Local Appropriation Model for Circular Maker Spaces (CMS) in Istanbul

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Abstract
This study focuses on circular maker spaces as catalysts, integrating new technologies and creative industries within Circular Economy (CE) strategies at a local neighbourhood scale in cities within the embedded narratives of equity and just future. The research develops a Local Appropriation Model (LAM) to guide site selection and integration, combining (1) the Local Communities Comprehension Tool (LCCT) to assess local expectations and a GIS-based multi-criteria spatial analysis for site selection. By analysing local dynamics, the study developed the core structure of the Local Appropriation Model based on common findings from six pilot neighbourhoods. Ultimately, it offers an inclusive and holistic framework, serving as a vital roadmap for integrating Circular Economy (CE) strategies into urban environments through CMSs.

Keywords; Circular Economy, Circular Maker Spaces, Sustainable Development, Local Appropriation, Neighbourhood Scale, Just Future

01. Circular Economy & Circular Maker Spaces – Why is it necessary?

The rapid consumption of natural resources and ongoing urbanization have led to various socio-economic and environmental challenges around the World. In response, the concept of a circular economy (CE) emerging from debates on sustainability and sustainable development has gained increasing importance and is continuously evolving through academic and policy research.

Unlike the dominant linear economy model, which follows a make-use-dispose trajectory, the circular economy emphasizes reuse, durability, and recycling. Here, the Ellen MacArthur Foundation, which provided one of the first and most widely accepted definitions of the circular economy, describes it as follows:

> "A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims to eliminate waste through the superior design of materials, products, systems, and business models." (Ellen MacArthur Foundation, 2013, p. 7)

Over time, the circular economy has evolved beyond its initial focus on recycling to encompass a broader range of strategies to minimize resource use and environmental impact. In this context, many countries have developed different approaches and policies related to the circular economy. For instance, early frameworks such as Japan's 3R Initiative (reduce, reuse, recycle, 2004) and the EU Waste Framework Directive (2008) laid the foundation for this shift by introducing basic "R" strategies (Ekins et al., 2019).

By 2017, this framework was expanded into the 9R strategy, introducing a more comprehensive and hierarchical approach to circularity (Potting et al., 2017; Kirchherr et al., 2017; Ekins et al., 2019). This framework targets smarter product use and circularity by prioritizing sustainability. Among the approaches developed in this context, the most important and primary strategies are rejection, rethinking, and reduction (R0–R2). It focuses on reducing overconsumption through innovative technology, product design, and organizational change. The second most important strategies are reuse, repair, refurbishment, remanufacturing, and repurposing (R3–R7); It contributes to resource efficiency by extending product life. The last and third most important strategies include recycling and recovery (R8–R9), material processing and energy recovery processes, and are closer to traditional linear

economic applications. This expanded R-framework supports a more sustainable future by promoting the transition from end-of-life waste management to systemic design and socio-technical transformation (Potting et al., 2017; Kirchherr et al., 2017; Ekins et al., 2019).

Followingly, the circular economy is operationally examined under 3 main scales in this context. These are respectively: It is defined as the micro level (products, companies, consumers), meso level (eco-industrial parks), and macro level (city, region, nation, and beyond) (Ekins et al., 2019). This provides an important framework for understanding the scope of potential future circular economic activities at different levels.

Furthermore, many researchers highlight that the circular economy will likely drive major changes in the labour market, which will affect the operations in different levels. New employment opportunities are expected to emerge in sectors such as repair, maintenance, remanufacturing, and reuse, as well as in digital technologies and sustainable design. In line with this, the European Commission (2020) predicts that over 700,000 new jobs could be created across the EU by 2030 as a result of new circular economy policies in the EU. The Ellen MacArthur Foundation (2015) also emphasizes that circular models stimulate growth in labour-intensive sectors, thereby supporting local employment. Cities will play a pivotal role in this transformation, as they not only host a large share of the global population but also account for 60–80% of global energy consumption and 75% of carbon emissions (Chen & Chen, 2012; Environment, 2017; Coskun et al., 2022).

