



Research Article

The relationship between industry 5.0 Process and ESG process: A qualitative analysis in the context of Türkiye's BIST Sustainability 25 Index white good sector

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ABSTRACT

This study aims to determine the relationship between Industry 5.0 and ESG (Environmental Social Governance) processes. In addition, this study aims to reveal how this relationship is evaluated within the scope of Vestel and Arçelik enterprises in the white goods sector within the scope of the BIST (Borsa Istanbul) Sustainability 25 Index in Türkiye. For this aim, the relationship between Industry 5.0 and ESG processes was first explained using document analysis, one of the qualitative analysis techniques. Then, descriptive content analysis, which is also one of the qualitative analysis techniques, was used to examine the latest annual reports of Vestel and Arçelik, which are in the white goods sector within the scope of the BIST Sustainability 25 Index in Türkiye, published in 2022. For Industry 5.0, Industry 4.0, environment, employees and society, and finally, the resilience of businesses components were considered, while for the ESG process, environmental, social and governance components were emphasised. NVivo (version 14.23.2) software was used for the analysis. As a result of the study, it was determined that there is a close bidirectional relationship between the components in the Industry 5.0 process and the components in the ESG process. In other words, it can be said that investing in ESG processes will contribute positively to the Industry 5.0 process and investing in the Industry 5.0 process will contribute positively to the ESG process. Within the scope of Industry 5.0 and ESG processes, Vestel and Arçelik have similar studies. In addition, this study offers suggestions for developing practices for the ESG process by adapting to technological change.

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INTRODUCTION

The industrial revolutions, reported to have started after James Watt discovered the steam engine in the 1700s, continued with the Industry 4.0 process in 2011. The Industry 4.0 process has recently started to be studied together with the digital transformation process of businesses. It has even been referred to as the digital transformation of businesses

rather than the definition of the Industry 4.0 process. Industry 4.0 is focused on increasing collective productivity and performance through collaboration between devices and software using machine learning (ML) [1].

In the industrial revolutions prior to Industry 4.0, there was unilateral automatisisation, that is, the process of doing business by giving commands from humans to machines or oth-

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er systems. In unilateral automatisisation, no data is obtained from machinery, equipment, software or employees within the business. It is thought that the most important difference that distinguishes the Industry 4.0 process from other industrial revolutions is the transition to bilateral automatisisation [2]. Bilateral automatisisation refers to processes that can be commanded from human to machine, machine to human, and machine to machine. In bilateral automation, it is possible to acquire data from machines, equipment, software or employees within the business. The knowledge that emerges from analysing the data obtained is shared with the systems that need it, and a data and knowledge cycle is established. In this way, benefits such as predictive maintenance work on machines, increasing product quality, automatically determining the location of inventories, assisting decision making, sustainable supply chain and human – technology collaboration are provided. These benefits also enable savings in labour and energy costs [2]. These processes are usually automated thanks to related software [2]. For example, thanks to the Internet of Things (IoT) infrastructure, the actions that arise from analysing the data collected from the production environment with software can be performed by actuators without human intervention [2].

The concept of employee and human (society), which was not fully explained in the Industry 4.0 process, started to be explained in the Industry 5.0 process, called the industrial revolution after the Industry 4.0 process. While Industry 4.0 aims to use machines and systems most efficiently, Industry 5.0 focuses on bringing back the human factor [3]. It emphasises a system based on robot-human collaboration that supports people to work more efficiently with technology support [4]. This collaboration can be explained with a human-centred approach. The human-centred approach represents a systematic transformation in industry that goes beyond economic and production outcomes and profoundly impacts civil society, governance structures and human identity [5].

In line with the principles of Industry 5.0, the Japanese government has initiated the idea of Society 5.0, which represents a human-centred society that balances economic development with solving social problems using a system that integrates the cyber and physical environment [6]. Society 5.0 promotes physical and cyber environment collaboration to solve employee, production and sustainability issues and social issues [7]. Related to this, it is noted that Society 5.0 and the United Nations Sustainable Development Goals share a common vision of creating a sustainable and inclusive future for all. Thus, the Industry 5.0 process is defined as an industrial revolution that can be considered a complement to the Industry 4.0 process, which explains issues such as employees and people, the environment, and the resilience of businesses with technological collaboration infrastructure. In addition, the relationship between sustainability's environmental, social and economic components and Industry 5.0 is emphasised [6].

The concept of ESG was first introduced in the United Nations Global Compact [8]. The concept of ESG emerged

from the abbreviation of the words "Environmental", "Social" and "Governance". ESG is a process that shows the performance of businesses on issues such as environmental sustainability, employee and community relations, and ethics in the workplace. Asset managers, investors, financial institutions and other stakeholders use ESG scores to make informed decisions, identify risk propensity, and assess a business's status compared to its peers [6].

Combining the technology-driven infrastructure of Industry 5.0 with the conceptual processes of ESG [9], it is important to consider that Industry 5.0 will strengthen ESG reporting [6, 10], a measure of a business's commitment to fulfilling its social responsibilities.

In terms of evaluating the relationship between Industry 5.0 and ESG, Asif et al. [6] examine the application of Industry 5.0 in ESG through the lens of fundamental management theories by providing a conceptual analysis of how Industry 5.0 can be leveraged to improve ESG disclosure effectiveness. Fatemi et al. [11] investigated the impact of ESG activities and their disclosure on business value. Sekaran et al. [9] emphasise the importance of using Industry 5.0 in ESG initiatives to sustain an organisation's supply chain and avoid social, environmental, ethical and other risks. Alkaraan et al. [12] also revealed that ESG practices regulate the relationship between corporate transformation disclosures to Industry 4.0 and financial performance. Kumar et al. [13] argue that ESG compliance and the use of Industry 4.0 technologies act as catalysts for adopting green services. Grabowska et al. [14] stated that the Industry 4.0 process does not provide the desired level of explanation about the status of employees and sustainable production in factories, and it is explained that sustainability and employee-related issues are elaborated in the Industry 5.0 process.

When all these studies are evaluated, it is possible to say that the technological infrastructure of Industry 5.0 and the conceptual collaboration of ESG and its applicability to different sectors have significantly contributed to the literature. However, no study examines the Industry 5.0 process with all the components of the ESG process by expressing the Industry 5.0 process as an equation "Industry 5.0 = Industry 4.0 + Employees and Society + Environment + Resilience of Businesses", and as a result, no study reveals this relationship in a matrix table. In addition, no study reveals how these results are evaluated in the white goods sector. It is considered important to investigate further the relationship between the components of Industry 5.0 and ESG. Therefore, while examining the relationship between Industry 5.0 and ESG, this study provides a detailed examination of other important issues that make Industry 5.0 a whole. Based on these explanations, the study aims to determine the relationship between Industry 5.0 and ESG processes. In addition, it is aimed to reveal how this relationship is evaluated within the scope of Vestel and Arçelik enterprises in the white goods sector within the scope of the BIST Sustainability 25 Index in Türkiye. The study sample is made up of Vestel and Arçelik enterprises. Docu-

