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DOUBLE MATERIALITY AND SUSTAINABILITY REPORTING IN THE TEXTILE AND APPAREL SECTOR

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Abstract: This paper provides a critically examine double materiality in the textile and apparel sector, an industry with significant environmental and social impacts. Double materiality refers to a dual assessment perspective in sustainability reporting that considers both the impacts of corporate activities on environmental and social systems (impact materiality) and the financial risks and opportunities that sustainability-related issues pose to firm value (financial materiality). With the introduction of the European Sustainability Reporting Standards (ESRS) under the Corporate Sustainability Reporting Directive (CSRD), double materiality has become a mandatory reporting principle. The paper compares ESRS with earlier frameworks such as the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB), highlighting key convergences and divergences. Unlike descriptive reviews, this study provides a critical and comparative analysis and synthesizes textile and apparel sector specific material topics across these global frameworks. The originality of this article lies in its identification, mapping, and critical evaluation of the three major reporting standards, combined with a textile and apparel sector-focused synthesis of frameworks. To the best of our knowledge, no comparable study has specifically examined double materiality in the textile and apparel sector; this paper fills that gap through critical comparative analysis and synthesis across ESRS, GRI, and SASB.

Keywords: Double Materiality, Textile Industry, Sustainability Reporting, GRI, SASB, ESRS, Sustainability.

Tekstil Ve Hazırgiyim Sektöründe Çifte Önemlilik Ve Sürdürülebilirlik Raporlaması

Öz: Bu makale, önemli çevresel ve sosyal etkileri olan bir sektör olan tekstil ve konfeksiyon sektöründe çifte önemliliği (Double Materiality) eleştirel bir bakış açısıyla incelemektedir. Çifte önemlilik, sürdürülebilirlik raporlamasında hem kurumsal faaliyetlerin çevresel ve sosyal sistemler üzerindeki etkilerini (etki önemliliği) hem de sürdürülebilirlikle ilgili konuların işletme değeri üzerinde oluşturduğu finansal risk ve fırsatları (finansal önemlilik) dikkate alan çift yönlü bir değerlendirme perspektifini ifade eder. Kurumsal Sürdürülebilirlik Raporlama Direktifi (CSRD) kapsamında Avrupa Sürdürülebilirlik Raporlama Standartları (ESRS) getirilmesiyle, çifte önemlilik zorunlu bir raporlama ilkesi haline gelmiştir. Makale, ESRS'yi Küresel Raporlama Girişimi (GRI) ve Sürdürülebilirlik Muhasebe Standartları Kurulu (SASB) gibi önceki çerçevelerle karşılaştırarak, temel benzerlikleri ve farklılıkları vurgulamaktadır. Standart derleme makalelerinden farklı olarak bu çalışma eleştirel ve karşılaştırmalı bir yaklaşım benimsemekte ve bu üç küresel çerçeveden tekstil ve hazır giyim sektörüne özgü önemlilik başlıklarını sentezlemektedir. Bu makalenin özgünlüğü, üç ana raporlama standardının tanımlanması, haritalandırılması ve eleştirel değerlendirilmesinin, sektör odaklı bir çerçeve senteziyle birleştirilmesinde yatmaktadır. Bilgimiz dahilinde, tekstil ve giyim sektöründe çift önemliliği özel olarak inceleyen benzer bir çalışma bulunmamaktadır; bu makale, ESRS, GRI ve SASB arasında eleştirel karşılaştırmalı analiz ve sentez yoluyla bu boşluğu doldurmaktadır.
Anahtar Kelimeler: Çifte Önemlilik, Tekstil Sanayii, Sürdürülebilirlik Raporlaması, GRI, SASB, ESRS, Sürdürülebilirlik

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1. INTRODUCTION

Sustainability has become a pressing issue as the foundations of life on Earth are threatened by pollution, biodiversity loss, and resource depletion. The manufacturing sector is recognized as the primary source of these effects due to high energy consumption and waste; specifically, the textile industry significantly impacts the environment, causing 10% of global greenhouse gas emissions (Filho et al., 2022) and 20% of global water pollution (Vlahović et al., 2024). While sustainability reporting is an important instrument for accountability in such circumstances (Amin et al., 2024), conventional methods frequently fall short, as companies may selectively disclose information to hide adverse effects or focus solely on financial stakeholders. As a solution to these shortcomings, a paradigm shift is provided by the idea of double materiality. Double materiality refers to a dual assessment perspective in sustainability reporting that considers both the impacts of corporate activities on environmental and social systems and the financial risks and opportunities affecting firm value (EFRAG, 2024). This approach fundamentally redefines corporate responsibility and transforms impact focused reporting which is once viewed as a good practice into a market access requirement. For the Turkish textile industry, which is deeply integrated into the EU market, this transformation represents not merely a compliance issue but also a strategic necessity. While double materiality is an emerging field, current research has explored its historical evolution from non-financial reporting (Baumüller & Sopp, 2022) and its conceptual links to SDGs and ESG factors (Delgado-Ceballos et al., 2023). Empirical studies have investigated assessment challenges (Mezzanotte, 2023) and reporting consistency among early adopters in Europe (Correa-Mejía et al., 2024), with specific regional analyses in Romania and Poland (Dragomir et al., 2024; Szalacha, 2024). Furthermore, sector-specific research has highlighted the necessity for standardized reporting in high-impact industries such as mining, oil and gas, banking, and renewable energy (Ng et al., 2022).

However, despite the textile and apparel industry's serious sustainability issues and pressing need for accountability, no studies have particularly examined double materiality in this sector.Therefore, this study seeks to fill this significant gap in the literature, providing an original contribution to both academic research and industry practice. This research contributes to a more comprehensive understanding of sustainability accountability within the textile and apparel Industry by providing insights into the application of double materiality in industry reporting. This study adopts an analytical and comparative approach to evaluate double materiality within the textile and apparel industry. A comprehensive review was conducted using leading academic databases (e.g., Web of Science, Scopus, Google Scholar) and institutional sources, including official GRI, SASB, and ESRS/EFRAG standards, EU regulations, and industry disclosures. The methodological process follows a three-stage approach: (1) mapping the conceptual evolution of materiality, (2) comparing the principles and disclosure requirements of the GRI, SASB, and ESRS frameworks, and (3) synthesizing textile-specific material topics to identify alignment, gaps, and implementation challenges within the sector. By mapping these synthesized topics to specific disclosure, the study transcends simple summarization. It provides an original scholarly contribution by linking framework constraints—such as disclosure logic and boundaries—with the specific implementation challenges faced by the textile sector.