On the other hand, the circular economy serves as an alternative economic model that promotes social and environmental sustainability while seeking a balanced relationship among the three pillars of sustainable development: environmental protection, social equity, and economic growth (Coşkun et al., 2022). At this point, while cities face various socio-economic and environmental challenges, questions arise regarding how circular economy strategies can be scaled and implemented within urban environments.

In line with this, it is crucial to recognize that urban space is a collective value and that all city residents have equal rights to its production (Lefebvre, 1996). Harvey (2008) emphasizes that residents have a collective right to access existing urban resources and engage in urban transformation, which are essential principles for fostering an inclusive and just transition in the cities. Accordingly, implementing circular economy practices in cities must be diverse, democratic, and equitable (Fainstein, 2010). Ensuring both a just transition and justice in emerging urban structures is essential.

Here, CMSs, which have the potential to advance sustainable development goals (SDGs) through circular-making activities such as reusing, repairing, refurbishing, and recycling (Galleguillos et al., 2023), emerge as a key mechanism for accelerating the just transition to a circular economy in urban spaces. Makerspaces provide an opportunity for individuals from diverse backgrounds to connect, exchange knowledge, and collaborate on creative projects (Einarsson & Hertzum, 2021). At the same time, these maker spaces serve as key focal points for building a sense of community and engagement, facilitating the adoption and implementation of circular economy principles within society. (Galleguillos et al., 2023, Kohtala & Bosqué, 2014). Moreover, they will function as platforms for social empowerment and social justice in the city.

As a result, the circular economy, which has emerged as part of the concept of sustainability in the face of various socio-economic problems that arise in a rapidly depletion and urbanization of the world, is seen as an important model that will reverse or slow down this situation due to its scope and capacity. In this context, CMSs appear as an important tool to implement the principles of the circular economy in cities, both environmentally and socially, and to ensure a just transition.

In this context, the local-scale implementation of circular production spaces, as tools for applying circular economy (CE) principles at the urban scale, will play a significant role in accelerating the process and promoting its wider integration at the grassroots level. In this regard, the next phases of this study explore how CMSs can be integrated at a local neighbourhood scale in cities within the embedded narratives of equity and a just future.

02. Local Appropriation of Circular Maker Spaces (CMS) – How Can CMSs Be Integrated at the Local Scale?
The concept of appropriation, based on Lefebvre's discussions on the production and construction of space, has been used by architects, planners, and designers since the 1960s and 70s in line with various discourses and policies in urban planning and development. Due to the multi-layered and complex nature of urban space, appropriation is shaped and realised not only physically, but also through socio-political, cultural, and environmental processes. (Lefevbre, 1991). Therefore, appropriation refers to the sum of all the actions we take to transform our environment for a specific purpose, while the individual's motivation is essential to initiate this transformation (Noschis, 1978).

On the other hand, the urban space that surrounds us can encourage or restrict us from this transformation. In the process of appropriation of space, understanding local elements is also an important factor in terms of sustainability and ownership of the space. In this context, the research seeks to provide a framework for the appropriation of circular maker spaces in urban space in line with CE principles.

While makerspaces serve as platforms for sharing knowledge, ideas, skills, and equipment by prioritizing sharing and learning over commercial gain (Kuznetsov & Paulos, 2010; Peppler et al., 2016; Galleguillos et al., 2023), they also foster community building. Additionally, makerspaces act as structures that promote local economic development through the use of digital technologies and traditional methods. In this context, circular makerspaces have the potential to support and transform existing local networks within the city. As social and inclusive spaces, they enhance the well-being of city residents and contribute to sustainability (Taylor et al., 2016; Galleguillos et al., 2023). (Taylor et al., 2016; Galleguillos et al., 2023).

The adoption of CMSs in urban areas is important for implementing CE principles locally and accelerating the transition. This study aims to provide a framework for integrating CMSs at this level. In this context, the study focuses on 6 different neighbourhoods of Bayrampasa district in Istanbul, which include different groups and have various application bases for CE applications. The selected neighbourhoods within the district borders, respectively, are Yıldırım, Kartaltepe, Cevatpasa, Muratpasa, Kocatepe, and Altıntepsi. The studies conducted in these neighbourhoods have been supported by qualitative and quantitative research methods to understand how urban residents perceive CMSs and where they place them in future scenarios. In addition, analyses have been conducted to determine how these spaces will be physically integrated into the urban space, in order to select an appropriate location.

