Analysis of barriers to circularity for agricultural cooperatives in the digitalization era

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Abstract

Purpose – This study aims to propose a novel framework for barriers to circularity within cooperative supply chains. The barriers in the adoption and implementation of circular economy principles are examined within a framework.

Design/methodology/approach – Fuzzy best-worst method is used to calculate the weights of barriers and identify the prioritization of barriers to circularity within cooperative supply chain.

Findings – "Insufficient implementation of circular economy laws" was found as the most important barrier, followed by "Lack of information", "Ineffective recycling policies", "Lack of awareness for circular economy", "Remanufacturing is a labor-intensive procedure", "Inconsistent price policies in sources and products", "Lack of environmental management system", "Cost of implementation for green activities" and "Lack of R&D capability" barriers, respectively.

Research limitations/implications – The number of participant professionals limits the conclusions of the study and reaching more general conclusions. A comprehensive research can be conducted by the participation of a greater number of professionals.

Originality/value – Several studies analyzed the barriers to circularity; however, to the best of the authors' knowledge, no study has been taken an approach for barriers to circularity for cooperatives or cooperative supply chains.

Keywords Cooperatives, Circular economy, Barriers, Fuzzy best-worst method

Paper type Research paper

1. Introduction

Cooperatives and unions are frequently seen business models across the globe (Candemir *et al.*, 2011). Their existence is an outcome of an interest that governmental bodies are looking for cooperative practices in order to establish a union focused on solidarity and cooperation. In this context, one of the most important and popular type of cooperatives is agricultural cooperatives.

The cooperatives were defined as the associations organized to work for mutual benefits to satisfy joint cultural, social and economic needs democratically (International Cooperatives Alliance, nd). Cooperatives are set up through cooperation within its members for common objectives. In other words, the members of a cooperative come together within a specific goal to unify their forces for a better outcome. This goal can include various sectors; one of them that comes into prominence is agricultural cooperatives (Wanyama, 2014). The cooperatives are important associations to serve and distribute the agricultural products.

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One of the key issues that prevent achieving sustainability is environmental problems, and their root is not only ecological but also social and economic-based, which are caused by humans' activities (Folke *et al.*, 2007). Cooperatives in that regard are assumed to contribute to sustainability by improving of social and economic conditions and thus help to protect the environment (Mojo *et al.*, 2015). Agricultural cooperatives contribute to creating a better environment socially by protecting its members from unfair bargaining, economically by preventing unfair pricings for both the producer and the customer and environmentally by sustainable and circular economy-based practices.

However, nowadays, changing economic and social conditions at global and local level stemmed big problems for food supply chains and humanity. Scarcity of resources, climate change, environmental problems, poverty, public health and social problems enforced governments, business world, universities and nongovernmental organizations to focus on possible solutions for the well-being of society. In this respect, the most promising recent development is the sustainability theory and circular economy model.

When both the cooperatives and unions, and the circular economy principles are taken into account, it is clearly seen that these concepts actually serve the principles of sustainable production. However, the organizations and associations face some challenges and problems while transition from linear to circular economy. There are several different barriers anticipated during this transition process. Some of these barriers were identified as operational, economic, financial, technological, institutional, governmental and social barriers (Kok *et al.*, 2013; Govindan and Hasanagic, 2018; Kazancoglu *et al.*, 2021; Kumar *et al.*, 2021).

Accordingly, in an attempt to comprehend the barriers to circular economy for agricultural cooperatives, it is important to establish a systematic framework. Furthermore, there is a need for a measurement system in order to identify a proper roadmap to handle sustainable cooperative supply chain management. Within this perspective, the research questions of the study were established as:

RQ1. How can a framework and a guideline be developed for barriers to circular economy for agricultural cooperatives?

RQ2. What are the barriers to circularity and their priorities within cooperative supply chain?

RQ3. Which solution techniques can be used to prioritize the barriers?

To respond these research questions, this study aims to propose a novel framework for barriers to circularity within cooperative supply chains. Within this framework, 12 main barriers and 51 sub-barriers were determined. A total of 12 main barriers were classified as internal and external barriers, respectively. Internal barriers include organizational, financial, operations and logistics, marketing, public relations and research and development barriers. External barriers cover governmental, legal, societal, market conditions, environmental and technological barriers. Fuzzy best-worst method is used to calculate the weights of respective barriers and identify the prioritization of barriers to circularity within cooperative supply chain. Several studies analyzed the barriers to circularity; however, to the best of the authors' knowledge, no study has been taken an approach for barriers to circularity for cooperatives or cooperative supply chains. Therefore, the main contribution of this study can be stated as developing a novel framework for barriers to circularity for agricultural cooperatives and prioritizing these barriers.

Following the introduction, Section 2 highlights the background for theoretical perspectives. Section 3 describes the proposed framework and Section 4 maps out the methodology. Section 5 discusses the case study and the results. Section 6 proposes the implications and discussions and finally, Section 7 highlights the concluding parts and possible future research directions.

2. Theoretical background

2.1 Cooperatives

Cooperatives and unions are business models that can be seen quite frequently all over the world (Candemir *et al.*, 2011). Definitions and classifications made on these concepts can be diversified. Even though the cooperatives that are known today was formed not so long ago, the idea behind cooperatives was existing even in ancient times in order to survive and create a force that is based on the saying "the more the merrier" (Zeuli and Cropp, 2004). Cooperatives are so well-integrated into everyday life that it is inevitable to hear something about the cooperatives and their activities, whether it is true or not. Their existence is also is an outcome of the support that governments and municipalities around the world show towards the activities of cooperatives in order to create a union based on solidarity and cooperation. There are various types of cooperatives according to their primary sector of doing business. One of the biggest and most seen cooperative type is "Agricultural Cooperatives". Having the power and an integrated workforce has had a crucial place in agriculture, this can be seen throughout history due to the economy being based on lands and farming before industrialization. By working in synch with an organized plan and duties, the work can be done more efficiently and effectively and by holding the economic power and workforce in hand, people within this union, which refers to the cooperatives now, can control the market and prices (Cook, 1995; Sexton, 1990; Staatz, 1987). As seen from different sides of daily life, people who got the power through economical advantage or influenced population that share the same objectives and goals as them can lead the sector/market to the direction they want. Furthermore, with the capital and adamant workforce, more work can be done in less time, and the work that would not be possible to finish due to its cost or lack of labor force with only one or a small group of people can be done easily and cost-efficiently.