2. MATERIALITY IN SUSTAINABILITY REPORTING: SINGLE, DOUBLE, AND DYNAMIC MATERIALITY

For organizations to effectively report on sustainability, they must identify relevant reporting topics. Some organizations may omit negative information to conceal weaknesses or exaggerate strengths to attract stakeholders (Pizzi et al., 2024). Others may prioritize the expectations of financial stakeholders over essential sustainability aspects (Adams & Abhayawansa, 2022). Thus, determining which topics are material is crucial. Materiality refers to assessing whether specific information should be included in a report based on its impact on decision-making and

stakeholder assessment. However, the type of disclosed information varies depending on the target audience (Mio et al., 2020), leading to different approaches to materiality. One approach to materiality focuses on financial performance, emphasizing relevance for investors and stakeholders (Abhayawansa, 2022). This is known as single materiality or financial materiality. It primarily considers how external factors impact the organization's financial performance, a perspective referred to as outside-in materiality (Remmer & Gilbert, 2019). However, single materiality does not fully meet the objectives of sustainability reporting, as it focuses predominantly on financial aspects rather than incorporating social and environmental considerations

Double materiality is a more extensive method that takes into account both inside-out and outside-in viewpoints, going beyond financial considerations. The outside-in viewpoint takes into account outside factors like investor demands, consumer expectations, and governmental regulations. According to Remmer and Gilbert (2019), the inside-out approach looks at how an organization affects society, the environment, and the overall economy.

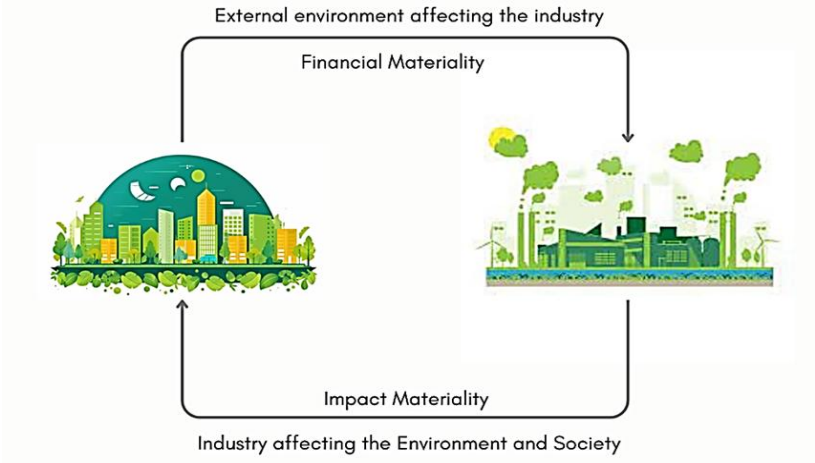

Figure 1:
The Double Materiality Concept

The way in which external environmental factors influence industries (financial materiality/outside-in), and how industries, in turn, affect the environment and society (impact materiality/inside-out), is illustrated in Figure 1. This interconnected perspective is crucial for sustainability reporting, as it highlights both financial risks and broader environmental and social responsibilities. Organizations must consider these interactions in a forward-looking manner, integrating financial, environmental, and economic aspects into their strategies (Gauzès et al., 2021). Ultimately, double materiality integrates both financial and impact materiality, emphasizing sustainability responsibilities.

Furthermore, Dynamic materiality, which acknowledges that non-financial issues may turn into financial ones, is another important idea. These problems, which are referred to as pre-financial materials, give the evaluation of materiality a dynamic component (Gauzès et al., 2021). This viewpoint emphasizes how important it is for organizations to keep an eye on new sustainability threats that may have an impact on their long-term financial results.

In summary, meaningful sustainability reporting requires an understanding of and adherence to appropriate materiality frameworks. Double materiality integrates societal and financial factors to offer a more comprehensive view than single materiality, which is still centered on financial performance. Furthermore, dynamic materiality emphasizes how sustainability issues are dynamic, which emphasizes the necessity of flexible and progressive reporting techniques.

3. SUSTAINABILITY ASSESSMENT AND REPORTING STANDARDS

Ensuring consistent and accurate sustainability assessments requires a structured methodology. Key frameworks such as the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) have shaped modern sustainability reporting, while the European Sustainability Reporting Standards (ESRS) operationalize double materiality more explicitly. Although all three frameworks serve as instruments for implementing double materiality, they rest on different structural and philosophical foundations. GRI reflects a 'corporate citizen' model focused on organizational impacts; SASB embodies a 'shareholder-priority' approach emphasizing financial relevance; and ESRS represents a legally mandated form of 'stakeholder capitalism', recognizing that a company's social and environmental impacts are intrinsically linked to its long-term financial performance.

3.1.1. Global Reporting Initiative (GRI)

GRI was originally created to encourage corporate responsibility on environmental matters, GRI afterwards grew to incorporate social, economic, and governance considerations (GRI - Mission & History, 2022). It addresses several stakeholder groups and is consistent with the double materiality principle (Alder, 2022). Three groups comprise the GRI standards:

1. Universal Standards: Including GRI 1 (basic reporting principles), GRI 2 (governance and organizational structure disclosures), and GRI 3 (materiality assessment guidelines), these establish the fundamental requirements for all organizations utilizing the GRI framework (Global Reporting Initiative, 2021).
2. Sector Standards: These improve the comparability between companies in the same sector. Oil and Gas (GRI 11), Coal (GRI 12), Agriculture, Aquaculture, and Fishing (GRI 13), and Mining (GRI 14) are among the published standards; textile and apparel standards are in construction (GRI - Sector Program, 2024).
3. Topic Standards: These specify the disclosure requirements for important sustainability subjects, such as social, environmental, and economic facets.

GRI is appropriate for multi-stakeholder reporting since it focuses primarily on impact materiality (Alder, 2022; EFRAG, 2024).

3.1.2. Sustainability Accounting Standards Board (SASB)

SASB, in contrast, focuses on financial materiality, catering to investors and financial stakeholders. While acknowledging double materiality, it emphasizes financial decision-making (EFRAG, 2024). SASB categorizes sustainability across five dimensions: environment, human capital, social capital, business model and innovation, and leadership and governance. It defines 26 issue categories and provides material topic lists for 77 industries across 11 broad sectors. The Apparel, Accessories & Footwear industry falls within the consumer goods sector.