Subsequently, a Local Community Comprehension Tool was developed through a survey conducted with neighbourhood residents and an examination of studies that will serve as a foundation for the municipality's CE applications. The Local Communities Comprehension Tool (LCCT) aims to understand local communities and authorities' expectations, their perception of the CE and its implementation on the local scale.

To ensure sustainable implementation, criteria for site selection were subsequently developed and tested through pilot applications using a Multi-Criteria Decision Analysis method based on GIS (Geographic Information Systems) that supports spatial decision-making. The site selection criteria included several important factors, such as accessibility for local residents. Additionally, detailed descriptions of related facilities and networks were considered, enabling discussion on the physical integration of these spaces into neighbourhoods.

02.1. Local Community Comprehension Tool (LCCT)
The Local Community Comprehension Tool consists of 3 stages. These intertwining phases aim to understand how the circular economy and circular production spaces are perceived in the local context, and what applications they have.

These phases are as follows:
(1) Understanding how local residents perceive the circular economy and maker spaces.
(2) Reviewing the local government's approaches and implementations regarding the circular economy and circular production.

(3) Understanding how city residents perceive the local government's implementations regarding circular production and CMSs. (Figure 01).

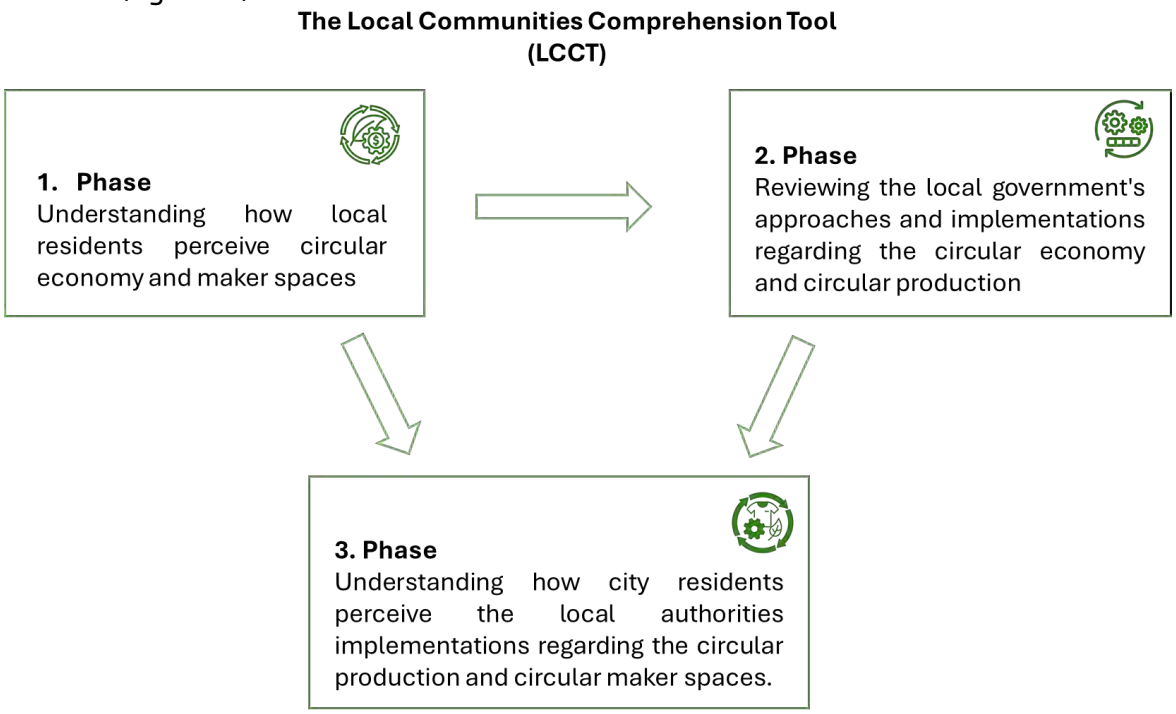

Figure 01. The Local Communities Comprehension Tool (LCCT)

Phase 1 contains survey data about the circular economy and maker spaces. Phase 2 contains a review of the implementations of the Bayrampasa Local Municipality related to the circular economy. Phase 3 contains survey data to understand the local authorities' perceptions of their implementations and their expectations of CMSs.

