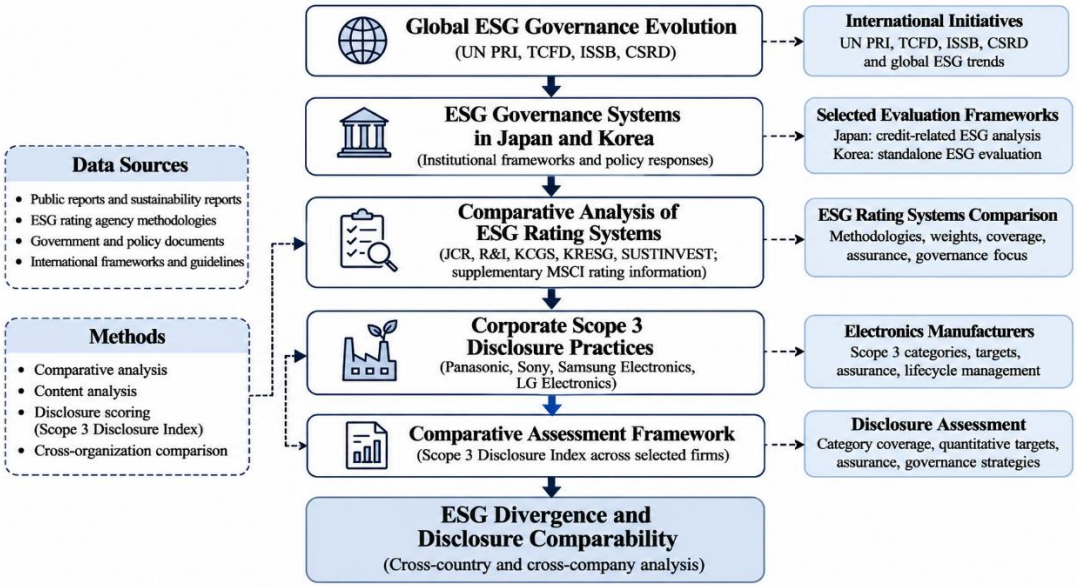

Figure 1. Research Framework of the Study

2.2 Comparative ESG Divergence Framework

To analyze methodological differences among ESG-related evaluation institutions, this study compares selected institutions in Japan and Korea, including Japan Credit Rating Agency (JCR), Rating and Investment Information (R&I), Korea Institute of Corporate Governance and Sustainability (KCGS), Korea Ratings ESG Research Institute (KRESG), and SUSTINVEST [16-21, 25-27]. The comparison focuses on five dimensions: 1) evaluation scope and rating structure, 2) environmental weighting and sector adjustment, 3) treatment of Scope 3 and climate-related indicators, 4) disclosure transparency of evaluation methodology, and 5) feedback and monitoring procedures. Table 1 summarizes the analytical framework used in this study.

Table 1. Comparative ESG Divergence Framework

Dimension	Analytical Focus
Evaluation structure	Rating scale, evaluation scope, sector classification
Weighting system	Environmental weighting and industry adjustment
Boundary setting	Scope 3 coverage and disclosure assumptions
Assurance and transparency	Third-party verification and methodological disclosure
Feedback and monitoring	Stakeholder communication and post-evaluation process

This framework organizes potential methodological sources of non-comparability among evaluation institutions; it does not separate their effects from corporate ESG performance. In this study, ESG rating divergence is understood not merely as inconsistency among agencies, but as a possible outcome of different assumptions regarding weighting, boundary setting, assurance, transparency, and stakeholder feedback [5, 6, 11, 12].

2.3 Scope 3 Disclosure Index

To assess the comprehensiveness of Scope 3 disclosure, this study develops a simple author-defined disclosure index informed by international climate-related disclosure frameworks and carbon-accounting guidance [14, 15, 34, 35]. The five criteria capture category-level reporting, value-chain coverage, product-use emissions, quantitative target setting, and external assurance. Category-level reporting provides disaggregation; value-chain coverage identifies upstream and downstream information; the product-use item addresses a prominent emissions source for these manufacturers; target disclosure records stated reduction commitments; and assurance identifies external scrutiny of reported data. They are selected for this comparative study rather than prescribed as a five-item index by these frameworks. Each criterion is scored as 1 if the relevant information is clearly disclosed and 0 if it is not disclosed or cannot be confirmed. Equal weighting is used as a transparent descriptive convention without assigning differential importance to the five dimensions; it does not establish that they have equal substantive importance. The total score ranges from 0 to 5. The five criteria and their operational rules are as follows:

· Disclosure of Scope 3 emissions by category: 1 when numerical emissions are reported for identifiable Scope 3 categories; otherwise 0. This does not require every category to be reported.

· Coverage of major upstream and downstream categories: 1 when numerical disclosure identifies the upstream and downstream activities considered in this comparison, including purchased goods and services (Category 1) and use of sold products (Category 11); otherwise 0. The criterion is interpreted within each reported inventory, not as a common percentage-based materiality threshold or a test of complete inventory coverage.

· Disclosure of product-use phase emissions: 1 when numerical emissions associated with the use of sold products (Category 11) can be identified; otherwise 0.

· Existence of quantitative Scope 3 reduction targets: 1 when a numerical absolute or intensity-based GHG reduction target, or an explicitly scoped net-zero target, identifies Scope 3 or value-chain emissions and a target year; otherwise 0. Product energy-efficiency or renewable-electricity objectives alone do not satisfy this criterion.