Table 1. Industry 5.0 process and its components

Data (Formerly known as Big Data) and Knowledge Process (Data Acquisition → Data Storage → Data Analysis → Valuable Knowledge)																
Cyber Security (OT / IT / Employee) [43,45]																
Industry 4.0 [40-42]	Vertical integration	Employees and technology integration	OT and IT technologies	Department collaboration (human Resources, Finance, etc.)	Government	Suppliers and logistics	Customers	Horizontal integration	Connected suppliers and logistics	Connected customers and smart products						
											New business models [40, 47]	Bio-tech.	Interdisciplinary studies [40, 46]	- Connected government	Connected suppliers and logistics	Connected customers and smart products
												Nanotech.				
												Health				
												Chemical				
Paas, subscription-based systems (software, asset usage, etc.), metaverse platforms, open innovation platforms, etc.	Other disciplines		- Laws and incentives													
	Organizational Digital Culture [48, 50]															
CPS (Cyber-Physical Systems) [52, 54]	OT and IT Software Infrastructure [51-53, 61]	AI, ERP, BI, MES, RPA, Finance and Human Resources Software, IT Management Software, etc (All of them Connected with others)	AR	VR	XR	IOT [54]	Autonomous vehicles [47]	Operational technologies (OT) [51]	Information technologies (IT) [58]	Environment						
											Metaverse [55]	Sensors	Addictive manufacturing [48]	Sustainable production [63]		
												Block chain [56]			Actuators	
											NFT [57]		Wearable technologies [40]	4-d Printing	Energy efficiency [62]	
												Smart products [58]				Communication technologies [59, 60]
											Public [59]		5G	Public	Employee and human	
												Cloud [59]				WiFi
											Waste management with tech [65]		LoRa	Circular economy [63]	Resilience	
												Society [39]				Wan
											Environmental friendly smart products [65]		Environmental resilience [63, 65]	Culture resilience [48-50]	Digital resilience [67, 68]	
Economic, healthcare, education, culture, etc. [48, 58]	Natural disasters resilience [38]	Other risks res. (epidemic disease, disruptive technological developments, etc) [38]														

Source: Authors Elaboration.

ment analysis was used as the data collection method in the study. For this purpose, document analysis, one of the qualitative analysis techniques, was used to answer the study's first research question (RQ1), "How are the components of the Industry 5.0 and ESG processes related to each other?". In this context, the references in the bibliography section of the study were scanned, and the sub-components of the components of the Industry 5.0 process are shown in Table 1. The components of the ESG process are also shown in Figure 1. Afterwards, the components of Industry 5.0 and ESG processes were placed in a matrix table (Table 2), and their relationship with each other was tried to be explained. In this way, the theoretical dimension of the study emerged. This theoretical dimension also forms the basis for the other research questions of the study. It is thought that the information on Industry 5.0 and ESG processes revealed in

both Table 1 and Figure 1 will provide an important reference for researchers who will work in this field.

After presenting the theoretical dimension of the study through document analysis, descriptive content analysis, one of the qualitative analysis techniques, was used to reveal how the relationship between the Industry 5.0 process and the ESG process is evaluated within the scope of Vestel and Arçelik enterprises in the white goods sector within the scope of the BIST Sustainability 25 Index in Türkiye. In this context, the annual reports of Vestel and Arçelik enterprises for 2022 were examined, and the following research questions were asked to be answered.

RQ2. In which areas do Vestel and Arçelik enterprises in the BIST Sustainability 25 index work within the scope of Industry 5.0?

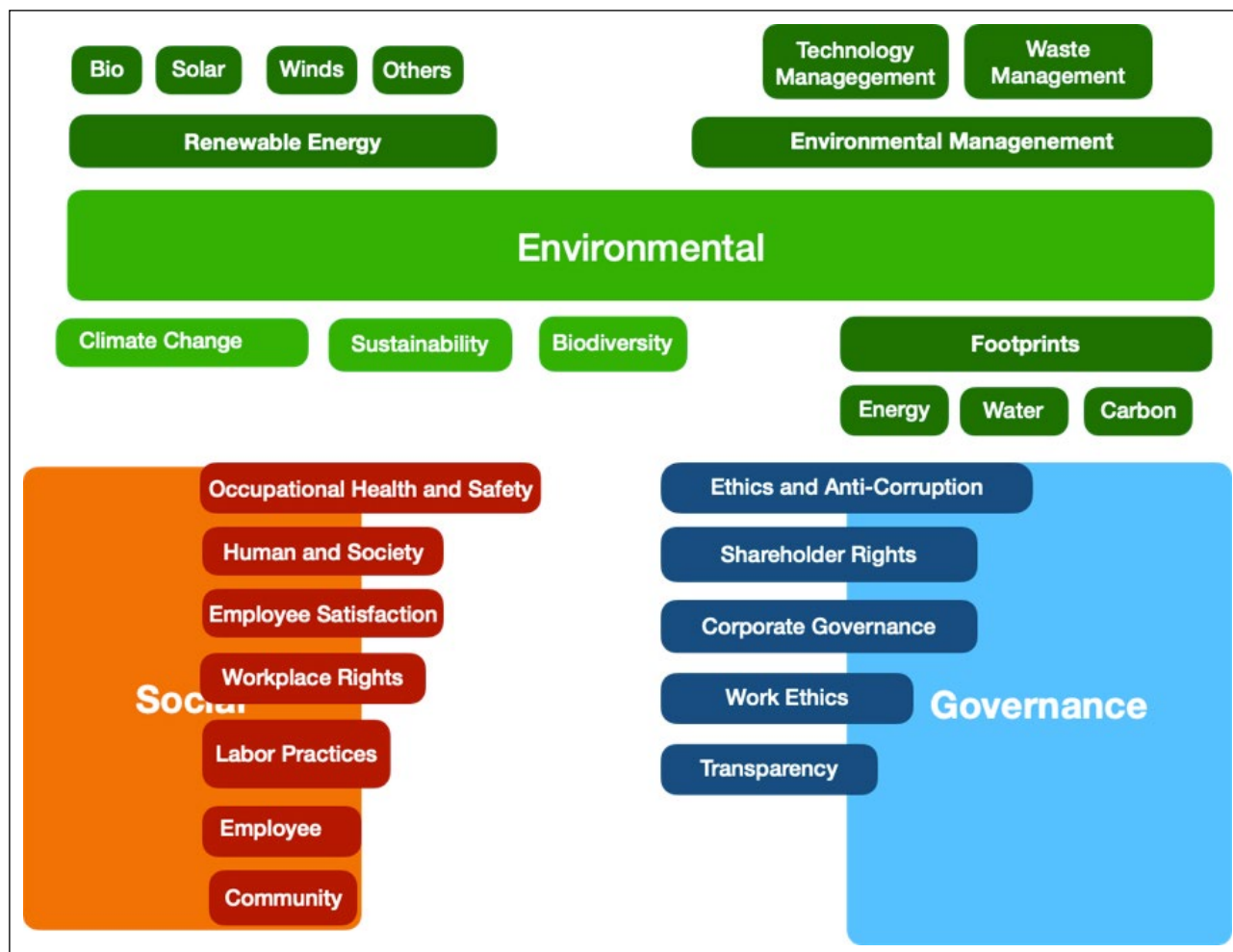


Figure 1. ESG concept and subcomponents (Source: Authors Elaboration).

RQ3. In which areas do Vestel and Arçelik enterprises in the BIST Sustainability 25 index work on ESG process?

RQ4. What is the relationship between the components of Industry 5.0 and the ESG components of environment, social and governance in Vestel and Arçelik enterprises in the BIST Sustainability 25 index?

Research questions 2, 3 and 4 of the study can be considered as the application of the relationships revealed in Research Question 1.

As a result of the study, it was concluded that both enterprises have carried out similar studies on the Industry 5.0 and ESG processes. In both enterprises, the technological infrastructure of the Industry 5.0 process contributes to ESG processes.

Finally, evaluations are made in the conclusion section based on all the findings.

CONCEPTUAL FRAMEWORK

Industry 5.0 Process

The Industry 5.0 process can be defined as a new industrial revolution that is being studied after the Industry 4.0 process. The Industry 5.0 process aims to bring solutions to

the human and employee factors and environmental issues not fully explained in the Industry 4.0 process. Industry 5.0 is focused on combining the innovation and labour of human beings with the speed, productivity and adaptability of robots. This collaboration is described as a human-centred approach [1, 15]. In this context, it can be said that the Industry 5.0 process focuses on a sustainable environment and the resilience of businesses against risks through the collaboration of employees, people and technology [16–18].