Many companies now use both standards together as they complement each other and make the reporting complete for all kinds of stakeholders, enhances transparency and stakeholder trust (Pizzi et al., 2024).

3.1.3. European Sustainability Reporting Standards (ESRS)

To improve sustainability reporting in line with double materiality, the European Commission assigned the European Financial Reporting Advisory Group (EFRAG) to develop the European Sustainability Reporting Standards (ESRS). ESRS was adopted in July 2023 and became effective on January 1, 2024 (Publications Office of the European Union, 2023). It assesses materiality using the Impact, Risk, and Opportunities (IRO) framework, distinguishing between impact materiality (business impact on society and the environment) and financial materiality (external risks and opportunities affecting business performance) (EFRAG, 2024).

ESRS consists of three main categories:

1-Cross-cutting Standards: These include ESRS 1 (General Requirements) and ESRS 2 (General Disclosures). ESRS 1 defines the framework, drafting rules, and key concepts, while ESRS 2 outlines governance, strategy, impact, risk, and opportunity management disclosures.

2-Topical Standards: This cover environmental, social, and governance topics, detailing required disclosures on governance, strategy, impact, risk and opportunities, metrics, and targets.

3-Sector Standards: These apply to industry-specific sustainability issues, ensuring comparability within sectors. However, sector standards are yet to be published.

ESRS requires companies to conduct materiality assessments and disclose their methodology. If a company omits a material topic, it must justify the exclusion in line with entity-specific standards (EFRAG, 2024). ESRS aligns with GRI's impact materiality and SASB's financial materiality, enabling companies to conduct more comprehensive assessments and identify additional materiality matters (EFRAG, 2024).

As a result, the integration of GRI, SASB, and ESRS reflects the evolving landscape of sustainability reporting, addressing both impact and financial materiality to meet the needs of diverse stakeholders. As sustainability regulations continue to evolve, organizations must adopt a comprehensive approach to ensure transparency and accountability in their reporting processes.

4. THE MATERIALITY ASSESSMENT PROCESS

The foundation of sustainability reporting is the materiality assessment, which identifies the topics most relevant to an organization. Although the core steps are similar across frameworks, their approaches differ. ESRS integrates risks and opportunities throughout the assessment process, whereas GRI focuses primarily on impacts. SASB, by contrast, provides predefined industry-specific material topics—such as those for the Apparel, Accessories & Footwear sector—and therefore does not require a materiality assessment.

The assessment begins with a comprehensive analysis of the organization's internal and external operating environment. This includes evaluating its strategy, sector, operations, workforce, and geographic footprint alongside broader legal, regulatory, and global sustainability challenges. Crucially, organizations must identify and map all relevant stakeholders—including value chain partners, investors, communities, and NGOs—to ensure the assessment accurately reflects the interests of those impacted by the entity's activities.

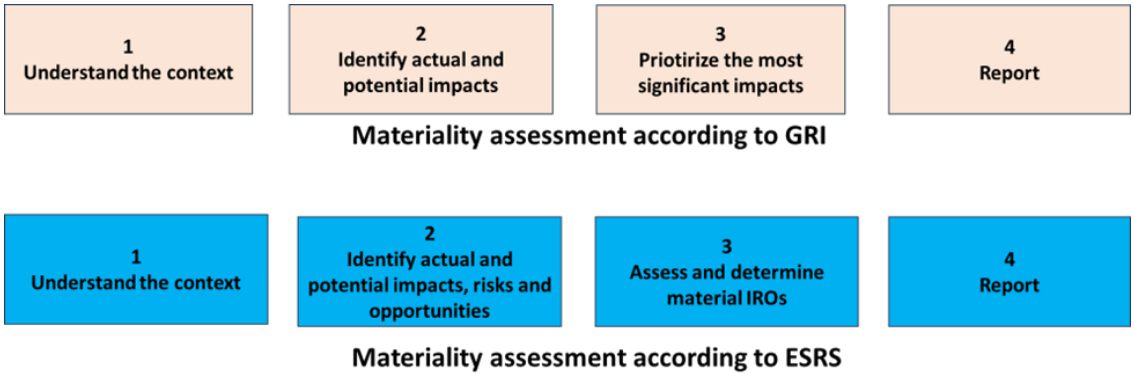

Figure 2:
Materiality assessment process according to GRI and ESRS

Next, organizations identify both positive contributions and negative impacts (actual or potential) across economic, environmental, social, and human rights dimensions. Through expert and stakeholder engagement, the entity must determine whether it is causing, contributing to, or directly linked to these impacts. Notably, the ESRS framework expands this scope by mandating the assessment of not only impacts but also associated risks and opportunities (IROs) across the organization's entire upstream and downstream value chain.

Identified impacts must then be evaluated and prioritized to establish reporting thresholds.

The GRI Approach**:** Significance is determined through qualitative and quantitative analyses, leveraging stakeholder consultation to mitigate subjectivity. Topics are ranked, cross-referenced with sector-specific standards to prevent omissions, and ultimately approved by the highest governance body (GRI Standards, 2024).
The ESRS Approach: ESRS mandates the application of both impact and financial materiality criteria (double materiality). This yields a consolidated list of material impacts, risks, and opportunities that forms the foundation of the sustainability statement (EFRAG, 2024).

As shown in Figure 2, both frameworks begin with understanding the organizational context and identifying impacts, but ESRS explicitly incorporates risks and opportunities, enabling more integrated decision-making and reporting. This distinction is essential for organizations aiming to meet evolving regulatory expectations and stakeholder demands.

5. IDENTIFYING AND ANALYZING DOUBLE MATERIALITY TOPICS IN THE TEXTILE AND APPAREL SECTOR

While global reporting standards provide general guidance, they often remain generic. Therefore, sector-specific adaptation is essential and in this study we made a textile and apparel sector specific analysis by critically examining and comparing the disclosure requirements of ESRS, GRI, and SASB.Figure 3 presents the Double Materiality Topics for the Textile Industry, synthesized from the three frameworks specifically within the scope of this study.