· Third-party assurance or verification of emissions data: 1 when an independent assurance statement or explicit report note includes at least selected Scope 3 emissions data within its coverage; otherwise 0. General assurance of other environmental indicators alone is insufficient.

A criterion is treated as clearly disclosed only when the relevant information can be explicitly identified in the reviewed public webpages, reports, or disclosure documents. Ambiguous or unconfirmed information receives 0, meaning that qualifying disclosure was not established in the reviewed source set, not that the practice necessarily does not exist. Coding decisions were discussed by both authors, and the final scores were determined through agreement, rather than independent parallel coding. The operational rules are specified to make the scoring process transparent. For the coverage item, the four reports all provide numerical information on Category 1 and Category 11: Panasonic, p. 37; Samsung Electronics, p. 62; Sony, p. 189; and LG Electronics, p. 144 [30-33]. The index measures disclosure comprehensiveness, not the accuracy of the emissions data, target ambition, or overall environmental performance.

The index is applied to four major electronics manufacturers: Panasonic and Sony from Japan, and Samsung Electronics and LG Electronics from Korea. These companies were selected because they are leading firms in the electronics industry and have relatively advanced ESG and sustainability disclosure practices [30-33].

2.4 Data Sources

ESG ratings, evaluation methodologies, corporate climate-related information, and policy information were collected directly from publicly available webpages and documents published by the respective evaluation institutions, companies, and public bodies. Published grades and stated corporate commitments are source information; the Scope 3 Disclosure Index is an author-assigned analysis of those public disclosures using the criteria in Section 2.3. The document review includes sustainability and climate-related materials published between 2023 and 2025, together with earlier institutional and policy sources. The analysis also refers to ISSB, CSRD, TCFD, and the Greenhouse Gas Protocol, and national developments including SSBJ and KSSB [3, 4, 12, 14, 15, 22, 28, 34-36].

The corporate comparisons refer to the report editions listed in [30-33]: the 2024 reports of Panasonic, Samsung Electronics, and Sony, and LG Electronics' 2023–2024 report. Printed report pages are identified where they substantiate the coding. Reported fiscal periods and organizational boundaries follow the sources and are not assumed to be identical. The rating examples reproduce information collected from the providers' public sources; they are not synchronized to a single assessment date and are not a current-rating dataset. These corporate observations are distinguished from the wider policy and institutional review. Later website changes are not substituted for the information used in the original comparison.

3. RESULTS AND DISCUSSION

3.1 Evolution of ESG Governance and Disclosure Frameworks in Japan and Korea

Table 2 summarizes the evolution of ESG governance and sustainability disclosure systems in global, Japanese, and Korean contexts. The timeline indicates that ESG governance in both Japan and Korea expanded after the mid-2010s, particularly following the introduction of TCFD-related disclosure initiatives and the establishment of ISSB. The timeline also indicates that both countries increasingly institutionalized climate-related disclosure systems, although their governance approaches and regulatory priorities differed [1-4, 22-28, 35-37].

In Japan, ESG governance initially developed through the expansion of corporate social responsibility (CSR) reporting and investor-oriented non-financial disclosure during the mid-2000s [12, 22]. Since the introduction of Japan's Stewardship Code in 2014 and the Corporate Governance Code in 2015, ESG governance has increasingly become linked to institutional investors, stewardship responsibilities, and market-based disclosure systems [2, 12, 22]. Subsequent developments, including GPIF's ESG investment initiatives, TCFD-equivalent disclosure for Tokyo Stock Exchange Prime Market firms under the Corporate Governance Code's comply-or-explain approach [37], and the establishment of the Sustainability Standards Board of Japan (SSBJ), further strengthened sustainability disclosure governance and ESG market transparency [2, 12, 22, 37].

In Korea, ESG governance evolved through an emphasis on disclosure obligations, sustainability management systems, and ESG evaluation frameworks [23-28]. Since the introduction of the Environmental Information Disclosure System and the National Pension Service's adoption of PRI, Korea has expanded ESG governance through institutional investor participation and disclosure-oriented regulatory approaches [2, 23, 24]. In particular, the formal introduction of ESG evaluation systems by KCGS, the expansion of ESG disclosure roadmaps, and the establishment of KSSB demonstrate Korea's policy focus on sustainability disclosure and ESG finance infrastructure [23-28].

The comparative results suggest that both countries have responded to international sustainability disclosure frameworks, while differences remain in the policy and institutional approaches reviewed here [3, 4, 22, 28]. Japan's stewardship and market-oriented initiatives and Korea's disclosure and evaluation initiatives provide contextual background for the selected institutional cases. These observations are not exhaustive characteristics of either national ESG system. They provide context for the subsequent comparison of evaluation methodologies and Scope 3 disclosure practices.

