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Analyzing The Barriers to Adoption of Circular Economy Models by SMEs in Textile Industry Using Fuzzy SWARA Method[1]

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Abstract

Despite the many micro and macro opportunities offered by the circular economy, businesses may encounter various obstacles in practice. These obstacles make it difficult for businesses to attempt towards circular economy and often cause them to abstain. This is especially true for SMEs. The aim of this study is to identify the potential barriers to the adoption of circular economy models by SMEs in the textile industry. Due to the change in the applicability of the circular economy according to the sectoral differences in SMEs, the application was made only in the textile sector. The obstacles in the study were evaluated by interviewing the managers of five companies, and they were weighted according to the level of importance with the Fuzzy SWARA Method. The importance of this study is that by determining the needs of SMEs in the textile industry for the circular economy, it will prepare the ground for developments that will ensure their adaptation to the process. As a result of the study, the uncertainty situations (demand and return) of SMEs in the transition to the circular economy are seen as the biggest possible obstacles, while the need for financial resources and limited technology have emerged as other important constraints.

Keywords: Circular Economy (CE), Circular Transformation, Barriers, SME, Fuzzy SWARA

Jel Codes: L21, L23, L67, M11, M21

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Tekstil Sektöründeki KOBİ'lerin Döngüsel Ekonomi Modellerini Benimsemesinin Önündeki Engellerin Bulanık SWARA Yöntemi Kullanılarak Analiz Edilmesi

Özet

Döngüsel ekonominin sunduğu mikro ve makro boyutlardaki birçok fırsata rağmen, işletmeler uygulamada çeşitli engellerle karşılaşabilmektedir. Bu engeller işletmelerin döngüsel ekonomiye yönelik girişimlerini zorlaştırmakta ve çoğu zaman çekimser kalmalarına neden olmaktadır. Özellikle KOBİ'lerde bu durum daha çok yaşanmaktadır. Bu çalışmanın amacı, tekstil sektöründeki KOBİ'lerin döngüsel ekonomi modellerini benimsemelerinin önündeki potansiyel engelleri belirlemektir. KOBİ'lerdeki sektörel farklılıklara göre döngüsel ekonominin uygulanabilirliğinin değişmesi sebebiyle uygulama sadece tekstil sektöründe yapılmıştır. Beş adet firmanın yöneticileriyle birebir görüşülerek çalışmadaki engeller değerlendirilmiş olup, Bulanık SWARA yöntemi ile önem düzeyine göre ağırlıklandırılmıştır. Bu çalışmanın önemi, tekstil sektöründeki KOBİ'lerin döngüsel ekonomiye yönelik ihtiyaçlarını belirleyerek, sürece yönelik uyumlarını sağlayacak gelişmelere zemin hazırlayabilecek olmasıdır. Çalışma sonucunda KOBİ'lerin döngüsel ekonomiye geçişteki belirsizlik durumları (talep ve getiri) muhtemel en büyük engellerden görülürken, finansal kaynaklara olan ihtiyaç, sınırlı teknolojiye sahip olma durumu diğer kısıtlayıcı durumlar olarak ortaya çıkmıştır.

Anahtar Kelimeler: Döngüsel Ekonomi (DE), Döngüsel Dönüşüm, Engeller, KOBİ, Bulanık SWARA

1. Introduction

In recent years, one of the issues that almost the whole world has focused on is achieving sustainable development goals. Sustainability initiatives are like "limiting the consumption of non-renewable resources, managing processes to ensure efficiency in the use of natural resources, ensuring energy efficiency, reducing waste generation, increasing recycling and recovery activities, and protecting public health and safety (Cevik Aka, 2022a: 196). Due to the focus on resource efficiency in studies on sustainability, it can be stated that sustainability and circular economy are intertwined. The circular economy is certainly an important tool for sustainable development (Kirchherr et al., 2018; Hofmann, 2019; Betancourt Morales & Zartha Sossa, 2020). For this reason, circular economy initiatives have become more important than ever today. Since the subject is very critical, it may be necessary to analyze in detail all situations at the point of implementation of the circular economy.

The rapid increase in population and the expansion of economies all over the world increase the amount of resource consumption considerably. A lot of research has been done on the fact that overexploitation of resources poses great risks in many ways. The situation of restrictions in production inputs, the need for efficient use of resources and the necessity of protecting nature push societies to establish new economic models (Cevik Aka, 2022b). The most appropriate consumption of resources is very important in order to meet the economic expectations of the businesses and to reduce the damage to the environment. For this reason, various steps had to be taken to reduce the need for natural resources and to cope with it. The circular economy creates a situation that produces solutions against these problems (Scarpellini et al., 2020).