The rapid rise of artificial intelligence technologies in the Industry 5.0 process has led to the addition of artificial intelligence (AI) to the human-centred approach. The collaboration of artificial intelligence and human intelligence is called hybrid intelligence or hybrid intelligence. Thanks to hybrid intelligence, both a significant increase in interdisciplinary studies and new business models are expected to emerge [5].

Industry 5.0 was named Society 5.0 by the Japanese government. The reason for this naming is that all advanced information technologies, artificial intelligence, augmented reality and robots are aimed to be actively used in the manufacturing industry, supply chain, business management and daily life and thus become an essential factor in ensuring the welfare of society [3, 7].

Table 2. Matrix table of industry 5.0 process and ESG process components

ESG			
Environmental	Social	Governance	
With technological progress, it is aimed to contribute to environmental problems, and sustainable production infrastructure is being worked on. To establish this infrastructure, businesses must complete vertical and horizontal integration processes [6, 75].	Studies should be carried out on the collaboration of employees and technology. With the development of smart products, the satisfaction of people (society), who are the enterprise's customers, with the products they buy can be increased to higher levels. In addition, product improvements can be made more efficiently with customer data [6, 9].	Technology constitutes the infrastructure for the establishment of the organisational structure in accordance with the digital culture, efficient communication between departments and the elimination of silos, and ethical and traceable relations with stakeholders [6, 48, 49].	Industry 4.0 Industry 5.0
The focus is on environmental issues such as biodiversity, water, carbon and energy footprints, and climate change. Technological collaboration is essential to address these issues efficiently. However, producing products with high sustainability rates is one of the studies that can be carried out in this field [75, 76].	People's purchase of products with high sustainability rates contributes to environmental sustainability. In addition, the welfare of people is also increased with the technological improvements provided by such products. At the same time, employees should be reminded that technology is valuable as long as it serves the environment and people by providing the necessary environmental sustainability training [6, 75].	Corporate governments must support developments that contribute to environmental sustainability [59]. While making investment decisions regarding the technological infrastructure of developments related to sustainability and calculating the costs in this regard, social contributions should be considered in the cost calculation for issues about environmental problems [9, 73].	Technology for environment
Environmental sustainability, Net 0 target, water and energy footprints, biodiversity, [82] contributing to environmental sustainability as employees and society, and making them more agile thanks to the momentum gained with the help of technological developments should become the goal of businesses, employees and society [9, 26].	The employee should be seen as a value. The machinery and equipment used by the employees ensure that the business processes are carried out efficiently. It is essential to continuously educate employees about technology and environmental problems, human and social relations. Efforts should be made to ensure that technological progress can increase the welfare of employees and people (society) [30, 39]	In return for employees and society, concepts such as ethical values and anti-corruption are emphasised. The transparent implementation of these concepts depends on technological progress and infrastructure. A digital infrastructure ensures that information about the business can be seen more transparently and ethical board human rights violations can be revealed more quickly [9, 29].	Technology for employee and human (society)
There is an essential relationship between resilience and environmental sustainability activities. If every business and society pays attention to individuals' environmental processes, business resilience and society will increase against environmental threats. In addition, trade between businesses that comply with the laws set by the states regarding environmental processes becomes easier. Businesses that do not comply may have problems, especially related to exports. This can lead to significant weaknesses in the resilience of businesses. [9, 22, 71]	It is emphasised that as businesses focus on moral and ethical values, their relations with their stakeholders can be established healthily, and thus, business resilience can be increased. If employees, people (society) and businesses can collaborate on fundamental values, the culture of solidarity is strengthened. In this way, it is possible to work for the welfare of the society [9, 75].	Studies should be conducted to increase Business Resilience against sudden threats such as COVID-19, natural disasters, cyber security, and disruptive digital innovation threats. Corporate management processes should be digitalised to ensure uninterrupted communication between business departments, automation of data acquisition processes related to the work done to eliminate silos between units, artificial intelligence-supported process automation and continuous repetitive workloads on units other than production should be taken [9, 27]	Resilience

The most important difference of Industry 5.0 from other industrial revolutions is that it starts without disruptive technological innovation. Industry 5.0 aims to solve the issues of human-centeredness, sustainability and resilience of businesses in the light of the technological infrastructure of the previous industrial revolution, Industry 4.0 [6]. In this regard, Xu et al. [19] emphasise the value given to people and the environment by considering

Industry 4.0 as technology-oriented and Industry 5.0 as value-oriented.

One of the distinguishing features of the Industry 5.0 process is the sustainability approach. In this way, it is expected to minimise the impact of businesses on the environment while producing and to provide maximum benefit from the products produced, including recycling. It is stated that the Industry 5.0

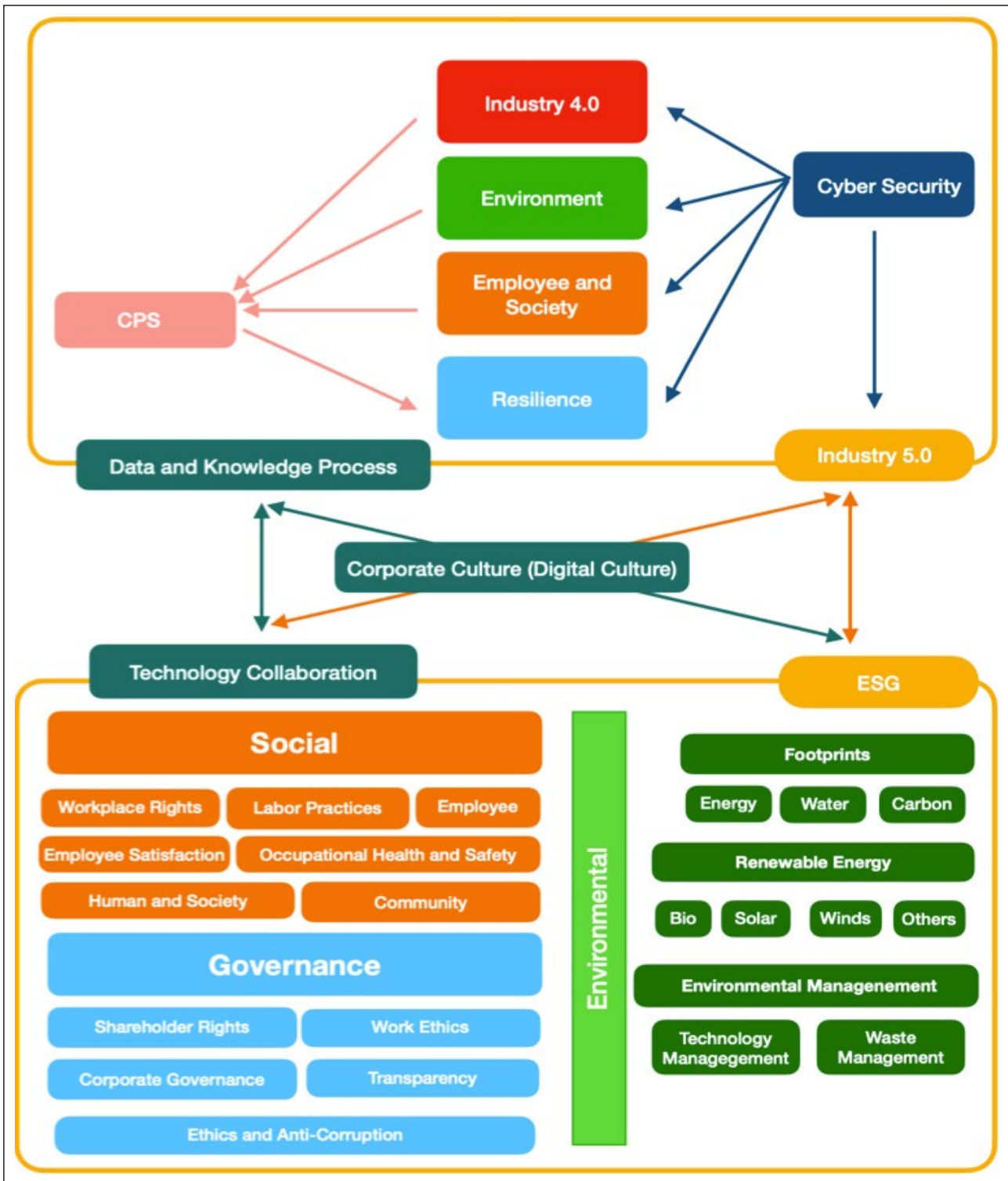


Figure 2. The relationship between Industry 5.0 and ESG process (Source: Authors Elaboration).

process will help establish a sustainable balance between ecology, industry and economy through the intelligent use of biological resources for industrial purposes [3, 18]. Asif et al. [6] state that the concept of Society 5.0 is closely aligned with the Sustainable Development Goals of the United Nations. In order to achieve sustainable development in all areas that concern society (such as education, health and economy), it is essential for society to establish positive relationships with technology [20].