The definition of cooperatives was identified as associations found by persons come together voluntarily to work towards their joint cultural, social and economic needs in a democratic manner (International Cooperatives Alliance, nd). In this regard, by this definition itself, it is evident that cooperatives trigger cooperation within its members while focusing on common goals. As the United Nations report (2009) clearly advocates the idea that cooperatives are meant to be self-governing and leaded democratically in order to focus on goals including environmental, social and economic related ones. Furthermore, they support and lead towards social integration and cooperation among its members. Cooperatives, together with unions, have been regarded as important organizations for providing services and for the distribution of agricultural and food products. They mostly establish strategic technical and organizational steps that bring advantage to the economy, to the production management and to the creating awareness in consumption. Both cooperatives and unions have a crucial impact on the business world. Nowadays, with constantly changing environment, the rates of unemployment are increasing and employed workers are feeling unsatisfied and under-represented in their jobs when they are alone. Cooperatives and unions provide a feeling of trust by being a viable and strong formation that workers can rely on to reach their goals. At the same time, cooperatives and unions protect their members on matters such as wages, tax payments and labor provisions. As the goal and the working structure of a cooperative or Union is analyzed, it can be seen that they are directly related with sustainability and circular economy.

2.2 Circular economy in food supply chain

The relationship between industry and environment must be well-understood in order to successfully implement the business models adopted in the circular economy principle (Geissdoerfer *et al.*, 2018; Henry *et al.*, 2020). This balance is crucial to industrial work performance. Therefore, in some cases, it is likely to see the pressure of environmental factors

on industrial enterprises. On the other hand, the supply and demand balance started to become difficult to maintain day by day, especially in the food-agriculture sector. Although the sector tries to keep performance management in production, every move that harms the sustainability cycle, such as the waste-weighted attitude of the consumer and the increase in waste, creates steps that are difficult to compensate in the industry. For this reason, the understanding of sustainability in both production and consumption sides should become well-established (Ngan *et al.*, 2019; Ang *et al.*, 2021). Otherwise, disposable consumption in the society will become more dominant and in this case, the hopelessness that may occur in the sector will bring the need for circular economic solution strategies again. Hence, the trend towards the use of additional resources will begin and the economies of these countries will face difficulties. As a result, due to the new consumer societies and the rapid growth in industrial activities, there will be a need to control some issues such as emissions, solid waste production and landfills. Also, the amount of natural resources consumed has increased due to the increase in world population and the growth of small and medium-sized enterprises (Wunderlich and Martinez, 2018). Due to the limited resources in the world, it becomes increasingly difficult to meet the needs arising from exponential growth in economic growth.

The need for new economic models has started to increase as a result of sharp fluctuations in the global economy and the depletion of resources (Kilian and Zhou, 2018). Currently, the studies have been focused on the new tools and methods to improve the overall resource performance of the economy (Franklin-Johnson *et al.*, 2016). In addition, businesses have begun to explore ways to reuse and recycle products, waste or components of these materials, even creating new opportunities in terms of energy and labor. While major steps have been taken in terms of an economic model to increase resource efficiency and discover new energy sources, unfortunately less thought has been given to systematizing issues such as raw material shortage, waste management and waste disposal (Fellner *et al.*, 2017; Malinauskaite *et al.*, 2017). Instead of using limited resources economically or reusing some resources, a system based solely on consumption can cause significant losses and negative interactions along the product value chain.

In this sense, conditions make it necessary to use circular economy principles day by day (Niero and Rivera, 2018; Yadav *et al.*, 2020). Circular economy is an industrial approach that moves towards design within a certain purpose by using different scientific interaction methods (Korhonen *et al.*, 2018). Thanks to the circular economy principle, the approach to termination of the product or service is changed; instead, the production is reperformed with the use of renewable resources. Therefore, it is possible to control the use of inefficient by-products and to prevent the use of harmful chemicals. Hence, the circular economy concept has become popular, and the number of scientists studying about circular economy is increasing day by day (Gazzola *et al.*, 2020). Although the scientific literature on circular economy generally develops on managerial and organizational theories, recently this concept has started to be studied by associating it with different fields including technology management, operations management and strategic management. Most of the studies have focused on introducing the concept of circular economy and taxonomy within the concept to companies in the dynamics of creating value in circular economy models and capturing the innovations of the era (Winans *et al.*, 2017). For this reason, the circular economy also reminds the radical changes that have been made or should be made in business models in terms of new value proposals and gaining competitive advantage.

It is not only the problem of environmental pollution that should be in the first place on the agenda but also the problem of global resource scarcity (Dawson *et al.*, 2017). In addition to the daily routine of the industry, it needs a good motivational tool such as a circular economy to overcome the pressure of environmental regulations, fluctuations in resource prices and risks in supply. In the light of some difficulties on the agenda of the sector and the limitations underlying the linear economy model, the new circular model applications can be considered

as an effective solution that can turn both economic growth and environmental protection targets into a form that is beneficial for the producers and consumers. There are several opportunities to examine the place and applications of the circular economy in the industry.