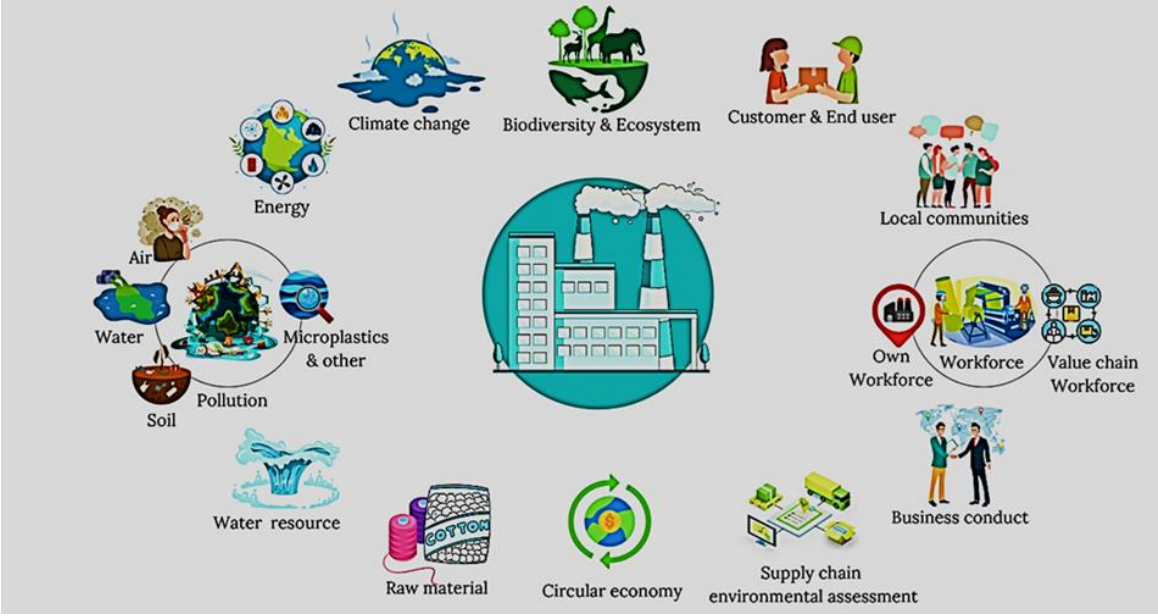

Figure 3:
Double materiality topics for the textile industry (synthesized from ESRS, GRI, and SASB).

5.1. Climate Change

The textile industry has a significant impact on climate change by contributing to greenhouse gas emissions at various stages, including raw material procurement, production, transportation, and distribution. This sector is responsible for approximately 10% of global greenhouse gas emissions, surpassing the combined emissions of international aviation and maritime transport. This highlights the substantial contribution of the textile industry to global warming. The production process is highly energy-intensive, generating approximately 1.2 billion tons of CO_2 equivalent annually. Notably, the carbon emissions from synthetic fibers are higher than those from cotton. Paradoxically, the use of synthetic fibers has grown exponentially, surpassing cotton as the most widely used textile fiber (Niinimäki et al., 2020). These issues are further exacerbated by the fast fashion trend, which accelerates production cycles. If current trends persist, the textile

industry is projected to account for 25% of the global carbon budget by 2050 (Fashion and the Circular Economy, 2019).

The European Sustainability Reporting Standards (ESRS) address climate change under the ESRS E1 topical standard. This standard requires organizations to disclose their plans and policies for climate change adaptation and mitigation, greenhouse gas emissions, internal carbon pricing, and related impacts, risks, and opportunities (Publications Office of the European Union, 2023). Additionally, GRI relates to this issue through GRI 305: Emissions (GRI - GRI Standards, 2024), which includes disclosures on CO_2 and other greenhouse gases, ozone-depleting substances, and requires the reporting of direct, energy indirect, and other indirect greenhouse gas emissions. The financial implications of climate change are, however, covered under GRI 201: Economic Performance (GRI - GRI Standards, 2024).

5.2. Energy Consumption

The textile industry is characterized by high energy consumption, often associated with inefficient energy use (Yacout et al., 2014). Energy costs represent 5–17% of total production expenses in this sector. Energy is primarily consumed in two ways: directly as electricity, which powers machinery but results in significant energy losses during processing (Qaisar & Bilal, 2022), and indirectly through the use of natural gas for electricity, heat, or steam production. The reliance on natural gas contributes to greenhouse gas emissions. Additionally, the electricity generation sector accounts for 43% of global greenhouse gas emissions (Michaelides, 2023). Therefore, improving energy efficiency and adopting renewable energy sources are critical for the textile industry, offering both financial benefits and positive environmental and social impacts.

From a double materiality perspective, energy management is a crucial issue. ESRS addresses energy consumption under ESRS E1, while GRI provides relevant guidelines under GRI 302: Energy (GRI - GRI Standards, 2024). These standards require disclosures on energy sources, the mix of renewable and non-renewable energy, energy efficiency measures, and electricity usage.

5.3. Air Pollution

Beyond CO_2 emissions, the textile industry significantly contributes to air pollution through the release of toxic compounds such as NO_2 and SO_2 from energy production, and volatile organic compounds (VOCs) from processing activities like coating and wastewater treatment (Guo et al., 2023; Islam, 2020). These pollutants, along with emissions from dyeing (aniline vapors, H_2S, chlorine) and printing (hydrocarbons, ammonia), contribute to smog, acid rain, and ozone depletion (Liu et al., 2016). Furthermore, the presence of carcinogens like formaldehyde and benzene-derived compounds, alongside cotton dust and endotoxins, poses severe respiratory risks to workers (Subramaniam et al., 2024).

Given these significant impacts, air pollution is a crucial material topic in sustainability reporting. ESRS addresses it under the ESRS E2 standard, while GRI includes it within GRI 305: Emissions. Organizations are required to disclose information on greenhouse gas emissions, ozone-depleting substances, nitrogen and sulfur oxides, and other regulated air pollutants under international and national regulations (GRI - GRI Standards, 2024).

