Performance evaluation of sustainability in a textile firm via multi-criteria decision-making method

DOI: 10.35530/IT.074.04.202270

ŞİMŞEK GÜNDÜZ GONCA GÜNDÜZ ÇAĞDAŞ

ABSTRACT – REZUMAT

Performance evaluation of sustainability in a textile firm via multi-criteria decision-making method

Today, the sustainability approach is an integral part of business life. Especially, considering the damage that various events can cause to the environment, environmental sustainability (ES) is getting much more attention. From this aspect, the textile industry which can cause serious environmental damage, should integrate a sustainability approach into its management concept. Therefore, decision-makers and practitioners need to evaluate the sustainability performance of the industry. Multi-criteria decision-making (MCDM) methods help them to evaluate sustainability performance usefully. This paper evaluates the sustainability performance of a selected company in the textile industry over the years by environmental performance indicators. The technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methodology is used to evaluate sustainability performance.

Keywords: *sustainability, environmental indicators, performance evaluation, TOPSIS, textile*

Evaluarea performanței sustenabilităţii într-o firmă de textile prin metoda de luare a deciziilor cu criterii multiple

Astăzi, abordarea sustenabilității este o parte integrantă a mediului de afaceri. În special, având în vedere daunele pe care diversele evenimente le pot cauza mediului, sustenabilitatea mediului (ES) primește mult mai multă atenție. Din acest punct de vedere, industria textilă care poate cauza daune grave asupra mediului, ar trebui să integreze abordarea sustenabilității în conceptul său de management. Prin urmare, este foarte important ca factorii de decizie și practicienii să evalueze performanța de sustenabilitate a industriei. Metodele de luare a deciziilor cu criterii multiple (MCDM) îi ajută să evalueze util performanța sustenabilității. Această lucrare evaluează performanța sustenabilităţii unei companii selectate din industria textilă de-a lungul anilor, prin indicatori de performanță de mediu. Metodologia pentru preferința ordinii prin similitudine cu soluția ideală (TOPSIS) este utilizată pentru a evalua performanța sustenabilității.

Cuvinte-cheie: *sustenabilitate, indicatori de mediu, evaluarea performanței, TOPSIS, textil*

INTRODUCTION

The textile industry which is one of the oldest industries in the world is growing day by day. According to a market research company called IMARC Group, the global textile market reached a value of $ 960 billion in 2020. It expects the market to grow at a rate of 4.40 % over five years [1]. More than 400 thousand businesses are operating in the industry all over the world. Now, the global textile industry employs nearly 10 million people [2]. These data show us how the industry plays an important role in global social economic development. On the other side, despite the importance of market size in economic development, the textile industry not only uses huge amounts of resources [3, 4] but also creates harmful effects on the environment and natural resources [5, 6]. Zhang et al. [7] stated these environmental impacts over the life cycle of a cotton t-shirt from production stages consisting of collection, processing, application, replenishment, consumption, and disposal. Another study conducted by World Wide Fund for Nature (WWF) in Turkey [8] stated clearly and in detail that the textile industry is among the sectors that consume high use of water, energy and chemicals. Angelis-Dimakis et al. [9] and Fujimori et al. [10] also explained the aforementioned environmental problems related to high water, raw material and energy consumption, dust emission, waste generation and water pollutant discharge level. Briefly, large amounts of resource consumption in the textile industry can cause various environmental problems. For this reason, there is a growing awareness about the conservation of environmental health. In light of this awareness, there is an increasing push for sustainable methods in the textile industry.

The concept of sustainability, which emerged as a tool for a solution to environmental problems at first, brings together today's and future generations in the context of conscious resource consumption. It shows a direction from the sustainability of environmental resources to the sustainability of economic development over time. The term “sustainability” is first discussed in detail in Our Common Future report (Brundtland Report) prepared by the World Commission on Environment and Development

(WCED) in 1987. The report aimed to seek solutions to environmental problems and to transfer natural resources to future generations by using them consciously without completely destroying them [11]. The report defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [12, 13].

