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Research Article

Development of a New Composite Index for Measuring the Sustainability Performance of Manufacturing Companies Operating in the BIST Sustainability Index*

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*This study is derived from the first author's doctoral thesis

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ABSTRACT

The number of studies on sustainability assessment tools and models has increased in the last two decades. Composite Indexes (CIs) have become popular as a useful tool for assessing business level sustainability to compare the companies operating in the same sector. Limited studies have covered all three dimensions (economic, environmental, and social) of the sustainability assessment in an integrated manner in Turkey. This paper aims to measure and evaluate the Corporate Sustainability (CS) performances of ten manufacturing companies operating in the Istanbul Stock Exchange Market. For this purpose, a new integrated sustainability composite index was developed by using previous composite indexes in the literature. The developed assessment model provides a practical tool for the organizations in the manufacturing sector in Turkey by measuring and evaluating their sustainability performances in a holistic way. By using the analytical hierarchy process (AHP), the levels of the sustainability performances of ten manufacturing organizations were assessed in a short time. The index allows managers to make comparisons among companies within the same sector. The results further indicated that the economic dimension score of the analyzed organizations had a weighty and salient effect on the total corporate sustainability performance score. This finding contributes to the literature that economic performance is predominantly effective in the sustainability performance of businesses.

Keywords: Sustainability Assessment, Integrated Measurement, Composite Index, Economic Dimension, BIST

1. Introduction

Problems such as climate change, reduction of natural resources, global warming, the extinction of some living species, increasing pollution, degradation of forest areas, and an unavoidable increase in global population pose critical threats to all humanity and our planet (Büyüközkan & Karabulut, 2018; Krajnc & Glavic, 2003; Veleva & Ellenbecker, 2001). The basis of these problems is generally economic and development-based activities, and many businesses, especially global ones, are trying to understand their effects on sustainable development. Undoubtedly, organizations need to adjust their management understandings by increasing their positive impacts on the environment, society, and economic development. This obligation forces businesses to reconsider their roles and responsibilities regarding nature and society and prompt them to embed sustainability principles into current management strategies (Medel-Gonzalez, Garcia-Avila, Acosta-Beltran, & Hernandez, 2013).

It is not easy to evaluate or make a judgment on the sustainability status of an organization. For this reason, measuring the sustainability of organizations using critical performance indicators and evaluating the measurement results according to specific predetermined criteria has emerged as one of the solutions (Linke, Corman, Dornfeld, & Tönissen, 2013). Elkington (1997), one of the theorists of Corporate Sustainability (CS) states that business activities need to be evaluated not only according to financial results but also to environmental and social effects. He proposed the Triple Bottom Line (TBL or 3P – People, Planet, Profit) approach, which are the dimensions of sustainable development. This approach emphasizes focusing on society and the ecological environment as well as on economic activities. A study conducted by KPMG (2020) has shown that the number of businesses that make corporate sustainability reporting based on the triple bottom line approach has increased by 300 % in the last 25 years.

Chen, Thiede, Schudeleit, & Herrmann (2014) state that none of the existing tools aimed at measuring the sustainability performances of organizations can simultaneously meet all requirements, such as having general applicability or measuring sustainability from a holistic perspective. Similarly, Veleva & Ellenbecker (2001) concluded that it is not possible to use a standard sustainability indicator set in all industries due to differences in firm sizes and activities. However, the use of quantitatively expressed sustainability indicators has emerged as a solution so that it would be possible to monitor the economic, social, and environmental performances of the organizations (Epstein, Buhovac, & Yuthas, 2015; Linke et al., 2013; Singh, Murty, Gupta, & Dikshit, 2012). By using the composite indicators or composite sustainability indexes as a valid method to measure the sustainability performances of organizations, it would be possible to include all three dimensions of the sustainable development concept (Feil, Schreiber, Haetinger, Strasburg, & Barkert, 2019; Niemeijer & Groot, 2008; UNCSD, 2012; Zhou, Tokos, Krajnc, & Yang, 2012).

Corporate sustainability studies in Turkey focus on two areas. These are the quality of corporate sustainability reporting and measuring the sustainability performance of companies. In essence, there were no sustainability reports published in Turkey before 2005 (Ertan, 2018). In other words, studies on corporate sustainability performances of enterprises in Turkey started in the last 15 years. While some of the studies conducted were based on sustainability reporting and the quality of the information level in these reports (Bozaykut Bük, 2020; Ertan 2018; Gümrah & Büyükipekçi, 2019; Hancıoğlu, Gülençer, & Tünel, 2018; Mısırdalı Yangil, 2015), others focused on financial performance and business sustainability indicators (Acar, Kılıç, & Güner, 2015; Aksoylu & Taşdemir, 2020; Bilge, Badurdeen, Seliger, & Jawahir, 2014; Ergüden & Çatlıoğlu, 2016). Although some works conducted in Turkey aimed to assess the sustainability performances of the businesses by using Multi-Criteria Decision Making (MCDM) methods, they are quite limited in number. Furthermore, while some of the studies for sustainability measurement dealt with a single dimension of sustainability (i.e., environment), others tackled only single company cases (Alp, Öztel, & Köse, 2015; Öztel, Köse, & Aytekin, 2012). Thus, there is a need to increase the number of studies measuring the sustainability performances of industrial organizations in a holistic approach.

Using the pre-determined methodology, composite indicators are the set of indicators created by performing the phases shown in Figure 1 below (Zhou et al., 2012). Even though composite indicators are mainly the tools for the evaluation of countries' sustainability performances in terms of their economic, social, and environmental progress, they can also be good instruments for the measurement of sustainability performances of the industrial organizations (Butnariu & Avasilcai, 2015).

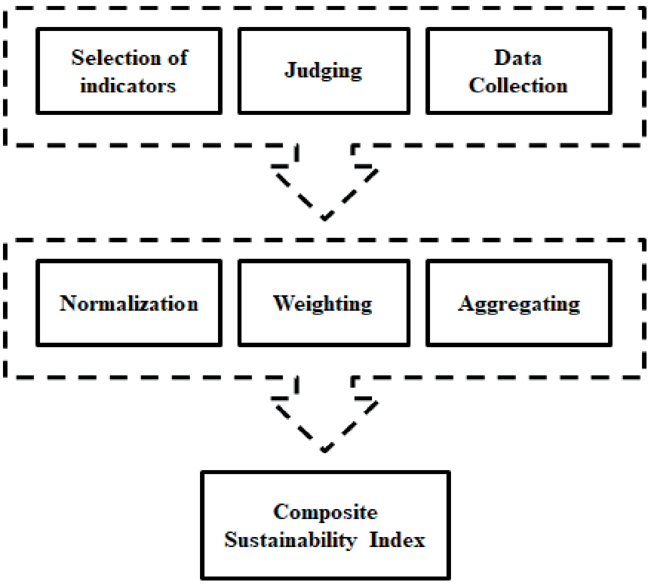

Figure 1: Steps for Creating CI for Sustainability Measurement (Zhou et al., 2012:792)

This study aims to develop a new CI using the methodology shown in Figure 1 and to measure and compare the sustainability performances of ten manufacturing companies operating in the Istanbul Stock Exchange (BIST) Sustainability Index.

2. Literature Review

This section provides brief information about sustainable development and corporate sustainability concepts. After giving a summary of developments of sustainability assessment tools and their categorization efforts, it concludes with information on composite indexes or indicators used in the literature.

2.1. Sustainable Development and Corporate Sustainability

Although sustainable development (SD) and corporate sustainability (CS) are two different concepts, they are closely related to each other. It is possible to say that these two concepts complement each other in theory and practice (Feil et al., 2019). While sustainable development covers the macro-level applications of the triple bottom line, corporate sustainability involves the micro-practices, which are at the business or corporate level. Even the definition of sustainable development continues to be ambiguous; the World Commission on Environment and Development defines it as "*…development that meets the needs of the present without compromising the ability of future generations to meet their own needs*". This definition is extensively recognized worldwide. It could be challenging to understand sustainable development since it is a complex, multi-dimensional subject and focuses on intergenerational equity based on economic, social, and environmental aspects (Ciegis, Ramanauskiene, & Martinkus, 2009).

Sustainable development is such an approach that it requires the development of human welfare with environmental protection and social equality in a balanced manner. From this point of view, Bork, de Souza, de Oliveira Gomes, Canhete, & De Barba (2016) state that natural resources are not unlimited, climate change accelerates with the effect of greenhouse gases, the extinction of some living species disrupts the balance of the ecosystem, and pollution affects human health negatively. The environmental problems mentioned above cannot be ignored. Similarly, sustainable development must comply with the laws and regulations in force in the relevant countries for decent working conditions, equal payment for equal jobs, and be sensitive to ethical issues.

Corporate/business sustainability is defined as "*adopting business strategies and activities that meet the needs of the enterprise and its stakeholder today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future*" (Deloitte & Touche, 1992). To be a sustainable organization, a program, an activity, or a project should meet all the following criteria (Brocket & Rezaee, 2012): (1) create economic value, (2) increase public welfare, (3) be socially acceptable, (4) be sensitive and respectful to the environment, (5) comply with ethical rules, and (6) comply with applicable rules and regulations.

Similarly, Veleva and Ellenbecker (2001) stated that the following conditions must be met for industries to be sustainable: (1) reduction of natural resource and energy usage, (2) reusing, or recycling of materials to avoid waste, (3) disposal of non-recyclable and environmentally acceptable wastes, (4) use of clean technologies in the production process and product life cycle, (5) reducing transportation conditions, (6) planning of adaptable and durable products that are easy to repair, (7) supporting social issues, and (8) making economic feasibility at every opportunity.