5.4. Water Pollution

The textile industry generates substantial wastewater during production, posing a serious environmental threat. It is responsible for approximately 20% of global water pollution, with wastewater often containing high concentrations of suspended solids, dyes, salts, and heavy metals, leading to water quality degradation (Dhameliya & Ambasana, 2023). Most contaminants originate from chemical processes used in dyeing, printing, and finishing. Additionally, effluents are often discharged at high temperatures and pH levels, further damaging ecosystems. Colloidal matter, dyes, and oily foams increase water turbidity, affecting its appearance and odor. The high coloration of wastewater obstructs sunlight penetration, hindering photosynthesis and depleting

dissolved oxygen levels, which threatens aquatic life (Islam, 2020). Moreover, microfibers, particularly microplastics, which can carry hazardous chemicals, have been detected in freshwater and marine ecosystems, posing risks to biodiversity and human health (Devi & Devi, 2024). The release of these microfibers during production is a growing concern. Water pollution in the textile industry extends beyond production. Cotton farming, for instance, involves intensive pesticide and fertilizer use, contaminating nearby water bodies (Islam, 2020). Poor wastewater management not only harms the environment but also impacts socio-economic development and consumer trust. Non-compliance with water pollution regulations can lead to reputational damage and financial losses, as manufacturers risk losing business opportunities (K. Gomes et al., 2023).

Recognizing its critical impact, ESRS addresses water pollution under the ESRS E2 standard, while GRI includes it in GRI 303: Water and Effluents, requiring disclosures on water usage, wastewater treatment, and effluent discharge (GRI - GRI Standards, 2024).

5.5. Soil Pollution

Textile production generates waste at various stages, some of which is non-toxic, such as fabric scraps, fibers, and packaging materials. These often end up in landfills, contributing to soil degradation. However, toxic waste, including bleach, sludge, lye, and dyes used in fabric treatment and dyeing, poses a more significant threat (Islam, 2020). Improper disposal of these substances results in long-term contamination of soil and water bodies, disrupting soil microbiota and reducing fertility, which adversely affects plant growth and agricultural productivity (Kumar et al., 2017). Annually, approximately 280,000 tons of dye effluents are released, with 12-15% of dyes used in manufacturing ending up in wastewater (Akter et al., 2023). Managing this vast quantity of dye effluents, including sludge, is a critical environmental concern.The ESRS E2 standards outline disclosure requirements for soil pollution, while GRI covers it under GRI 306: Waste, emphasizing the need for responsible waste management and proper disposal practices (GRI - GRI Standards, 2024).

5.6. Other Kinds of Pollution

Microplastic pollution is another concerning environmental issue, and the textile industry is one of the contributors due to the release of microfibers and microplastics during the manufacturing process. The production and use of synthetic textiles, such as polyester and nylon, lead to the shedding of microfibers during washing, which can enter wastewater systems. The application of polymeric finishes on textiles contributes to the release of polymeric nanoplastics (PNPs) and fibrous microplastics (FMPs) during washing (Ali et al., 2024). Microplastics can accumulate in aquatic environments, posing risks to marine life through ingestion and entanglement, and can absorb harmful toxins. Microplastics have been detected in the human food chain, raising concerns about potential health impacts from consumption (Chan et al., 2024). An estimated 35% of primary microplastics in marine environments originate from synthetic clothing (Devi & Devi, 2024), making it a concern for this industry. Enhancing the efficiency of wastewater treatment plants (WWTPs) can significantly reduce microplastic discharge into the environment (Magalhães et al., 2024). There is a pressing need for standardized testing methods and regulations to monitor and limit microplastic emissions from textile production. As a result, reporting about microplastics can be an important topic for the textile industry.

It can also be an important topic for the industry to report on substances of concern and substances of very high concern, as some chemicals—such as formaldehyde, phthalates, and azo dyes—frequently used in textile processing, or carcinogenic and mutagenic substances found in wastewater, are categorized under these concern classes (Patra & Pariti, 2022). ESRS E2 standards cover these topics where it requires the disclosure of the amount of microplastics generated or used by the entity, the production, use, distribution, import, export etc. of the substances of concern and substances of very high concern etc. GRI, however, doesn't exclusively mention microplastic pollution but covers the standards about hazardous materials in GRI 306: Waste. (GRI - GRI Standards, 2024).

5.7. Water Resource Management

The textile industry is one of the most water-intensive industries, consuming large volumes throughout various stages of production. The average water consumption for textile processing can reach up to 164 liters per kilogram of fabric, with dyeing operations alone accounting for 136 liters per kilogram (Uddin et al., 2023). Water plays a crucial role as a solvent for dyes and chemicals, a medium for dye transfer, and for washing and rinsing fabrics. It is extensively used in pretreatment, dyeing, printing, and finishing, with variations depending on fiber type and machinery. Beyond production, raw material cultivation, particularly cotton farming, is also highly water-intensive. For example, producing a single cotton shirt and a pair of jeans requires approximately 20,000 liters of water (Islam, 2020).

To meet this enormous demand, the textile industry heavily relies on groundwater, often leading to depletion in regions with high industry concentration (Uddin et al., 2023). Sustainable water management is critical, requiring transparency regarding water sources, consumption, discharge, and policies aimed at reducing environmental impact. The ESRS E3 standards outline requirements for water resource disclosures, while GRI includes related guidelines in GRI 303: Water and Effluents. These standards mandate reporting on water sourcing, treatment, reuse, discharge, and sustainability initiatives (GRI - GRI Standards, 2024).

5.8. Raw Materials

The textile industry utilizes a diverse range of raw materials. Natural fibers such as cotton, jute, flax, hemp, kenaf, and ramie are valued for their renewability and biodegradability, making them a more sustainable option. Animal-derived fibers like wool and silk are also considered environmentally preferable to synthetic fibers, though traditional wool processing methods have historically been. Synthetic fibers, including polyester and nylon, offer durability and cost-effectiveness but pose significant environmental challenges due to their non-biodegradability and association with microplastic pollution. Regenerated cellulosic fibers, such as rayon, provide a balance between natural and synthetic fibers, though their production remains chemically intensive (Lacasse & Baumann, 2004).

There is a growing emphasis on sustainable raw materials and environmentally friendly processing methods, including the use of organic cotton, biodegradable dyes, and recycled water, to minimize the textile industry's environmental footprint (Amjad & Kumar, 2022). Unlike ESRS, which does not directly address raw materials, GRI 301: Materials standard requires organizations to disclose the share of renewable and non-renewable materials used, as well as the proportion of virgin and recycled materials (GRI - GRI Standards, 2024).

Additionally, SASB standards emphasize financial materiality, examining the effects of climate change, resource scarcity, and geopolitical factors on raw material supply chains. These standards require organizations to report on priority raw materials, associated environmental and social risks, business implications, and strategies for managing these risks (“Sustainability Accounting Standard Apparel, Accessories & Footwear,” 2023).