In terms of meeting the basic life needs of people, the agriculture-food sector has an important place among different branches of industry in the transformation of materials from raw materials to products (Anderson, 2019; Jones and Ejeta, 2016). Activities in the field of agriculture and food create the opportunity to touch both the producer and the consumer on the journey from field to fork. For this reason, it is a strategic area where circular economy principles can be applied in different business models.

Circular economy in the agricultural sector is an approach that does not have a direct impact on the environment, but ensures a reduction in the use of natural resources and waste production, and effectively reduces the waste to be processed and designs their use in systems as valuable by-products (Ferronato *et al.*, 2019; Tóth Szita, 2017). For this reason, in the transition to a circular economy, studies are carried out to collect data, to share data, to produce pilot samples and to share these products at an appropriate level, to develop and produce new samples to a certain extent, to invest in innovation and to accelerate cooperation (De Jesus *et al.*, 2018). Some of these are made to include all departments in the business beyond the company level (De Mattos and De Albuquerque, 2018).

Circular production in agricultural production ranges from feed or fertilizer raw materials, food components, the quality of irrigation and drinking water to the evaluation of biofuels and wastes obtained at the end of production (Rajput and Singh, 2020). Failure to occur in any of these factors will result in loss of efficiency or damage in other factors. In this context, vegetable and animal production, food processing and retail sector will be able to be analyzed comprehensively in order to use resources sparingly and consciously under the supervision of the circular economy concept and to evaluate by-and-waste products thanks to new sustainable value chains. Similar to the activities in the agricultural sector, the circular economy perception in the food sector also means reducing waste amount, reusing food, using by-products, ensuring nutrient recycling and making changes towards diverse and efficient food models in diet planning (Pagotto and Halog, 2016; Pashova *et al.*, 2018). However, the concept of protection from food waste and excess, which is one of the most prominent controlling factors, also requires a responsibility in the competence and awareness of consumers in both production and consumption processes. For this reason, especially the food raw material cycle can be made cyclical on the principle of reuse of food and utilization of food waste. In this context, keeping food waste at the lowest possible level will reshape the consumption perception in the economy and lead the radical changes in the transition from the linear economy to the circular model. At this point, some responsibilities should be assigned to both consumers and producers. Consumers can be made aware of the use of agro-food products in the light of certain guidelines. It is also possible to monitor and control the situation. However, in the service provider, the roles are distributed among different stakeholders.

Since the beginning of the industrial revolution in the industry, mass production of products has been started using new methods (Komarova *et al.*, 2019). In this way, products have begun to be produced in a more affordable and more efficient way. This approach has provided significant opportunities for businesses to switch from a linear economy with a "buy-make-use-dispose" logic to a circular economy (Millar *et al.*, 2019). However, the provision of the service by large-scale industrial establishments does not always become advantageous due to reasons such as raw material type, raw material amount, consumer preferences, geographical conditions, capital and production capacity. At this point, within the concept of circular economy, agricultural cooperatives and unions have been adopted as accelerator structures that capture the synergy between producer and consumer (Yanbykh *et al.*, 2019; Sakovska, 2020; Sultana *et al.*, 2020).

When both the cooperatives and unions and the circular economy principles are taken into account, it is clearly seen that these concepts actually serve the principles of sustainable production. Considering that sustainable lifestyle should be prioritized, it is inevitable to experience many activities to be done in the field of resource and production management in the field of agricultural production.

3. Proposed framework

In this section, a novel framework is developed to show the research flow for barriers to circular economy for cooperative supply chain. The barrier list includes 12 main barriers and 51 sub-barriers. Twelve main barriers include organizational, financial, operations and logistics, marketing, public relations, research and development, governmental, legal, societal, market conditions, environmental and technological barriers. Organizational, financial, operations and logistics, marketing, public relations, research and development barriers were classified as internal barriers, whereas governmental, legal, societal, market conditions, environmental and technological barriers were categorized as external barriers.

Based on an extensive literature review, 12 main and 51 sub-barriers were validated with three professors in universities from operations management, food engineering and information management departments. One of academic experts has experience of more than 25 years, and two have more than 10 years. The barrier list was discussed with these academics using interviews. After the validation stage, these barriers were used to determine barriers to circular economy for cooperative supply chain. Fuzzy best-worst method was used to find the respective main and sub-barrier weights. The reason of hiring fuzzy logic is its capability to deal with the uncertainties and vagueness inherent in decision-making process. The reason to use fuzzy best-worst method is that it needs fewer comparisons than in analytic hierarchy process or analytic network process because it is a vector-based method. Since there are fewer comparisons, the solution can be obtained in less time with less complexity. Figure 1 shows the overall flow of the present research work.

Table 1 sows the barrier list to circular economy for agricultural cooperative supply chain.

In the next section, fuzzy best-worst method was discussed.

4. Methodology

Multi-criteria decision-making (MCDM) methods are popular while dealing with decision-making problems. MCDM techniques are used to weigh the selection criteria, or select the best option among various alternatives.

AHP and ANP are commonly used methods for weighting mechanism. Also, there is a comparatively newer method called best-worst method (BWM), which was introduced by Rezaei (2015). BWM needs fewer comparisons than in AHP or ANP because it is a vector-based method. Since there are fewer comparisons, the solution can be obtained in less time with less complexity. Moreover, the BWM method includes a mathematical model; therefore, it is more reliable compared to other methods. It is used to identify the criteria weights by comparing the most important criterion with others, and the other criteria with the least important criterion. In this study, BWM is used to find the criteria weights. It is integrated with fuzzy set theory (Zadeh, 1965) in order to minimize the subjectivity and vagueness in decision-making process.

Next sub-section summarizes the properties of fuzzy BWM method.