2.2. Sustainability Assessment Tools and Their Categorization

It is difficult to define sustainable business, which is a rather vague and broad concept. It is difficult to reveal the sustainability degree for a company since no model and measurement tool has been agreed on. Labuschagne et al. (2005) stated that managers do not have enough tools to measure the sustainability performance of organizations. Similarly, Singh Murty, Gupta, & Dikshit (2007) highlighted that no framework provides a comprehensive assessment of sustainability performance management in businesses. Briassoulis (2001) demonstrated that the most dominant factor for not integrating the sustainability approach into the organization is that companies do not know how to measure it systematically, and the tools supporting sustainability management practices are inadequate. Although many businesses have adopted standards and guidelines such as ISO 14000, Social Accountability (SA) 8000, Social Responsibility and Management System ISO 26000, and AccountAbility 1000, these are only recommendations and suggestions.

Some authors have examined and made different categorizations of sustainability assessment tools from different perspectives. For example, Ness, Urbel-Piirsalu, Anderberg, & Olsson (2007) analyzed and categorized whether tools were integrated or non-integrated. They also examined and classified whether the tools were designed for the product or policy level. Furthermore, Feng, Joung, Che, & Li (2010 a, b) analyzed the tools in terms of hierarchy, and whether they were created for the global, country, sector, company, product, or process level. Labuschagne et al. (2005) reviewed whether the tools comprised a set of indicators and integrated the three dimensions of sustainability. Madanchi, Thiede, Sohdi & Herrmann (2019) made a practical and easily understandable categorization, which is depicted in Figure 2. Authors classified and categorized the sustainability assessment tools by looking at the following factors:

- If the tool integrates the three dimensions of sustainability: economic, social, and environmental,
- Whether the tool covers the global, country, sector, corporate, or product level and,
- Whether the tool is developed by an organization or a company.

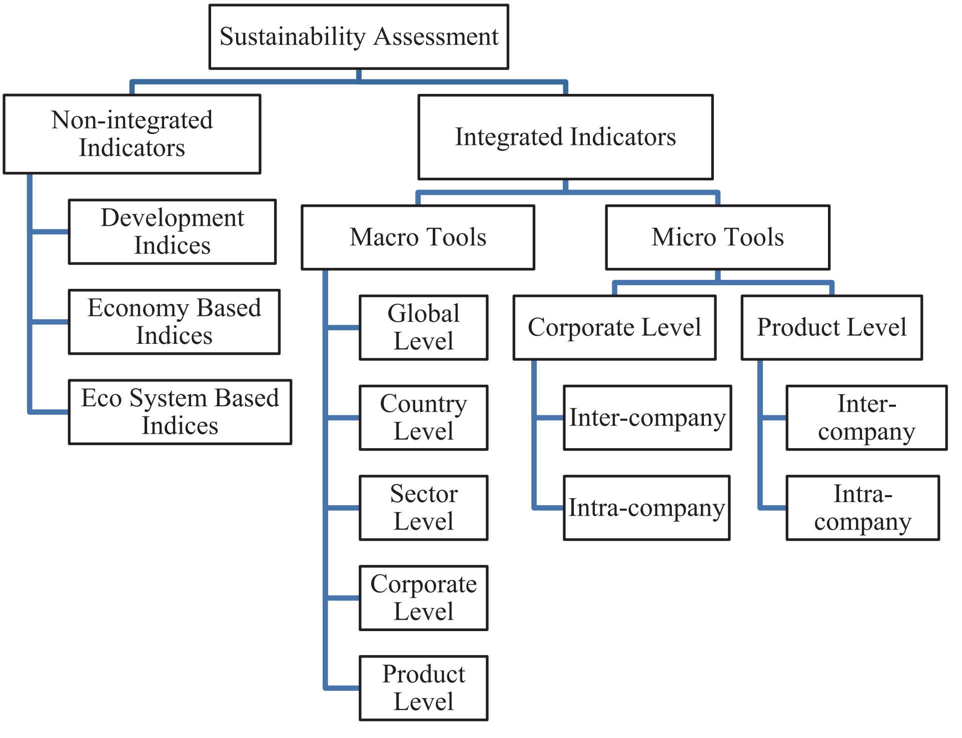

Figure 2: Categorization of Assessment Tools (Madanchi et al., 2019)

The most baffling aspect of measuring sustainability, including industrial organizations, is the uncertainty inherent in sustainability and the difficulties encountered in quantifying its sustainability effects (Büyüközkan & Karabulut, 2018; Lee & Saen, 2012). However, if an indicator set reflects the measurements of the dimensions of sustainability, it can provide a valuable picture of the sustainability status of an organization from a holistic perspective. Using composite indexes to evaluate companies' measurement and sustainability might be easier to support the decision-making system since it brings multi-dimensional issues into one index and provides comprehensive information (Zhou et al., 2012). Measurement results can also help companies establish focus areas for sustainability improvement (Joung et al., 2012).

Sustainability assessment aims to evaluate the status of an organization in terms of the triple-bottom-line of sustainable development (Lozano & Huisingh, 2011). It is a significant step to have a sustainability assessment tool that evaluates the sustainability performances of business organizations or industries, which provides a fast and integrated assessment with a minimum time effort. The sustainability concept contains differences from country to country and region to region because of cultural, social, and economic differences. It requires adjusted sustainability assessment tools that enable measurement (Zijp et al., 2017).

2.3. Composite Indexes (CIs) in the Literature

Business management can get benefits by using sustainability assessment tools, in short, to be able to monitor the sustainability developments of the organization. Thus, managers can identify possible improvements or deterioration in their sustainability activities by comparing their results with other businesses (Madanchi et al., 2019).

Composite or integrated indexes have started to be an accepted and increasingly important tool in informing stakeholders about the sustainability performance of organizations, as well as creating sustainability strategies and policies and providing effective internal and external communication (Harik, El Hachem, Medini, & Bernard, 2015; Helleno, De Moraes, & Simon, 2017; Singh, Murty, Gupta, & Dikshit, 2009). Within this context, possible pros and cons of CIs are listed in Table 1 (Nardo, Saisana, Saltelli, Tarantola, Hoffman, & Giovannini, 2008: 13).

Table 1: Pros and Cons of CIs

Pros of Composite Index	Cons of Composite Index
Summarize multi-dimensional and complex issues and support the decision-making system	May send misleading or non-robust messages if poorly constructed
Provide an easier and quick picture of the organization's sustainability status	The big picture may draw simplistic policy conclusions to decision-makers
Provide a good link with the public and stakeholders and raise their interest	Selection of sub-indicators, deciding for the model, weighting, normalizing and aggregating indicators may raise some problems and may need some statistically acceptable treatments
Give more information with a single unit or figure	

Mainly, constructing a sustainability index requires following these procedures systematically: (1) Selecting suitable indicators for each dimension, (2) Weighting the selected indicators after normalization and, (3) Aggregating all sub-indexes into a composite index (Gan, Fernandez, Guo, Wilson, Zhao, Zhou, & Wu, 2017).

Weighting and aggregating methods are important steps for constructing sustainability indexes because of the inherent complexity and interlinkages among the dimensions of the sustainability concept (Nardo et al., 2008). Gan et al. (2017) categorized the weighting methods most used in the literature as follows:

(1) Equal weighting, (2) Statistic-based weighting (Principal Component Analysis or Factor Analysis, Benefit of Doubt Approach, Regression Analysis, Unobserved Component Models) and, (3) Public/Expert opinion-based weighting (Budget Allocation, Public Opinion, Analytic Hierarchy Process, Conjoint Analysis). They identified the most used aggregation methods as (1) Additive aggregation, (2) Geometric aggregation and, (3) Non-compensatory aggregation.

However, one of the most discussed issues on sustainability indicators in the literature is the number of indicators used in measurement. According to Linke et al. (2013), the number of indicators determined needs to be enough to perform the desired analysis, but not more. Similarly, Singh et al. (2007), Krajnc and Glavic (2005), Veleva and Ellenbecker (2001) and Tokos, Pintaric, & Krajnc (2012) emphasized that performance evaluation using too many sustainability indicators would be difficult.

The other problematic area for measurement tools is the selection of the indicators for the evaluation model. Selection and prioritization of sustainability indicators from many indicators requires logical and reasonable explanation. Niemeijer (2002) argues that indicators may be chosen for being: (1) data-driven when the main concern is data availability, or (2) theory-driven when the quality of the data has the utmost importance, or (3) policy-driven when a specific policy is to be followed. Furthermore, evaluation tools need to be generic and applicable to large firms and SMEs as well (Veleva & Ellenbecker, 2001; Cagno, Neri, Howard, Brenna, & Trianni 2019).

There have not been many integrated sustainability assessment tools developed by researchers to measure company-level sustainability with a holistic perspective. Docekalova and Kocmanova (2016) created an integrated corporate sustainability index that can be used in businesses by offering the set of main indicators used by organizations, such as the Global Reporting Initiative (GRI), International Integrated Reporting Council (IIRC), and United Nations Conference on Trade and Development (UNCTAD), which work on corporate sustainability performance measurement. The number of indicators dropped when the correlation and factor analysis was conducted from the first indicator pool, without any reduction from the initial information. They removed repeated information from the model, and as a result, they obtained 17 critical performance indicators for the model. With the proposed model, it was possible to measure four dimensions (economic, social, environmental, and governance) of the industrial organizations. The indicators in the model with their properties are presented in Table 2 below.