Table 2. Major Developments in ESG Disclosure and Sustainability Governance in Global, Japanese, and Korean Contexts

Year	Global	Japan	Korea
2004	"Who Cares Wins" report introduces the term ESG	Growing expansion of CSR and environmental reporting among large corporations	Increasing discussion on corporate governance reform and corporate social responsibility
2005	G8 Climate Change Roundtable established	Increasing corporate environmental disclosure and sustainability reporting practices	Expansion of sustainability management and environmental reporting among major conglomerates
2006	UN Principles for Responsible Investment (PRI) launched	Growing discussion on responsible investment and ESG-related corporate disclosure	Environmental Information Disclosure System introduced under the Environmental Technology and Industry Support Act (implemented in 2009)
2007	Expansion of sustainability and integrated reporting discussions globally	Japanese corporations increasingly publish CSR and sustainability reports	Expansion of sustainability reporting and environmental management systems among listed firms
2008	Expansion of global ESG investment and sustainability reporting frameworks	Increasing adoption of integrated reporting concepts and non-financial disclosure	Korea Exchange increases attention toward sustainability disclosure and governance standards
2009	Expansion of PRI signatories; establishment of IIRC discussions	Growing interest in integrated reporting and ESG disclosure among institutional investors and listed companies	National Pension Service (NPS) signs PRI
2010	ISO 26000 on social responsibility issued	Expansion of integrated reporting and ESG-related disclosure among major listed firms	Expansion of CSR reporting and sustainability disclosure among major Korean corporations
2011	Creation of Shared Value (CSV), revision of OECD Guidelines for Multinational Enterprises, establishment of SASB	Growing emphasis on integrated reporting and long-term corporate value disclosure	Korea Corporate Governance Service (later KCGS) formally introduces ESG evaluation system
2012	Expansion of sustainability governance and ESG investment frameworks	Increased attention to ESG disclosure and investor-oriented non-financial reporting	Growing institutional investor interest in ESG investment and sustainability disclosure
2013	IIRC publishes International Integrated Reporting Framework (IR Framework)	Rapid increase in integrated reporting and ESG disclosure among Japanese listed companies	Expansion of ESG reporting and sustainability governance discussions among listed firms
2014	EU Non-Financial Reporting Directive adopted	Japan's Stewardship Code introduced	
2015	Adoption of SDGs and establishment of TCFD	GPIF signs PRI; Corporate Governance Code introduced	
2016	GRI Standards published		Korean Stewardship Code introduced
2017	TCFD Final Recommendations published	GPIF launches ESG index investment	
2018	SASB standards published; EU Sustainable Finance Action Plan announced	Corporate Governance Code revised	

Source: Compiled by the authors based on international sustainability disclosure frameworks and related policy documents in Japan and Korea [2-4, 22, 28, 36, 37].

Table 2. Major Developments in ESG Disclosure and Sustainability Governance in Global, Japanese, and Korean Contexts (cont.)

Year	Global	Japan	Korea
2019	EU Taxonomy proposal announced		
2020	Davos Manifesto 2020 announced	Japan's Stewardship Code revised	
2021	SEC begins review of climate disclosure rules; ISSB established during COP26	Corporate Governance Code substantially revised; transition finance guidelines issued	Financial Services Commission announces ESG Responsible Investment Infrastructure Plan
2022	EU CSRD adopted [36]; UK mandates TCFD disclosure	Prime Market firms subject to TCFD-equivalent disclosure under the Corporate Governance Code (comply or explain) [37]; SSBJ established	ESG Infrastructure Advancement Policy announced
2023	IFRS S1 and S2 standards published		ESG disclosure roadmap announced
2024	EU Taxonomy expansion proposal considers social and governance dimensions		KSSB prepares Korean Sustainability Disclosure Standards exposure draft
2025	ISSB proposes amendments to IFRS S2 focusing on Scope 3 disclosure	SSBJ publishes sustainability disclosure standards	Expansion of mandatory ESG disclosure planned

Source: Compiled by the authors based on international sustainability disclosure frameworks and related policy documents in Japan and Korea [2-4, 22, 28, 36, 37].

3.2 Comparative Analysis of ESG Rating Systems and Corporate ESG Performance

This section compares selected ESG-related evaluation systems in Japan and Korea and examines how leading electronics manufacturers are evaluated under different ESG assessment frameworks. The analysis focuses on Japan Credit Rating Agency (JCR), Rating and Investment Information (R&I), Korea Institute of Corporate Governance and Sustainability (KCGS), Korea Ratings ESG Research Institute (KRESG), and SUSTINVEST, together with ESG evaluation results for Panasonic, Sony, Samsung Electronics, and LG Electronics [16-21, 25-29]. Table 3 summarizes the main characteristics and environmental evaluation focus of the selected institutions.

Table 3. Comparative Characteristics of Selected ESG-related Evaluation Systems in Japan and Korea

Institution	Country	Main Characteristics	Environmental Evaluation Focus	Distinctive Features
JCR	Japan	ESG integrated into credit-rating framework	Climate change, environmental risk, biodiversity, natural disasters	Strong emphasis on financial materiality and sector-specific risk
R&I	Japan	ESG linked to business and financial risk evaluation	GHG emissions, pollution prevention, resource management	Emphasis on climate and pollution-related financial impacts
KCGS	Korea	Independent ESG evaluation framework	Climate change, resource circulation, eco-supply chain	Strong governance and disclosure-oriented ESG structure
KRESG	Korea	Quantitative ESG scoring model	Environmental management, climate response, environmental risk	Includes environmental opportunity and environmental sanctions
SUSTINVEST	Korea	Sustainability-oriented ESG assessment	Innovation, supply-chain management, biodiversity	Emphasis on sustainability innovation and ESG management practices

Source: Compiled by the authors based on ESG methodology documents published by JCR, R&I, KCGS, KRESG, and SUSTINVEST [16-21, 25-27].