Circular economy initiatives include industries in different sectors and find many application areas. Globally, priority is given to implementing the circular economy system in sectors such as automobile (Agyemang et al., 2019), manufacturing (Kumar et al., 2019), construction (Ghisellini et al., 2016), and food (Sharma et al., 2019). (Khandelwal et al., 2020). One of the sectors in which the circular economy is applied is textile and ready-made clothing (Jia et al., 2020). Today, the global need for textile products is constantly increasing. Processing, weaving, knitting, dyeing or printing in textiles are recognized as major sources of CO_2 emissions and other types of pollution (Steffen et al., 2015). With the adoption of the circular economy approach, the reuse of textile waste has gained more importance (Hussain et al., 2021).

SMEs have a very large and important place in the textile manufacturing sector. Today, the rapid development of technology has brought many innovations and developments that are accepted as a revolution in manufacturing. However, there are many obstacles faced by SMEs to implement these innovations due to their existing structures and certain characteristics. It may take a lot of effort to overcome these obstacles.

The aim of this study is to prioritize the obstacles faced by small or medium-sized businesses operating in the textile sector before implementing circular economy initiatives. In order to achieve this aim, one-on-one interviews were conducted with five managers. The important aspect of the study is that it will be able to support businesses to prepare action plans to facilitate the process by identifying the needs for the situations they see as major obstacles. In the first part of the study, a conceptual framework for the circular economy is drawn and the potential obstacles that form the focus of the study are discussed. In the next section, the F-SWARA method and the steps to be

used in practice are mentioned. In the fourth chapter, the findings of weighting criteria with five experts working in SMEs in the textile industry are given, while the results are detailed in the last chapter.

2. Conceptual Framework

2.1. Circular Economy (CE)

The concept of the circular economy has been the subject of major trends over the past decade by practitioners and academics. Researchers and academics have begun to pay attention to the implementation of circular economy initiatives in the supply chain (Rizos et al., 2016; Batista et al., 2019). When we look at the refereed journals, it is seen that while the subject was examined in about thirty articles in 2014, it was seen in more than a hundred articles in 2016, and this number reached at least 4-5 times in 2020. It is effective in increasing the interest in the subject, as it is seen as an operationalization step in sustainable development, which is frequently discussed by businesses especially recently (Murray et al., 2017). The fact that the circular economy is used in different disciplines has caused it to be expressed in different ways.

Circular economy first appeared in Pearce and Turner's (1990) studies in which they discussed the links between environment and economic activities. For the first time, this concept was defined as a closed-loop material flow in which the economic system takes place according to the principle of "everything is the input of everything else" (Su et al., 2013). There are concept definitions in different principles formulated such as “industrial ecology” (Erkman, 1997), “performance economy” (Stahel, 2008) and industrial economics (Ghisellini et al., 2018) (Merli et al., 2018). Jonker et al., (2017) attempted several definitions emphasizing various aspects of the circular economy and argued that CE is based on redesigning production systems at various levels with a focus on product value preservation. Ghisellini et al., (2018) expressed the circular economy as an industrial economy aiming at sustainability enriched by design. One of the most generally accepted definitions was made by Geissdoerfer et al., 2017). Researchers defined the circular economy as a regenerative system that minimizes the input and waste of resources, gas emissions and energy consumption by limiting energy and material consumption.

The circular economy is an economic model that aims to protect the environment and provide long-term value recovery with socio-economic benefits (Morseletto, 2020). The main purpose of CE is to recycle and reuse materials to reduce waste and to minimize the environmental impact of

products such as carbon footprint, water footprint and air acidification (Agrawal et al., 2020). While CE requires a closed material flow, it is a system that limits the use of resources such as energy and water. While it is seen that the definitions for the circular economy focus especially on resource use and energy efficiency, economic opportunities should not be ignored. The main aim of this approach is to make products or materials available by extending their life cycles in a circular supply chain design to minimize waste generation (Batista et al., 2019).

Circular business models consist of a series of strategic decisions for products and services to create economic and environmental value (Werning & Spinler, 2020). Because the circular economy creates a synergy effect between economic development and the environment (Masi et al., 2017). The inevitable transformation in production systems with constantly developing technologies necessitated a change in existing business models. Circular business models are characterized by the closure of raw material chains, the shift from ownership to service delivery, and more intensive use of product functionality (Rogge & Reichardt, 2016). The transition to the circular economy requires businesses to take innovative actions in their supply chains (De Angelis et al., 2018). In circular business models; purposes such as creating value, developing value-providing distribution systems and encouraging the correct use of resources are taken into account.

CE models are based on the concept of transforming the take-away model into closed material flow loops. Closed material cycles are possible with different functions such as maintenance, repair, reuse, refurbishment, remanufacturing and recycling. CE principles encourage the elimination of waste and pollution, maximizing the use of products and materials, and regeneration of natural systems (EMF, 2020). At the core of the circular economy is the idea of coordinating waste generation and resource use by transforming production and consumption systems in a way that creates value.