Today, the United Nations (UN) plays an important role based on the interest shown for sustainable development, for this purpose the UN has identified several topics supporting sustainable development [14]. As it is understood from these topics, social, economic and environmental relations are at the forefront of sustainable development. In other words, there must be an integration between economic, social and environmental systems [15, 16].

In fact, in Brundtland's report, it is seen that both “sustainability” and “sustainable development” concepts are used interchangeably from time to time, referring to their commitment to the environment, economy and social justice. It is also stated that while establishing the relationship between the environment and economic development, it is necessary to attach importance to sustainability. To define sustainability at this point, it shows the relationship between the ecosystem’s capacity and resource consumption according to Hawken [17]. Therefore, sustainability means that society should not use more resources than its renewal potential [18]. The aim here is to create a participatory process by creating and adopting a vision for this understanding in society by using all resources in a balanced way [19].

Sustainability is a process related to using resources economically and applying business models suitable for environmental health and social life. Companies need to turn to the environment, society and economy-friendly approaches in this process. Corporate sustainability, on the other hand, is defined as the corporate-level equivalent of the concept of sustainability. The contribution of sustainable development to corporate sustainability occurs in two ways. First, it helps companies to focus on environmental, social and economic performance. Secondly, it provides common goals for institutions, governments and civil society to ensure ecological, social and economic sustainability [20]. Signitzer and Prexl [21] have stated corporate sustainability as a permanent improvement process to ensure the integrity of the company's activities in terms of economic, social and environmental aspects. Since, environmental, economic and social sustainability are three interconnected factors [22], these factors should be a significant perspective in business decisions to reach targets.

As in other industries, there is an increasing awareness of sustainability in the textile industry.

Especially, the use of harmful chemicals, high materials, water and energy consumption, and waste generation can cause many environmental problems in the production of finished goods. In other words, the textile industry creates major environmental impacts. To gain ES, industry designers and managers must follow environmentally and socially responsible trends and focus on creating more innovative products. They should consider sustainability in their business practices [5]. Because, the demand for textiles is increasing according to the rise in consumer awareness. Today, customers are expecting better quality products along with their sustainable features. Textile firms must meet these needs with a sustainable approach. Among hundreds of thousands of textile companies in the world, some have taken priority ES in business practices. Periodic statistics are published to evaluate the importance given sustainability issues by research groups. One of them is Corporate Knights’ index of the world’s most sustainable corporations. Rating methodology is based on some key performance indicators covering ES, social responsibility, and financial management [23]. The list also creates an image element for the listed companies. The 2021 Global 100 list included three textile companies, Kering SA from France (ranked 7), Adidas AG from Germany (ranked 76) and Industria de Diseno Textil SA from Spain (ranked 92).

While the global market size of the textile industry creates a positive view for the sector, this view can sometimes be criticized due to the environmental effects that it causes. Therefore, it is necessary to evaluate ES correctly. But ES evaluation is complex for the textile industry because it uses high energy, water, raw materials and chemicals for production. The industry has a wide range of products. On the production side, a wide variety of materials, equipment and technologies have been included in the process of each one, with different environmental impacts. On the consumer side, the rapidly changing fashion and customer preferences have shortened product life. As a result, this has led to an increase in environmental burden and waste [24]. Many indicators affect ES to evaluate it. Zhang et al. [25], Wang et al. [26] and Thies et al. [27] have emphasized the simultaneous consideration of multiple factors when evaluating ES. Since sustainability is a complex concept involving multiple decision points, MCDM methods are also useful tools for evaluating performance in such situations.

In this study, TOPSIS, one of the MCDM methods widely used in the literature, is utilized to evaluate sustainability performance indicators of a selected company over the years by environmental performance indicators.

The objectives of using this method are: (i) being non-subjective; (ii) providing easy calculations based on Euclidean metrics; (iii) rapid assessment of environmental indicators; (iv) being a strong and simple mathematical structure [28]. Therefore, this study contributes significantly to the evaluation of ES through a structured approach. This includes both the mathematical model and technical solutions. This work was implemented for a particular textile manufacturing organization in Turkey.