4.1 Fuzzy best-worst method

BWM has five steps to perform for weighting the decision criteria.

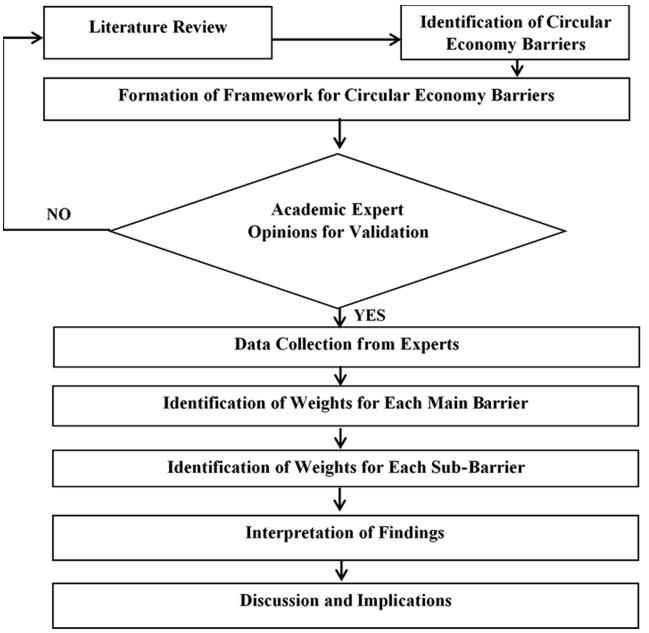

Figure 1.
The proposed framework

Step 1: Define a decision criterion set, which is $\{c_1, c_2, \ldots, c_n\}$.

Step 2: Define the criteria that have the highest and the lowest importance and create a set for each one. Criteria with the highest importance and the lowest importance can be represented as c_B and c_W, respectively.

Step 3: Compare the most important criterion with each one. The linguistic judgments of decision-makers should be converted to fuzzy numbers. Best-to-others vector is determined through the comparison of most important criterion with others. Best-to-others vector can be expressed as $\tilde{A}_B = (\tilde{a}_{B1}, \tilde{a}_{B2}, \ldots, \tilde{a}_{Bn})$. Since $\tilde{A}_B$ is a fuzzy vector, $\tilde{a}_{Bj}$ represents the fuzzy force of the most important criterion over criterion j. For example, $\tilde{a}_{BB} = (1, 1, 1)$.

Step 4: Compare each criterion with the least important criterion. Similarly, the linguistic judgments of decision-makers should be converted to fuzzy numbers. Others-to-worst vector is determined through the comparsion of each criterion with the least important one. Others-to-worst vector can be expressed as $\tilde{A}_W = (\tilde{a}_{1W}, \tilde{a}_{2W}, \ldots, \tilde{a}_{nW})^T$. Since $\tilde{A}_W$ is a fuzzy vector, $\tilde{a}_{iW}$ represents the fuzzy force of criterion j over the least important criterion. For example, $\tilde{a}_{WW} = (1, 1, 1)$.

Step 5: Calculate the optimal fuzzy weights $(\widetilde{w_1^*}, \widetilde{w_2^*}, \ldots, \widetilde{w_n^*})$. The criteria's optimal fuzzy weights are $\tilde{w}_B/\tilde{w}_j = \tilde{a}_{Bj}$ and $\tilde{w}_j/\tilde{w}_W = \tilde{a}_{jW}$ for each pair. These should determine the maximum absolute differences $|\frac{\tilde{w}_B}{\tilde{w}_j} - \tilde{a}_{Bj}|$ and $|\frac{\tilde{w}_j}{\tilde{w}_W} - \tilde{a}_{jW}|$ for all j. All j values should be formulated as a minimization model. $\tilde{w}_B$, $\tilde{w}_W$ and $\tilde{w}_j$ are fuzzy triangular numbers. All variables should be 0, or greater than 0. Sum of the weights should be exactly 1. Following mathematical model was developed by using these constraints.

Barriers	Reference
Organizational	
Unclear vision in terms of CE	Pan *et al.* (2015), Govindan and Hasanagic (2018)
Lack of appropriate implementation of new business models	Kok *et al.* (2013), Masi *et al.* (2018)
Lack of skilled human resource in implementation of circular economy and supply chain management including knowledge, skill and professional advice	Luthra *et al.* (2011), Balasubramanian (2012), Dube and Gawande (2014), Jayant and Azhar (2014), Dhull and Narwal (2016), Govindan and Hasanagic (2018), Jia *et al.* (2018)
Inappropriate organization structure for CE implementation	Jayant and Azhar (2014), Delmonico *et al.* (2018), Dhull and Narwal (2016), Govindan and Hasanagic (2018)
Lack of energy management and waste management within the organization	Dube and Gawande (2014)
Lack of standardized metric and measurement method for a CE	Su *et al.* (2013), Govindan and Hasanagic (2018)
Lack of training	Carter and Rogers (2008), Balasubramanian (2012), Dhull and Narwal (2016), Wang *et al.* (2016), Kaur *et al.* (2018)
Lack of practical knowledge sharing regarding CE and SC applications among managers and employees within the enterprise	Rizos *et al.* (2016)
Poor commitment, management and leadership for CE	Ravi and Shankar (2005), Mudgal *et al.* (2010), Luthra *et al.* (2011), Balasubramanian (2012), Mathiyazhagan *et al.* (2013), Su *et al.* (2013), Zhu and Geng (2013), Dube and Gawande (2014), Jayant and Azhar (2014), Dhull and Narwal (2016), Luthra *et al.* (2016), Delmonico *et al.* (2018), Govindan and Hasanagic (2018), Kaur *et al.* (2018)
Financial	
High investment costs	Ravi and Shankar (2005), Walker *et al.* (2008), Luthra *et al.* (2011), Balasubramanian (2012), Kok *et al.* (2013), Dhull and Narwal (2016), Masi *et al.* (2018)
Disposal costs for hazardous products or wastes	Mathiyazhagan *et al.* (2013), Jayant and Azhar (2014)
Conversion cost of renewable energy	Kaur *et al.* (2018)
Cost of implementation for green activities	Jia *et al.* (2018)
Production costs are getting higher	Govindan and Hasanagic (2018)
Operations and logistics	
Lack of management initiatives for transport and logistics	Dube and Gawande (2014)
Challenges for biosphere safe return	Ghisellini *et al.* (2016), Govindan and Hasanagic (2018)
Difficulty of managing product quality	Ghisellini *et al.* (2016), Singh and Ordoñez (2016), Govindan and Hasanagic (2018)
Producing high quality products through recovering	Ghisellini *et al.* (2016), Singh and Ordoñez (2016), Govindan and Hasanagic (2018)
Remanufacturing is a labor-intensive procedure	Govindan and Hasanagic (2018)
Certification	
Lack of information	Ravi and Shankar (2005), Balasubramanian (2012), Mathiyazhagan *et al.* (2013), Dube and Gawande (2014), Jayant and Azhar (2014), Dhull and Narwal (2016)
Marketing	
Consumer perception towards CE	Genovese *et al.* (2017)