2.2. Barriers in the Circular Economy

Besides its many potential benefits, the circular economy is hindered by various situations and constraints (Masi et al., 2017; Ghisellini et al., 2018). Due to these obstacles, firms slow down in transition to the circular economy (CE) (Masi et al., 2017) and cannot take advantage of the opportunities that the circular economy will offer. Various studies have been carried out in the literature to identify the obstacles faced by businesses in implementing the circular economy. Jesus & Mendonca (2018) grouped the cyclical economy barriers into four categories: technological,

market, institutional and cultural (social) barriers. Govindan & Hasanagic (2018) expressed as policy, operational, financial, infrastructural, technological, customer and social bariers. Jaeger & Upadhyay (2020) classified the barriers to adoption of the circular economy in seven categories as high start-up costs, complex supply chains, business-to-business (B2B) collaboration, product design and manufacturing, technical skills, quality and difficult disassembly of products. According to Kazancoglu et al. (2020) financial, organizational, technology-based, policy, market situations and logistics; Khandelwal & Barua. (2020) examined under 5 headings: legal, organizational, technical, market and financial.

The eight criteria included in this study are supported by the relevant literature as follows:

a. Company culture: An unstable and resistant corporate culture to change and innovation is seen as one of the major obstacles to the circular economy (Kirchherr et al., 2018; Grafström & Aasma, 2021). It is very difficult to change people's mentality towards implementing the circular system (De Jesus & Mendonça, 2018). Many of the businesses tend to work with traditional business models and can resist innovations.

Leadership is an important element in the corporate culture. While the attitude of the managers towards innovation and transformation is a situation that can facilitate the circular economy, the opposite is also possible. The lack of strong commitment and support from the top management is seen as an important obstacle to the implementation of the new economy model in organizations (Gupta & Barua, 2016). On this situation, the limited successful business models of the circular economy have created a situation that limits managers (Tura et al., 2019).

b. Lack of flexibility and coordination between departments: One of the barriers seen as weak cooperation throughout the supply chain is lack of coordination (Katiyar et al., 2018; Grafström & Aasma, 2021). Collaboration and coordination between "upstream" and "downstream" partners of supply chains is essential (Zhu et al., 2010). The power of communication and collaboration among businesses is critical to the success of a supply chain, as businesses need multiple departments to work together to adjust their operations. If this is not achieved, businesses potentially have to endure large transaction costs and delays in markets between companies (Eijk, 2015). On the other hand, many businesses in developing economies do not have the flexibility to implement the circular economy (Guldmann & Huulgaard, 2020). However, it is important for businesses to have a flexible supply chain in order to implement a new technology or new business models. From this

point of view, it can be stated that the ability of the units in the supply chain to adapt to each other and communication is an important element for the circular economy.

c. Limited technology availability: One of the barriers to the adoption of circular economy is limited technology availability. When technological barriers are evaluated, product designs; It has been stated that it is a major obstacle for remanufacturing, reuse and recycling (Masi et al., 2018). It is very difficult to manage the design of products that can be reused (Kirchherr et al., 2018). The complexity in product designs and the materials used determine whether the products gain value again after use. Circular economy is affected by the fact that the existing products do not have a circular design, so the reuse of materials and the fact that processes such as remanufacture are not easy (Singh & Sarkar, 2019). Circular economy is affected by the fact that the existing products do not have a circular design, so the reuse of materials and the fact that processes such as remanufacture are not easy (Singh & Sarkar, 2019). Failure in the design of reuse products hinders the ability of businesses to reuse and recycle (Agyemang et al., 2018).

On the other hand, it may be necessary to have good technology in order to collect, sort, process and re-value wastes. This limited situation in waste management can lead to differences in the amount, properties and quality of recycled materials. An effective waste management system is not something that every company can achieve equally. It is often difficult to make a high-quality product with recycled or reused materials (Govindan & Hasanagic, 2018). The ability to deliver high quality remanufactured products requires good technology application (Kirchherr et al., 2018). For this, it is often expected that businesses have good technologies. The absence of smart technologies in businesses is one of the biggest constraints in monitoring information about material flow in the supply chain (Mangla et al., 2018).

d. Limited financial resources availability: High costs often act as a deterrent to the implementation of the circular economy in the supply chain (Ghisellini et al., 2016; Govindan & Hasanagic, 2018). Since one of the application areas of the circular economy is directly related to the management of waste, it can be stated that the costs needed in waste management directly affect the circular economy initiatives. There is a general belief that a greater focus on recycling and reuse of products in the circular economy is cost-intensive (Govindan & Hasanagic, 2018; Tura et al., 2019). The high cost of waste collection, transportation, separation and processing

activities constrains businesses to adopt new operational practices (Prakah & Barua, 2016; Paletta et al., 2019).