The Industry 5.0 process emphasises the welfare of society and employees, the sustainability of the environment, as well as the resilience of businesses against all kinds of risks and crises. In this context, the efforts made to ensure that production and services do not stop under all kinds of risks and crises and that society and the sector are minimally affected are directly related to the resilience of businesses [19].

As a result of all these explanations, the Industry 5.0 process can be briefly expressed as “Industry 5.0 = Industry 4.0 + Environment + Employees and Society + Resilience of Businesses”.

ESG Process

The concept of ESG was explained in detail in a report titled “Who Cares Wins” prepared by the United Nations in 2004 [8, 21]. Before this concept, the sectors to be invested in were determined according to the ethical guidelines determined by the Socially Responsible Investing (SRI) concept. ESG has started to be used as an alternative to SRI in this context [22].

The Environmental component of the ESG process describes the environmental issues and standards of a business and its stakeholders, such as carbon emissions and waste management. The Social component describes social issues and standards, such as employee rights and community issues. The Governance component describes issues and standards such as corporate policies, transparency, and workplace ethics [9]. It is emphasised that the market values of businesses that invest in these standards can positively affect global financial markets [23]. In this context, these standards define non-financial performance indicators of businesses [24]. The resulting ESG score, which maps a business's performance in three dimensions: environmental, social, and governance, is used by investors, buyers, regulators, and other stakeholders [6].

The report generated while preparing the ESG score is based on internal and external data sources [25, 26]. Internal data sources include data from businesses's environmental management systems, quarterly and annual financial, governance and performance reports, corporate leadership reports, executive salary disclosures and press releases. External data sources include news, media reports analysed through natural language processing, and data obtained through social media [6, 27, 28]. Businesses that perform well in the components of ESG can easily adapt to market conditions, and such businesses may gain an advantage in being preferred by investors.

The performance of a business in the components of ESG provides a holistic picture of a country's economic prospects and business environment, which enables businesses to make informed investment decisions in line with the United Nations Sustainable Development Goals [10, 29, 30].

In Türkiye, businesses that can take their ESG efforts to the next level are included in the BIST Sustainability 25 Index. The BIST Sustainability Index emerged for the first time in 2014. As a result of the basic rules published in 2014, 25 enterprises were included in this index. Within these rules, the sustainability performance of the enterprises to be included in this index, other than their financial performance, was evaluated by the Ethical Investment Research Services Limited (EIRIS) Organization [27]. These evaluation criteria include environmental, governance and social areas. In 2021, the London Stock Exchange Group (LSEG) was selected as the criteria evaluator [28]. The selection criteria were taken from ESG work areas [29, 30].

Relationship Between Industry 5.0 and ESG Processes

In 2004, it was seen that the ESG components in the report prepared by the United Nations and the components of the Industry 5.0 process are parallel. In this report, it is thought that businesses with better ESG performance can better manage environmental, social and governance risks and take necessary measures [6, 31]. They are also assumed to predict consumer trends more accurately [6, 32]. The collaboration of the employee, society, and environment components described in the Industry 5.0 process through the technology component emphasises the environmental, social, and governance components of the ESG process. However, it is thought that there is a bidirectional relationship between the content of the ESG process and the content of the Industry 5.0 process. This statement is supported by Asif et al. [6] and Kumar et al. [13] in the literature. In other words, investing in the ESG process also means moving forward in the Industry 5.0 process, and investing in the Industry 5.0 process also means moving forward in the ESG process.

Studies on Industry 5.0 and ESG processes are generally discussed in international environments and enter the literature. Considering the general and corporate culture when implementing these processes for businesses in Türkiye or any other country is essential. Because culture may have different sub-components for each nation. Since corporate culture is also affected by general culture, it would be appropriate for businesses to pay attention to cultural issues [33].

The following research question was put forward to reveal the dimensions of the relationship between Industry 5.0 and ESG processes.

RQ1. How are the components of the Industry 5.0 and ESG processes related? In line with the first research question, the following questions were posed to reveal how the theoretical relationship between Industry 5.0 and ESG processes is evaluated from Vestel and Arçelik enterprises in the white goods sector included in Türkiye's BIST Sustainability 25 index.

RQ2. In which areas do Vestel and Arçelik enterprises in the BIST Sustainability 25 index work within the scope of Industry 5.0?

RQ3. In which areas do Vestel and Arçelik enterprises in the BIST Sustainability 25 index work on ESG process?

RQ4. What is the relationship between the components of Industry 5.0 and the ESG components of environment, social and governance in Vestel and Arçelik enterprises in the BIST Sustainability 25 index?

MATERIALS AND METHODS

This study aims to determine the relationship between Industry 5.0 and ESG processes. In addition, this study aims to reveal how this relationship is evaluated within the scope of Vestel and Arçelik enterprises in the white goods sector within the scope of the BIST Sustainability 25 Index in Türkiye.

For this purpose, to determine the relationship between Industry 5.0 and ESG processes, document analysis, one of the qualitative analysis techniques, was used within the scope of the first research question and the references in the bibliography section of the study were reviewed. Document analysis can be used as a stand-alone analysis, or it can be used to support other analysis techniques [34]. This study used document analysis to determine the relationship between Industry 5.0 and ESG processes. In addition, it was also used to support descriptive content analysis to reveal how the relationship between Industry 5.0 and ESG processes is evaluated in Vestel and Arçelik. The sub-components of the components of the Industry 5.0 process are shown in Table 1. The components of the ESG process are also shown in Figure 1. Afterwards, a matrix table was generated to show the relationship between all components of Industry 5.0 and ESG processes. Each of the intersections of the rows and columns of the table shows the relationship of the components in the row and column.

Descriptive content analysis, one of the qualitative analysis techniques, was used to reveal how the relationship between the Industry 5.0 process and the ESG process is evaluated within the scope of Vestel and Arçelik enterprises in the white goods sector within the scope of the BIST Sustainability 25 Index in Türkiye. Descriptive analysis is the presentation of the data obtained from interviews, observations and document analysis to the reader in an organised and interpreted manner [35]. Descriptive content analysis requires examining the collected data in more detail and identifying the concepts, categories, and themes that explain these data [36]. In this context, the annual reports of Vestel and Arçelik for the year 2022 were analysed to answer research questions 2, 3 and 4. The answers to the research questions were tried to be revealed as a result of the analysis of the statements used by Vestel and Arçelik enterprises in their annual reports in the Nvivo program.

Only Vestel and Arçelik, which are included in the BIST Sustainability 25 Index and meet the relevant criteria from the white goods sector, were selected as the study sample by convenience sampling method.