The comparative analysis indicates that the selected ESG-related evaluation systems share several common characteristics, particularly regarding attention to climate-related disclosure, carbon emissions management, resource efficiency, and sustainability governance. However, important differences remain in evaluation methodologies, weighting systems, disclosure assumptions, and governance priorities. These differences identify institutional and methodological issues to consider when interpreting ESG ratings, alongside corporate environmental performance [5, 6, 10, 11].

3.2.1 Japan

Among the selected Japanese institutions examined here, ESG considerations are integrated with conventional financial and credit-rating frameworks. JCR and R&I incorporate ESG-related risks into broader assessments of financial materiality, medium-term business risks, and sustainability-related corporate governance [16-21]. Consequently, their environmental evaluation approaches tend to emphasize climate-related financial risks, pollution prevention, resource management, and sector-specific environmental exposure. JCR considers environmental risks including climate change, hazardous substance management and circular economy, biodiversity and natural environment, and natural disaster risks [16-18]. The institution also applies sector-specific environmental risk assessment frameworks and company-level environmental management analysis. R&I similarly emphasizes environmental factors directly associated with financial and operational risks, particularly greenhouse gas emissions, pollution prevention, and climate-related business impacts [19-21]. These characteristics indicate that the selected Japanese evaluation frameworks are closely associated with market-oriented sustainability governance and financial materiality perspectives. The selected credit-related documents emphasize the relationship between environmental risks, long-term corporate value, and financial stability. Table 4 presents credit and ESG rating results for major Japanese electronics manufacturers.

Table 4. Credit and ESG Rating Results of Major Japanese Electronics Manufacturers

Company	JCR Credit rating	R&I Credit rating	MSCI ESG rating
Panasonic	N/A	A	AA
Sony	AA	AA	AAA

Source: Authors' compilation of publicly available JCR, R&I, and MSCI rating information. Provider-framework references: [18, 21, 29]; the Japanese corporate reports also identify the MSCI grades [30, 32]. Credit and ESG grades have different purposes and scales and are not a common cross-agency ranking. These collected observations are not synchronized to a single assessment date.

Table 4 presents different forms of evaluation rather than directly equivalent measures of ESG performance. Within the displayed MSCI scale, Sony is rated AAA and Panasonic AA; the 2024 corporate reports also identify these grades [30, 32]. JCR/R&I credit information should be distinguished from these standalone ESG grades. Corporate climate-related governance, long-term value, and financial materiality provide context for the selected Japanese cases, but the table does not identify which environmental indicators determine each grade. Japanese policy and institutional discussions also connect sustainability disclosure with investors and stewardship responsibilities [2, 12, 19-21].

3.2.2 Korea

In contrast to the selected Japanese credit-related frameworks, the selected Korean ESG evaluation institutions have developed relatively independent ESG-focused evaluation frameworks emphasizing sustainability governance, disclosure obligations, stakeholder communication, and environmental management systems [23-28].

KCGS evaluates ESG performance through governance, risk management, operational performance, and stakeholder communication dimensions [25]. The institution places relatively strong emphasis on ESG disclosure transparency and governance integration. KRESG additionally incorporates environmental opportunities, environmental innovation, and environmental sanctions into its evaluation model [26]. SUSTINVEST focuses on sustainability innovation, biodiversity, supply-chain management, and ESG management systems while considering industrial characteristics and firm size [27]. Within the selected cases, these characteristics emphasize disclosure-oriented sustainability governance and ESG management structures. Table 5 presents the ESG rating results reported for Samsung Electronics and LG Electronics across the selected agencies. The following discussion distinguishes these overall grades from company-level descriptions of management practices.

Table 5. ESG Rating Results of Major Korean Electronics Manufacturers

Company	KCGS	KRESG	SUSTINVEST	MSCI
Samsung Electronics	A	A+	A	AA
LG Electronics	A	A	A	A

Source: Authors' compilation of public rating information from KCGS, KRESG, SUSTINVEST, and MSCI; provider references [25-29]. The values reproduce the authors' website-based collection and are not a date-matched comparison or a statement of current ratings.

Table 5 reports overall ESG grades for Samsung Electronics and LG Electronics. Samsung's corporate disclosure discusses climate-related reporting, technological innovation, and supply-chain management, while LG's report describes sustainability management, lifecycle assessment, and renewable energy transition strategies [31, 33]. These descriptions should not be inferred from the aggregate grades as evidence of superiority in individual evaluation dimensions. Differences in institutional priorities, weighting systems, and disclosure assumptions may be relevant to rating

interpretation [5, 6, 10, 11], but the table does not establish the agency-specific causes of the reported grades.

Overall, the comparative analysis indicates that the selected Japanese evaluation frameworks emphasize financial materiality and market-oriented governance, whereas the selected Korean ESG evaluation frameworks emphasize disclosure-oriented sustainability governance and ESG management systems. These institutional differences provide important foundations for understanding subsequent differences in Scope 3 disclosure practices and ESG disclosure comparability discussed in later sections. These findings concern the selected institutions, not either national system as a whole. Because the Japanese cases are credit-related frameworks and the Korean cases are standalone ESG evaluations, country context and institution type cannot be separated in this sample.