In many cases, materials having an environmentally friendly profile can increase operating costs (Govindan & Hasanagic, 2018). There are also cases where raw materials are available at lower prices than recycled materials (Kirchherr et al., 2018). However, this situation should not have a generalizable idea due to the characteristics of each material group and the materials to be recycled. In the study prepared by Cevik Aka (2022b) on the recycling of plastic, steel, glass and aluminum industrial product groups, the economic and environmental advantages for materials with certain properties were evaluated. Although there are many situations in which the circular economy is economically advantageous in many studies, the general idea is that the need for financial resources for certain activities is an obstacle.

e. Lack of technical knowledge/lack of expertise: One of the biggest concerns of businesses at the point of adopting a new application or a new action is whether they will be successful in this regard. For the success of a process, it is very important to have expertise on the subject and to act with the right information. With this well-known fact, a similar situation is that the information that businesses need to implement the circular economy is important. One of the biggest obstacles to the implementation of the circular economy is the lack of knowledge (Tura et al., 2019, Guldmann & Huulgaard, 2020). Many businesses do not have the technical expertise or knowledge of how to transform traditional operations into circular applications (Sharma et al., 2019). Businesses' concerns about the circular economy are often geared towards the quality of products. Because it is very difficult to know exactly what is done with the material and whether the recycled material is processed well in terms of quality (Torstensson, 2016).

f. Uncertainties in demand and in return: Uncertainties about demand are also referred to as market barriers in the literature. Market barriers arise from the absence of an existing large market for product recycling or recovery. Quality perceptions, supply uncertainties (Tura et al., 2019) and price fluctuations affect the demand for recycled materials markets. The markets for refurbished products are very small, which reduces consumers' choices for these products (Govindan & Hasanagic, 2018). Customers may think that a refurbished product is of lower quality than a new product (Bilal et al., 2020). Consumers' perspectives on refurbished products and their acceptance of this situation can be challenging. It has been determined in many studies that consumers are

more inclined to buy a new product rather than a remanufactured product (Govindan & Hasanagic, 2018). For this reason, uncertainties regarding demand in the circular economy and, as a result, uncertainties in returns are one of the issues that businesses worry about. On the other hand, price uncertainty can cause market instability by breaking the confidence of both sellers and buyers. The insecure environment of the market can also be seen as one of the obstacles to the circular economy.

g. Government policies: Governments are one of the most critical stakeholders influencing the implementation of CE in supply chains (Govindan & Hasanagic, 2018) and has started to take place as a guiding principle in the policies of many countries today (George et al., 2015). CE has attracted the attention of policy makers because of the many opportunities it promises (Ghisellini et al., 2018). However, today, legal and regulatory policies are seen as important obstacles in the circular economy (Bet et al., 2018; García et al., 2020; Kazancoglu et al., 2020; Khandelwal et al., 2020). Govindan & Hasanagic (2018) stated the policy barriers in the circular economy as the lack of standards for refurbished products, the lack of enforcement laws for circular business models in the supply chain, and the government's ambiguous vision for implementing the circular economy. Kaur et al., (2018) expressed the lack of legislation in an efficient circular economy and Masi et al. (2018) expressed the absence of mandatory requirements and responsibilities for manufacturers/suppliers.

Government policies, business practices and consumer behavior can complicate the acceptance of the circular economy so that coherent policies and strategies need to be developed (Manninen et al., 2018). Policies, regulations and legislation can guide businesses in adopting the circular economy, and businesses need these supports. The legal regulations to be made by governments for CE should not only be related to waste management, but also should be supportive in design, monitoring of recyclable products, collecting and sorting materials, as in every stage of the supply chain (Jia.et al., 2020).

h. Limitation of financial incentives: In economies where cost is a major concern, government support in the circular economy appears to be limited (Kirchherr et al., 2018). This situation can also be seen as an important limiting obstacle. The government's tax relaxation policies can be seen as a motivating factor for the implementation of the circular economy (Mangla et al., 2018). Funds and economic incentives are needed to transition from a linear economy to a circular

economy, especially in developing countries with weaker economies (Rizos et al., 2016; Govindan & Hasanagic, 2018). It is known that these incentives have a great impact on businesses to adopt the circular economy (Kirchherr et al., 2018; Tura et al., 2019).

3. Method

Fuzzy SWARA (F-SWARA)

The SWARA method is a multi-criteria decision-making method developed by Keršuliene et al. in 2010. SWARA is a method that facilitates decision making in situations where there are many criteria and more than one decision maker, as in other multi-criteria decision making methods. When the existing literature is examined, it is seen that the method is used in different disciplines.

In this study, since the SWARA method will be used under the uncertainty of the decision makers, it is in the form of Fuzzy SWARA by using the fuzzy set. The fuzzy SWARA method has also been a preferred method by researchers for many different purposes. It is seen that the method has been used especially in research in the field of sustainability in recent years. Looking at the literature, fuzzy SWARA was used by Ansari et al., (2020) to prioritize the criteria for remanufacturing supply chain risks, Moniri et al., (2020) to prioritize the criteria for project risks, Rani et al., (2021) to prioritize the criteria for sustainable supplier selection. Other hand Tas et al., (2021) and Tus & Adalı (2022) used F-SWARA to prioritize the criteria for green supplier selection, Ghasemi et al., (2021) to prioritize the criteria for sustainable health tourism destination.