Table 2: CI Developed by Docekalova and Kocmanova (2016)

Dimension	KPI	Indicator	Formulas	Type	Benchmark
Environment	KPI-1	Consumption of recycled materials and raw materials	(Total recycled materials / Total materials) X 100	Max	90%
	KPI-2	Fuel consumption	(Annual fuel consumption / Annual production) X 100	Min	Approaching to 0
	KPI-3	Waste production	(Annual waste production / Annual Production) X 100	Min	Approaching to 0
	KPI-4	Environmental Costs	(Non-investment annual environmental costs / Annual value added) X 100	Min	Approaching to 0
Social	KPI-1	Percentage of employment for collective agreement	(number of employee for collective agreement / Average annual employee) X 100	Max	100%
	KPI-2	Occupational diseases	(Annual occupational diseases reported / Average annual employee) X 100	Min	0%
	KPI-3	Percentage of products or Services for which the impact on health and safety for customers is evaluated during life cycle	(Number of products and services evaluated for the customer safety / Total products produced) X 100	Max	100%
	KPI-4	Expenditures on identifying and ensuring customer satisfaction	(Expenditures on identifying customer satisfaction / Annual value added) X 100	Max Min	Can not be determined
	KPI-5	Wage discrimination	(Average wage of men / Average wage of women) X 100	Max Min	Alternating preferences
	KPI-6	Violations of code of ethics	(Number of cases / Average annual number of employee) X 100	Min	0%
Economic	KPI-1	Cash flows	(Net increase/decrease in cash / Annual value added) X 100	Max	Best in group
	KPI-2	Return on assets	(EBIT / assets) X 100	Max	Best in group
Governance	KPI-1	Contributions to political parties, politicians and other institutions	(Total annual such contributions / Annual value added) X 100	Min	0%
	KPI-2	Percentage of complaints received from stakeholders	(Number of complaints received / Number of board members) X 100	Min	0%
	KPI-3	Percentage of women in the board	(Number of women in the board / Number of board members) X 100	Max Min	50%
	KPI-4	Percentage of achieved strategic goals	(Number of achieved strategic goals / Total strategic objectives) X 100	Max	100%
	KPI-5	Sanctions for non-compliance with laws and regulations	(Number of sanctions / Number of board members) X 100	Min	0%

A similar study was conducted by Feil et al. (2019). In this study, the researchers determined the characteristic features of sustainability indicators by scanning the literature and considering repetitive sustainability indicators. They reduced the number of indicators in the environmental, social, and economic dimensions by 93.7%, 91.8%, and 91.3%, respectively. Thus, they reduced the number of indicators from 753 to 69. The indicator set offered by the authors is presented in Table 3. It denotes the sustainability indicator pool by Feil et al.

Table 3: The Sustainability Indicator Set Presented by Feil et al. (2019)

S.NU.	ENVİRONMENT	FN	S.NU.	SOCIAL	FN	S.NU.	ECONOMIC	FN
	Electric Energy			**Employees**			**Costs / Expense**	
1	Electric energy consumption	38	1	Number of Employees	12	1	Nonconformity costs	2
2	Use of renewable energies	9	2	Turnover index	10	2	Expense with wages	10
	Water		3	Trainings for employees (hours)	15	3	Expense with taxes	6
3	Water consumption	31	4	Level of teh formal instruction	6	4	Environmental expenses	8
4	Reuse and rcycling	3	5	Discrimination	7	5	Operational expense	8
5	Water acidification	6	6	Wages and benefits	8		**Profit**	
	Waste		7	Health and security	21	6	Liquid profit	13
6	Volume of solid waste	28	8	Career and stability	6	7	Financial indicators	5
7	Volume od hazardous waste	9	9	Participation in management	4	8	Edded Value	13
	Emission		10	Complaining	4	9	Productivity	4
8	Volume of atmospheric gases	42	11	Deaths	4		**Investments**	
	Product		12	Job creations	7	10	Capital for investments	10
9	Volume of rcycling	6		**Work**		11	Benefits for employees	5
10	Volume of reuse	5	13	Child labor	7	12	Investments for R&D	8
11	Durability level	11	14	Satisfaction level	5	13	Return on assets	2
	Resources / Materials		15	İntensity level	5		**Suppliers**	
12	Consumption of natural resources	29	16	Noise level	6	14	Local suppliers	5
13	Consumption of recycling materials	9	17	Accidents / Injuries	15		**Gross Revenue**	
14	Hazardous materials	3	18	Number of Diseases	10	15	Gross Revenue value	14
	Effluents		19	Management quality	5		**Shareholders / Director's Board**	
15	Volume of liquid materials	26		**Clients / Consumers**		16	Participation of shareholders	8
	Labels and Certificates		20	Satisfaction level	7	17	Meetings of board of directors	5
16	Environmental labels and certificates	6	21	Number of complaining consumers	5		**Institutional**	
	Logistics			**Community and Stakeholders**		18	Number of organizational units	7
17	Transportation and logistics	6	22	Engagement of community	21	19	Contributions or donations	2
18	Reverse logistics	3	23	Local partnership	10	20	Competitiveness / market	4
	Environmental Investments / Spendings		24	Investments for community	8	21	Expense with clients	5
19	Environmental spendings	14		**Ethics**				
20	Environmental fines	3	25	Ethical behaviour	18			
21	Environmental management system	9						
	Environmental Impacts / Degradations							
22	Impacts / Environmental degradation	25						
	Soil							
23	Quality and use of soil	5						
	Total frequency = 326 Total of indicators = 348 Percentage of compilation = % 93,7 Number of compiled indicators = 23			Total frequency = 224 Total of indicators = 244 Percentage of compilation = % 91,8 Number of compiled indicators = 25			Total frequencyp = 147 Total of indicators = 161 Percentage of compilation = % 91,3 Number of compiled indicators = 21	

Taking into consideration the growing number of frameworks and tools with different focus areas, Madanchi et al. (2019) developed a new CI for manufacturing companies to evaluate their sustainability performances. The total number of the indicators in the sub-dimensions was 20, and the tool is depicted in Table 4.

Table 4: The CI developed by Madanchi et al. (2019)

SN	Dimension	Theme	Indicator	Unit
1	Environment	Natural resources and assets	Energy use	MWh
2			Material use	kg
3			Freshwater consumption	m3
4			Waste generation kg	kg
5		Pollution	Global warming potential	t CO2-eq
6			Acidification potential	t SO2-eq
7	Social	Health and Safety	Working accidents	-
8			Safety training	-
9			Hazardous materials	kg
10		Labor development and work satisfaction	Training and education	h
11			Sickness frequency	days
12			Employee attrition rate	%
13		Equal opportunity and decent work	Share of women in workforce	%
14			Share of women in management positions	%
15			Wages at lowest wage group	$
16	Economic	Financials	Net profit margin	%
17			Return of capital employed	%
18		Development	Investment in R &D	$
19			Investment in Staff Development	$
20			Expenditures on EHS Compliance	$

3. Methodology

This study aims to measure the corporate sustainability performances of manufacturing companies operating in the BIST Sustainability Index in Turkey. For this purpose, a new CI was developed using the methodology shown in Figure 1 above. Creating a composite index requires the selection of the appropriate sustainability indicators for each dimension. To do this, the integrated measurement tools developed in the literature were reviewed and a new one was created by selecting the appropriate sustainability indicators for each dimension. The proposed CI was presented to academic experts to receive their confirmation for content validity analysis. In the next step, the selected indicators were examined to determine whether they contributed positively or negatively to sustainable development. Since it is not possible to combine indicators with different units without normalization, the next step was the normalization process. After that, weights were assigned to each indicator using the AHP method to obtain a meaningful sustainability picture of the organization. The final steps were finding the aggregated values of sub-indexes and total sustainability scores of the companies for the relevant years.

3.1. Determining Indicator groups and Obtaining Expert Evaluations for the Proposed Composite Index

To determine which sustainability indicators are to be included in the proposed CI, other indexes developed by researchers in the literature were identified. Composite indexes developed by Docekalova and Kocmanova (2016), Feil et al. (2019), Cagno et al. (2019), and Madanchi et al. (2019) were carefully examined. The proposed CI model was built based on an understanding that it should cover the main sustainability issues with a minimum number of indicators. The choice of the indicators is a kind of process based on the preferences of the authors, so receiving experts' evaluation could be a logical way to be sure of the validity of the content of the developed CI. The experts were selected from among faculty members working at universities in Turkey. All experts were academics who have worked on corporate sustainability and whose articles on sustainability have been published in national or international journals. They were determined by using internet database search engines. The experts (n=20) were asked to evaluate the sustainability measurement effectiveness of the model by choosing one of the options as "very good", "acceptable", or "weak". The questionnaire was sent to the experts by e-mail. Fourteen of the twenty academics responded to the questionnaire. According to the experts' evaluations, the content of the proposed CI was acceptable and reliable. The developed CI is presented in Table 5 and the content validity analysis of the CI is presented in Appendix A.

Table 5: The CI Developed for Turkish Manufacturing Companies

DIMENSION	THEME	INDICATOR	UNIT
Economic	Financial Efficiency	Return on assets (ROA)	%
		Return on investment (ROI)	%
		Return on equity (ROE)	%
	Investments	R&D Investments	Turkish Lira (TL)
Environment	Natural Resources	Total energy consumption per unit production	GJ / tonnes
		Total water consumption	M3
		Reused water per unit production	M3 / tonnes
	Pollution	Total waste per unit production	% tonnes or kg
		Total recycled waste per unit production	% tonnes or kg
		Total hazardous waste per unit production	% tonnes or kg
		Total GHG emissions per unit production	t-CO2
		Air emissions per unit production	t-SO2
	Environmental Development	Environmental investments per unit production	TL / tonnes
Social	Employee Development & Job Satisfaction	Total employee number	-
		Employee turn over rate	%
		Total employee trainings	hour
		Training hours per employee	hour
	OHS	OHS training per employee	
		Accident Rate (Formula 1 below)	%
		Accident frequency rate (Formula 2 below)	%
	Gender Equity and Decent Job	Female employee rate	%
		Female manager rate	%
		Rate of collective agreement for employees	%

Formula 1 = (Total lost working day / Total net working days) X 1.000

Formula 2= (Total accident number / Net working days X working hours per day) X 1.000.000

3.2. Determining Impacts of the Indicators (Positive/Negative Contribution to SD)

It is necessary to determine whether the indicators used in the developed CI have positive or negative impacts on Sustainable Development (SD). While positive indicators' (I^+) increasing value, such as total employee training, contributes positively to SD, negative indicators' (I^-) increasing value, such as total waste per unit production, contributes negatively to SD. In the normalization phase, positive and negative type indicators have different formulas. Table 6 summarizes the impact on the sustainable development of the indicators.