Table 1.
The barrier list

(*continued*)

Barriers	Reference
Inconsistency in consumer intentions to purchase the products	van Weelden *et al.* (2016), Govindan and Hasanagic (2018)
Consumers knowledge and awareness about CE	van Weelden *et al.* (2016), Govindan and Hasanagic (2018)
Customer pressure	Mudgal *et al.* (2010), Mathiyazhagan *et al.* (2013), Kaur *et al.* (2018)
Public relations	
Lack of awareness for circular economy	Ravi and Shankar (2005), Geng and Doberstein (2008), Walker *et al.* (2008), Luthra *et al.* (2011), Balasubramanian (2012), Mathiyazhagan *et al.* (2013), Su *et al.* (2013), Dube and Gawande (2014), Jayant and Azhar (2014), Dhull and Narwal (2016), Lieder and Rashid (2016), Wang *et al.* (2016), van Weelden *et al.* (2016), Govindan and Hasanagic (2018), Jia *et al.* (2018), Kaur *et al.* (2018)
Lack of confidentiality and trust to the company or to the products	Kok *et al.* (2013), Masi *et al.* (2018)
Research and development	
Lack of R&D capability	Zhu and Geng (2013)
Problems in the application of technological knowledge on product or concept basis	Zhu and Geng (2013)
Lack of technological infrastructure	Ravi and Shankar (2005), Luthra *et al.* (2011), Balasubramanian (2012), Jayant and Azhar (2014), Dhull and Narwal (2016)
Governmental	
Financial governmental incentives support the linear economy	Kok *et al.* (2013), Dhull and Narwal (2016), Masi *et al.* (2018), Kazancoglu *et al.* (2021)
Lack of government support towards environmental policies	Mudgal *et al.* (2010), Luthra *et al.* (2011), Balasubramanian (2012), Jayant and Azhar (2014), Dhull and Narwal (2016), Luthra *et al.* (2016), Kaur *et al.* (2018), Kazancoglu *et al.* (2021)
Lack of government support towards public procurement	Dube and Gawande (2014), Jayant and Azhar (2014), Luthra *et al.* (2016), Wang *et al.* (2016), Delmonico *et al.* (2018), Kazancoglu *et al.* (2021)
Governance issues concerning responsibilities, liabilities and ownership	Mathiyazhagan *et al.* (2013), Kaur *et al.* (2018), Kazancoglu *et al.* (2021)
Inconsistent price policies in sources and products	Kazancoglu *et al.* (2021)
Ineffective recycling policies	Kok *et al.* (2013), Govindan and Hasanagic (2018), Masi *et al.* (2018), Kazancoglu *et al.* (2021)
Legal	
Lack of effective legislation	Mathiyazhagan *et al.* (2013), Kaur *et al.* (2018), Kazancoglu *et al.* (2021)
Insufficient implementation of circular economy laws	Su *et al.* (2013), Govindan and Hasanagic (2018), Kazancoglu *et al.* (2021)
Inconsistency of existing laws with CE	Govindan and Hasanagic (2018), Kazancoglu *et al.* (2021)
Societal	
GDP is an insufficient indicator to show the progress of society	Kok *et al.* (2013), Masi *et al.* (2018)

(*continued*)

Table 1.

Barriers	Reference
Lack of perception about urgency of CE	Kok *et al.* (2013), Masi *et al.* (2018)
Market conditions	
Limited availability of reuse products	van Weelden *et al.* (2016), Govindan and Hasanagic (2018)
Pollution/Wastage in industries	Jayant and Azhar (2014)
Environmental	
Lack of abilities for energy saving	Zhu and Geng (2013)
Lack of efforts for R activities	Jayant and Azhar (2014)
Lack of environmental management system	
Technological	
Resistance to advance technology adoption	
Lack of technology use	Mathiyazhagan *et al.* (2013), Wang *et al.* (2016)
Technological limitations	Su *et al.* (2013), Genovese *et al.* (2017)
Lack of efficient information system	Kok *et al.* (2013), Dhull and Narwal (2016), Masi *et al.* (2018)
Lack of IT application	

Table 1.

$$\text{Minimize } \max\{|\tfrac{\tilde{w}_B}{\tilde{w}_j} - \tilde{a}_{Bj}|,\ |\tfrac{\tilde{w}_j}{w_W} - \tilde{a}_{jW}|\}$$

$$\text{s.t.} \begin{cases} \sum_{j=1}^{n} R(\tilde{w}_j) = 1 \\ l_j^w \le m_j^w \le u_j^w \\ l_j^w \ge 0 \\ j = 1, 2, \ldots, n \end{cases}$$