Table 1: Linguistic Variables and Triangular Fuzzy Numbers

Linguistik Variable	Fuzzy Number
Equally Important	(1.0000, 1.0000, 1.0000)
Moderately Less Important	(0.6667, 1.0000, 1.5000)
Less Important	(0.4000, 0.5000, 0.6667)
Very Less Important	(0.2857, 0.3333, 0.4000)
Much Less Important	(0.2222, 0.2500, 0.2857)

Source: Chang (1966)

With this fundamental difference, the steps of the Fuzzy SWARA Method are: (Keshavarz Ghorabaee et al., 2018)

Step 1: All relevant criteria are ranked in order of importance by each of the decision makers.

Step 2: The criteria listed in order of importance are compared in pairs consecutively, starting from the first line, and expressed with the $\tilde{s}j$ motivation as "comparative importance of the mean value".

Step 3: The coefficient $\tilde{k}j$ is determined for each decision maker. The coefficient $\tilde{k}j$ is calculated as follows.

$\tilde{k}j$ = {1, j = 1; $\tilde{s}j$ + 1, j > 1} Equation (1)

Step 4: For each decision maker, the $\tilde{q}$j value, which shows the importance weight, is calculated.

$\tilde{q}$j = {1, j = 1; $\tilde{q}$j-1 / $\tilde{k}j$, j > 1} Equation (2)

As in equations (1) and (2), $\tilde{k}$1 and $\tilde{q}$1 are always equal to 1.

Step 5: The final fuzzy weights ($\tilde{q}$j) of all criteria are normalized and calculated. Relative importance weight value is obtained by dividing the importance weight ($\tilde{q}$j) of each criterion by the total importance weight of all criteria, $\tilde{q}$k.

$\tilde{w}_j = \tilde{q}_j / (\sum_{k=1}^{n} \tilde{q}k)$ Equation (3)

Step 6: $\tilde{w}$j values calculated with F-SWARA are converted to exact numbers by defuzzification. The relevant equation for calculating BNP (Best Nonfuzzy Performance Value):

BNP= ([(u-l)+ (m-l)]/3)+ l Equation (4)

4. Application

In the study, subjective weighting of the criteria was made by making one-to-one interviews with the executive level employees of five companies operating in the textile sector. These people selected as decision makers are the people who are active in the field of sustainability and are the executives of sustainability projects in the companies they work for. These five experts in the study were chosen, especially in terms of knowing the sector they are in and working on related issues in a way that meets the purpose of this study.

In the study, there are 8 criteria as obstacles to the textile industry. These criteria are;

C1: Company culture

C2: Lack of flexibility and coordination between departments

C3: Limited technology availability

C4: Limited financial resources availability

C5: Lack of technical knowledge/expertise

C6: Uncertainties in demand in return

C7: Government policies,

C8: Limitation of financial incentives

In practice, eight criteria were evaluated subjectively by five different experts and the following steps were followed in case the SWARA method was applied.

Step 1: Each decision maker (En) ranked 5 criteria (C_n) in order of importance.

Table 2: Ranking of the criteria in order of importance

C_n	E1	E2	E3	E4	E5
C_1	8	5	8	5	7
C_2	7	8	7	8	6
C_3	2	3	4	4	2
C_4	3	2	1	3	1
C_5	4	4	3	2	4
C_6	1	1	2	1	3
C_7	5	7	6	7	8
C_8	6	6	5	6	5

Steps 2, 3, 4, and 5: First, separate criteria for each decision maker were compared in pairs consecutively. In this step, $\tilde{s}j$, $\tilde{k}j$, $\tilde{q}$j and $\tilde{w}$j were obtained, respectively. Table 2 was used for $\tilde{s}j$, which is the comparative significance of the mean value. In this step, the fuzzy numbers of Chang, who made one of the first studies on fuzzy set theory, were used (Table 1). Equation (1) for $\tilde{k}j$, Equation (2) for importance weight $\tilde{q}$j and finally Equation (3) for relative weight $\tilde{w}$j of criteria. The values reached for the decision makers are shown in Table 3.

For example; Decision maker (E1) found that the uncertainty in demand and thus return (C_6) was moderately less important than having limited technology (C_3).

According to this evaluation, using Table 1, the fuzzy value corresponding to the linguistic variable was (0.6667, 1.0000, 1.5000). Therefore, the $\tilde{s}$j value for C_3 was equal to (0.6667, 1.0000, 1.5000). Secondly, when calculating the $\tilde{k}$j value for C_3, it was obtained by +1 operation (1.6667, 2.0000, 2.5000) in the direction of Equation (1). By applying Equation (2) for another operation $\tilde{q}$j; (1.0000, 1.0000, 1.0000) ⊘ (1.6667, 2.0000, 2.5000) = (0.4000, 0.5000, 0.5999) was obtained. $\tilde{w}$j

weight value for C_3 was reached (0.4000, 0.5000, 0.5999) ⊘ (2.4646, 2.9010, 3.3272) = (0.1502, 0.1723, 0.2434) in the direction of Equation (3).