Table 6: Indicators Measuring Positive and Negative Impacts to SD

S.NU	INDICATORS MEASURES POSITIVE IMPACTS	S.NU	INDICATORS MEASURES NEGATIVE IMPACTS
1	Return on assets (ROA)	1	Total energy consumption per unit production
2	Return on investment (ROI)	2	Total water consumption
3	Return on equity (ROE)	3	Total waste per unit production
4	R&D Investments	4	Total hazardous waste per unit production
5	Reused water per unit production	5	Total GHG emissions per unit production
6	Total recycled waste per unit production	6	Air emissions per unit production
7	Environmental investments per unit production	7	Employee turn over rate
8	Total employee number	8	Accident Rate (Formula 1 below)
9	Total employee trainings	9	Accident frequency rate (Formula 2 below)
10	Training hours per employee		
11	OHS training per employee		
12	Female employee rate		
13	Female manager rate		
14	Rate of collective agreement for employees		

3.3. Normalization of the Sustainability Indicators

Normalization is one of the important steps for sustainability measurement. What needs to be done here is to create a common measurement unit that will enable indicators with different measurement units to be aggregated. Thus, it is possible to illustrate indicators with many different units with a single value. Therefore, normalization ensures that the original units of the indicators expressed in different units are converted to a common unit so that different indicators can be summed up and expressed with a single score. For example, adding the unit value of the energy consumption indicator in the environmental dimension, which is expressed in gigajoules, with the value expressed in m3 of the water consumption indicator, is only possible after the normalization process.

As is stated by Zang, Xu, Yeh, Liu, & Zhou (2016) and Kandakoğlu, Frini, & Amor (2019), evaluating corporate sustainability can be seen as a multi-criteria decision-making problem since sustainability indicators are numerous and the measurement units of each indicator are frequently different. There are no standardized normalization techniques in Multi-Criteria Decision-Making (MCDM) methods (Özdağoğlu, 2013). Among the normalization techniques, the linear maximum technique, linear maximum-minimum technique, linear sum technique, vector normalization technique, and logarithmic normalization technique can be used when MCDM methods are applied (Vafaei et al., 2016). The linear maximum-minimum technique was used for normalization in this study. The formulas for the selected technique are presented below:

Positive Indicators: $N_{ijt} = (I_{ijt} - I_{ijMin}) / (I_{ijMax} - I_{ijMin})$

Negative Indicators: $N_{ijt} = 1 - (I_{ijt} - I_{ijMin}) / (I_{ijMax} - I_{ijMin})$

As can be seen from the formulas, the measured value of the sustainability indicator in the year "t" is subtracted from the measured minimum value in the time series and normalized by proportioning the difference between the maximum and minimum values in the time series. The same is done by subtracting the number 1 for the negative indicators.

3.4. Weighting the Sustainability Indicators of the Proposed CI

At this stage, it is necessary to determine the weight values of each indicator in the proposed CI. Generally, the weighting of indicators can be obtained with three different methods: equal weighting, statistic-based, and public/expert opinion. In the public/expert opinion method, data envelopment, budget allocation, and analytical hierarchy process techniques are used (Gan et al., 2017). Singh et al. (2007) stated that AHP is the leading model for MCDM problems since it has many advantages, such as being easily understood, easily applied by managers, and being capable of taking quantitative and qualitative properties of the indicators into consideration. In this study, the AHP method was used to assign the weights of the indicators.

AHP, developed by Saaty (1980), is a method that enables decision making in multivariate environments. It considers the criteria and sub-criteria to be used in problem solving in a hierarchical structure that prioritizes and weights these criteria with pair-wise comparisons. AHP permits the decision-makers to consider both objective and subjective evaluations and includes them in the decision-making process. In this method, experts evaluate how important indicator j is relative to indicator i. Experts assign values to relevant indicators on a scale of 1 to 9 to show the intensity of preference (Saaty, 1980).

To weigh the proposed CI indicators, expert opinions were received. For this purpose, 20 experts, consisting of 11 academics and 9 managers, were asked to compare each indicator with others in the related dimension and to assign a score between 1 and 9 to that indicator, in short, they were asked to make pair-wise comparisons. After the pair-wise comparison, results were indicated in a matrix, and the weight value of each indicator was found. Academic experts were selected from faculty members working at universities in Turkey, while expert managers were selected from among those who work as managers in various companies in Manisa Organized Industrial Zone. Selected managers are continuing their master thesis program at Manisa Celal Bayar University and work in human resources, production, supply chain, and other units in their companies.

The weight values of each indicator in the proposed CI are presented in Table 7, and the expert evaluations are presented in Appendix B.

Table 7: Weighted Values of Indicators

Dimension	Indicators	Weighted Value	Dimension	Indicators	Weighted Value
Economic	Return on assets (ROA)	0.250	Social	Total employee number	0.105
	Return on investment (ROI)	0.208		Female employee rate	0.088
	Return on Equity (ROE)	0.292		Female manager rate	0.088
	R&D Investments	0.250		Rate collective agreements for employee	0.088
Environmental	Total energy consumption per unit production	0.111		Employee turnover rate	0.123
	Total water consumption	0.111		Total employee trainings	0.105
	Reused water per unit production	0.111		Training hours per employee	0.105
	Total GHG emission per unit production	0.111		OHS training per employee	0.088
	Air emission per unit production	0.111		Accident rate	0.105
	Total waste per unit production	0.093		Accident frequency rate	0.105
	Total recycled waste per unit production	0.111			
	Total hazardous waste per unit production	0.111			
	Environmental investments per unit production	0.130			

3.5. Calculation of Sub-Indexes and CI

The sustainability value of each indicator was obtained by multiplying the normalized and weighted values of the indicator. Sustainability values of all indicators in the sub-index were aggregated to find the total sustainability value of the sub-index. By dividing this value by the number of indicators in the sub-index, the final sustainability value of the relevant index was obtained (arithmetic or additive aggregation method). Similarly, the total value of the CI in the relevant year was found by adding the total values of the three sub-indices, specifically the economic, social, and environmental dimensions. The formulation of these processes is presented below.

Total Value of Sub-index = $1 /n \sum W_{ji} * I_{Nji}$ ji = from 1 to n, where W_{ji} is the weight of the indicator i in the group j; I_{ji} is the normalized value of the indicator i in the group j.

Total Value of CI = $\sum$ Sub-index$_j$ j= from 1 to n (n=3 sub-indexes, namely economic, environment and social dimensions)

4. Analysis and Findings

This section analyzes the data attained from the sustainability and the business activity reports of the ten manufacturing companies following the procedures mentioned in the methodology section. All manufacturing companies listed in Table 8 were examined from the years 2014-2018. In this article, only the calculations of the Arçelik company are shown to be practical. The data of other companies were calculated similarly and their sustainability performances in the relevant years were found (see first author's dissertation for all calculations: Alaca, 2020).

Table 8: Manufacturing Companies Examined Operating in BIST Sustainability Index

S.NU.	Examined Companies	S.NU.	Examined Companies
1	Anadolu Cam Inc.	6	Erdemir Inc.
2	Anel Elektrik Inc.	7	Kordsa Inc.
3	Arçelik Inc.	8	Şişe Cam Inc.
4	Brisa Inc.	9	Tat Gıda Inc.
5	Çimsa Inc.	10	Ülker Inc.

4.1. Corporate Sustainability Performance Evaluation of Arçelik from the Years 2014 to 2018

The annual sustainability and activity reports published by the company covering the years 2014 to 2018 were examined and the quantitative values of the indicators in the CI are presented in Table 9.

Table 9: Data Obtained from Sustainability & Activity Reports of Arçelik Inc.

Dimension	ICSET Indicators	Arçelik				
		2018	2017	2016	2015	2014
Economic	Return on assets (ROA)	0.0321	0.0453	0.0856	0.0685	0.0501
	Return on investment (ROI)	0.0357	0.044	0.079	0.0601	0.0574
	Return on equity (ROE)	0.1108	0.1339	0.2409	0.2012	0.1411
	R&D Investments	204,792	170,177	151,668	125,173	102,055
Environment	Total energy consumption per unit production	1.659	3.154	2.998	2.669	2.170
	Total water consumption	1.736	1.967	1.875	1.642	1.803
	Reused water per unit production	1.651	1.566	1.547	1.273	1.023
	Total GHG emissions per unit production	0.157	0.162	0.131	0.115	0.122
	Air emissions per unit production	No data	No data	No data	No data	No data
	Total waste per unit production	0.157	0.156	0.141	0.136	0.148
	Total recycled waste per unit production	0.137	0.138	0.119	0.031	0.050
	Total hazardous waste per unit production	0.0036	0.0043	0.0047	0.0046	0.0040
	Environmental investments per unit production	0.45	0.35	0.32	0.27	0.20
Social	Total employee number	28,119	27,360	29,551	26,337	24,876
	Female employee rate	0.194	0.168	0.154	0.166	0.165
	Female manager rate	0.211	0.228	0.221	0.210	0.184
	Rate of collective agreement for employees	0.60	0.63	0.68	0.74	0.75
	Employee turn over rate	0.184	0.229	0.135	0.142	0.125
	Total employee trainings	599,276	603,428	443,573	534,007	517,237
	Training hours per employee	21.31	22.06	15.01	20.28	20.79
	OHS training per employee	7.02	11.02	8.25	6.78	5.78
	Accident Rate (Formula 1 below)	1.05	2.96	2.38	6.37	3.51
	Accident frequency rate (Formula 2 below)	0.010	0.033	0.021	0.036	0.040

The values of indicators belonging to Arçelik Inc. from the years 2014 to 2018 were calculated to correspond between 0 and 1 by using the normalization formulas. The values of the normalized indicators were multiplied by the weight values determined from expert opinion, and the sustainability performance value of that indicator in the relevant year was calculated. Obtained normalization, weight, and sustainability values of all indicators in the proposed CI are presented in Table 10.