5.9. Biodiversity and Ecosystem Management

The textile industry significantly impacts biodiversity and ecosystems, primarily through pollution. Textile dyes contain heavy metals and organic contaminants that are toxic to aquatic organisms, leading to oxidative stress, developmental disruptions, and behavioral alterations in species (Dutta et al., 2024). Aquatic biodiversity is particularly vulnerable, as studies show that reactive dyes can severely impact species such as *Vibrio fischeri*, indicating high ecological risks (Garcia et al., 2021). Industrial wastewater from textile processing disrupts entire ecosystems, leading to biodiversity loss. Additionally, lethal and sublethal effects have been documented in bacteria, crustaceans, and mollusks (Garcia et al., 2021). The industry is also a significant source of microplastic pollution, which accumulates in aquatic organisms and disrupts marine ecosystems (Magalhães et al., 2024). These microplastics can enter the food chain, impacting biodiversity on a larger scale.

Moreover, the textile industry's contribution to climate change indirectly affects ecosystems over time, exacerbating biodiversity loss. Given these significant impacts, biodiversity and ecosystem management are critical sustainability topics. ESRS addresses this under ESRS E4, while GRI includes it in GRI 101: Biodiversity. Organizations are required to disclose their transition plans, biodiversity risk assessments, policies, and management strategies, as well as the location and extent of their environmental impact (GRI - GRI Standards, 2024).

5.10. Circular Economy Practices

The transition from a resource-intensive linear production model to a circular economy is imperative for the textile industry to mitigate severe pollution and reduce extensive water, chemical, and energy consumption. Implementing circular principles—such as recycling, reuse, and waste reduction—significantly decreases the sector's environmental footprint while driving design innovation to extend material usability and minimize reliance on virgin resources (Radukić et al., 2023).This circular shift aligns with stringent global regulatory frameworks, particularly within the European Union (De Oliveira Neto et al., 2023), and offers brands a competitive advantage by satisfying consumer demand for sustainability (Radhakrishnan, 2021). To ensure transparency, major reporting frameworks mandate comprehensive circularity disclosures; specifically, the European Sustainability Reporting Standards (ESRS E5) require detailed reporting on waste hierarchy policies and resource flow management, while the Global Reporting Initiative addresses these imperatives through GRI 306: Waste (GRI Standards, 2024).

5.11. Supply Chain Environmental Impacts

Brand owning companies depend on global supply chains for production, making sustainability a critical concern within the textile supply chain due to its significant environmental impact. Increasing stakeholder and consumer scrutiny, along with regulatory requirements in certain regions, has intensified the pressure on companies to reduce environmental harm across their supply chains. Regulatory and reporting frameworks emphasize supplier environmental assessments to enhance sustainability efforts. The European Sustainability Reporting Standards (ESRS), specifically ESRS G1: *Business Conduct*, mandate the evaluation of suppliers' environmental performance. Similarly, the Global Reporting Initiative (GRI) includes relevant guidelines in *GRI 308: Supplier Environmental Assessment* (GRI - GRI Standards, 2024).. Additionally, the Sustainability Accounting Standards Board (SASB) requires disclosures related to wastewater discharge compliance and environmental data assessments, including the Sustainable Apparel Coalition's Higg Facility Environmental Module or equivalent methodologies (“Sustainability Accounting Standard Apparel, Accessories & Footwear,” 2023; Publications Office of the European Union, 2023).

These standards emphasize the need for companies to adopt sustainable supply chain practices and ensure transparency in their environmental impact.

5.12. Own Workforce

The textile industry has historically been a labor-intensive sector, driving industrialization in many countries with abundant labor and relatively simple technologies (Fukunishi & Yamagata, 2014). While technological advancements have led to increased capital intensity in processes such as spinning and weaving, downstream processes, particularly sewing, remain heavily reliant on manual labor. In developing countries, low labor costs make manual labor more economically viable than automation (Fukunishi & Yamagata, 2014). Consequently, ensuring fair and safe working conditions for this extensive labor force remains a critical concern.

5.12.1. Social and Labor Rights

Decent work is predicated on predictable and safe working hours; however, many textile workers face excessive and often forced overtime due to the purchasing practices of lead firms, which impose short lead times and high order volatility. Furthermore, wages in the textile sector

frequently fail to reflect workers' social contributions, with persistently low pay exacerbated by the price squeeze imposed by lead firms that drive down supplier prices (Berg et al., 2023; Anner, 2020).

Effective social dialogue is essential for safeguarding labor rights and improving working conditions. However, many factories in developing countries lack structured social dialogue mechanisms. Additionally, the absence of freedom of association and collective bargaining rights continues to hinder progress toward fair labor practices. Excessive working hours further exacerbate these challenges by negatively impacting workers' well-being, leading to increased stress and a diminished quality of life ((Sodhi, 2024;Berg et al., 2023; Anner, 2020).

5.12.2. Occupational Health and Workplace Safety

Beyond excessive working hours, occupational health hazards remain a significant concern in the textile industry. As a highly polluting sector, textile production exposes workers to serious health risks, including exposure to indoor cotton dust and substandard working conditions (Adhikari et al., 2024). Moreover, equal opportunities, fair wages, gender equality, and workforce inclusion continue to be pressing issues. For instance, the ready-made garment (RMG) sector in Bangladesh has contributed to women's empowerment by providing employment and enhancing their role in household decision-making. However, wage disparities persist, with RMG workers earning an average of only $69 per month, highlighting the need for equal pay for equal work (Chowdhury, 2017). Furthermore, poor working conditions, including workplace violence and harassment—particularly against female workers—remain widespread. Implementing robust anti-harassment policies is therefore essential for fostering safer work environments (Sukalova & Ceniga, 2021).

5.12.3. Violations of Labor Rights

Other labor rights violations, such as forced labor and privacy concerns, have also been reported in textile factories (Delaney & Connor, 2016; Delaney & Tate, 2015). Addressing these challenges necessitates the implementation of stricter labor regulations, enhanced corporate accountability, and ethical business practices to foster a more just and sustainable textile industry. These concerns are reflected in the European Sustainability Reporting Standards (ESRS**),** which include reporting requirements under the ESRS S1 topical standards. These standards mandate disclosures regarding impacts, risks, and opportunities (IROs) related to workforce characteristics, non-employee workers within the organization's workforce, collective bargaining and social dialogue practices, diversity metrics, health and safety conditions, fair wages, social protection, training and development, disability inclusion, remuneration, work-life balance, incidents, complaints, and human rights violations (Publications Office of the European Union, 2023).