Phase 1: Understanding How Local Residents Perceive the Circular Economy and Maker Spaces

The survey on the circular economy and production spaces was conducted online. The survey questions were directed at city residents and were organised under five main headings. These were: 'Circular Economy', 'Circular Production Spaces', 'Circular Production Spaces and the Municipality', 'Circular Production Spaces and Participation', 'Circular Economy and the Future of the City', and 'Circular Production Spaces and Social Impacts'.

A total of 66 people participated in the survey. Of these, 30 were male and 36 were female. Therefore, men accounted for 45% of the total participants, while women accounted for 55%. (Table 01)

Table 01. Participants' Age Ratios

Age Range	Number of Participants	Participant Ratio (%)
18-25	15	23
26-35	25	38
36-45	11	17
46-55	6	9
55>	9	13
Total	66	100

The participants are divided into six age categories. These are the 18–25 age range, the 26–35 age range, the 36–45 age range, the 46–55 age range and the over-55s. The proportion of participants in the survey is as follows: 23% are in the 18–25 age range, 38% are in the 26–35 age range, 17% are in the 36–45 age range, 9% are in the 46–55

age range, and 14% are in the over-55 age range. These values show that the majority of participants are young. (Table 02).

The section measuring the participants' level of education is divided into five categories. These are: primary school (compulsory education); high school, vocational school, university; and graduate education.

Table 02. Participants' Educational Background

Educational Background	Number of Participants	Participant Ratio (%)
Primary School – Compulsory Education	6	9
High School	10	15
Vocational School	9	14
University	35	53
Master's Degree	9	9
Total	66	100

Nine per cent of the respondents have completed compulsory education (primary school). Their education levels are as follows: high school (15%), vocational school (14%), university (53%) and master's degree (9%). The survey data shows that the majority of participants have a higher level of education. (Table 02).

The proportion of survey participants from the sample neighbourhoods selected for the study in the Bayrampaşa district are as follows: Yıldırım District (26%), Kartaltepe District (20%), Cevatpaşa District (15%), Muratpaşa District (15%), Kocatepe District (13%) and Altıntepsi District (11%).

According to the survey data, 33% of participants said they had heard of the circular economy, while 67% said they had not. Of those who had heard of the concept, 26% associated the circular economy with the efficient use of resources, while 74% associated it with the reuse and recycling of waste.