For the application, a textile company traded in the Borsa Istanbul (BIST) sustainability index is selected. Data are obtained from the sustainability reports pub-

lished by the company between 2018–2020. The indicators used for the analysis are limited to those published by the company as they are easily accessible. The following can be said as the contribution of the study to the literature:

- An objective model is used in the performance evaluation of sustainability.
- Environmental indicators are determined from company data prepared in accordance with Global Reporting Initiative (GRI) content index. (GRI is an independent international organization that guides businesses and their stakeholders on important sustainability issues. It emphasizes global practices in sustainability reporting).
- A real case in the textile industry is used for performance evaluation.

This study is organized in the following order; the literature review is covered in the second section, followed by the research methodology which is detailed in the third section. Application and findings are covered in the fourth section and the fifth section details the conclusions.

LITERATURE REVIEW

Since the topic is of great importance, there are lots of studies conducted about ES and performance evaluation in the literature. It is seen from the literature that methods used in performance evaluation differ from each other. Here, some of the studies performed in the textile industry area using MCDM methodologies are explained in brief as follows.

Ilangkumaran and Kumanan [29] proposed an integrated fuzzy analytic hierarchy process (AHP) and TOPSIS approaches to select the optimum maintenance strategy in the textile industry. Four indicators were evaluated under 4 main areas; environmental conditions, component failure, training required and flexibility in their study. Shyjith et al. [30] discussed the same problem as the selection of an optimum strategy for maintenance in the textile domain. They used AHP and TOPSIS. Lu et al. [31] developed a fabric hand-based textile material evaluation model, and then the human machine measure hybrid fuzzy MCDM methodology proposed by them. They suggested that the proposed method and software can effectively support textile designers in selecting fabrics. Ünal and Güner [32] proposed the AHP approach which is utilised to select Enterprise Resource Planning (ERP) suppliers.

Tseng et al. [33] conducted this by using both fuzzy synthetic methods and the Decision Making Trial and Evaluation Laboratory (DEMATEL) approach. They tried to assess corporate sustainability performance by employing those methods. Results showed that the Taiwanese textile industry's performance is low because of a lack of social responsibility. Acar et al. [34] adopted TOPSIS to measure the sustainability performance of a textile firm by concentrating on some environmental factors. Their study covered the years between 2008 and 2012. They found that 2010 was the most effective year in terms of ES performance. In another study by Ergüden and Çatlıoğlu [35], the TOPSIS method is preferred and the corporate sustainability performance of the industry is examined.

Kumar et al. [36] focused on the supplier selection problem using fuzzy AHP in the Indian textile industry. Chakraborty et al. [37] study aimed to evaluate and select the best cotton fibre using integrated DEMATEL and VIKOR (VIšeKriterijumska Optimizacija I Kompromisno Resenje – Multicriteria Optimization and Compromise Solution) methodology. Kaplan et al. [38] studied about navel selection problem for rotor spinning. They used Elimination Et Choix Traduisant la Realité III (ELECTRE III) method to select the appropriate navel for Ne 12 rotor yarn spun to weave denim fabric. Zhu et al. [39] used the grey-based DEMATEL approach to structure and evaluate barriers to eco-friendly apparel production in the apparel industries. They emphasized on lack of human resource capabilities and difficulties faced to enter environmentally friendly clothing markets as important barriers.

Other studies performed in the textile industry can be listed as Rezaie et al. [40] used SWOT, DEMATEL, fuzzy AHP, and ELECTRE methods; Yin et al. [41] used DEMATEL, ISM, ANP methodologies; Adalı and Işık [42] utilized DEMATEL, ANP, and DEA (Data Envelopment Analysis) methods. All of these studies cope with different problems to make a judgment about optimum alternatives among the other alternatives by applying different MCDM methodologies. Kılıç and Yalçın [43] searched methods used in sustainability studies as assessment tools. They stated that MCDM techniques are the most frequently used techniques in the literature. It may be stated from the aforesaid statements that many significant studies have been performed in the textile industry in various countries. But, so few studies have focused on the sustainability aspect using MCDM methodologies, especially TOPSIS. Specifically, this study appears to be one of fewer studies using TOPSIS to evaluate sustainability performance over the years by environmental performance indicators.