Document analysis was preferred as the data collection method in the study. In this context, the annual reports of the enterprises and all references mentioned in the bibliography section were analysed. While examining the annual reports, the analysis was carried out in accordance with the equation “Industry 5.0 = Industry 4.0 + Environment + Employees and Society + Resilience of Businesses” and the components of the ESG process. In the NVivo (version 14.23.2) program, a code configuration parallel to Table 1 and Figure 1 was made. For each code, the statements used in the annual reports were scanned.

During the descriptive content analysis in the study, it was observed that information on the concept of ESG was clearly stated in the annual reports. However, no explicit statement about the Industry 5.0 process was found. For this reason, during the analysis, an appropriate coding was made on the right side of the equation: “Industry 5.0

= Industry 4.0 + Environment + Employees and Society + Resilience of Businesses”. The value provided by the results of this coding to the main statement on the left side of the equation was revealed.

FINDINGS AND EVALUATIONS

RQ1. How are the components of the Industry 5.0 and ESG processes related?

The components of the Industry 5.0 process are Industry 4.0, environment, employees and society, and resilience of businesses. In the study by Grabowska et al. [14], the Industry 5.0 process was examined as human-centeredness, sustainability and resilience of businesses, similar to the component structure in this study. In order to facilitate the examination of the components within the scope of document analysis and to reveal the Industry 5.0 process in all its details, the Industry 5.0 process is expressed as an equation as follows.

“Industry 5.0 = Industry 4.0 + Environment + Employees and Society + Resilience of Businesses”.

The most important reason for expressing the components of the Industry 5.0 process as an equation is to reach the expression on the left side through studies on the components on the right side. In this way, even if a business does not refer to the Industry 5.0 process in its studies, it is thought to structure the Industry 5.0 process with the studies on the components on the right side. In this context, Table 1, which presents the Industry 5.0 process obtained from the literature scanned by document analysis, was generated. In accordance with the equation expressed in the study, Table 1 shows the Industry 5.0 process in 4 subcategories: Industry 4.0, employee and society, environment and resilience of businesses.

The abbreviation list of Table 1 is as follows:

NFT (Non-fungible Token), OT (Operational Technologies), IT (Information Technologies), PAAS (Product as a Service), AR (Augmented Reality), VR (Virtual Reality), XR (Extended Reality), AI (Artificial Intelligence), ERP (Enterprise Resource Planning), MES (Manufacturing Executing System), BI (Business Intelligence), RPA (Robotic Process Automation), Env. (Environment), Res. (Resilience), Tech. (Technology), Int. (Intelligence)

Similar to the Industry 5.0 process, the components of the ESG process were analysed in 3 different subcategories as a result of the document analysis. As a result of this analysis, Figure 1 was drawn, and the sub-components of the components of the ESG process were also shown.

It is understood that the environmental component of the Industry 5.0 process constitutes the technological infrastructure of the issues within the scope of the environmental component of the ESG process. The study by Asif et al. [6] also supports that the environmental components of these two processes are interrelated. While the social component of the ESG process focuses on employee, stakeholder and

Table 3. Evaluation of the activities carried out by Vestel and Arçelik about Industry 4.0 component within the scope of the Industry 5.0 process through their annual reports

Industry 4.0	Vestel	Arçelik
	94	91
New business models	6	1
Digital culture	6	2
Data and knowledge process	12	9
Cyber security	11	5
CPS	1	1
Vertical and horizontal integration (collaboration)	62	73
Vertical integration	41	39
Departments	1	2
Technologies	40	37
Operational technologies	23	17
AR	2	1
VR	1	1
NFT	0	1
IOT	14	6
Digital twin	1	5
Cobots	2	1
Addictive manufacturing	2	1
Others	1	1
OT software infrastructure	10	8
AI	3	5
BI	0	1
Others	7	2
Information technologies	6	8
Data storage	0	0
Local	0	0
Cloud	0	0
Cloud computing systems	3	3
Public clouds	2	1
Private clouds	1	2
Communication technologies	0	1
IT software infrastructure	1	4
RPA	1	4
Horizontal integration	21	34
Suppliers	10	12
Logistics	2	7
Government	0	0
Customers	9	15

community relations, the employee and community component of the Industry 5.0 process ensures that this focus can be maintained more efficiently through technological collaboration [69, 70]. For example, horizontal integration

Table 4. Evaluation of the activities carried out by Vestel and Arçelik about the environmental component within the scope of the Industry 5.0 process through their annual reports

Environment (with technology collaboration)	Vestel	Arçelik
	31	25
Technology for the environment	3	2
Sustainable production	9	9
Sharing economy with technology	0	0
Energy efficiency	8	9
Circular economy	11	5

may ensure more efficient communication between businesses and their customers and suppliers and thus establish a fair commercial structure [5, 54, 71]. The relationship between the resilience of the businesses component of the Industry 5.0 process and the governance component of the ESG process is also focused on technological infrastructure and collaboration. For example, for the relevant enterprise to be monitored and audited transparently by stakeholders and to prevent corruption, every process should be recorded. These records should not be changed; even if they are changed, it should be known by whom, when and for what reason. In addition, ensuring communication within the organisation and eliminating silos between business departments is also through technology-oriented communication [72, 73]. This relationship is confirmed by studies in the literature [6, 26, 74].

The relationship between Industry 5.0 and ESG processes can be expressed in Figure 2 by utilising Table 2 and the knowledge revealed from the document analysis.

RQ2. In which areas do Vestel and Arçelik enterprises in the BIST Sustainability 25 index work within the scope of Industry 5.0?

No terminology related to Industry 5.0 was found in the annual reports of either Vestel or Arçelik. In accordance with the methodology of the study analysis, an attempt was made to identify the "Industry 5.0" process on the left side of the equation derived from "Industry 4.0 + Environment + Employees and Society + Resilience of businesses" on the right side. Tables 3, 4, 5 and 6 show the structure that emerged in this context. In this context, it is seen that both enterprises carry out studies on the Industry 5.0 process, although they do not explicitly use the term "Industry 5.0". The findings obtained from the examination made by considering all the components in the equation one by one are given below, respectively.

i. Industry 4.0: Table 3 presents the data obtained from analysing the annual reports of Vestel and Arçelik with the help of NVivo software in relation to the activities carried out by these enterprises within the scope of Industry 4.0 technology. On the left side of this table, the technologies and processes found in the annual reports, in accordance with Table 1, are written. On the right side of the table, the extent

Table 5. Evaluation of the activities carried out by Vestel and Arçelik about employees and society components within the scope of the Industry 5.0 process through their annual reports

Employee and society	Vestel	Arçelik
	17	17
Technology for human	7	8
Hybrid intelligence	0	0
Employee is a value, not an asset	1	3
Employee and technology collaboration	9	6

Table 6. Evaluation of the activities carried out by Vestel and Arçelik about the resilience of businesses within the scope of the Industry 5.0 process through their annual reports

Resilience	Vestel	Arçelik
	13	10
Environmental resilience	3	3
Digital resilience	5	2
Cyber resilience	5	5

to which these technologies and processes are mentioned in the annual reports of Vestel and Arçelik and the activities carried out are shown.

When evaluated in terms of Industry 4.0 components within the scope of Industry 5.0, it can be seen that Vestel (94) has more statements regarding Industry 4.0 technology than Arçelik (91) in the annual reports of Vestel and Arçelik. When analysed in detail, it is seen in Table 2 that the statements related to horizontal and vertical integration are the most frequently used statements in the annual report in terms of Industry 4.0 components. When horizontal and vertical integration is considered, it is understood that Arçelik, with 73 statements, included more statements in its annual report compared to Vestel's annual report. When horizontal integration and vertical integration are considered separately, it is seen that Vestel (41) included more statements in its annual report than Arçelik (39) in horizontal integration, while Arçelik (34) included more statements in its annual report than Vestel (21) in vertical integration. Apart from these, it is observed that Vestel has more statements related to new business models, digital culture, data and knowledge process, cyber security, operational technologies - especially IOT technology, and OT software infrastructure codes than Arçelik. Table 2 shows that Arçelik has more statements related to information technologies and IT software infrastructure than Vestel.