The Global Reporting Initiative (GRI) similarly provides multiple material topic standards addressing these social issues, including *GRI 401: Employment, GRI 402: Labor/Management Relations, GRI 403: Occupational Health and Safety, GRI 404: Training and Education, GRI 405: Diversity and Equal Opportunities, GRI 406: Non-discrimination, GRI 407: Freedom of Association and Collective Bargaining, GRI 408: Child Labor, and GRI 409: Forced or Compulsory Labor*. Additionally, *GRI 202: Market Presence* is relevant in addressing wage-related concerns. Notably, *GRI 410: Security Practices* focuses on disclosing the conduct of security personnel, risks associated with excessive use of force, and potential human rights violations (GRI - GRI Standards, 2024).

5.13. Workforce in the Value Chain

Textile production is predominantly outsourced to developing countries due to their comparative advantages, such as lower labor costs, cost efficiency, and favorable trade policies (Wang, 2013). However, Reports of labor rights abuses—including long working hours, forced overtime, low wages, and gender inequality—are prevalent among workers in developing

countries' textile value chains (Annapoorani, 2017). Consequently, buyers face mounting pressure from stakeholders to manage supply chains responsibly and ensure compliance with social and environmental standards (Busse et al., 2016).

To address supplier-related sustainability concerns, ESRS standards require organizations to report on supplier social sustainability performance through the ESRS S2 topical standards (Publications Office of the European Union, 2023). Likewise, GRI 414: Supplier Social Assessment mandates disclosure regarding suppliers' labor conditions (GRI - GRI Standards, 2024). Furthermore, the Sustainability Accounting Standards Board (SASB) highlights that labor conditions within supply chains can elevate an organization's reputational risk, increase short- and long-term costs, and cause supply disruptions—ultimately affecting financial materiality. The SASB standards, therefore, include specific disclosure requirements addressing these labor conditions ("Sustainability Accounting Standard Apparel, Accessories & Footwear," 2023).

5.14. Communities

Organizations profoundly impact local communities, as exemplified by the textile industry, where localized operations can generate severe negative externalities—such as noise, airborne microfibers, and wastewater odors that raise health concerns and diminish residents' quality of life.Conversely, companies in the textile sector can contribute positively by engaging in philanthropic activities which not only enhance corporate social responsibility but also improve brand image and create financial opportunities. To ensure accountability for these impacts, the European Sustainability Reporting Standards (ESRS S3) mandate comprehensive disclosures regarding affected communities. Organizations must articulate their adherence to the UN Guiding Principles, the ILO Declaration, and the OECD Guidelines, detailing their strategies for human rights protection (particularly concerning indigenous populations), community engagement, and impact remediation.These requirements are outlined in the ESRS S3 Topical Standards (Publications Office of the European Union, 2023).

Concurrently, the Global Reporting Initiative (GRI) reinforces this accountability through GRI 413, which governs disclosures on community impact assessments and development programs, and GRI 202, which measures local economic contributions (GRI Standards, 2024). Collectively, these frameworks ensure rigorous, standardized reporting on corporate social and environmental responsibilities toward local populations.

5.15. Customers and End Users

The European Sustainability Reporting Standards (ESRS) mandate under the ESRS S4 standard that organizations comprehensively disclose their impacts on consumers and end users. The fashion industry illustrates the critical need for these disclosures through three primary risk areas: the pervasive use of "greenwashing" and misleading labels that perpetuate unsustainable consumption (Haque & Liu, 2024); the presence of regulated chemicals in finished apparel, which threatens consumer safety and an organization's social license to operate; and significant privacy vulnerabilities stemming from the collection of intimate consumer sizing and preference data (Vänskä et al., 2024). To mitigate these risks, ESRS S4 requires detailed reporting on data protection, health and safety, product accessibility, and responsible marketing. Aligning with these imperatives, the Global Reporting Initiative (GRI) addresses these concerns through specific topical standards GRI 416, 417, and 418; covering customer health, marketing, and privacy (GRI Standards, 2024). Furthermore, the Sustainability Accounting Standards Board (SASB, 2023) reinforces physical product safety via its "Management of Chemicals in Products" standard, ensuring a rigorous, multi-framework approach to consumer transparency and risk management.

5.16. Business Conduct

The ESRS standard also requires organizations to disclose their business conduct under the ESRS G1 Topical Standard (Publications Office of the European Union, 2023). This includes explanations of how organizations uphold their code of conduct, manage unlawful behavior, and

implement policies and procedures related to anti-corruption and anti-bribery. Additionally, organizations must disclose their whistleblower protection mechanisms and, where applicable, their policies concerning animal welfare.

Furthermore, the standard mandates transparency regarding supplier relationships, including procurement processes, policies to prevent late payments—particularly concerning Small and Medium Enterprises (SMEs)—and the broader impact of such practices. Organizations are also required to disclose their criteria for supplier selection, emphasizing social and environmental factors.

If relevant, organizations should disclose their political influence and contributions, specifying the types and purposes of lobbying activities. The corresponding GRI governance standards include GRI 204: Procurement Policies, GRI 205: Anti-Corruption, GRI 415: Public Policy, GRI 308: Supplier Environmental Assessment, and GRI 414: Supplier Social Assessment (GRI - GRI Standards, 2024).

5.17. Other Topics

Certain topics are covered exclusively by GRI standards but receive limited mention in ESRS. To enhance the comprehensiveness of sustainability reports, textile industries may consider incorporating these additional GRI standards:

GRI 201: Economic Performance – Covers disclosures related to economic value generation and distribution, defined benefit plan obligations, financial assistance received from the government, and financial implications of climate change (GRI - GRI Standards, 2024).

GRI 203: Indirect Economic Impacts – Addresses the organization's indirect economic impact on local communities and regional economies, including infrastructure investments and services supported (GRI - GRI Standards, 2024).

GRI 206: Anti-competitive Behavior – Disclosure about the legal actions faced regarding anti-competitive behavior, which is the action to limit the effects of the market, including fixing prices or coordinating bids, creating market or output restrictions, imposing geographic quotas, and allocating customers, suppliers, geographic areas, or product lines or anti-trust and monopoly practices that hinder entry to the sector and prevent competition (GRI - GRI Standards, 2024).