Table 3: Calculation of Fuzzy Weights

E1	$\tilde{s}1$	$\tilde{k}1$	$\tilde{q}1$	$\tilde{w}1$
C_6		(1.0000, 1.0000, 1.0000)	(1.0000, 1.0000, 1.0000)	(0.3005, 0.3447, 0.4057)
C_3	(0.6667, 1.0000, 1.5000)	(1.6667, 2.0000, 2.5000)	(0.4000, 0.5000, 0.5999)	(0.1502, 0.1723, 0.2434)
C_4	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.3111, 0.4000, 0.4908)	(0.1168, 0.1378, 0.1991)
C_5	(0.2857, 0.3333, 0.4000)	(1.2857, 1.3333, 1.4000)	(0.2222, 0.3000, 0.3817)	(0.0832, 0.1034, 0.1548)
C_7	(0.2857, 0.3333, 0.4000)	(1.2857, 1.3333, 1.4000)	(0.1587, 0.2250, 0.2968)	(0.0595, 0.0775, 0.1204)
C_8	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.1542, 0.1800, 0.2428)	(0.0463, 0.0620, 0.0985)
C_2	(0.4000, 0.5000, 0.6667)	(1.4000, 1.5000, 1.6667)	(0.1234, 0.1200, 0.1734)	(0.0278, 0.0413, 0.0703)
C_1	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.0095, 0.0960, 0.1418)	(0.0216, 0.0330, 0.0575)
		∑	(2.4646, 2.9010, 3.3272)	
E2	$\tilde{s}2$	$\tilde{k}2$	$\tilde{q}2$	$\tilde{w}2$
C_6		(1.0000, 1.0000, 1.0000)	(1.0000, 1.0000, 1.0000)	(0.2699, 0.2991, 0.3404)
C_4	(0.4000, 0.5000, 0.6667)	(1.4000, 1.5000, 1.6667)	(0.5999, 0.6666, 0.7142)	(0.1619, 0.1994, 0.2431)
C_3	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.4658, 0.5332, 0.5842)	(0.1257, 0.1595, 0.1988)
C_5	(0.2857, 0.3333, 0.4000)	(1.2857, 1.3333, 1.4000)	(0.3327, 0.3999, 0.4543)	(0.0898, 0.1196, 0.1546)
C_1	(0.4000, 0.5000, 0.6667)	(1.4000, 1.5000, 1.6667)	(0.1996, 0.2660, 0.3245)	(0.0538, 0.0795, 0.1104)
C_8	(0.2857, 0.3333, 0.4000)	(1.2857, 1.3333, 1.4000)	(0.1425, 0.1995, 0.2523)	(0.0384, 0.0596, 0.0858)
C_7	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.1108, 0.1596, 0.2064)	(0.0299, 0.0477, 0.0702)
C_2	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.0861, 0.1276, 0.1688)	(0.0232, 0.0381, 0.0574)
		∑	(2.9374, 3.3424, 3.7047)	
E3	$\tilde{s}3$	$\tilde{k}3$	$\tilde{q}3$	$\tilde{w}3$
C_4		(1.0000, 1.0000, 1.0000)	(1.0000, 1.0000, 1.0000)	(0.2549, 0.2767, 0.3072)
C_6	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.7777, 0.8000, 0,8181)	(0.1982, 0.2214, 0.2513)
C_5	(0.4000, 0.5000, 0.6667)	(1.4000, 1.5000, 1.6667)	(0.4666, 0.5333, 0.5843)	(0.1189, 0.1476, 0.1795)
C_3	(0.2857, 0.3333, 0.4000)	(1.2857, 1.3333, 1.4000)	(0.3332, 0.3999, 0.4544)	(0.0849, 0.1106, 0.1395)
C_8	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.2591, 0.3199, 0.3717)	(0.0660, 0.0885, 0.1141)
C_7	(0.2857, 0.3333, 0.4000)	(1.2857, 1.3333, 1.4000)	(0.1850, 0.2399, 0.2891)	(0.0471, 0.0664, 0.0888)
C_2	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.1438, 0.1919, 0.2365)	(0.0366, 0.0531, 0.0602)
C_1	(0.4000, 0.5000, 0.6667)	(1.4000, 1.5000, 1.6667)	(0.0862, 0.1279, 0.1689)	(0.0219, 0.0354, 0.0518)
		∑	(3.2551, 3.6128, 3.9230)	
E4	$\tilde{s}4$	$\tilde{k}4$	$\tilde{q}4$	$\tilde{w}4$
C_6		(1.0000, 1.0000, 1.0000)	(1.0000, 1.0000, 1.0000)	(0.2705, 0.2989, 0.3412)
C_5	(0.4000, 0.5000, 0.6667)	(1.4000, 1.5000, 1.6667)	(0.5999, 0.6666, 0.7142)	(0.1622, 0.1993, 0.2437)
C_4	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.4658, 0.5332, 0.5842)	(0.1260, 0.1594, 0.1993)
C_3	(0.2857, 0.3333, 0.4000)	(1.2857, 1.3333, 1.4000)	(0.3327, 0.3999, 0.4543)	(0.0900, 0.1195, 0.1550)
C_1	(0.4000, 0.5000, 0.6667)	(1.4000, 1.5000, 1.6667)	(0.1996, 0.2660, 0.3245)	(0.0539, 0.0795, 0.1107)
C_8	(0.2857, 0.3333, 0.4000)	(1.2857, 1.3333, 1.4000)	(0.1425, 0.1995, 0.2523)	(0.0385, 0.0596, 0.0861)
C_7	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.1108, 0.1596, 0.2064)	(0.0299, 0.0477, 0.0704)
C_2	(0.2857, 0.3333, 0.4000)	(1.2857, 1.3333, 1.4000)	(0.0791, 0.1197, 0.1605)	(0.0213, 0.0142, 0.0756)
		∑	(2.9303, 3.3445, 3.6964)	
E5	$\tilde{s}5$	$\tilde{k}5$	$\tilde{q}5$	$\tilde{w}5$
$C_{4\ EKO}$		(1.0000, 1.0000, 1.0000)	(1.0000, 1.0000, 1.0000)	(0.2442, 0.2624, 0.2869)
$C_{3\ TEK}$	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.7777, 0.8000, 0,8181)	(0.1899, 0.2099, 0.2347)
C_6	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.6048, 0.6400, 0.6693)	(0.1477, 0.1679, 0.1920)
$C_{5\ BİL}$	(0.4000, 0.5000, 0.6667)	(1.4000, 1.5000, 1.6667)	(0.3628, 0.4266, 0.4780)	(0.0886, 0.1119, 0.1371)
$C_{8\ TEŞ}$	(0.2857, 0.3333, 0.4000)	(1.2857, 1.3333, 1.4000)	(0.2591, 0.3199, 0.3717)	(0.0632, 0.0839, 0.1066)
$C_{2\ KOO}$	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.2015, 0.2559, 0.3041)	(0.0492, 0.0671, 0.0872)
$C_{1\ KÜL}$	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.1567, 0.2047, 0.2488)	(0.0382, 0.0537, 0.0714)
$C_{7\ POL}$	(0.2222, 0.2500, 0.2857)	(1.2222, 1.2500, 1.2857)	(0.1218, 0.1637, 0.2035)	(0.0297, 0.0429, 0.0584)
		∑	(3.4844, 3.8108, 4.0935)	