Table 7. Evaluation of Vestel and Arçelik's annual reports regarding the Industry 5.0 process

	Industry 5.0	=	Industry 4.0	+	Environment	+	Employee and society	+	Resilience
Vestel	155		94		31		17		13
Arçelik	143		91		25		17		10

It is seen in Table 2 that both enterprises are working intensively on the Industry 4.0 process. The studies conducted are similar to each other. Vestel's annual report provides more information on cyber security, digital corporate culture and new business models, while Arçelik's annual report provides more information on digital twin and RPA technologies.

It was found that Arçelik included more information on horizontal integration processes in its annual report than Vestel. Vestel, on the other hand, gives more importance to vertical integration processes than horizontal integration.

Both enterprises' annual reports found insufficient information on Metaverse, NFT, and blockchain infrastructure. It is thought that the importance of these technologies will increase more in the future. Thanks to the widespread use of 5G fast mobile internet infrastructure, metaverse infrastructure systems may develop further.

It may be very important for the stakeholders of the enterprises in the current study to focus relatively more on their activities related to Industry 4.0 in their annual reports and to clarify the efforts they have made and will make in this field.

ii. Environment: The evaluation of Vestel and Arçelik's activities related to the environment within the scope of the Industry 5.0 process through their annual reports is given in Table 4.

When Table 4 is analysed, it is determined that Vestel (31) uses more environmental statements than Arçelik (25).

It is seen that both enterprises use technology for sustainable production and a more livable environment within the scope of the Industry 5.0 process. Both enterprises included sustainable production in their annual reports equally. Circular economy issues are covered more in Vestel's annual report than in Arçelik's. Both enterprises work intensively on energy efficiency. These efforts are thought to be related to the environmental component of the ESG process [7]. Environmental issues are made more sustainable through technology collaboration. In this way, contributions are made to the ESG process.

iii. Employees and Society: The evaluation of Vestel and Arçelik's activities related to employees within the scope of the Industry 5.0 process through their annual reports are presented in Table 5.

When Table 5 is analysed, it is seen that both enterprises have conducted studies on the use of technology in collaboration with employees and society. While Vestel's annual report contains more explanations and studies on the collaboration between technology and employees, Arçelik's annual report contains more explanations and studies on the value of employees.

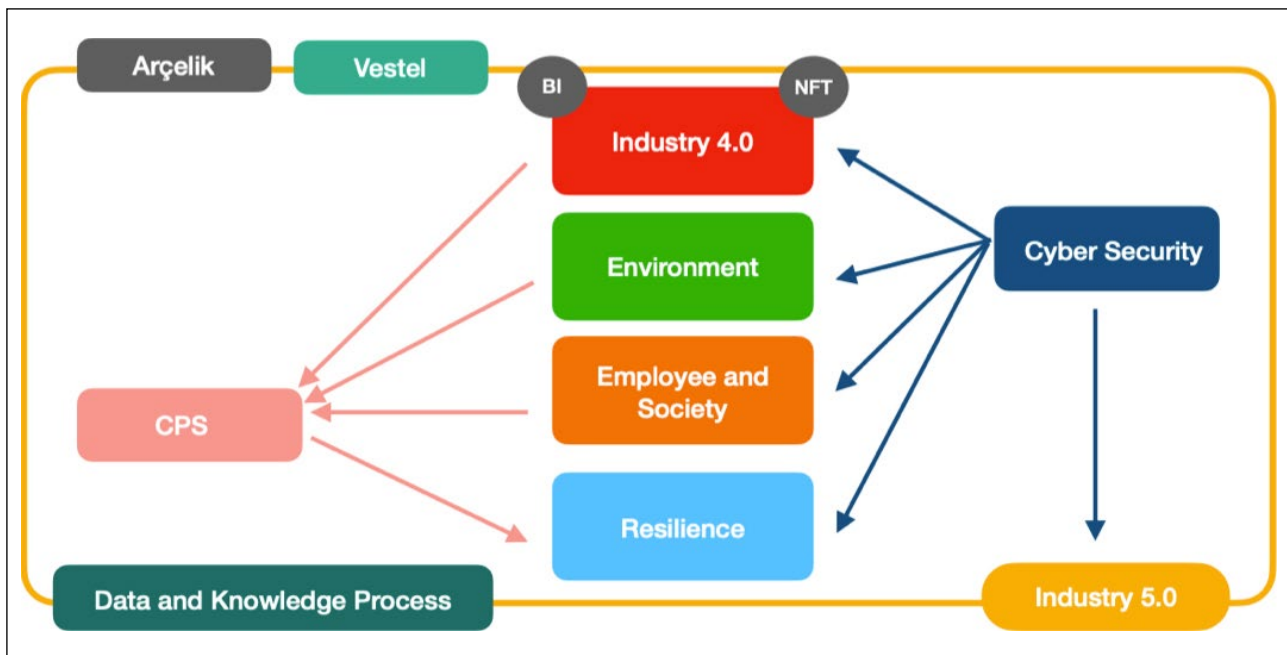


Figure 3. Comparison of Industry 5.0 process components through Arçelik and Vestel annual reports (Source: Authors Elaboration).

Both enterprises declared in their annual reports that they develop and use technology to benefit society and explained their efforts in this area. The effects on the social component of the ESG process are strengthened with the expansion of technology and employee collaboration in the Industry 5.0 process to society [6].

iv. Resilience of Businesses: The evaluation of Vestel and Arçelik enterprises' activities related to the resilience of businesses within the scope of the Industry 5.0 process through their annual reports is given in Table 6.

When Table 6 is analysed, it is seen that both enterprises conduct studies on resilience. Resilience studies on cyber security are equally included in the annual reports of both enterprises. There are more studies on digital resilience at Vestel (5) than at Arçelik (2). Digital resilience not only increases resilience against threats such as pandemics and natural disasters, but it is also important for solving problems such as solving communication problems within the organisation, removing silos between business units, making production processes more efficient, and not being able to evaluate employee performance fully [75, 76]. These studies are considered to be related to the governance component in the ESG process and are supported by studies in the literature [9, 77, 78].

When evaluated for the concepts considered as components of Industry 5.0 and expressed as equations in the study, the statements included in the annual reports of both enterprises are given in Table 7.

When Table 7 is analysed, it is seen that Vestel's annual report includes a total of 155 statements regarding the Industry 5.0 process, while Arçelik includes 143 statements. When Table 7 is analysed, it is seen that both enterprises are engaged in intensive activities related to the components on the right side of the equation.

As a result of the evaluation of Tables 3, 4, 5 and 6 together, the findings showing the comparison of Vestel and Arçelik enterprises' activities related to the Industry 5.0 process according to their annual reports are presented in Figure 3.

RQ3. In which areas do Vestel and Arçelik enterprises in the BIST Sustainability 25 index work on ESG process?

The studies conducted for the ESG process have similar characteristics for both enterprises. In this regard, it has been determined that both enterprises focus on sustainability, ethics, workplace rights, and social issues and carry out studies. These studies are necessary to be included in the BIST Sustainability 25 index. The findings from the environmental, social, and governance components of the ESG process are given below.

i. Environment (E): The evaluation of Vestel and Arçelik on the environmental component of the ESG process through their annual reports is presented in Table 8.

Table 8 shows that Vestel includes more environmental issues in its annual reports compared to Arçelik. Noteworthy results reveal that Vestel uses more statements on sustainability, waste management, footprint, water and energy than Arçelik. On the other hand, only technology management and climate change are more frequently mentioned in Arçelik than in Vestel.

ii. Social (S): The evaluation of Vestel and Arçelik's activities related to the social component of the ESG process through their annual reports is presented in Table 9.