RESEARCH METHODOLOGY

The research methodology has two main stages including determining the indicators and sustainability performance ranking. In the first step, the literature is reviewed to determine the environmental indicators. In the second step, the proposed method called TOPSIS is performed to rank the sustainability performance by years. The technical background of TOPSIS is given in this part of the study. Besides, before presenting the steps of TOPSIS, some information about the data set used is provided.

Data set

The research model is applied to a Turkish company which manufactures industrial textile products operating in 12 facilities throughout 5 countries with nearly 5.000 employees.

Table 1

ENVIRONMENTAL PERFORMANCE INDICATORS				
Material	**Energy**	**Waste (tonne)**	**Emission (tCO_2e)**	**Water (m^3)**
TCF chemical ratio	Electricity (kWh)	Hazardous waste	Greenhouse gas emissions	Consumption
NY salt/flake ratio	Natural gas (m^3)	Non-hazardous waste		Discharge
SEC chemical ratio		Recycling		Recycling
		Total disposal waste		
		Total waste		

Note: TCF – Tire Cord Fabric, NY – Nylon, SEC – Single End Cord.

Data, which covers the years between 2018 and 2020 are derived from sustainability reports of the firm [44]. The company has been preparing sustainability reports since 2014. When these reports are examined, it is seen that the content specification processes of reports presented in 2018, 2019 and 2020 show similarities. In addition, as a result of our review, it is understood that data in the relevant reports are useful for our research in terms of tracking trends more effectively. The summary of indicators is summarized in table 1.

In the study, TCF chemical ratio is represented as (C1), NY salt/flake ratio as (C2), SEC chemical ratio as (C3), electricity as (C4), natural gas as (C5), hazardous waste as (C6), non-hazardous waste as (C7), recycled waste as (C8), total disposal waste as (C9), total waste as (C10), greenhouse gas emissions as (C11), water consumption as (C12), water discharged as (C13) and recycled water as (C14). Finally, data obtained were analysed in the Microsoft Office Excel program.

TOPSIS

The TOPSIS method, proposed by Hwang and Yoon [45] is a well-known MCDM method in the literature. This method is later developed by some authors like Chen [46], Zavadskas, Turskis and Tamosaitiene [47], Hung and Chen [48]. The main point of TOPSIS is to identify the positive ideal solution which consists of all of the best values accessible to the criteria and the negative ideal solution which is composed of all worst values accessible to the criteria. The best alternative should have the shortest distance from the positive ideal solution and the longest distance from the negative ideal solution [49].

TOPSIS steps are summarized as follows [50].

Step 1. Construct a decision matrix shown in equation 1:

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ A_i \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} X_1 & X_2 & & X_jX_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1j}x_{1n} \\ \dots & \dots & \dots & \dots\dots \\ x_{i1} & x_{i2} & \dots & x_{ij}x_{in} \\ x_{m1} & x_{m2} & \dots & x_{mj}x_{mn} \end{bmatrix} \end{array} \quad (1)$$

where A_i – i^{th} alternative, x_{ij} – the numerical score of the i^{th} alternative concerning j^{th} criteria

Step 2. Normalize the decision matrix as in equation 2.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n}(x_{ij})^2}} \quad (2)$$

Step 3. Calculate the weighted normalized decision matrix. In this step, the weighted normalized value is computed as given in equation 3.

$$v_{ij} = w_{ij} * r_{ij} \quad (3)$$

Step 4. Acquire the positive ideal solution (A^*) and negative ideal solution (A^-) as provided in equations 4 and 5.

$$A^* = \{(max\ v_{ij} \mid j \in J), (min\ v_{ij} \mid j \in J')\} \quad (4)$$

$$A^- = \{(min\ v_{ij} \mid j \in J), (max\ v_{ij} \mid j \in J')\} \quad (5)$$

Step 5. Compute the distance of each alternative from the positive ideal value and the negative one as in equations 6 and 7:

$$S_i^* = \sqrt{\sum_{i=1}^{n}(v_{ij} - v_j^*)^2} \quad (6)$$

where $i = 1,2,\dots,m$.

$$S_i^- = \sqrt{\sum_{i=1}^{n}(v_{ij} - v_j^-)^2} \quad (7)$$

where $i = 1,2,\dots,m$.