Table 10: Calculated Normalization and Sustainability Values for Arçelik Inc.

Indicator	Arçelik					Weight	Arçelik				
	2018	2017	2016	2015	2014		2018	2017	2016	2015	2014
ROA	0.00	0.25	1.00	0.68	0.34	**0.250**	0.000	0.062	0.250	0.170	0.084
ROI	0.00	0.19	1.00	0.56	0.50	**0.208**	0.000	0.040	0.208	0.117	0.104
ROE	0.00	0.18	1.00	0.69	0.23	**0.292**	0.000	0.052	0.292	0.203	0.068
R&D INV	1.00	0.66	0.48	0.23	0.00	**0.250**	0.250	0.166	0.121	0.056	0.000
Positive Normalization = (i-jmin. / jmax.- jmin.) Negative Normalization = 1-(i-jmin. / jmax.- jmin.)						***Economic Sub-Index***	**0.063**	**0.080**	**0.218**	**0.137**	**0.064**
TEC	1.00	0.00	0.10	0.32	0.66	**0.111**	0.111	0.000	0.012	0.036	0.073
TWC	0.71	0.00	0.28	1.00	0.51	**0.111**	0.079	0.000	0.032	0.111	0.056
RW	1.00	0.87	0.84	0.40	0.00	**0.111**	0.111	0.096	0.093	0.044	0.000
GHG	0.11	0.00	0.67	1.00	0.85	**0.111**	0.012	0.000	0.074	0.111	0.095
AEM	No data	No data	No data	No data	No data	**0.111**	No data	No data	No data	No data	No data
TWP	0.00	0.02	0.79	1.00	0.41	**0.093**	0.000	0.002	0.074	0.093	0.038
TRW	0.99	1.00	0.83	0.00	0.17	**0.111**	0.109	0.111	0.092	0.000	0.019
THW	1.00	0.38	0.00	0.12	0.65	**0.111**	0.111	0.042	0.000	0.013	0.072
EIN	1.00	0.060	0.50	0.30	0.00	**0.130**	0.130	0.078	0.065	0.039	0.000
Positive Normalization = (i-jmin. / jmax.- jmin.) Negative Normalization = 1-(i-jmin. / jmax.- jmin.)						***Environment Sub-Index***	**0.083**	**0.041**	**0.055**	**0.056**	**0.044**
TEN	0.69	0.53	1.00	0.31	0.00	**0.105**	0.073	0.056	0.105	0.033	0.000
FER	1.00	0.35	0.00	0.28	0.25	**0.088**	0.088	0.031	0.000	0.025	0.022
FMR	0.61	1.00	0.84	0.59	0.00	**0.088**	0.054	0.088	0.074	0.052	0.000
CAR	0.00	0.20	0.53	0.93	1.00	**0.088**	0.000	0.018	0.047	0.082	0.088
ETR	0.43	0.00	0.90	0.84	1.00	**0.123**	0.053	0.000	0.111	0.103	0.123
TET	0.97	1.00	0.00	0.57	0.46	**0.105**	0.102	0.105	0.000	0.059	0.048
THE	0.89	1.00	0.00	0.75	0.82	**0.105**	0.094	0.105	0.000	0.078	0.086
OHS	0.24	1.00	0.47	0.19	0.00	**0.088**	0.021	0.088	0.041	0.017	0.000
ACR	1.00	0.64	0.75	0.00	0.54	**0.105**	0.105	0.067	0.079	0.000	0.056
AFR	1.00	0.23	0.63	0.13	0.00	**0.105**	0.105	0.025	0.067	0.014	0.000
Positive Normalization = (i-jmin. / jmax.- jmin.) Negative Normalization = 1-(i-jmin. / jmax.- jmin.)						***Social Sub-Index***	**0.070**	**0.058**	**0.052**	**0.046**	**0.042**

The final corporate sustainability scores from the years 2014 to 2018 for Arçelik Inc. are presented in Table 11. The graphical representations of the company's overall corporate sustainability performance and its economic, social, and environmental dimensions are presented in Figure 3 and Figure 4.

Table 11: Corporate Sustainability Scores of Arçelik Inc. for 2014-2018

Dimension	Sustainability Scores of Arçelik				
	2018	2017	2016	2015	2014
Economic	0.063	0.080	0.218	0.137	0.064
Environment	0.083	0.041	0.055	0.056	0.044
Social	0.070	0.058	0.052	0.046	0.042
Total Score	**0.216**	**0.179**	**0.325**	**0.239**	**0.150**

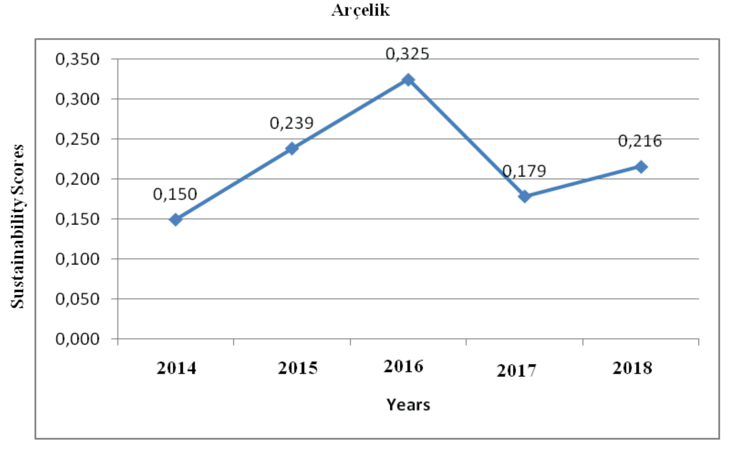

Figure 3: Corporate Sustainability Performance of Arçelik Inc.

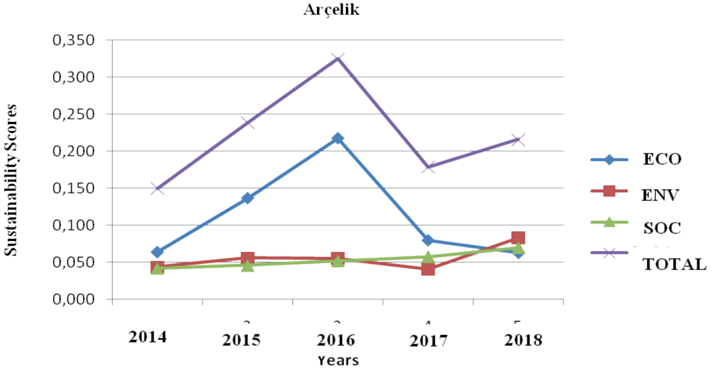

Figure 4: Corporate Sustainability Performance of Arçelik with Dimensions

4.2. Ranking the Manufacturing Companies Operating in Istanbul Stock Exchange Market from the Years 2014 to 2018

The corporate sustainability performances of manufacturing companies were measured with the developed CI and model mentioned in Fig 1. Companies' sustainability performances were aggregated to a single score. The obtained scores were compared and their rankings from the years 2014-2018 are depicted in Figures 5 to 9.