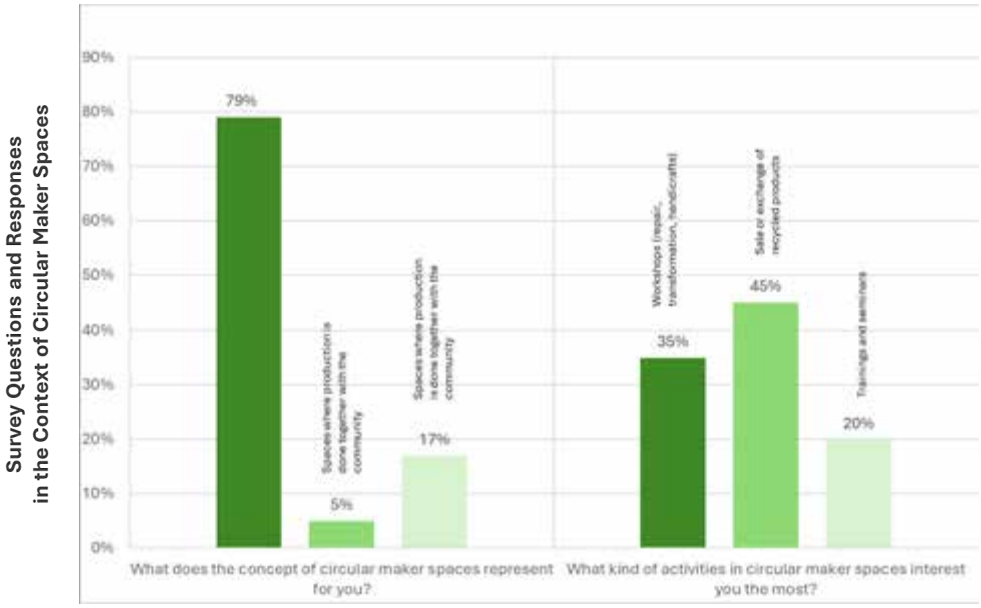

Figure 02. Survey Q&R in the context of Circular Maker Spaces

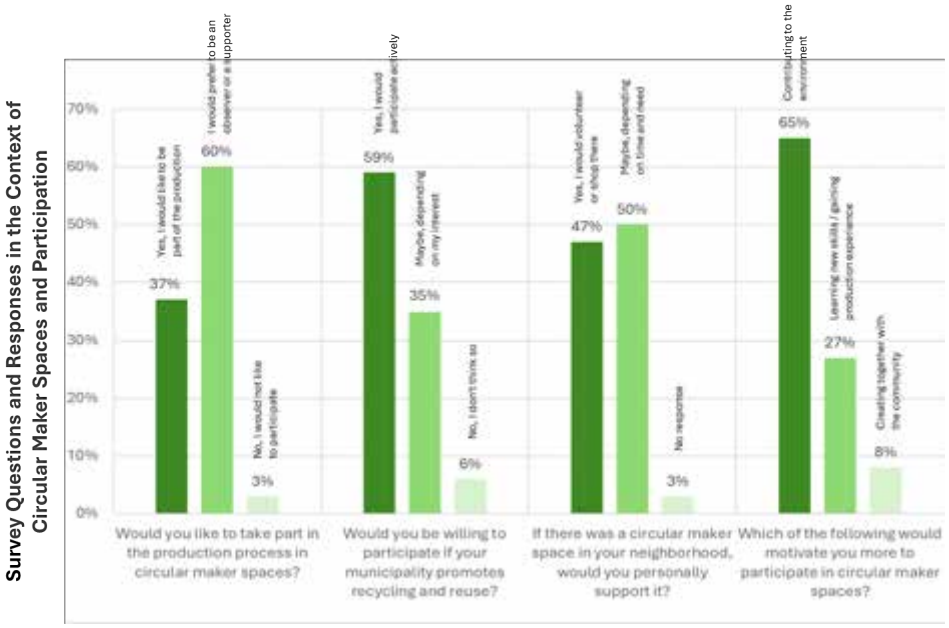

Figure 03. Survey Q&R in the context of CMS and Participation

Participants defined circular production spaces as places where new products are made from waste, with 79% defining them as such. Meanwhile, 17% defined them as places focused on repair, transformation, and sharing, and 5% as areas where production is carried out with society. On the other hand, when asked what activities they would like to take part in at circular production spaces, 35% replied workshops (e.g., repair, conversion, and handicrafts), 40% replied selling or exchanging recycled products, and 20% said training and seminars. As a result, it illustrates that the participants support activities that produce new added value from existing waste products. (Figure 2).

When asked about the municipalities' CMSs, 41% of participants stated that they were familiar with the municipalities' practices regarding CMSs, while 58% stated that they were not. One percent did not answer this question. Following this, when asked about participation, 37% of participants stated that they wanted to be involved in the production in circular maker spaces, while 60% stated that they just wanted to be observers or supporters. Three per cent of participants said they did not want to be involved in the production process.

This result shows that, although the participants have reservations about the production process, they still support it. This can be considered a positive development for the production of CMSs (Figure 03).

Another question about the participation process is whether municipalities promoting recycling and reuse should be allowed to participate. While 59% of participants said they would actively participate in recycling and reuse practices if encouraged by municipalities, 35% said they might participate depending on their interest, and 6% said they would not participate. This result shows that most participants support waste recycling and reuse and want to be involved in the process (Figure 03).

While 47% of participants said they would volunteer or shop individually if there were a circular production space in their neighbourhood, 50% said they might support it, depending on their schedule and needs. Consequently, it is assumed that participants will support the implementation of CMSs or applications at the neighbourhood scale at a high rate. In the following question, when asked what would motivate them the most to participate in CMSs, 65% of the participants said contributing to the environment, 27% said learning new skills or gaining production experience, and 8% said producing with the community. This reveals that environmental concerns are the most important factor encouraging participants to engage with CMSs. (Figure 03).