$\tilde{w}_B = (l_B^w, m_B^w, u_B^w)$, $\tilde{w}_W = (l_W^w, m_W^w, u_W^w)$, $\tilde{w}_j = (l_j^w, m_j^w, u_j^w)$,

Suppose that this model can be modified as the following constrained mathematical model;

Minimize $\tilde{\xi}$

$$\text{s.t.} \begin{cases} \sum_{j=1}^{n} R(\tilde{w}_j) = 1 \\ l_j^w \le m_j^w \le u_j^w \\ \left|\frac{\tilde{w}_B}{\tilde{w}_j} - \tilde{a}_{Bj}\right| \le \tilde{\xi} \\ \left|\frac{\tilde{w}_j}{w_W} - \tilde{a}_{jW}\right| \le \tilde{\xi} \\ l_j^w \ge 0 \\ j = 1, 2, \ldots, n \end{cases}$$

$$\tilde{\xi} = (l^{\xi}, m^{\xi}, u^{\xi}).$$

It can be supposed that $\tilde{\xi}^* = (k^*, k^*, k^*)$ and $k^* \le l^\xi$ when $l^\xi \le m^\xi \le u^\xi$. Then, the mathematical model can be transformed into;

Minimize $\tilde{\xi}$

$$\text{s.t.} \begin{cases} \sum_{j=1}^{n} R(\tilde{w}_j) = 1 \\ l_j^w \le m_j^w \le u_j^w \\ \left| \dfrac{l_B^w, m_B^w, u_B^w}{\left(l_j^w, m_j^w, u_j^w\right)} - (l_{Bj}, m_{Bj}, u_{Bj}) \right| \le (k^*, k^*, k^*) \\ \left| \dfrac{\left(l_j^w, m_j^w, u_j^w\right)}{\left(l_W^w, m_W^w, u_W^w\right)} - (l_{jW}, m_{jW}, u_{jW}) \right| \le (k^*, k^*, k^*) \\ l_j^w \ge 0 \\ j = 1, 2, \ldots, n \end{cases}$$

By solving the mathematical model, optimal fuzzy weights $(w_1^*, w_2^*, \ldots, w_n^*)$ can be obtained.

5. Case study

This study considers the implementation, which is conducted in agricultural cooperatives located in Izmir, Turkey. The main aim is to identify the barriers to circular economy for agricultural cooperatives.

Data were gathered through pairwise comparisons. These comparisons are conducted with the permission and approval of the board of directors. Fifteen authorities carried out pairwise comparisons. Table 2 presented information about participants in detail.

The proposed framework is generic and applicable to similar studies where barriers to circular economy for agricultural cooperatives are studied; however, the results are unique and shall not be generalized.

Table 3 shows the best and worst criteria for each main criterion.

Within organizational barriers cluster, "Unclear vision in terms of CE" and "Poor commitment, management and leadership for CE" barriers were found as the most important barriers with weights of 0.315 and 0.192, respectively. This means more than 50% of organizational challenges are caused by these two barriers.

Within financial barriers cluster, "Cost of implementation for green activities" and "Production costs are getting higher" barriers were found as the most important barriers with weights of 0.416 and 0.237, respectively. This results show that more than 65% of financial challenges are triggered by these two barriers.

Within operations and logistics barriers cluster, "Lack of information" and "Remanufacturing is a labor-intensive procedure" were found as the most important barriers with weights of 0.353 and 0.209, respectively, which means these two barriers consist of nearly 56% of operations and logistics challenges.

Within marketing barriers cluster, "Consumers knowledge and awareness about CE" and "Consumer perception towards CE" were found as the most important barriers with weights of 0.466 and 0.259, respectively. Analysis of this result demonstrated that nearly 73% of challenges of marketing issues are caused by these two barriers.

Experts	Position	Total work experience in years	Experts	Position	Work experiences (Year)
1	Cooperative manager	5–10	9	Cooperative manager	15–20
2	Cooperative manager	10–15	10	Cooperative employee	5–10
3	Cooperative vice manager	5	11	Cooperative manager	10–15
4	Cooperative vice manager	5–10	12	Cooperative vice manager	5–10
5	Cooperative vice manager	5	13	Cooperative employee	5–10
6	Cooperative employee	10–15	14	Cooperative employee	10–15
7	Cooperative employee	0–5	15	Cooperative employee	0–5
8	Cooperative vice manager	5–10			

Table 2.
Information about participants

Main criteria	Best criteria	Worst criteria
Organizational	Unclear vision in terms of CE	Lack of an standardized metric and measurement method for a CE
Financial	Cost of implementation for green activities	Conversion cost of renewable energy
Operations and logistics	Lack of information	Challenges for biosphere safe return
Marketing	Consumers knowledge and awareness about CE	Customer pressure
Public relations	Lack of awareness for circular economy	Lack of confidentiality and trust to the company or to the products
R&D	Lack of R&D capability	Problems in the application of technological knowledge on product or concept basis
Governmental	Ineffective recycling policies	Financial governmental incentives support the linear economy
Legal	Insufficient implementation of circular economy laws	Lack of effective legislation
Societal	Lack of perception about urgency of CE	GDP is an insufficient indicator to show the progress of society
Market conditions	Limited availability of reuse products	Pollution/Wastage in industries
Environmental	Lack of environmental management system	Lack of abilities for energy saving
Technological	Lack of technology use	Lack of efficient information system

Table 3.
The best and worst criteria for each main criterion

Within public relations barriers cluster, "Lack of awareness for circular economy" was found as the most important barrier with a weight of 0.806, which means, the challenges about public relations are dominated by this barrier.