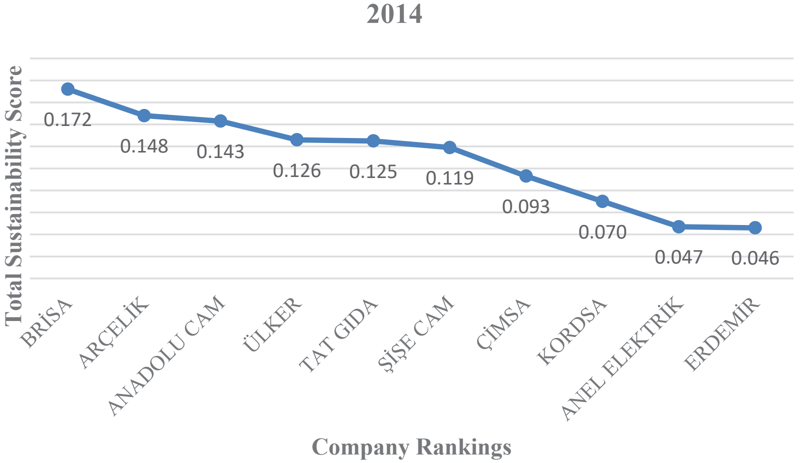

Figure 5: Company Rankings Examined in 2014

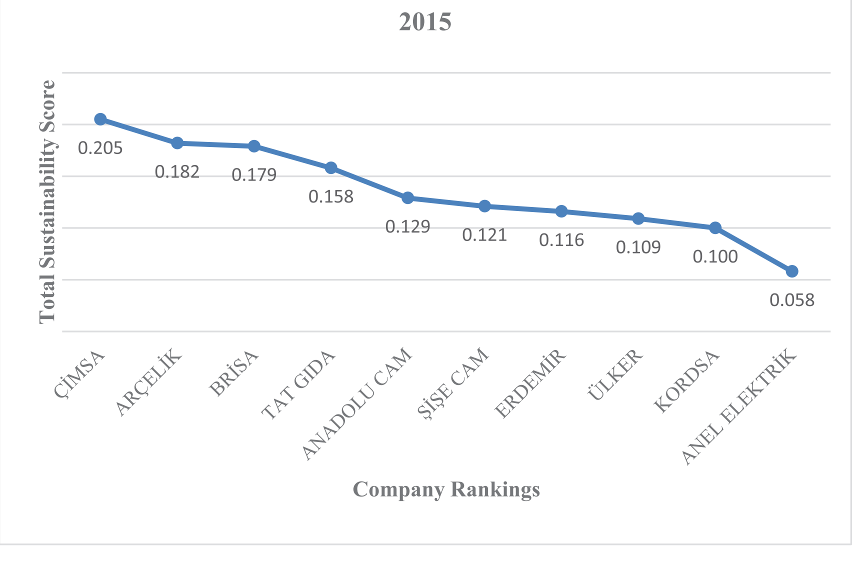

Figure 6: Company Rankings Examined in 2015

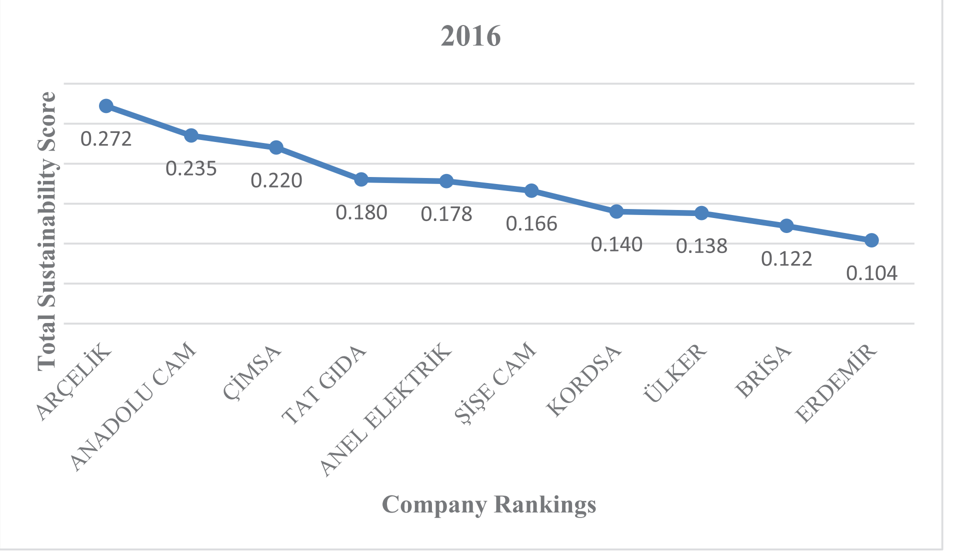

Figure 7: Company Rankings Examined in 2016

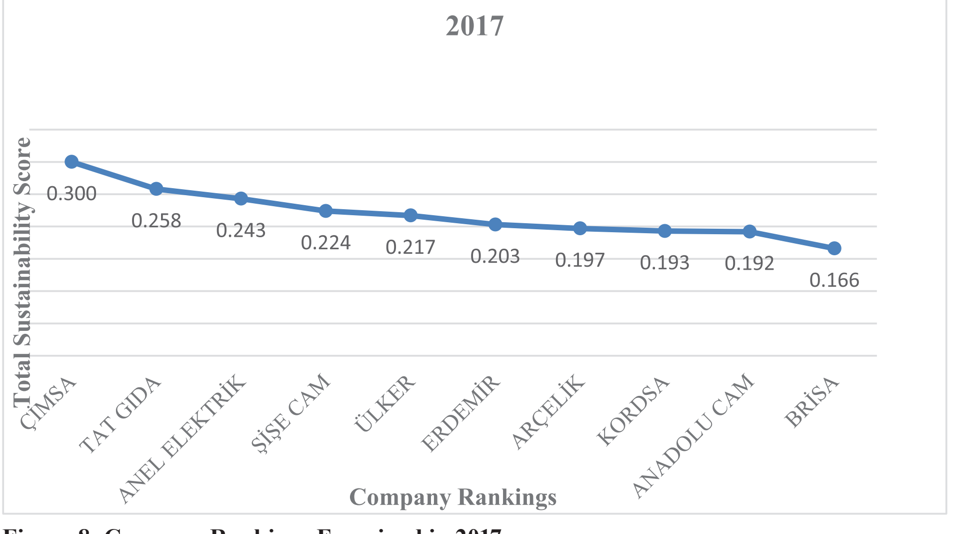

Figure 8: Company Rankings Examined in 2017

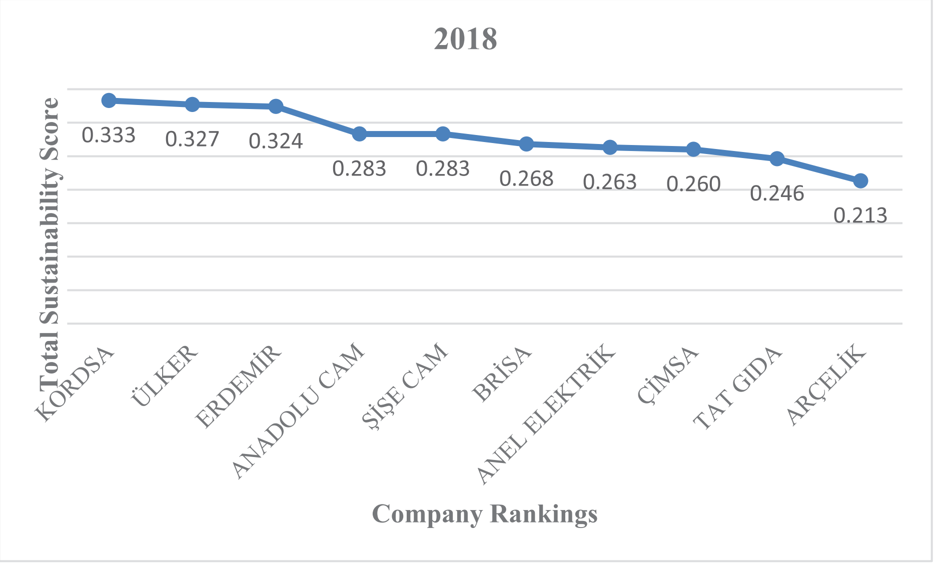

Figure 9: Company Rankings Examined in 2018

5. Conclusions and Implications

The concept of corporate sustainability has gained importance in recent years, is still developing, and remains on the agenda for the management of organizations. One of the most important phases of the concept is to measure the companies' performance in a holistic way. Although various models have been developed in the literature, which measure how stable the organizations are, no study measures all the production processes, products, and services of manufacturing companies in a way that covers all three dimensions of sustainability (Bilge et al., 2014; Harik et al., 2015; Helleno et al., 2017). Composite indexes (CIs), mainly comparing country or region performance, have become a viable solution for measuring the sustainability performances of the companies and comparing them over the years (Butnariu & Avasilcai, 2015). Since CIs aggregate multi-dimensional issues into one index, they can give quick and comprehensive information and provide a useful tool for decision-makers.

By using the methodology suggested by Zhou et al. (2012), a composite index was developed and the sustainability performance scores of ten companies operating in the BIST Sustainability Index were calculated. The company with the highest total corporate sustainability score in 2014 was Brisa, Çimsa in 2015 and 2017, Arçelik in 2016, and Kordsa in 2018. There have been limited studies in Turkey measuring the corporate sustainability of companies/sectors in an integrated way. In this study, as the Triple Bottom Line (TBL) approach requires, the economic, social, and environmental sustainability performances of some manufacturing companies operating in the Istanbul Stock Exchange Market Sustainability Index were effectively measured with a holistic perspective. Thus, this study contributes to the literature by providing an assessment tool to be used in future studies.

This study showed that it is possible to monitor the increases or decreases in the sustainability performances of the organizations. Therefore, it is likely to determine the reasons and which dimension of themes/issues are causing the increase or decrease. This provides considerable input to decision-makers in checking whether the organization can reach its previously determined sustainability goals. In short, the proposed CI model in this study is a tool that can shed light on determining the level achieved by the manufacturing organizations operating in Turkey in terms of their sustainability activities and draws a fast, simple, and understandable picture of their sustainability states. Consequently, it would be possible to take necessary actions to produce improved sustainability policies. The proposed model and method allow businesses to periodically monitor their sustainability-related activities to see and correct their deficiencies, as well as to compare themselves with other businesses in terms of their economic, environmental, and social impact levels. Thus, businesses will have the opportunity to improve their strategic and operative activities by comparing themselves with others and taking their good practices as an example.

Another remarkable finding in the study is that the economic dimension score of the analyzed organizations has a weighty and salient effect on the total corporate sustainability performance score. This result may be attributed to management practices that attach more importance to the economic activities of the companies examined. Epstein et al. (2015) reported that the companies' informal systems support sustainability, but their formal systems still reinforce financial performance. This finding contributes to the literature that economic performance is predominantly effective in the formation of the sustainability performances of businesses. However, evolving theories such as the Triple Bottom Line Approach, Corporate Sustainability, and Green Economics establish that the sustainability of businesses is concerned with the balance of economic, social, and ecological aspects of corporate performance. Conceivably, the existing practices in social and environmental dimensions in corporate sustainability activities in Turkey are not at a sufficient level of total sustainability.