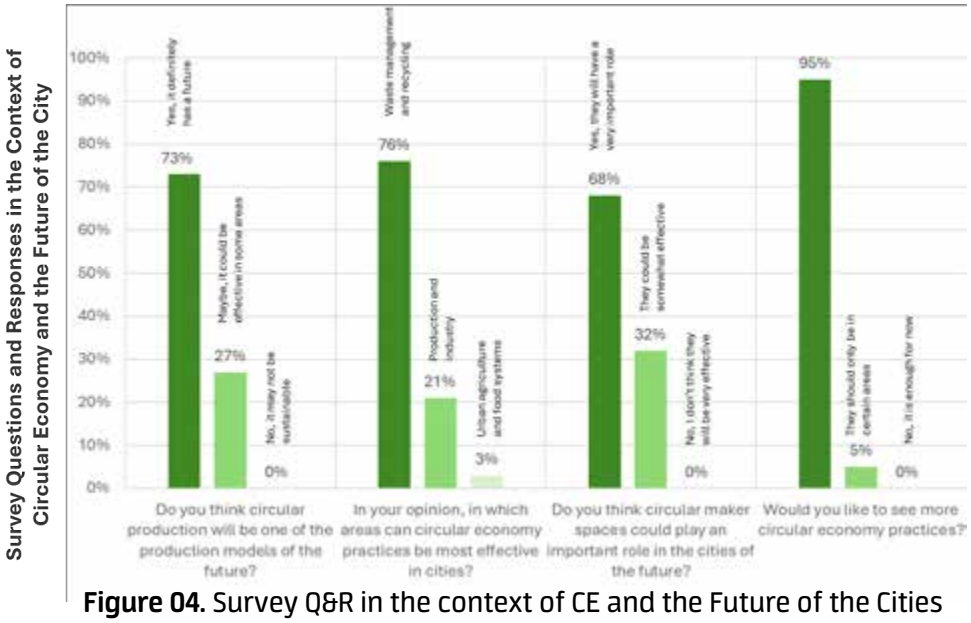

Figure 04. Survey Q&R in the context of CE and the Future of the Cities

While 73% of participants said that circular production would be one of the dominant production models in the future, 27% said that it might only be effective in certain areas. All of the participants agree that circular production will be one of the dominant production models of the future. Therefore, based on the survey data, we can conclude that the participants firmly believe that circular production will be one of the dominant production models in the future (Figure 04). When asked which areas of the city could benefit most from circular economy practices, 76% of participants answered waste management and recycling, 21% replied production and industry, and 3% responded urban agriculture and food systems. This question supports the above answers and reveals that participants are concerned about environmental and waste issues (Figure 04).

In answer to the question of whether CMSs will play an important role in the future of cities, 68% said that they would be very important, while 32% said that they might be partially effective. None of the participants said that they did not think it would be effective. This question's outcome reflects participants' belief that CMSs will play an important role in future scenarios. Additionally, 95% of participants supported the implementation of circular economy practices throughout the city, while 5% favoured a more targeted approach. None of the participants considered existing circular economy practices to be sufficient (Figure 04).