Within research and development barriers cluster, "Lack of R&D capability" and "Lack of technological infrastructure" were found as the most important barriers with weights of 0.644 and 0.244, respectively. Results show that nearly 90% of R&D challenges are caused by these two barriers.

Within governmental barriers cluster, "Ineffective recycling policies" and "Inconsistent price policies in sources and products" were found as the most important barriers with weights of 0.379 and 0.221, respectively. This means 60% of governmental challenges are caused by these two barriers.

Within legal barriers cluster, "Insufficient implementation of circular economy laws" and "Inconsistency of existing laws with CE" were found as the most important barriers with weights of 0.688 and 0.188, respectively. Analysis of this result demonstrated that "Insufficient implementation of circular economy laws" barrier dominated the legal challenges.

Within societal barriers cluster, "Lack of perception about urgency of CE" was found as the most important barrier with a weight of 0.623, respectively, which means the societal challenges are dominated by this barrier.

Within market conditions barriers cluster, "Limited availability of reuse products" was found as the most important barrier with a weight of 0.65. This results show that 65% of market conditions challenges are triggered by this barrier.

Within environmental barriers cluster, "Lack of environmental management system" and "Lack of efforts for R activities" were found as the most important barriers with weights of 0.583 and 0.333, respectively. Analysis of this result demonstrated that nearly 92% of environmental challenges are cause by these two barriers.

Within technological barriers cluster, "Lack of technology use" and "Technological limitations" were found as the most important barriers with weights of 0.416 and 0.237, respectively, which means these two barriers consist of nearly 65% of technological challenges.

According to the fuzzy BWM calculations, in an overall manner, "Insufficient implementation of circular economy laws" was found as the most important barrier with a weight of 0.095. It is followed by "Lack of information", "Ineffective recycling policies", "Lack of awareness for circular economy", "Remanufacturing is a labor-intensive procedure", "Inconsistent price policies in sources and products", "Lack of environmental management system", "Cost of implementation for green activities" and "Lack of R&D capability" barriers with weights of 0.062, 0.061, 0.041, 0.037, 0.036, 0.036, 0.036 and 0.034, respectively. Table 4 shows the overall findings.

6. Discussions and implications

Cooperatives trigger cooperation within its members while focusing on common goals. They support and lead towards social integration and cooperation among its members. They have been regarded as important organizations for providing services and for the distribution of agricultural and food products. However, the organizations face with some obstacles while transition from linear to circular economy. Scarcity of resources, climate change, environmental problems, poverty, public health and social problems were some of those obstacles. Therefore, governments and organizations are forced to focus on possible solutions.

Also, there are several barriers anticipated during the transition process. These barriers were determined as operational, economic, financial, technological, institutional, governmental and social barriers (Kok *et al.*, 2013; Govindan and Hasanagic, 2018; Kazancoglu *et al.*, 2021; Kumar *et al.*, 2021).

Analysis of the results demonstrated that among 51 barriers, 9 of them, namely, "Insufficient implementation of circular economy laws" was found as the most important barrier, followed by "Lack of information", "Ineffective recycling policies", "Lack of awareness for circular economy", "Remanufacturing is a labor-intensive procedure", "Inconsistent price policies in sources and products", "Lack of environmental management system", "Cost of implementation for green activities" and "Lack of R&D capability" have a total nearly 44% importance weight. Analysis of the results demonstrated that operations and logistics, governmental and legal barriers were identified as the most important barriers to circular

Main barriers	Sub-barriers	Weights
Organizational	Unclear vision in terms of CE	0.025
	Lack of appropriate implementation of new business models	0.005
	Lack of skilled human resource in implementation of circular economy and supply chain management including knowledge, skill and professional advice	0.008
	Inappropriate organization structure for CE implementation	0.004
	Lack of energy management and waste management within the organization	0.004
	Lack of standardized metric and measurement method for a CE	0.002
	Lack of training	0.006
	Lack of practical knowledge sharing regarding CE and SC applications among managers and employees within the enterprise	0.010
	Poor commitment, management and leadership for CE	0.015
Financial	High investment costs	0.014
	Disposal costs for hazardous products or wastes	0.010
	Conversion cost of renewable energy	0.006
	Cost of implementation for green activities	0.036
	Production costs are getting higher	0.021
Operations and logistics	Lack of management initiatives for transport and logistics	0.015
	Challenges for biosphere safe return	0.007
	Difficulty of managing product quality	0.025
	Producing high quality products through recovering	0.018
	Remanufacturing is a labor-intensive procedure	0.037
	Certification	0.012
	Lack of information	0.062
Marketing	Consumer perception towards CE	0.013
	Inconsistency in consumer intentions to purchase the products	0.009
	Consumers knowledge and awareness about CE	0.023
	Customer pressure	0.005
Public relations	Lack of awareness for circular economy	0.041
	Lack of confidentiality and trust to the company or to the products	0.010
R&D	Lack of R&D capability	0.034
	Problems in the application of technological knowledge on product or concept basis	0.006
	Lack of technological infrastructure	0.013
Governmental	Financial governmental incentives support the linear economy	0.008
	Lack of government support towards environmental policies	0.024
	Lack of government support towards public procurement	0.018
	Governance issues concerning responsibilities, liabilities and ownership	0.014
	Inconsistent price policies in sources and products	0.036
	Ineffective recycling policies	0.061
Legal	Lack of effective legislation	0.017
	Insufficient implementation of circular economy laws	0.095
	Inconsistency of existing laws with CE	0.026
Societal	GDP is an insufficient indicator to show the progress of society	0.017
	Lack of perception about urgency of CE	0.028
Market conditions	Limited availability of reuse products	0.029
	Pollution/Wastage in industries	0.016
Environmental	Lack of abilities for energy saving	0.005
	Lack of efforts for R activities	0.021
	Lack of environmental management system	0.036
Technological	Resistance to advance technology adoption	0.006
	Lack of technology use	0.022
	Technological limitations	0.012
	Lack of efficient information system	0.004
	Lack of IT application	0.008

Table 4.
Weights of criteria

economy for cooperative supply chains. This is not a surprise because the most important activities within cooperatives can be operational and logistics activities. In addition, governmental and legal barriers are directly related to policies, which were determined by governmental bodies externally; therefore, it is normal to find these two barriers as important ones.