Step 6. Compute the relative closeness to the ideal solution as given in equation 8:

$$C_i^* = \frac{S_i^-}{(S_i^* + S_i^-)} \quad (8)$$

where $i = 1,2,\dots,m$

Step 7. Rank the preference order for each alternative according to the closeness coefficient. The bigger C_i^* value means better performance.

APPLICATION AND FINDINGS

TOPSIS is widely used in many different areas in MCDM problems. In this paper, this method is used to evaluate sustainability performance over the years by environmental performance indicators. The research methodology is applied under two main steps including determining the indicators and ranking of sustainability performance. Findings are provided in tables 2, 3, 4, 5 and 6.

When the closeness coefficients of the last three years are ranked, it is seen that 2018 is the most effective year for the company. The lowest performance

Table 2

THE INITIAL DECISION MATRIX														
Year	**C1**	**C2**	**C3**	**C4 (000,000)**	**C5 (000,000)**	**C6 (000)**	**C7 (000)**	**C8 (000)**	**C9 (000)**	**C10 (000)**	**C11 (000)**	**C12 (000)**	**C13 (000)**	**C14 (000)**
2018	1.04	1.11	1.11	599.49	61.36	435.28	10.17	2.56	7.59	9.22	10.07	3.48	2.03	189.44
2019	1.00	1.11	1.20	576.01	62.35	423.68	10.08	2.68	7.40	7.13	9.25	4.09	2.62	181.67
2020	0.91	0.92	0.79	490.18	54.27	357.05	10.88	2.30	8.58	6.73	10.59	2.90	1.99	184.10

Table 3

NORMALIZED DECISION MATRIX														
Year	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**
2018	0.61	0.61	0.61	0.62	0.60	0.62	0.57	0.59	0.56	0.69	0.58	0.57	0.53	0.59
2019	0.59	0.61	0.66	0.60	0.61	0.60	0.56	0.61	0.54	0.53	0.54	0.67	0.68	0.57
2020	0.53	0.51	0.44	0.51	0.53	0.51	0.61	0.53	0.63	0.50	0.61	0.48	0.52	0.57

Table 4

THE WEIGHTED DECISION MATRIX														
Year	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**
2018	8.53	8.52	8.62	8.69	8.32	8.64	7.89	8.23	7.78	9.65	8.13	8.03	7.38	8.24
2019	0.04	8.55	9.36	8.35	8.46	8.41	7.82	8.57	7.58	7.46	7.47	9.42	9.52	7.90
2020	0.04	7.07	6.16	7.10	7.36	7.09	8.44	7.35	8.79	7.03	8.55	6.69	7.25	8.00

Table 5

THE POSITIVE AND NEGATIVE IDEAL SOLUTIONS														
Solution	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**
A^*	8.53	8.55	9.36	8.69	8.46	8.64	8.44	8.57	8.79	9.65	8.55	9.42	9.52	8.24
A^-	0.04	7.07	6.16	7.10	7.36	7.09	7.82	7.35	7.58	7.03	7.47	6.69	7.25	7.90

Table 6

THE RELATIVE CLOSENESS COEFFICIENTS		
Year	C_i^*	**Ranking**
2018	0.768	1
2019	0.384	2
2020	0.141	3

seems to be in 2020. It is understood from the results that the company is gradually moving away from its ES target.

CONCLUSIONS

In recent years, the sustainability approach is an integral part of business management. It is accepted that a well-organized management approach based on sustainability is crucial for stakeholders to evaluate the impacts of a company's activities. To set long-term strong relationships with stakeholders cares about not only the future of the company but also the future of the world. For this reason, there is an increasing trend based on the significance of the topic among practitioners. This is also available for the textile industry. At this point, the performance evaluation of sustainability over the years concerning environmental indicators becomes very important. Thus, it is focused on in the study.

Two main steps including indicators determination and sustainability performance ranking part are given in the research methodology. It is benefited from TOPSIS to achieve the study's goal.