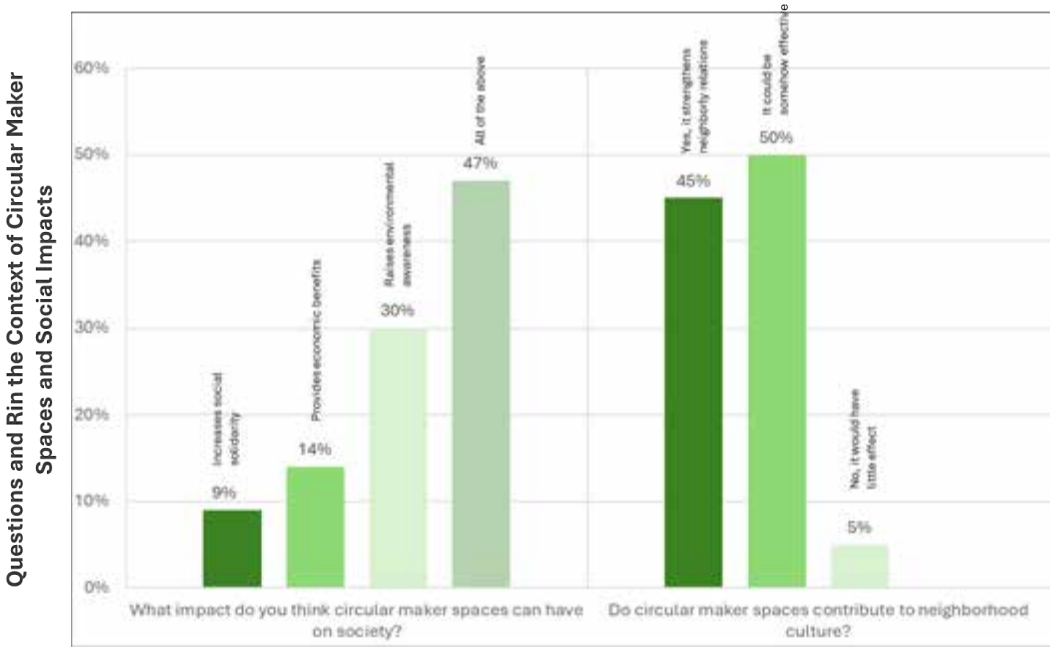

Figure 05. Survey Q&R in the context of CMS and Social Impact

Figure 05 shows the responses given by participants when asked what impact maker spaces can have on society in the context of CMSs and their social impacts. The responses were as follows: 9% increased social solidarity, 14% provided economic benefits, 30% increased environmental awareness, and 47% all ticked. Examining the survey data for this question reveals that participants believe circular maker spaces will have a positive social, economic, and environmental impact on society. This demonstrates that participants view CMSs as socially sustainable. In response to the question regarding the contribution of CMSs to neighbourhood culture, 45% of participants agreed that they strengthen neighbourhood relations, while 50% believed they could be partially effective. Five percent of participants believe that CMSs will not contribute to neighbourhood culture (Figure 05).

As a result of this phase, the survey revealed that participants were sensitive to environmental issues and found solutions and waste management practices to be insufficient. Furthermore, they believe that CE practices will be crucial in addressing these problems, particularly the promotion of CMSs. Although the survey data emphasizes that municipalities should support these practices, it also shows that participants are quite willing to support circular maker spaces on their own. Lastly, participants responded very positively to questions about the future social impact of circular production spaces, stressing that these spaces would be socially sustainable.

Phase 2: A review of Bayrampasa Local Municipality's Implementations related to CE

Although the Bayrampasa Municipality does not officially adopt the principles of the circular economy, it has implemented numerous projects of various sizes and scopes related to this concept. These projects aimed to encourage waste separation at source, promote recycling and energy efficiency, and foster sustainable environmental awareness. In addition, the Istanbul Provincial Zero Waste Management System Plan (2020), published by the Ministry of Environment, Urbanisation and Climate Change, states that the Zero Waste Management and Practices, which have been in active implementation since 2018, were started by the Bayrampasa Municipality in 2019 (URL 01).

Figure 08 shows the municipality's practices related to CE principles and supporting the transition to CE. These include the Bayrampasa Recycling Mobilisation, the Collection of Recyclable Waste, the Zero Waste Project Containers, the Recycling Education Programme, the Zero Waste Children's Play Area, the Pasakart and the Solar-Powered Lighting. (Table 03).

Table 03. Implementations of the Bayrampasa Municipality

Implementations that are related to Circular Economy	
Implementations	**Purpose**
Bayrampaşa Recycling Mobilization	Raising Public Awareness
Collection of Recyclable Waste – Distribution of Blue Waste Bags	Promoting Recycling
Zero Waste Project – Recycling Waste Collection Containers (glass, clothing, batteries, oil, etc.)	Promoting Recycling
Recycling Education in Schools	Raising Public Awareness & Education
Zero Waste Children's Play Performance	Raising Public Awareness & Education
Paşakart (point accumulation within the scope of the Zero Waste Project)	Raising Public Awareness & Economic Development
Solar-Energy Lighting in Parks and Squares	Promoting Energy Efficiency

These applications have various purposes, including raising public awareness, education, local economic development, and improving energy efficiency. In this context, some of them stand out. The Zero Waste Project, initiated and supported by the ministry, is particularly well known among city residents. Conversely, these practices are concrete examples of the environmentally friendly policies and approach of Bayrampasa Municipality, which will form the basis for a circular economy. Incorporating waste into the economy, raising environmental awareness, and taking steps towards a sustainable future demonstrate the municipality's engagement with this issue.