The implications were determined based on the most important barriers.

"Insufficient implementation of circular economy laws" was found as the most important barrier. This is in line with the findings of Masi *et al.* (2018), Govindan and Hasanagic (2018) and Kazancoglu *et al.* (2021), who also identified that insufficient implementation of environmental regulations was the most significant barrier to circularity. This may be caused by the lack of communication of central and local governmental bodies with the cooperative stakeholders.

"Lack of information" was found as the second most important barrier. One of the managerial aspects in a successful supply chain is the trust among the partners of the supply chains. The lack of information between the stakeholders affects the trust or trustworthiness negatively and therefore, has adverse consequences. The concepts of information sharing and transparency are crucial to able to achieve a successful supply chain.

"Ineffective recycling policies" was found as the third most important barrier. In many emerging economies, there is a lack of policies regarding the recycling procedures. Not only recycling but also redesigning, reusing, reducing, recovering and remanufacturing policies shall be determined through strict regulations by governmental bodies. This is parallel with the findings of Govindan and Hasanagic (2018), who determined that applying 6R principles would always achieve better results regarding environmental management.

"Lack of awareness for circular economy" was found as the fourth important barrier. This is just because the current legislation is for linear economy. In emerging economies, the governments still are not aware of the urgency of circular economy implementation. The governments shall change their view by transforming their vision to circularity. In addition, the governments should make pressure to organizations about circularity in order to enhance the level of awareness of organizations. Furthermore, nongovernmental organizations have great influence and role to force businesses to behave in accordance with corporate environmental management standards of sustainability; and therefore, may help organizations improve their awareness about circularity. This is in line with the findings of Kazancoglu *et al.* (2021), who also emphasized the importance of awareness about circularity.

"Remanufacturing is a labor-intensive procedure" was found as the fifth most important barrier. Since the remanufacturing process includes labor-intensive procedures, the organizations are obliged to hire new employees who are eligible to remanufacturing principles. This requires training programs, and even a need for education programs in universities for satisfying the need for qualified employees.

"Inconsistent price policies in sources and products" was found as another important barrier. This creates a problem in outsourcing process for organizations. There may be a need for systematic supplier selection process and outsourcing procedures for cooperatives in order to provide a cost-friendly purchasing behavior.

"Lack of environmental management system" was found as another important barrier. To create a higher level of economic values, organizations should be forced to redesign their manufacturing processes to protect the environment and reduce the pollution. This is in line with the findings of Bocken *et al.* (2016), who claimed that there is a need for corporate environmental management system to create high economic value for organizations.

"Cost of implementation for green activities" was found as another important barrier. Since the implementation of green activities requires capital investment, there may be some obstacles for organizations to act in accordance with environmentally friendly policies. The governments should give financial incentives or even tax reductions to the cooperatives in

order to enhance the level of green and circular activities. Moreover, the governments shall organize the free education programs to take ISO14001 certifications.

Finally, "Lack of R&D capability" was found as another important barrier. R&D activities are costly and require great innovation abilities. There is a need for education programs to improve the level of education for employees. Even, there may be a need for a new and systematic personnel selection process regarding the R&D capabilities. Again, governments shall give financial incentives to organizations to develop their R&D ablities.

7. Conclusion

The International Cooperative Alliance (n.d.) signifies cooperatives as being associations found by people come together voluntarily to work towards their joint cultural, economic and social needs in a democratic manner. The members of cooperatives cooperate to achieve better results in the sector. In this context, one of the most important and popular type of cooperatives is agricultural cooperatives.

However, changes occur in the effective parameters in the maintenance of life due to both individual and environmental factors. These changes can be handled within a broad framework from the efficient management of resources to the management of people's consumption habits. At this point, the necessity to follow the rapid changes in the field of agriculture and food has emerged because awareness has started to develop about the circular economy principles in resource management, especially in terms of cooperatives. In this context, the main barriers in the adoption and implementation of circular economy principles are examined under a research flow within the scope of the study.

In this study, 12 main and 51 sub-barriers to circularity were identified while transition from linear to circular economy for agricultural cooperatives. Fuzzy BWM method was used to calculate the weights of these barriers. "Insufficient implementation of circular economy laws" was found as the most important barrier, followed by "Lack of information", "Ineffective recycling policies", "Lack of awareness for circular economy", "Remanufacturing is a labor-intensive procedure", "Inconsistent price policies in sources and products", "Lack of environmental management system", "Cost of implementation for green activities" and "Lack of R&D capability" barriers, respectively.

The main limitation of this study is that, since the data collection process includes subjective judgments, the findings of this study is unique and specific; and therefore, cannot be generalized. However, the proposed framework and the barrier set were generic. Another limitation is the number of participant professionals, which limits the conclusions of the study and reaching more general conclusions. A comprehensive research can be conducted by the participation of a greater number of professionals.

Future possible research can focus on using different MCDM technique. Moreover, to reach more generic results, more participants can contribute to data collection process. In addition, the proposed framework can be implemented to different cooperatives to understand whether it is appropriate for their industries. Furthermore, different cooperatives can be ranked in terms of the level of adaptation to circular economy.

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