Table 9 shows that Arçelik includes more social issues in its annual reports compared to Vestel. Arçelik uses more statements on shareholder rights, occupational health and safety and employee satisfaction than Vestel.

Table 8. Evaluation of the activities carried out by Vestel and Arçelik about the environmental component of the ESG process through their annual reports

Environment	Vestel	Arçelik
	124	77
Sustainability (resource efficiency)	24	17
Renewable energy (solar)	5	5
Waste management	34	8
Technology management	1	3
Climate change	14	17
Biodiversity	6	6
Footprints	31	24
Water	10	7
Energy	9	3
Carbon (net 0)	14	14

iii. Governance (G): The evaluation of Vestel and Arçelik's activities related to the governance component of the ESG process through their annual reports is presented in Table 10.

Table 10 shows that Arçelik includes more governance issues in its annual reports than Vestel. It is noteworthy that Arçelik has more statements on corporate governance than Vestel, and Vestel has more statements on ethics and anti-corruption than Arçelik.

When the studies conducted by Vestel and Arçelik, both of which are included in the BIST Sustainability 25 index, on the ESG process are analysed, the fact that both enterprises show similarities in ESG-related issues can be attributed to their inclusion in the BIST Sustainability 25 index. In order to be included in this index, studies on ESG issues are required.

As a result of the evaluation of Tables 8, 9 and 10 together, the findings showing the comparison of Vestel and Arçelik's ESG-related activities according to their annual reports are presented in Figure 4.

RQ4. What is the relationship between the components of Industry 5.0 and the ESG components of environment, social and governance in Vestel and Arçelik enterprises in the BIST Sustainability 25 index?

Within the scope of Industry 5.0 and ESG processes, the findings obtained based on examining the studies conducted by Vestel and Arçelik enterprises were evaluated. According to this evaluation, the relationship between the Industry 5.0 process and the ESG process was revealed by comparing the statements used in the annual reports of Vestel and Arçelik, which are included in the BIST Sustainability 25 index, within the scope of the components of these processes.

When the annual reports of Vestel and Arçelik are analysed, it is understood that the activities carried out within the scope of the ESG process are carried out in collaboration with technology [79, 80]. It is observed that both

Table 9. Evaluation of the activities carried out by Vestel and Arçelik about the social component of the ESG process through their annual reports

Social	Vestel	Arçelik
	51	62
Workplace rights	3	3
Shareholder rights	8	15
Occupational health and safety	4	8
Employee and rights	4	3
Human and society	17	14
Employee satisfaction	12	17
Community relations	3	2

Table 10. Evaluation of the activities carried out by Vestel and Arçelik about the governance component within the scope of Industry 5.0 through their activity reports

Governance	Vestel	Arçelik
	37	44
Work ethic	11	12
Transparency	4	5
Shareholders	10	10
Ethics and anti-corruption	5	2
Corruption and bribery	3	5
Corporate governance	4	10

enterprises exhibit some weaknesses in the "People and Workers" section, which is a vital component of the Industry 5.0 process. This assessment is based on the information summarised in the annual report. It is important to note that the Industry 5.0 process shapes the collaboration between employees, society and the environment through technological developments, whereas Industry 4.0 does not share such a focus. At the outset of this study, it is imperative to outline how the collaboration between staff and technology should be formalised through written documentation. This is because the current technologies used can only be sustained with the support of effective staff-technology collaboration. However, it is crucial to determine how to collaborate with AI when AI procedures increasingly dominate business structures. Businesses may benefit from examining hyperintelligence (hybrid intelligence) issues, demonstrating how artificial and human intelligence coexist.

Figure 5 shows the relationship between Industry 5.0 and ESG processes according to Vestel and Arçelik's annual reports.

CONCLUSION

Businesses that try to survive by struggling against uncertainties in the process of rapid change and an environment of intense competition are also dealing with

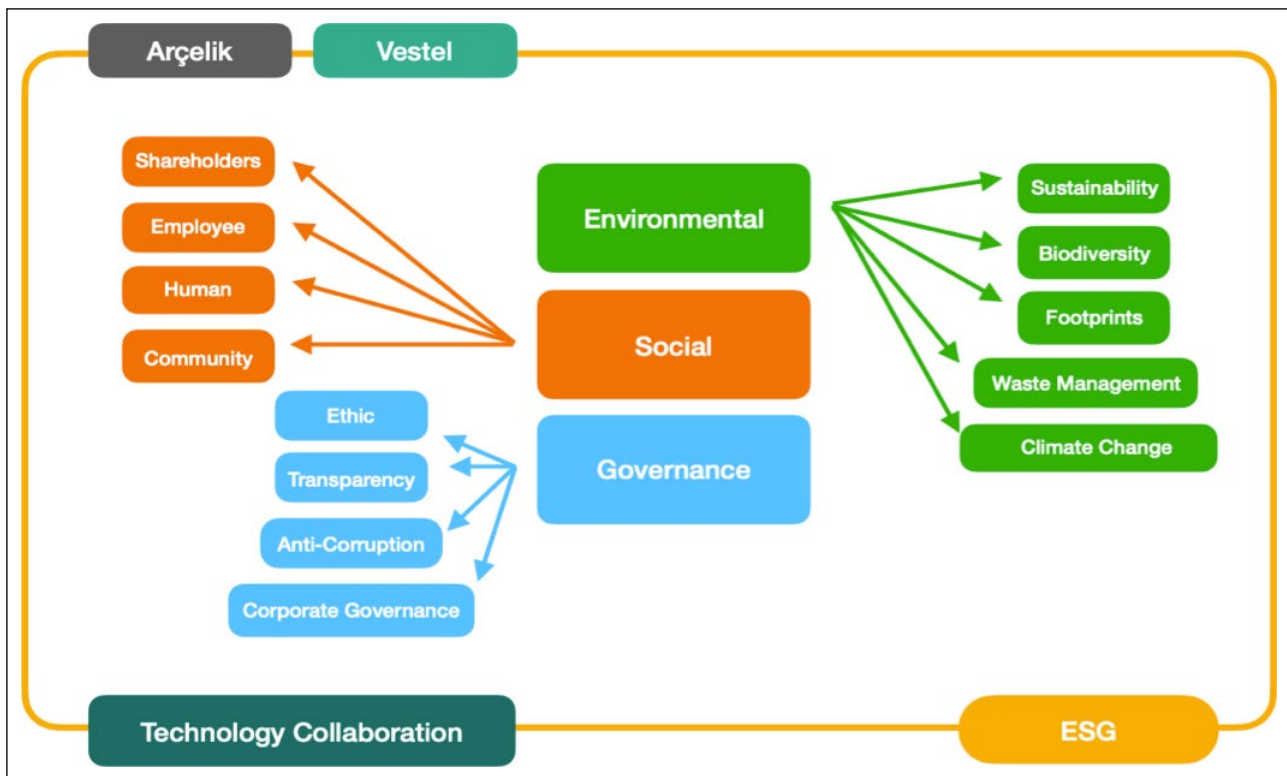


Figure 4. Comparison of ESG process components through Arçelik and Vestel annual reports (Source: Authors Elaboration).

problems such as the threat of deterioration of the world's ecological balance. In this struggle, sustainability principles have been placed on the agenda of profit-seeking organisations depending on the field in which studies are carried out on this threat's environmental, social and economic effects. Businesses now act with great responsibility towards society for a more livable world in the environmental, social and economic fields within the framework of sustainability principles. On the other hand, they produce strategies to survive in an intensely competitive environment. Especially in recent times, with the rapid change experienced within the scope of digitalisation, it develops its strategies depending on the principles of sustainability that can be acted in harmony. Within the framework of these harmonious and socially beneficial activities, it is important for businesses to continue their work in line with the principles of technology and sustainability, both for themselves and for the local community and the world.