The methodology is applied to a company from the Turkish textile industry. Data are derived from sustainability reports of the company for the years 2018 and 2020. However, it is seen that the content specification processes of reports vary and some detailed information in the reports does not exist in some years so it is difficult to make a complete comparison. Therefore, it has been thought that data from the 2018, 2019 and 2020 reports are useful for our research and if so, the used methodology would give more accurate results if these data are provided. The results show that the best sustainability performance for the company is received in 2018.

Although the textile industry is very important for the global economy, if the sustainability approach is ignored, it can lead to serious environmental problems. For instance, consuming resources unconsciously,

and creating harmful effects on natural resources and the environment are some of these problems. At this point, ES means the permanence of natural resources and therefore, it is very important for companies in the industry. Powerful strategies at the business level must be implemented in the textile industry. Also, at the national level governments must constitute and control these strategies. Moreover, they should not forget to update them. That's why, this study contributes to the sustainability performance evaluation process by providing a methodology which can systematically evaluate environmental performance indicators. In particular, the decision-makers from the textile industry should see their weaknesses, make business plans accordingly and ensure continuous improvement in terms of sustainability.

Eventually, this study is performed on a single company's data in the textile industry. As a future study, more companies can be elected in the same or different industries to see how their perspectives on the ES approach. Also, the same company can be studied with more sustainability dimensions like environmental, social and economic indicators. In addition to its use for the evaluation of sustainability performance by environmental indicators in the textile industry, the proposed methodology can also be used in other MCDM problems where their net scorings. If not, the proposed methodology can be modified and fuzzy technics can be utilized. Finally, the same study can be repeated several times over the same firm in different years. Thus, it can be observed whether the firm's policy on sustainability has changed over the years.

REFERENCES

[1] IMARC Group, Available at: https://www.imarcgroup.com/textile-market [Accessed on October 2021]
[2] IBIS World, Available at: https://www.ibisworld.com/global/market-research-reports/global-apparel-manufacturing-industry/ [Accessed on October 2021]
[3] Janaina, A.K., Miguel, P., Davi, B.G., Barrella, W., *Textile. sustainability: a Brazilian etiquette issue*, In: Environ. Sci. Pol., 2020, 109, 125–130
[4] Jia, F., Yin, S.Y., Chen, L.J., Chen, X.W.J., *The circular economy in the textile and apparel industry: A systematic literature review*, In: J. Clean. Prod., 2020, 259, 1–20
[5] Choudhury, R., *Roadmap to Sustainable Textiles and Clothing*, Muthu, S., Ed.; Springer: Singapore, 2015, 137–173