3.3 Comparative Analysis of Scope 3 Disclosure Practices

This section compares Scope 3 disclosure practices and climate-related sustainability strategies among major electronics manufacturers in Japan and Korea. The analysis focuses on Panasonic, Sony, Samsung Electronics, and LG Electronics because these firms play important roles in global electronics supply chains and are highly exposed to value-chain emissions associated with manufacturing, logistics, electricity consumption, and product-use phases [30-33]. The comparative analysis indicates that all four firms increasingly recognize Scope 3 emissions management as a central component of ESG governance and sustainability disclosure. At the same time, differences remain in disclosure comprehensiveness, category coverage, assurance practices, and climate-related management strategies. These differences indicate that comparison of Scope 3 disclosures requires attention to disclosure boundaries, lifecycle management approaches, and the reported governance context, rather than being interpreted directly as differences in environmental performance.

3.3.1 Japanese Electronics Manufacturers

Panasonic has strengthened climate-related disclosure through its “Panasonic GREEN IMPACT” initiative and expanded disclosure regarding lifecycle emissions, product efficiency, and supply-chain management [30]. The company discloses multiple Scope 3 categories, including purchased goods and services, fuel- and energy-related activities, upstream transportation, product use, and end-of-life treatment. Panasonic also presents quantitative reduction targets for product-use phase emissions and applies external assurance to sustainability-related disclosure data. Sony has also expanded sustainability disclosure through its “Road to Zero” environmental strategy and net-zero initiatives [32]. The company emphasizes reductions in product-use emissions, energy-efficient product development, and renewable energy utilization. Sony additionally strengthened climate-related commitments by accelerating carbon neutrality targets within its value chain. Sony’s 2024 report also includes limited assurance covering an aggregate of selected Scope 3 categories (p. 195), satisfying the assurance-presence criterion [32].

These findings suggest that the selected Japanese electronics manufacturers increasingly integrate Scope 3 disclosure into long-term corporate value creation, product efficiency improvement, and climate-related financial risk management. In particular, product-use phase emissions management and lifecycle-oriented sustainability governance play important roles in the climate strategies of these cases.

Table 6 summarizes major Scope 3 disclosure characteristics of Japanese electronics manufacturers.

Table 6. Comparative Scope 3 Disclosure Practices of Japanese Electronics Manufacturers

Company	Major Scope 3 Focus	Disclosure Characteristics	Assurance	Distinctive Features
Panasonic	Product-use emissions, supply chain	Multiple category disclosure and quantitative reduction targets	External assurance applied	Panasonic GREEN IMPACT initiative
Sony	Product-use emissions, energy efficiency	Net-zero commitments and lifecycle-oriented disclosure	Limited assurance covering selected Scope 3 categories	"Road to Zero" environmental strategy

Source: Compiled by the authors based on sustainability reports [30, 32].

3.3.2 Korean Electronics Manufacturers

Samsung Electronics has expanded climate-related disclosure through relatively comprehensive Scope 3 reporting and supply-chain management practices [31]. The company discloses multiple upstream and downstream emissions categories and provides detailed information regarding semiconductor manufacturing efficiency, lifecycle carbon reduction initiatives, and product-use phase emissions. Samsung additionally applies external verification procedures to sustainability disclosure data and actively incorporates low-carbon technologies into manufacturing processes. However, a qualifying numerical Scope 3 or value-chain GHG reduction target was not identified in the reviewed 2024 report; the product power-consumption objective is a different type of target [31]. LG Electronics demonstrates relatively comprehensive sustainability disclosure practices associated with lifecycle management, renewable energy transition, and resource circulation strategies [33]. The company discloses Scope 3 emissions together with eco-design initiatives, supply-chain engagement systems, and carbon neutrality strategies. LG Electronics also links sustainability disclosure with RE100 initiatives and applies external assurance procedures to climate-related disclosure data.

These findings indicate that the selected Korean electronics manufacturers emphasize disclosure comprehensiveness, sustainability management systems, and climate-related operational performance. The two reports describe ESG disclosure infrastructure, supply-chain management systems, and sustainability governance practices; these are case descriptions rather than a national ranking. Table 7 summarizes major Scope 3 disclosure characteristics of Korean electronics manufacturers.

Table 7. Comparative Scope 3 Disclosure Practices of Korean Electronics Manufacturers

Company	Major Scope 3 Focus	Disclosure Characteristics	Assurance	Distinctive Features
Samsung Electronics	Semiconductor manufacturing, supply chain	Extensive category disclosure and lifecycle carbon management	External verification applied	Technology-oriented climate strategy
LG Electronics	Lifecycle management, renewable energy	RE100-linked disclosure and eco-design strategies	External assurance applied	Sustainability management integration

Source: Compiled by the authors based on corporate sustainability reports [31, 33].

Overall, Tables 6 and 7 show that all four firms increasingly recognize Scope 3 disclosure as an essential component of ESG governance and climate-related sustainability management. Nevertheless, important differences remain in category coverage, reduction targets, assurance practices, and disclosure strategies. These differences raise questions about the comparability of Scope 3 disclosure

across firms and the interpretation of ESG ratings; their effects on rating outcomes are not estimated here [5, 6, 10, 11].