The most important distinguishing feature of the Industry 5.0 concept from previous industrial revolutions is the adoption of technological developments in Industry 4.0. This shows that businesses that can complete Industry 4.0 processes can also be successful in the Industry 5.0 process if they address issues related to employees, environment and organisational flexibility.

In this study, to theoretically determine the relationship between Industry 5.0 and ESG processes, the position of employees in the Industry 5.0 process, their compliance and necessity within the sustainability and social benefit principles framework are tried to be revealed in the con-

text of technological collaboration. The annual reports of Vestel and Arçelik, which are in the white goods sector within the scope of the BIST Sustainability 25 Index, were analysed to reveal how the study's theoretical background was evaluated. The Industry 5.0 process is evaluated as a component of Industry 4.0, which includes the environment, employees, society, and the resilience of businesses. These components were formulated using the equation: "Industry 5.0 = Industry 4.0 + Environment + Employees and Society + Resilience of Businesses". Table 1 was generated in this context, and the Industry 5.0 process was tried to be expressed with all its subcomponents. All subcomponents of the ESG process are also tried to be expressed in Figure 1. By evaluating Table 1 and Figure 1 together, the relationship between Industry 5.0 and ESG processes is shown in the matrix table in Table 2. Each intersection of the rows and columns of Table 2 shows the relationship of the components in the row and column. This relationship constitutes the answer to the employee's research question 1 and the study's theoretical background.

In order to determine how the theoretical background of the study is evaluated by Vestel and Arçelik, the leading representatives of the Turkish white goods industry operating within the scope of the BIST Sustainability 25 Index, the most recent annual reports of both enterprises for the year 2022 were analysed. In this context, it is noteworthy that both enterprises carry out studies with parallel themes. In particular, both enterprises produced studies on Industry 5.0 and ESG processes, which share similar interrelated processes, as shown in Figure 5.

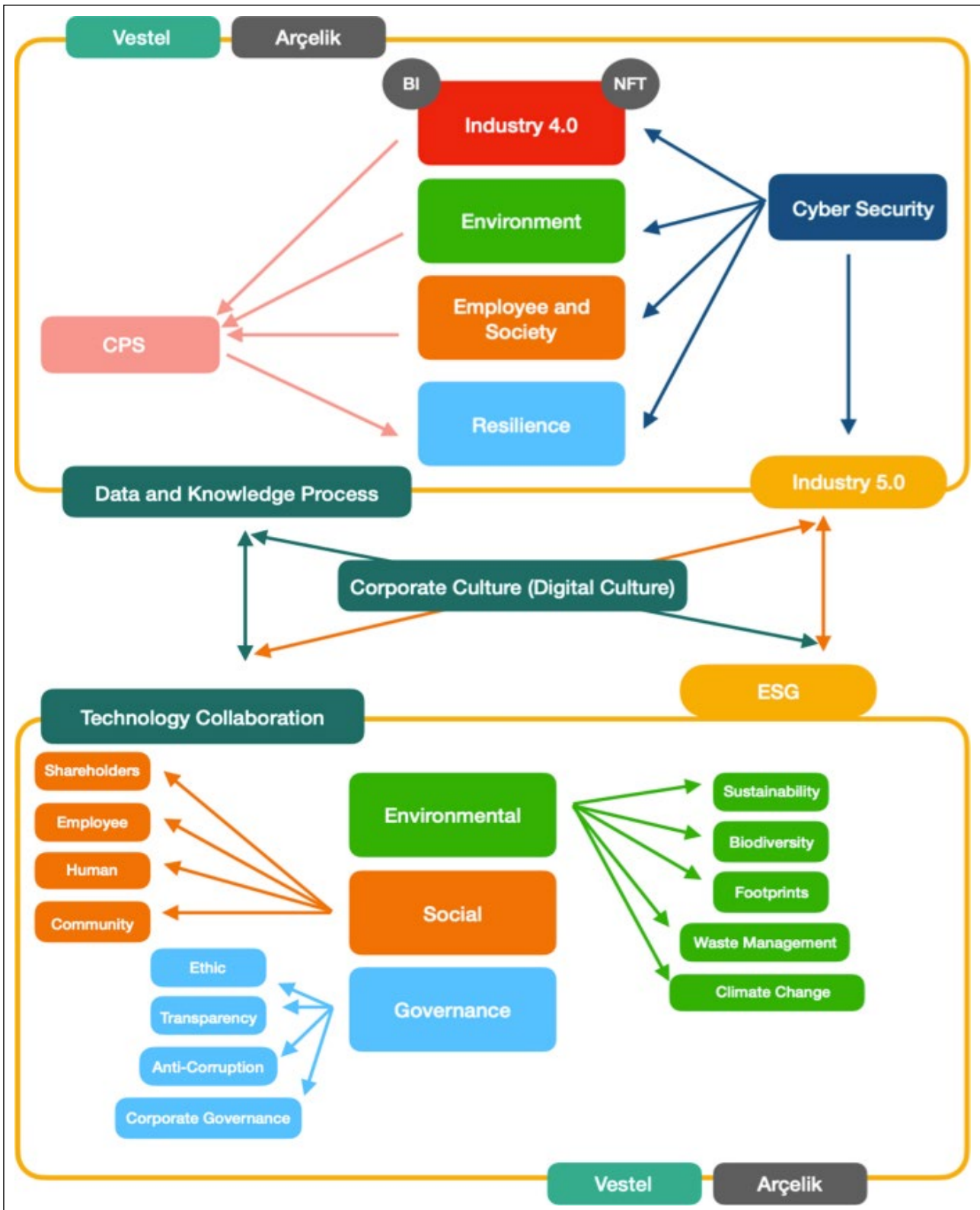


Figure 5. The relationship between Industry 5.0 and ESG processes that emerged as a result of analysing the annual reports of Vestel and Arçelik (Source: Authors Elaboration).

It is recognised that there is an effective correlation between Industry 5.0 and ESG processes. This correlation can be explained by the statement that the Industry 5.0 process forms the technological foundations of the ESG process. The relationship between the concepts related to

the environmental component in the Industry 5.0 process within the scope of environment-technology collaboration is closely related to the environmental component in the ESG process. Similarly, the relationship of the concepts related to the employees and society component in

the Industry 5.0 process within the scope of employee-society-technology collaboration can be evaluated in the context of generating the technological infrastructure of social concepts in the ESG process. The relationship between the concepts related to the resilience component of businesses in the Industry 5.0 process within the scope of business resilience-technology collaboration is closely related to the governance component in the ESG process. In this context, the technological infrastructure in the Industry 5.0 process minimises the risk of silos in businesses by eliminating communication problems between departments in businesses. Thus, ensuring that the studies on the Industry 5.0 process are more efficient can also contribute to the studies on the ESG process.

This study is intended to help researchers, who study Industry 5.0 and ESG processes theoretically and practically. In addition, it can contribute to developing practices for the ESG process by adapting businesses to technological change. In addition, this study reveals the direction of the relationship between Industry 5.0 and ESG processes. In order to reveal the degree of the relationship, more comprehensive analyses with quantitative or mixed designs should be conducted in different sectors of businesses working on these two processes. However, Tables 1, Figure 1, and 2 presented within the study's scope are valuable as they can guide researchers in creating the infrastructure for quantitative or mixed design studies.

In the application part of this study, the annual reports of two enterprises were analysed. Conducting the study only through the annual report is considered an important limitation. The fact that only two enterprises in the white goods sector are included in the BIST Sustainability 25 Index is considered another limitation.

As a result, it can be stated that one way to expand the implementation of sustainable policies all over the world is for businesses to manage the ESG process well. Those who can adapt their businesses to the Industry 5.0 process that supports sustainable actions can carry out the ESG process more easily.

DATA AVAILABILITY STATEMENT

The author confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

USE OF AI FOR WRITING ASSISTANCE

Not declared.

ETHICS

There are no ethical issues with the publication of this manuscript.

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