[6] Khan M. R., Islam, M., *Materials and manufacturing environmental sustainability evaluation of apparel product: knitted T-shirt case study*, In: Textiles and Clothing Sustainability, 2015, 1, 1, 1–12
[7] Zhang, Y., Liu, X., Xiao, R., Yuan, Z., *Life cycle assessment of cotton T-shirts in China*, In: Int. J. Life Cycle Assess., 2015, 20, 7, 994–1004
[8] WWF Turkey, Available at: https://www.wwf.org.tr/?8020/wwf-ve-hm-gruptan-tekstil-sektorunde-temiz-uretim-rehberi [Accessed on November 2021]
[9] Angelis-Dimakis, A., Alexandratou, A., Balzarini, A., *Value chain upgrading in a textile dyeing industry*, In: J. Clean. Prod. 2016, 138, 2, 237–246
[10] Fujimori, S., Hanasaki, N., Masui, T., *Projections of industrial water withdrawal under shared socioeconomic pathways and climate mitigation scenarios*, In: Sustain. Sci. 2017, 12, 2, 275–292
[11] Quental, N., Lourenço, J.M., Da Silva, F.N., *Sustainable development policy: goals, targets and political cycles*, In: Sustainable Development, 2011, 19, 1, 15–29
[12] WCED, Available at: https://www.un.org/ga/search/view_doc.asp?symbol=A/42/427 [Accessed on November 2021]
[13] Davidson, K.M., Reporting Systems for Sustainability: What Are They Measuring?, In: Social Indicators Research, 2011, 100, 2, 351–365
[14] UN, Available at: http://www.un.org/esa/sustdev/natlinfo/indicators/guidelines.pdf. [Accessed on November 2021]
[15] Munasinghe, M., *Environmental Economics and Sustainable Development,* The World Bank: Washington, USA, 1993
[16] Munasinghe, M., *Sustainable development and climate change: Applying the sustainomics transdisciplinary meta-framework*, In: International Journal of Sustainable Development, 2002, 4, 2, 125–182
[17] Hawken, P., *The ecology of commerce: a declaration of sustainability,* Harper Business, New York, USA, 1993
[18] Aras, G., Crowther, D., Corporate Sustainability Reporting: A Study in Disingenuity?, In: Journal of Business Ethics, 2009, 87, 279–288
[19] Viederman, S., *The economics of sustainability: Challenges*, In: Proceedings, Workshop on the Economics of Sustainability, Recife, Brazil, 1994, 1–22
[20] Wilson, M., *Corporate Sustainability: What Is It and Where Does It Come From?*, In: Ivey Business Journal, 2003, 67, 4
[21] Signitzer, B., Prexl, A., Corporate Sustainability Communications: Aspects of Theory and Professionalization, In: Journal of Public Relations Research, 2008, 20, 1–19
[22] Cheng, R., Li, W., Lu, Z., Zhou, S., Meng, C., *Integrating the three-line environmental governance and environmental sustainability evaluation of urban industry in China*, In: J. Clean. Prod., 2020, 264, 1–13
[23] Corporate Knights, Available at: https://www.corporateknights.com/rankings/global-100-rankings/2021-global-100-rankings/ [Accessed on November 2021]
[24] Clube, R.K.M., Tennant, M., *Exploring garment rental as a sustainable business model in the fashion industry: does contamination impact the consumption experience?*, In: J. Consum. Behav. 2020, 19, 4, 359–370
[25] Zhang, J., Qian, X., Feng, J., *Review of carbon footprint assessment in textile industry*, In: Ecofeminism and Climate Change, 2020, 1, 1, 51–56
[26] Wang, H., Pan, C., Wang, Q., Zhou, P., *Assessing sustainability performance of global supply chains: An input-output modeling approach*, In: Eur. J. Oper. Res., 2020, 285, 393–404