3.4 Comparative Scope 3 Disclosure and Climate-related Management Practices

The previous sections described Scope 3 disclosure and climate-related sustainability governance among the selected Japanese and Korean electronics manufacturers. However, important differences remain in climate-related management priorities, carbon reduction strategies, disclosure comprehensiveness, and sustainability governance approaches among firms.

To evaluate the overall comprehensiveness and comparability of Scope 3 disclosure practices, Table 8 summarizes the comparative assessment results based on the Scope 3 Disclosure Index introduced in the methodology section. The assessment focuses on category-based disclosure, upstream and downstream coverage, product-use phase disclosure, quantitative reduction targets, and third-party assurance practices.

Table 8. Comparative Assessment of Scope 3 Disclosure Practices of Major Electronics Manufacturers

Company	Category-based Disclosure	Upstream & Downstream Coverage	Product-use Phase Disclosure	Quantitative Reduction Targets	Third-party Assurance	Total Score
Panasonic	1	1	1	1	1	5
Sony	1	1	1	1	1	5
Samsung Electronics	1	1	1	0	1	4
LG Electronics	1	1	1	1	1	5

Note: Each criterion is scored as 1 when the relevant information is clearly disclosed and 0 when disclosure is absent or cannot be confirmed. Total scores range from 0 to 5.
Source: Compiled by the authors based on sustainability reports and climate-related disclosure documents published by Panasonic Holdings Corporation, Samsung Electronics, Sony Group Corporation, and LG Electronics [30-33].

The results presented in Table 8 show broad coverage of the five disclosure criteria among the selected companies. Panasonic, Sony, and LG Electronics receive scores of 5, while Samsung Electronics receives a score of 4. All four firms disclose Scope 3 categories, upstream and downstream emissions, product-use emissions, and external assurance of at least selected Scope 3 information. Under the defined coding rules, the only item-score difference concerns a qualifying quantitative Scope 3 or value-chain emissions reduction target [30-33]. These observations describe the reviewed reports, not convergence over time or superiority to unexamined manufacturers.

Panasonic, Sony, and LG Electronics receive scores of 5 because their reports provide relatively comprehensive category-level disclosure, quantitative reduction targets, and external assurance covering at least selected Scope 3 information [30, 32, 33]. Panasonic particularly emphasizes lifecycle carbon reduction and product-use phase emissions management through the Panasonic GREEN IMPACT initiative [30]. LG Electronics also demonstrates relatively strong integration between sustainability disclosure, lifecycle management, renewable energy transition strategies, and supply-chain engagement systems [33]. Sony presents climate-related disclosure and net-zero commitments through its “Road to Zero” strategy [32]. Sony’s assurance statement covers selected Scope 3 categories; this establishes assurance presence, not complete value-chain verification. Samsung Electronics provides extensive disclosure regarding supply-chain emissions, semiconductor manufacturing efficiency, and lifecycle carbon management [31]. A qualifying numerical Scope 3 GHG target was not identified in Samsung’s reviewed report, resulting in a score of 4. Equal assurance scores do not imply equal coverage, and the totals are not rankings of environmental performance.

In addition to the comparative assessment results presented in Table 8, Table 9 provides a detailed qualitative comparison of Scope 3 disclosure and climate-related management practices among Samsung Electronics, LG Electronics, Panasonic, and Sony using selected environmental themes informed by the MSCI framework and adapted for this qualitative comparison [29]. The comparison focuses on carbon emissions management, Scope 1–3 reduction strategies, climate change vulnerability, climate-related governance systems, environmentally related financial impacts, and product carbon footprint management. Company-level entries are drawn from the corporate reports [30-33], not MSCI component scores; the rows are not presented as an exact MSCI scoring taxonomy.

The comparative results indicate that all four firms established long-term carbon neutrality strategies and increasingly integrated climate-related disclosure into corporate sustainability governance systems. Nevertheless, substantial differences remain in management priorities, climate-related governance structures, and disclosure approaches.

Samsung Electronics places relatively strong emphasis on semiconductor manufacturing efficiency, operational emissions reduction, and supply-chain carbon management [31]. The company actively applies climate-risk scenario analysis, external verification systems, and product carbon footprint certification while integrating low-carbon technologies into manufacturing processes. These characteristics reflect a technology-oriented climate management strategy strongly associated with operational efficiency and manufacturing competitiveness. LG Electronics demonstrates relatively strong integration between lifecycle management, renewable energy transition, and sustainability governance systems [33]. The company connects sustainability disclosure with RE100 initiatives, lifecycle assessment (LCA), carbon accounting systems, and eco-design strategies. LG Electronics' report emphasizes sustainability management integration and environmental governance structures. Panasonic focuses on lifecycle carbon reduction, product-use phase emissions management, and climate governance integration through its "Panasonic GREEN IMPACT" initiative [30]. The company additionally applies scenario-based climate-risk analysis and environmental data management systems while expanding renewable energy utilization and Scope 3-related disclosure practices. Sony demonstrates relatively strong climate governance and product-oriented carbon reduction strategies through its "Road to Zero" initiative [32]. The company particularly emphasizes renewable energy transition, product lifecycle management, and logistics optimization associated with Scope 3 emissions reduction. Sony also applies climate-risk scenario analysis based on multiple temperature pathways, including 1.5°C, 2°C, and 4°C scenarios.