GRI 207: Tax – Involves disclosure of the organization's tax strategy, governance, control frameworks, integrity measures, assurance processes, stakeholder engagement, and country-by-country tax reporting (GRI - GRI Standards, 2024).

GRI 410: Security Practices – Examines the conduct and risks associated with the use of force or other human rights violations by security personnel employed by the organization or third-party security providers (GRI - GRI Standards, 2024).

By incorporating these additional GRI standards, organizations can provide a more holistic view of their sustainability and governance practices.

6. CONCLUSION

The comparative analysis of the GRI, SASB, and ESRS frameworks highlights both areas of convergence and divergence in their treatment of materiality, stakeholder focus, and sectoral relevance. While GRI predominantly emphasizes impact-oriented disclosures and SASB focuses on financially material sustainability issues relevant to investors, ESRS emerges as a more integrative framework by explicitly combining impact materiality and financial materiality within a single reporting logic. This integrated structure requires companies to assess how environmental and social impacts discussed throughout the manuscript—particularly those relevant to the textile and apparel sector—simultaneously affect firm value and broader stakeholder interests. The practical relevance of double materiality can be further illustrated through sector-specific examples from the textile and apparel industry. Environmental and social impact areas discussed—particularly water-intensive wet processing operations, the extensive use of synthetic fibers and associated microplastic concerns, and labor-intensive global supply chains with related social risks simultaneously generate financial risks and opportunities for firms.

Table 1: *Comparative overview of GRI, SASB, and ESRS frameworks based on discussions in this study*

Comparison Dimension	GRI	SASB	ESRS
Primary orientation	Impact-oriented sustainability reporting focusing on organizations' effects on the environment and society	Financial materiality–oriented, focusing on sustainability issues that may affect enterprise value	Explicitly integrates impact materiality and financial materiality through a double materiality approach
Materiality logic	Primarily inside-out perspective (organizational impacts on environment and society)	Outside-in perspective (financial risks and opportunities for investors)	Dual logic combining inside-out (impact) and outside-in (financial) materiality
Stakeholder focus	Broad stakeholder group including communities, workers, consumers, and the environment	Primarily investors and financial stakeholders	Both financial stakeholders and affected stakeholders across the value chain
Regulatory status	Voluntary global reporting framework	Voluntary, investor-oriented standards	Mandatory for companies under the EU CSRD
Sector specificity for textiles	General standards applied to textiles through topic-based disclosures (e.g., water, waste, biodiversity)	Sector-specific standards for apparel, accessories, and footwear emphasizing financially material risks	Sector-agnostic structure complemented by detailed topical ESRS standards applied to the textile value chain
Environmental topic coverage	Covers water, waste, biodiversity, emissions, materials through dedicated GRI standards (e.g., GRI 303, 306, 301, 101)	Covers environmental issues where they pose financial risk (e.g., water stress, raw material availability)	Extensive and structured coverage through ESRS E1–E5, explicitly linking impacts and financial risks
Social topic coverage	Strong emphasis on labor practices, human rights, and community impacts	Social topics addressed when financially material (e.g., labor conditions affecting operations)	Social impacts and risks addressed under ESRS S standards with double materiality assessment
Supply chain consideration	Supply chain impacts addressed through impact disclosures and due diligence expectations	Supply chain risks addressed mainly in terms of cost, disruption, and financial exposure	Explicit value-chain perspective requiring assessment of upstream and downstream impacts and risks
Treatment of raw materials	Requires disclosure of renewable/non-renewable and recycled materials (GRI 301)	Focuses on raw materials as a source of financial risk and supply volatility	Raw materials addressed indirectly through environmental impact, circular economy, and risk disclosures
Pollution and waste focus	Emphasizes waste management, hazardous materials, and effluents (GRI 306)	Addressed when pollution leads to regulatory or financial risk	Detailed disclosure requirements for pollution, chemicals, and microplastics under ESRS E2
Circular economy perspective	Addresses waste reduction and recycling through waste standards	Considered where circular practices affect costs and competitiveness	Explicitly embedded in ESRS E5 with structured waste hierarchy and resource flow reporting
Reporting objective	Transparency on sustainability impacts and accountability	Decision-useful information for investors	Holistic sustainability accountability integrating societal impact and financial performance
Role in double materiality	Contributes mainly to impact materiality assessment	Contributes mainly to financial materiality assessment	Operationalizes double materiality as a core reporting principle

Table 2: Illustrative examples of double materiality in the textile and apparel sector

Corporate activity	Impact materiality (inside-out)	Financial materiality (outside-in)
Dyeing and finishing processes	Water pollution, ecosystem degradation	Regulatory compliance costs, water scarcity risks
Use of synthetic fibers	Microplastic emissions, environmental persistence	Regulatory pressure, changing consumer preferences
Garment manufacturing	Labor conditions and worker safety impacts	Reputational risk, supply chain disruptions
Energy-intensive production	Greenhouse gas emissions	Energy price volatility, carbon-related costs

ESRS introduces a more integrated approach by explicitly combining impact materiality and financial materiality, requiring companies to assess how environmental and social factors influence both firm value and stakeholder welfare. While convergence exists in disclosure scope and stakeholder inclusion, notable differences remain in boundary definitions and indicator design.

Overall, the study offers original, synthesis-based insights by integrating comparative framework analysis with sector-specific synthesis. Building on the findings discussed in the previous sections, a subsequent paper will develop strategic recommendations to strengthen the integration of double materiality into sustainability-reporting practices across the textile value chain.

USE OF AI TOOLS AND ETHICAL CONSIDERATIONS

In accordance with the Council of Higher Education (YÖK, 2024) guidelines and the EU Artificial Intelligence Act (Regulation 2024/1689), AI tools (ChatGPT, GPT-4o) were employed solely to refine grammar, clarity, and textual coherence. All original conceptualization, critical analyses of the ESRS–GRI–SASB frameworks, and sector-specific interpretations remain the authors' exclusive work. The authors have meticulously reviewed all AI-assisted refinements and assume full responsibility for the manuscript's integrity and accuracy.

CONFLICT OF INTEREST

The author(s) confirm that there are no known conflicts of interest and no competing/shared interests with any institution, organization, or individual.

AUTHOR CONTRIBUTIONS

Md Riaz HOSSAIN: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data Curation, Writing – Original Draft, Visualization.
Ayşe ÖZKAL: Formal analysis, Validation, Writing – Review & Editing, Supervision.
All authors have read and agreed to the published version of the manuscript.

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