Step 6: The criteria weights determined as a result of the decision makers' evaluation of the relevant criteria were calculated in Step 5, and then $\tilde{w}_{av}$ (mean of $\sum\tilde{w}j$) was calculated to reach a single weight value (Table 4). This value shows the total fuzzy weights of the criteria. The BNP was obtained by using Equation (4) so that the final weight values of all criteria in the study were not blurred.

Table 4: Final Weight Values of Criteria

	$\tilde{w}_1$	$\tilde{w}_2$	$\tilde{w}_3$	$\tilde{w}_4$	$\tilde{w}_5$	$\tilde{w}_{av}$	BNP	R
C_1	(0.0216, 0.0330,0.0575)	(0.0538, 0.0795,0.1104)	(0.0219, 0.0354,0.0518)	(0.0539, 0.0795,0.1107)	(0.0382, 0.0537,0.0714)	(0.0378, 0.0562,0.0803)	0.058	7
C_2	(0.0278, 0.0413,0.0703)	(0.0232, 0.0381,0.0574)	(0.0366, 0.0531,0.0602)	(0.0213, 0.0142,0.0756)	(0.0492, 0.0671,0.0872)	(0.0316, 0.0427,0.0701)	0.048	8
C_3	(0.1502, 0.1723,0.2434)	(0.1257, 0.1595,0.1988)	(0.0849, 0.1106,0.1395)	(0.0900, 0.1195,0.1550)	(0.1899, 0.2099,0.2347)	(0.1281, 0.1543,0.1942)	0.158	3
C_4	(0.1168, 0.1378,0.1991)	(0.1619, 0.1994,0.2431)	(0.2549, 0.2767,0.3072)	(0.1260, 0.1594,0.1993)	(0.2442, 0.2624,0.2869)	(0.1807, 0.2071,0.2938)	0.227	2
C_5	(0.0832, 0.1034,0.1548)	(0.0898, 0.1196,0.1546)	(0.1189, 0.1476,0.1795)	(0.1622, 0.1993,0.2437)	(0.0886, 0.1119,0.1371)	(0.1085, 0.1362,0.1739)	0.139	4
C_6	(0.3005, 0.3447,0.4057)	(0.2699, 0.2991,0.3404)	(0.1982, 0.2214,0.2513)	(0.2705, 0.2989,0.3412)	(0.1477, 0.1679,0.1920)	(0.2373, 0.2664,0.2995)	0.267	1
C_7	(0.0595, 0.0775,0.1204)	(0.0299, 0.0477,0.0702)	(0.0471, 0.0664,0.0888)	(0.0299, 0.0477,0.0704)	(0.0297, 0.0429,0.0584)	(0.0392, 0.0564,0.0975)	0.064	6
C_8	(0.0463, 0.0620,0.0985)	(0.0384, 0.0596,0.0858)	(0.0660, 0.0885,0.1141)	(0.0385, 0.0596,0.0861)	(0.0632, 0.0839,0.1066)	(0.0504, 0.0707,0.1175)	0.079	5