Some limitations need to be mentioned for proper evaluation of the study's findings. First, the analysis conducted was based on the information available in secondary data sources. When the relevant data could not be found in the sustainability reports of the examined companies, the analysis was made with data missing. Although the companies were asked to send their missing figures, no response was received. It can be deduced that the data collection and processing system related to sustainability issues in the organizations may not have been fully established and operational. Second, the study covered only some organizations in the Istanbul Stock Exchange Market Sustainability Index. Third, although the validity of the proposed CI model has been confirmed based on expert opinions in the study, it still contains subjectivity.

The study has some suggestions for future work. The sustainability performance evaluation studies with the AHP method in Turkey are limited. It would be appropriate for academics in this field to conduct comparative studies using the proposed CI model and other models in the literature. In this study, only the companies in the manufacturing sector in the Istanbul Stock Exchange Market Sustainability Index that have adopted the sustainability approach have been analyzed. Researchers who will conduct further studies in this field will be able to work with a sample that will cover all businesses included in the Istanbul Stock Exchange Market Sustainability Index. Further, by making sectorial comparisons, researchers and managers can reveal which sector has what problems or advantages in sustainability.

Ethics Committee Approval: The article is derived from a doctoral thesis, and ethics committee approval was not obtained because the research data were collected in 2019 and using secondary sources (corporate sustainability reports of enterprises).
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Appendix -A

Content Validity Analysis of Proposed Composite Index

A new integrated Composite Index (CI), consisting of 23 indicators was constructed. To improve face and content validity of the index expert opinions were requested. The quality and the number of experts (between 5 and 40) to be consulted are very important in obtaining objective results in the content validity analysis (Yeşilyurt & Çapraz, 2018). The issue of whether the proposed CI content is appropriate was confirmed by taking expert opinion from 14 academicians who have previously worked in the field of corporate sustainability in Turkey. The title distribution of the academicians whose opinions were received via e-mail is presented in Table 1 below.

Table 1. Demographic Distribution of the Experts

Gender	Academic Title				Total
	Prof.	Assoc. Prof.	PhD Lecturer	Lecturer	
Male	3	-	2	2	7
Female	3	2	2	-	7
Total	6	2	4	2	14

Whether each indicator remains within the model is determined by calculating the Content Validity Ratio (CVR). If the calculated value of the indicator is greater than the Scope Validity Criterion (SVC), which is set according to the number of experts, then that indicator remains in the set. If it is smaller than SVC, then it is taken out of the index. Lawshe (1975), according to the number of experts and $\alpha = 0.05$ significance level has prepared Scope Validity Criterion values as a table according to the number of experts. Scope Validity Criterion values are shown in Table 2 below.

Table 2. Minimum Acceptance Values of Content Analysis

Number of Expert	SVC Value	Number of Expert	SVC Value	Number of Expert	SVC Value
5	0,99	11	0.59	25	0.37
6	0,99	12	0.56	30	0.33
7	0,99	13	0.54	35	0.31
8	0.78	**14**	**0.51**	40	0.29
9	0.75	15	0.49		
10	0.62	20	0,42		

The number of experts whose opinions were consulted in this study is 14, and its SVC value is 0.51. The academics, whose opinions were requested, were asked to evaluate whether each of the indicators in the CI corresponds to the "very good" or "acceptable" or "poor" options. The received opinions were classified with the excel program, and the Content Validity Ratio (CVR) of each indicator was calculated with the help of the following formula:

CVR = [Nu / (N/2)]-1;

Nu = Number of experts who evaluated as "Very Good",

N= Number of experts

In this context, the CVRs of 23 indicators were calculated one by one, and the content validity of the model was accepted statistically by comparing the SVC value.

Examples for the calculations:
ROA:
Nu: 14
SVC: 0.51
CVR of ROA = [14 / (14/2)] – 1
CVR of ROA = (14/7) – 1
CVR of ROA = 2-1 = 1 ~ 0,99
0,99 ≥ 0,51 then ROA is included in the model, so acceptable.

ROE:
Nu: 13
SVC: 0,51
CVR of ROE = [13 / (14/2)] – 1
CVR of ROE = (13/7) – 1
CVR of ROE = 1,86 – 1 = 0,86
0,86 ≥ 0,51 then ROE is included in the model, so acceptable.

The chart of the operation performed is presented in Table 3.

Table 3. Content Validity Analysis of the Proposed CI

Dimension	Indicator	Number of NU Received	CVR	SVC Value	Decision
Economic	Return on assets (ROA)	14	0,99	0,51	Accept
	Return on investment (ROI)	14	0,99	0,51	Accept
	Return on equity (ROE)	13	0,86	0,51	Accept
	R&D Investments	13	0,86	0,51	Accept
Environment	Total energy consumption per unit production	13	0,86	0,51	Accept
	Total water consumption	12	0,71	0,51	Accept
	Reused water per unit production	13	0,86	0,51	Accept
	Total waste per unit production	13	0,86	0,51	Accept
	Total recycled waste per unit production	14	0,99	0,51	Accept
	Total hazardous waste per unit production	12	0,71	0,51	Accept
	Total GHG emissions per unit production	13	0,86	0,51	Accept
	Air emissions per unit production	13	0,86	0,51	Accept
	Environmental investments per unit production	12	0,71	0,51	Accept
Social	Total employee number	12	0,71	0,51	Accept
	Employee turn over rate	14	0,99	0,51	Accept
	Total employee trainings	13	0,86	0,51	Accept
	Training hours per employee	12	0,71	0,51	Accept
	OHS training per employee	14	0,99	0,51	Accept
	Accident Rate (Formula 1 below)	12	0,71	0,51	Accept
	Accident frequency rate (Formula 2 below)	13	0,86	0,51	Accept
	Female employee rate	13	0,86	0,51	Accept
	Female manager rate	13	0,86	0,51	Accept
	Rate of collective agreement for employees	13	0,86	0,51	Accept

Furthermore, the Scope Validity Index (CGI) for the entire CI was calculated by dividing the total CVR by 23, which was the indicator number, and it was concluded that the entire model was valid and reliable at the significance level of $\alpha = 0.05$.

Whole ICSET Model = 19.53 / 23 = 0.85, 0.85 > 0.51

Appendix -B

Calculation of Weight Values of Indicators in the Proposed Composite Index

To determine the weights of each indicator in the proposed CI, the opinion of a group of 20 experts consisting of 11 faculty members and 9 managers was consulted. Experts were asked to evaluate the importance of 4 economic, 9 environmental, and 10 social indicators in their dimensions by making a pairwise comparison, by giving a number for each indicator between 1 to 9. The order of importance of numbers and corresponding definitions found by Saaty (1980) are presented in Table 1 below. The average importance value of the relevant indicator was found by adding the values assigned by the experts for each indicator and dividing the result by 20. The titles and ages of the experts, whose opinions were taken, and the average importance values for each indicator are shown in Table 2.

Table 1. Fundamental Scales of the Numbers (Saaty, 1980)

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation

As an example, to calculate the weight values of economic dimension indicators, a matrix was created. The importance values of each indicator determined by the experts were written in the matrix. Thus, pair-wise comparison matrixes were created. In the matrix, the horizontal side of each indicator was compared with the average importance value of each vertical indicator's assigned values and divided by each other. In the obtained new matrix, every row's total was calculated. The calculated rows were divided by the vertical total, so every indicator's relative weighted value was obtained. For example, the importance value of the Asset Profitability indicator determined by the experts was 6, the importance value of the Economic Efficiency indicator was 5, the importance value of the Financial Efficiency indicator was 7, and the importance value of the R&D indicator was 6. By substituting these values in the matrix and performing simple division operations, the numerical values in the second part of Table 3 were reached. The horizontal total values of the relevant indicator were found by adding horizontally the values formed after each indicator itself and the other pair-wise comparisons. For example, the horizontal value total resulting from the pair-wise comparison of the Asset Profitability indicator was 4.1. By dividing this value by the matrix total value, that was, by 16.2, the weight value of the Asset Profitability indicator, 0.250, was found. As can be seen in Table 3 below, the same operations were performed for other indicators, and the weight value of the Economic Efficiency indicator was calculated as 0.208, the weight value of the Financial Efficiency indicator as 0.292, and the weight value of the R&D indicator as 0.250. The sum of the weight values calculated here is equal to 1.