[27] Thies, C., Kieckhafer, K., Spengler, T.S., Sodhi, M.S., Operations research for sustainability assessment of products: Areview, In: Eur. J. Oper. Res., 2019, 274, 1, 1–21
[28] Cheng, S., Chan, C.W., Huang, G.H., *Using multiple criteria decision analysis for supporting decisions of solid waste management*, In: Journal of Environment Science Health, 2002, 37, 6, 975–990
[29] Ilangkumaran, M., Kumanan, S., *Selection of maintenance policy for textile industry using hybrid multi-criteria decision making approach*, In: J. Manuf. Technol. Manag., 2009, 20, 7, 1009–1022
[30] Shyjith, K., Ilangkumaran, M., Kumanan, S., *Multi-criteria decision-making approach to evaluate optimum maintenance strategy in textile industry*, In: J. Qual. Maint. Eng., 2008, 14, 4, 375–386
[31] Lu, J., Zhu, Y., Zeng, X., Koehl, L., Ma, J., Zhang, G., *A linguistic multi-criteria group decision support system for fabric hand evaluation*, In: Fuzzy Optim. Decis. Mak., 2009, 8, 4, 395–413
[32] Ünal, C., Güner, M.G., *Selection of ERP suppliers using AHP tools in the clothing industry*, In: Int. J. Cloth. Sci. Technol. 2009, 21, 4, 239–251
[33] Tseng, M.L., Wu, K.J., Ma, L., Kuo, T.C., Sai, F., *A hierarchical framework for assessing corporate sustainability performance using a hybrid fuzzy synthetic method-DEMATEL*, In: Technological Forecasting and Social Change, 2019, 144, 524–533
[34] Acar, E., Kılıç, M., Güner, M., *Measurement of sustainability performance in textile industry by using a multi-criteria decision making method*, In: Textile and Apparel, 2015, 25, 1, 3–9
[35] Ergüden, E., Çatlıoğlu, E., Sustainability Reporting Practiceses in Energy Companies with Topsis Method, In: The Journal of Accounting and Finance, 2016, 201–221
[36] Kumar, D., Singh, J., Singh, O.P., *A decision support system for supplier selection for Indian textile industry using analytic hierarchy process based on fuzzy simulation*, In: International Journal of Business Performance and Supply Chain Modelling, 2011, 3, 4, 364–382
[37] Chakraborty, S., Chatterjee, P., Prasad, K., *An Integrated DEMATEL–VIKOR Method-Based Approach for Cotton Fibre Selection and Evaluation*, In: Journal of The Institution of Engineers (India): Series E , 2018, 99, 63–73
[38] Kaplan, S., Araz, C., Göktepe, Ö., *A Multicriteria Decision Aid Approach on Navel Selection Problem for Rotor Spinning*, In: Textile Res. Journal, 2006, 76, 12, 896–904
[39] Zhu, Q., Sarkis, J., Geng, Y., *Barriers to environmentally-friendly clothing production among Chinese apparel companies*, In: Asian Business & Management, 2011, 10, 3, 425–452
[40] Rezaie, K., Ansarinejad, A., Nazari-Shirkouhi, S., Karimi, M., Miri-Nargesi, S.S., *A Novel Approach for Finding and Selecting Safety Strategies Using SWOT Analysis*, In: Proceedings, International Conference on Computational Intelligence, Modelling and Simulation, Bali, Indonesia, 2010, 394–397
[41] Yin, S.H., Wang, C.C., Teng, L.Y., Hsing, Y.M., *Application of DEMATEL, ISM, and ANP for key success factor (KSF) complexity analysis in R&D alliance*, In: Scientific Research and Essays, 2012, 7, 19, 1872–1890
[42] Adalı, E., Işık, A., *Integration of DEMATEL, ANP and DEA methods for third party logistics providers' selection*, In: Management Science Letters, 2016, 6, 5, 325–340
[43] Kilic, H.S., Yalcin, A.S., *Comparison of municipalities considering environmental sustainability via neutrosophic DEMATEL based TOPSIS*, In: Socio-Economic Planning Sciences, 2021, 75, 1–2
[44] Kordsa, Available at: https://www.kordsa.com/tr/surdurulebilirlik/detay/Cevre-Yonetim-Politikamiz/3 46/394/0 [Accessed November 2021]
[45] Hwang, C.L., Yoon, K., *Multiple attribute decision making, methods and applications: 186 (Lecture Notes in Economics and Mathematical Systems)*, Springer-Verlag, New York, 1981
[46] Chen, C.T., *Extensions of the TOPSIS for group decision-making under fuzzy environment*, In: Fuzzy Sets and Systems, 2000, 114, 1, 1–9
[47] Zavadskas, E.K., Turskis, Z., Tamošaitienė, J., *Construction risk assessment of small scale objects by applying TOPSIS method with attributes values determined at intervals*, In: The 8th international conference "Reliability and statistics in transportation and communication" (RelStat-08), Riga, Latvia, 2008, 351–357
[48] Hung, C.C., Chen, L.H., *A fuzzy TOPSIS decision making model with entropy weight under intuitionistic fuzzy environment*, In: Proceedings of the International Multi-Conference of Engineers and Computer Scientists IMECS, Hong Kong, 2009
[49] Wang, Y.J., Lee, H.S., *Generalizing TOPSIS for fuzzy multiple-criteria group decision-making*, In: Computers and Mathematics with Applications, 2007, 53, 11, 1762–1772
[50] Shih, H.S., Shyur, H.J., Lee, E.S., *An Extension of TOPSIS for Group Decision Making*, In: Mathematical and Computer Modelling, 2007, 45, 7–8, 801–813

Authors:

ŞİMŞEK GÜNDÜZ GONCA[1], GÜNDÜZ ÇAĞDAŞ[2]

[1]Pamukkale University, Denizli Vocational School of Technical Sciences, Department of Textile Technologies, 20160, Denizli, Turkey

[2]Pamukkale University, Faculty of Applied Sciences, Department of Capital Market, 20600, Denizli, Turkey
e-mail: cagdasgunduz35@gmail.com

Corresponding author:

ŞİMŞEK GÜNDÜZ GONCA
e-mail: gsimsek@pau.edu.tr