The best non-fuzzy values (BNP) shown in Table 4 show the degree of importance of the relevant criteria to meet the purpose of the study. When paying attention; the sum of the non-fuzzy weight values of all criteria is equal to 1.

When the findings of the study are examined, the weight of the lack of flexibility and coordination between departments criterion had the lowest value with 0.048 (4.8%), while the weight of the uncertainties in the demand and accordingly the return had the highest value with 0.267 (26.7%). When the situation is examined in terms of other criteria, the financial resources availability of the businesses were 0.227 (22.7%), the situation of technology availability was 0.158 (15.8%), technical knowledge/expertise was 0.139 (13.9%), financial incentives was 0.079 (7.9%). Finally, company culture was among the other criteria with low scores with a weight value of 0.058 (5.8%) and the government's supportive and protective policies 0.064 (6.4%).

Conclusion and Discussion

The aim of this study is to determine the situations that restrict the circular economy initiatives of small or medium-sized textile businesses and to prioritize these criteria according to their

importance. In the study, textile businesses from a single sector took place due to the change in the development speed of SMEs in different sectors, their adaptation to technology and their approach to innovation. One-on-one interviews were conducted with five experts in order to reveal the obstacles to the adoption of the circular economy by different businesses. For this reason, the subjective evaluations of experts were very important for the study. Due to the subjective evaluation of the criteria by the experts, the fuzzy approach was preferred and SWARA was used as the method. In the study, it is thought that it will be important to work on taking steps towards the process by determining the general needs as a result of prioritizing the barriers to transition to the circular economy in the relevant sector.

As a result of the study, *uncertainty in the the demand* and *return* accordingly, which is seen as market barriers, were determined as the criteria that most limit the businesses' initiatives towards the circular economy. Actually the uncertainty here had a weight value of 26.7% among all criteria. Businesses' concerns about demand are particularly affected by customers' perceptions of quality. One of the biggest obstacles in the transition to the circular economy was the need for financial resources with a weight value of 22.7%,. The fact that attempts to new processes often require high costs has been seen as a deterrent for managers.

While businesses see the economic competence they need to have in circular economy initiatives as a major obstacle, they didn't see the limited financial incentives to be provided by the government through various channels as such a major obstacle. While this situation can be interpreted as a facilitator in the circular economy, incentives cannot be seen as a major obstacle if they are not. On the other hand, the third important criterion was determined as having limited technology with a weight value of 15.8%. This result was probably influenced by the re-design of the products to use the circular economy, the selection of appropriate materials and production procedures. For this reason, it can be stated that experts see technological limitation as an obstacle.

It is seen that the first three criteria constitute a major obstacle with 65.8% weight ratio among all criteria of small or medium-sized businesses operating in the textile sector. In other words, businesses are worried about implementing the circular economy due to the uncertainties in demand and returns, the need for economic resources and the great need for technology. In particular, the development of appropriate action plans and projects by focusing on these three issues can contribute to creating many economic and environmental opportunities in the long run.

On the other hand, the lack of flexibility and coordination among the departments emerged as the least important criteria with a weight ratio of 4.8% and company culture with a weight ratio of 5.8%. In other words, cooperation between departments in the circular economy implementation of small or medium-sized businesses, and secondly the general culture structure of the company were the last issues they were concerned about. Businesses were not too concerned about the cooperation and co-organization required in the supply chain in the implementation of the circular economy. At the same time, experts thought that they would not be faced with an indecisive and resistant attitude on the part of the management towards the new circular economic model.

It may be important to point out a few considerations for researchers planning to conduct research on similar topics. The current study can be repeated by using the criteria determined for researchers who want to conduct similar studies in different sectors. In addition, although the most emphasized basic criteria in the literature are included in this study, it may be possible to add new variables for situations in different sectors. This study was conducted for small or medium-sized enterprises, but another study is applicable to large enterprises that have difficulties in implementing the circular economy. Under such a situation, it is estimated that the results of the study may change.

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