Table 2. Importance Values of the Indicators Assigned by the Experts

S.Nu.	Expert	Age	Eco 1	Eco 2	Eco 3	Eco 4	Env 1	Env 2	Env 3	Env 4	Env 5	Env 6	Env 7	Env 8	Env 9	Soc 1	Soc 2	Soc 3	Soc 4	Soc 5	Soc 6	Soc 7	Soc 8	Soc 9	Soc 10
1	Academic	41	7	7	9	8	7	7	8	4	5	3	6	4	7	8	2	2	4	7	5	5	6	7	7
2	Academic	43	3	5	7	5	3	5	5	9	7	1	3	1	7	1	1	1	5	9	5	5	3	7	5
3	Academic	50	5	7	8	7	5	7	5	7	5	3	5	3	7	5	2	2	3	7	5	5	5	7	5
4	Academic	35	5	3	9	7	5	5	6	6	6	5	5	7	7	5	5	5	5	7	7	5	5	7	5
5	Academic	43	4	3	5	7	6	5	7	7	5	3	9	9	7	7	7	7	4	4	7	7	5	7	7
6	Academic	50	2	4	3	5	4	2	1	3	2	5	1	1	4	1	2	5	4	5	1	2	3	2	3
7	Academic	45	3	7	5	7	3	3	9	7	7	5	7	5	7	7	9	9	5	5	7	5	5	7	5
8	Academic	30	9	7	3	7	7	7	4	8	7	6	3	9	3	3	5	5	3	7	9	9	9	7	7
9	Academic	53	5	3	5	7	3	3	5	9	9	7	7	5	5	7	5	3	5	9	5	3	4	3	3
10	Academic	32	5	3	7	5	5	7	7	7	5	4	7	6	8	5	7	8	8	7	6	7	5	5	3
11	Academic	47	5	3	7	9	9	7	5	7	9	7	5	3	5	9	5	7	3	3	5	5	3	7	5
12	Manager	52	9	7	9	5	9	9	7	7	5	5	9	9	7	5	7	5	3	3	3	5	9	7	7
13	Manager	36	7	5	8	9	7	8	6	3	1	4	2	5	9	9	3	2	1	8	7	8	6	4	5
14	Manager	34	5	1	7	5	9	7	6	5	5	3	5	7	7	5	5	5	9	7	5	6	5	7	7
15	Manager	35	7	9	5	1	9	9	9	8	8	8	8	8	9	9	9	9	7	9	8	8	9	9	9
16	Manager	33	5	5	5	9	9	7	7	1	5	7	7	3	5	5	7	7	3	9	5	7	5	9	9
17	Manager	35	7	3	5	5	7	9	5	5	7	3	7	9	7	7	7	7	5	9	7	5	5	7	7
18	Manager	34	5	2	9	5	5	5	7	5	5	5	5	3	9	7	3	1	7	3	5	5	5	7	7
19	Manager	37	5	1	9	7	5	5	9	3	3	3	7	5	9	9	7	7	3	5	9	9	7	5	5
20	Manager	52	7	5	7	5	3	7	8	7	5	9	5	9	9	3	7	7	8	7	5	7	5	7	5
Total			**110**	**90**	**132**	**125**	**120**	**124**	**126**	**118**	**111**	**96**	**113**	**111**	**138**	**117**	**105**	**104**	**95**	**130**	**116**	**118**	**109**	**128**	**116**
Average Number			**6**	**5**	**7**	**6**	**6**	**6**	**6**	**6**	**6**	**5**	**6**	**6**	**7**	**6**	**5**	**5**	**5**	**7**	**6**	**6**	**5**	**6**	**6**

Table 3. Calculated Weights of Economic Dimension Indicators

Dimension	Indicators	ROA	ROI	ROE	R&D	Pair-wise Comparison	ROA	ROI	ROE	R&D	TOTAL	Weigted Calculations	Calculation	Obtained Weight
Economic	Return on Assets	**6/6**	6/5	6/7	6/6		**1,0**	1,2	0,9	1,0	4,1		4,1 / 16,2	**0,250**
	Return on Invest.	5/6	**5/5**	5/7	5/6		0,8	**1,0**	0,7	0,8	3,4		3,4 / 16,2	**0,208**
	Return on Equity	7/6	7/5	**7/7**	7/6		1,2	1,4	**1,0**	1,2	4,7		4,7 / 16,2	**0,292**
	R & D Investments	6/6	6/5	6/7	**6/6**		1,0	1,2	0,9	**1,0**	4,1		4,1 / 16,2	**0,250**
							Total				**16,2**			

With the same procedure, the weights of environmental and social dimensions calculated are presented at the Table 4 and Table 5.

Table 4. Calculated Weights of Environment Dimension Indicators

Dimension	Indicators	TEC	TWC	REW	GHG	TAE	TWP	TRW	THW	ENI
Environment	Total energy consumption per unit production	**6/6**	6/6	6/6	6/6	6/6	6/5	6/6	6/6	6/7
	Total water consumption	6/6	**6/6**	6/6	6/6	6/6	6/5	6/6	6/6	6/7
	Reused water per unit production	6/6	6/6	**6/6**	6/6	6/6	6/5	6/6	6/6	6/7
	Total GHG emissions per unit production	6/6	6/6	6/6	**6/6**	6/6	6/5	6/6	6/6	6/7
	Air emissions per unit production	6/6	6/6	6/6	6/6	**6/6**	6/5	6/6	6/6	6/7
	Total waste per unit production	5/6	5/6	5/6	5/6	5/6	**5/5**	5/6	5/6	5/7
	Total recycled waste per unit production	6/6	6/6	6/6	6/6	6/6	6/5	**6/6**	6/6	6/7
	Total hazardous waste per unit production	6/6	6/6	6/6	6/6	6/6	6/5	6/6	**6/6**	6/7
	Environmental investments per unit production	7/6	7/6	7/6	7/6	7/6	7/5	7/6	7/6	**7/7**

Indicators	Pair-wise Comparisons	TEC	TWC	REW	GHG	TAE	TWP	TRW	THW	ENI	Tot.	Calculation of Weights	Calculation	Obtained Weight
Total energy consumption per unit production		**1,0**	1,0	1,0	1,0	1,0	1,2	1,0	1,0	0,9	9,1		9,1 / 81,5	**0,111**
Total water consumption		1,0	**1,0**	1,0	1,0	1,0	1,2	1,0	1,0	0,9	9,1		9,1 / 81,5	**0,111**
Reused water per unit production		1,0	1,0	**1,0**	1,0	1,0	1,2	1,0	1,0	0,9	9,1		9,1 / 81,5	**0,111**
Total GHG emissions per unit production		1,0	1,0	1,0	**1,0**	1,0	1,2	1,0	1,0	0,9	9,1		9,1 / 81,5	**0,111**
Air emissions per unit production		1,0	1,0	1,0	1,0	**1,0**	1,2	1,0	1,0	0,9	9,1		9,1 / 81,5	**0,111**
Total waste per unit production		0,8	0,8	0,8	0,8	0,8	**1,0**	0,8	0,8	0,7	7,5		7,5 / 81,5	**0,093**
Total recycled waste per unit production		1,0	1,0	1,0	1,0	1,0	1,2	**1,0**	1,0	0,9	9,1		9,1 / 81,5	**0,111**
Total hazardous waste per unit production		1,0	1,0	1,0	1,0	1,0	1,2	1,0	**1,0**	0,9	9,1		9,1 / 81,5	**0,111**
Environmental investments per unit production		1,2	1,2	1,2	1,2	1,2	1,4	1,2	1,2	**1,0**	10,6		10,6 / 81,5	**0,130**
		Total									**81,5**			

Table 5. Calculated Weights of Social Dimension Indicators

Dimension	Indicators	TEN	FEM	FMN	CAR	ETR	TET	TPE	OHS	ACR	AFR
Social	Total employee number	**6/6**	6/5	6/5	6/5	6/7	6/6	6/6	6/5	6/6	6/6
	Female employee rate	5/6	**5/5**	5/5	5/5	5/7	5/6	5/6	5/5	5/6	5/6
	Female manager rate	5/6	5/5	**5/5**	5/5	5/7	5/6	5/6	5/5	5/6	5/6
	Collective agreement rate	5/6	5/5	5/5	**5/5**	5/7	5/6	5/6	5/5	5/6	5/6
	Employee turn over rate	7/6	7/5	7/5	7/5	**7/7**	7/6	7/6	7/5	7/6	7/6
	Total employee trainings	6/6	6/5	6/5	6/5	6/7	**6/6**	6/6	6/5	6/6	6/6
	Training hours per employee	6/6	6/5	6/5	6/5	6/7	6/6	**6/6**	6/5	6/6	6/6
	OHS training per employee	5/6	5/5	5/5	5/5	5/7	5/6	5/6	**5/5**	5/6	5/6
	Accident Rate	6/6	6/5	6/5	6/5	6/7	6/6	6/6	6/5	**6/6**	6/6
	Accident frequency rate	6/6	6/5	6/5	6/5	6/7	6/6	6/6	6/5	6/6	**6/6**

Indicators	Pair-wise Comparisons	TEN	FEM	FMN	CAR	ETR	TET	TPE	OHS	ACR	AFR	Tot.	Calculation of Weights	Calculation	Obtained Weights
Total employee number		**1**	1,2	1,2	1,2	0,86	1	1	1,2	1	1	10,7		10,7 / 101,2	**0,105**
Female employee rate		0,83	**1**	1	1	0,71	0,83	0,83	1	0,83	0,83	8,9		8,9 / 101,2	**0,088**
Female manager rate		0,83	1	**1**	1	0,71	0,83	0,83	1	0,83	0,83	8,9		8,9 / 101,2	**0,088**
Collective agreement rate		0,83	1	1	**1**	0,71	0,83	0,83	1	0,83	0,83	8,9		8,9 / 101,2	**0,088**
Employee turn over rate		1,17	1,4	1,4	1,4	**1**	1,17	1,17	1,4	1,17	1,17	12,4		12,4 / 101,2	**0,123**
Total employee trainings		1	1,2	1,2	1,2	0,86	**1**	1	1,2	1	1	10,7		10,7 / 101,2	**0,105**
Training hours per employee		1	1,2	1,2	1,2	0,86	1	**1**	1,2	1	1	10,7		10,7 / 101,2	**0,105**
OHS training per employee		0,83	1	1	1	0,71	0,83	0,83	**1**	0,83	0,83	8,9		8,9 / 101,2	**0,088**
Accident Rate		1	1,2	1,2	1,2	0,86	1	1	1,2	**1**	1	10,7		10,7 / 101,2	**0,105**
Accident frequency rate		1	1,2	1,2	1,2	0,86	1	1	1,2	1	**1**	10,7		10,7 / 101,2	**0,105**
		Total										**101,2**			