Overall, Tables 8 and 9 indicate shared basic disclosure features alongside differences in disclosure detail, target scope, assurance coverage, and sustainability governance strategies. These findings support a cautious discussion of comparability. They do not establish that international disclosure frameworks caused convergence or that the observed disclosure differences caused particular ESG rating outcomes [5, 6, 10, 11].

Table 9. Comparative Scope 3 Disclosure and Climate-related Management Practices of Major Electronics Manufacturers Using Adapted Environmental Comparison Themes

Environmental comparison themes	Samsung Electronics	LG Electronics	Panasonic	Sony
Carbon Emissions	Company-wide net-zero Scope 1 and 2 emissions target by 2050	Scope 1 and 2 GHG reduction target of 54.6% by 2030 from the 2017 baseline	Value-chain net-zero CO2 vision toward 2050; own Scope 1 and 2 CO2 net-zero target by 2030	"Road to Zero" initiative including Scope 1–3; net-zero target by 2040
Scope 1 & 2 Management Strategies	100% renewable energy transition at DX Division business sites by 2027; process-gas reduction and alternative-gas development	Introduction of process efficiency and carbon reduction facilities; renewable energy expansion and process gas reduction	"Panasonic GREEN IMPACT" initiative; operational Scope 1 and 2 CO2 reductions and expanded renewable energy use	100% renewable electricity and net-zero Scope 1 and 2 emissions from own operations by 2030
Scope 3 Management	Integrated emissions management system and annual third-party verification	Product lifecycle assessment and supply-chain emissions reduction strategies	Product-use phase emissions reduction and lifecycle management	Supply-chain emission reduction and logistics optimization
Climate Change Vulnerability	Climate-risk scenario analysis and global operational risk management	Carbon management system and energy-use management	Climate-risk analysis based on multiple scenarios	Climate-risk scenario analysis based on 1.5°C, 2°C, and 4°C scenarios
Climate-related Governance	TCFD-aligned climate disclosure and internal climate governance systems	CDP-based climate disclosure and environmental governance structure	Climate governance integrated into sustainability strategy	PDCA-based climate-risk management framework
Environmentally Related Financial Impact	CDM investment projects and increased environmental investment	Carbon accounting system and internal carbon pricing	Environmental data collection and carbon management systems	Renewable energy procurement and climate-related investment strategies
Product Carbon Footprint	Product carbon footprint certification and recycling initiatives	Lifecycle assessment (LCA) and eco-index systems	Supply-chain emissions analysis and Scope-based disclosure	Carbon reduction strategies in product design and lifecycle management

Source: Compiled by the authors based on corporate sustainability reports and climate-related disclosure documents of Samsung Electronics, LG Electronics, Panasonic, and Sony [30-33]. Target scopes and years follow the cited report editions; these are not harmonized measures of target ambition.

3.5 ESG Divergence and Disclosure Comparability

The comparative analyses presented in the previous sections identify methodological and institutional differences to consider alongside corporate environmental performance when interpreting ESG evaluations and Scope 3 disclosures. Although international sustainability disclosure frameworks increasingly encourage standardization and comparability, the literature reports rating divergence and the selected cases illustrate disclosure-comparability issues [5-12].

Recent literature suggests that ESG rating divergence reflects differences in evaluation methodologies, institutional priorities, and sustainability assumptions rather than simple evaluation inconsistency [6, 7, 8]. Christensen et al. [7] examine ESG disclosure and rating disagreement, while Gibson Brandon et al. [8] examine ESG rating disagreement and stock returns. Similarly, Avramov et al. [9] analyze sustainable investing under ESG rating uncertainty. These discussions indicate that ESG divergence represents a structural characteristic of ESG evaluation systems rather than a temporary market anomaly.

The selected Japanese and Korean evaluation institutions exhibit differences in their stated priorities and approaches. The selected Japanese credit-related frameworks emphasize financial materiality, climate-related business risks, and market-oriented governance structures associated with institutional investors and stewardship systems. In contrast, the selected Korean ESG evaluation frameworks emphasize disclosure comprehensiveness, sustainability management systems, stakeholder communication, and disclosure-oriented governance structures. These case-specific patterns should not be generalized to all evaluation institutions in either country.

The framework identifies weighting systems, evaluation boundaries, and assurance practices as potential sources of differences in ESG assessments, without estimating their individual effects. Some institutions place relatively stronger emphasis on climate-related financial risks and operational efficiency, while others prioritize governance integration, sustainability innovation, environmental disclosure, or supply-chain management systems. Consequently, even when evaluating the same company, ESG rating outcomes may differ depending on institutional priorities and methodological assumptions. These findings are broadly consistent with previous studies emphasizing the importance of methodological heterogeneity in ESG evaluation systems [5, 6, 10].

Scope 3 disclosure remains one of the most important sources of disclosure comparability challenges. Although all four electronics manufacturers examined in this study disclose Scope 3 emissions and increasingly strengthen climate-related governance systems, important differences remain in category coverage, disclosure detail, reduction targets, product-use phase management, lifecycle boundaries, and third-party assurance practices. In particular, supplier-emissions coverage and disclosure assumptions need to be considered when interpreting evaluations that use public sustainability information [11, 12].

The electronics manufacturing industry presents a particularly important context for ESG disclosure comparability because product-use phase emissions, electricity consumption, semiconductor manufacturing, and global supply-chain emissions account for substantial portions of lifecycle carbon footprints. As international sustainability disclosure frameworks increasingly strengthen Scope 3 disclosure requirements, comparability and transparency issues are likely to become more significant for both corporations and ESG rating agencies.

The case findings, considered alongside the rating-divergence literature [6-11], suggest that improving corporate disclosure alone may not fully eliminate ESG rating divergence. Greater methodological transparency regarding weighting systems, evaluation criteria, disclosure assumptions, and assurance procedures is also necessary to improve the reliability and comparability of ESG evaluations. In this regard, recent developments associated with ISSB, CSRD, SSBJ, and KSSB may contribute to greater convergence in climate-related disclosure frameworks, although institutional and methodological differences among ESG evaluation systems are likely to persist.

Overall, this study describes ESG governance and climate-related disclosure in the selected Japanese and Korean cases within the context of international reporting developments. The observed methodological and disclosure differences are relevant to interpreting ESG evaluations, but the analysis does not estimate national effects or the causes of specific rating outcomes.

Taken together, the results address the three analytical objectives stated in the Introduction. First, the institutional comparison describes the evaluation priorities of the selected Japanese and Korean frameworks. Second, the comparative framework organizes methodological issues concerning weighting, boundaries, assurance, transparency, and feedback. Third, the Scope 3 Disclosure Index shows broad coverage of the five criteria, with Panasonic, Sony, and LG Electronics scoring 5 and Samsung Electronics scoring 4; the remaining item-score difference concerns a qualifying quantitative Scope 3 GHG target. These findings connect the institutional comparison, methodological framework, and corporate disclosure analysis without treating them as a causal decomposition of rating divergence.

4. CONCLUSIONS

This study examined ESG rating systems and Scope 3 disclosure practices in Japan and Korea, with a particular focus on the electronics manufacturing industry. The major conclusions of this study are as follows.

First, ESG governance and sustainability disclosure systems in both Japan and Korea have developed in response to international climate-related disclosure frameworks such as TCFD, ISSB, and CSRD. Within the selected institutions and policy developments reviewed here, the Japanese cases emphasize stewardship, market-oriented governance, and financial materiality, while the Korean cases emphasize disclosure-oriented sustainability governance. These are patterns within the selected cases rather than comprehensive national characteristics.

Second, methodological differences remain across the selected ESG-related evaluation institutions. Differences in weighting systems, evaluation boundaries, disclosure assumptions, and assurance practices are potential issues in interpreting rating divergence; their effects on the same firms are not estimated in this study.

Third, Panasonic, Sony, Samsung Electronics, and LG Electronics show broad coverage of the five Scope 3 disclosure criteria. Panasonic, Sony, and LG Electronics score 5, while Samsung Electronics scores 4 because a qualifying quantitative Scope 3 GHG target was not identified in its reviewed report. Beyond the binary scores, differences remain in target scope, lifecycle management strategies, and the coverage of third-party assurance.

Fourth, the comparison and prior literature suggest that improving corporate disclosure alone may not fully eliminate ESG rating divergence. Greater methodological transparency and comparability in ESG evaluation systems are also necessary to improve the reliability of sustainability assessments.

Fifth, as international sustainability disclosure frameworks develop, disclosure comparability, assurance systems, and climate-related governance transparency will become increasingly important for corporations, investors, and regulators.

While this study offers valuable institutional insights by comparing ESG evaluation systems and Scope 3 disclosure practices within the Japanese and Korean electronics industries, several limitations should be acknowledged. First, the empirical focus on four mega-cap multinational corporations restricts the generalizability of the findings to small and medium-sized enterprises (SMEs) that face distinct resource constraints within broader supply chains. Second, the Scope 3 Disclosure Index developed in this study relies on a binary assessment of disclosure availability and does not fully capture differences in methodological quality or reliability of reported emissions data. Third, the selected institutions do not represent either national evaluation system as a whole; the Japanese credit-related and Korean standalone ESG cases also differ in institution type. Fourth, equal weighting and overlapping disclosure dimensions limit the interpretation of the total score. Consensus coding was used rather than independent parallel coding, and no inter-coder reliability statistic is reported. Finally, the

findings reflect the public webpages, reports, and evaluation documents reviewed for the study period. Provider-level rating dates and reporting boundaries are not harmonized, which limits direct comparison of the collected grades. Corporate targets, Scope 3 reporting, assurance coverage, and evaluation methodologies may subsequently change, so the findings should not be read as current information beyond the reviewed sources.

To overcome these limitations, future research should expand the analytical scope to include Tier-1 suppliers and broader manufacturing networks in order to examine how sustainability disclosure requirements and ESG governance pressures cascade throughout global value chains. Moreover, subsequent econometric analyses are required to empirically validate how ESG rating divergence and variations in disclosure quality translate into financial performance indicators, including the cost of capital, financing accessibility, and corporate valuation. Continued monitoring and periodic reassessment should document subsequent changes in corporate targets, Scope 3 disclosure, assurance coverage, and evaluation methodologies.

Acknowledgement

The authors acknowledge the research support provided by the Multi-disciplinary Research Aiming for Planetary Health (MIRAI-PH) Program of Nagasaki University.

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