Another application, Pasakart, is a recycling initiative introduced by the municipality. Thanks to this project, citizens can take recyclable waste, such as paper, plastic, glass, and metal, accumulated in their homes to waste collection points in their neighborhood on certain days. 'Money Points' are loaded onto the Pasakart according to the weight of waste measured by digital scales. These points can be used by citizens at contracted markets and restaurants within the borders of Bayrampasa. According to data from 2023, over 1,300 people became Pasakart holders, and a total of 13,437 kg of recyclable waste and 350 litres of waste oil were collected. As a result of these recycling activities, citizens received a total of 22,638 TL worth of Money Points. Additionally, approximately 24,000 trees were saved from being cut down, and millions of litres of water were saved from pollution by collecting 50 tonnes of waste vegetable oil. In addition, approximately 24,000 trees were saved from being cut down, and millions of litres of water were saved from becoming polluted by collecting 50 tons of waste vegetable oil (URL 02). This project, which protects the environment while providing economic benefits to citizens, is an important step towards a sustainable future and CE practices.

As part of the Bayrampasa Recycling Mobilisation initiative, teams from the Municipality's Climate Change and Zero Waste Directorate visited 8,063 households in the Kocatepe district. They informed citizens about the importance of recycling and distributed brochures and household waste bags for recycling. This event is important in terms of both community empowerment and raising public awareness. It supports the transition to recycling, which is one of the principles of the CE. (URL 03).

Phase 3: Understanding the Perception of the Local authorities' Implementations and Expectations from CMSs
In this phase of the study, an online survey on circular maker spaces was conducted with city residents living in six selected neighbourhoods in the Bayrampasa district of Istanbul. The survey aimed to understand urban residents' perspectives on CMSs in different neighbourhoods. In this context, the survey includes a total of 14 questions, organised under the following headings: the municipality's zero waste management and practices;

the use and operation of circular production spaces; the settlement preference of CMSs at neighbourhood level; the individual impact of CMSs at neighbourhood level; and how city residents imagine the context of CMSs. Thirteen of these questions are multiple-choice and one is open-ended.

A total of 53 people took part in the study. Of these, 30 identified as female and 23 identified as male. This equates to 43% male and 57% female participants. The participants' ages were divided into five categories. These were 18–25 years old, 26–35 years old, 36–45 years old, 46–55 years old, and over 55 years old. The proportion of respondents in each age range who participated in the survey is as follows: 18-25 years old (13%), 26-35 years old (42%), 36-45 years old (21%), 46-55 years old (13%), and over 55 years old (11%). These values reveal that the majority of participants are young people (Table 04).

Table 04. Participants aga range

Age Range	Number of Participants	Participant Ratio (%)
18-25	7	13
26-35	22	42
36-45	11	21
46-55	7	13
55>	6	11
Total	53	100

The section measuring the participants' level of education is divided into six categories. These are: primary school (compulsory education), high school, vocational school, university, and graduate education. 9% of respondents have completed compulsory education (primary school). The respective education levels of the participants are as follows: high school (14%), vocational school (6%), university (51%), and master's degree (8%). The survey data shows that the majority of participants have a higher level of education. (Table 05).

Table 05. Participants educational background

Educational Background	Number of Participants	Participant Ratio (%)
Primary School – Compulsory Education	5	9
High School	14	26
Vocational School	3	6
University	27	51
Master's Degree	4	8
Total	53	100

The participant rates from the six selected sample neighbourhoods are as follows: Yıldırım Neighborhood (17%), Kartaltepe Neighbourhood (25%), Cevatpasa Neighbourhood (6%), Muratpasa Neighbourhood (11%), Kocatepe Neighbourhood (34%), and Altıntepsi Neighbourhood (8%).

The survey questions and answers are divided into four groups according to their context. The questions were designed to understand the municipality's participation in the zero-waste project since 2018, the communication between the municipality and city residents, and the effectiveness of the project's practices. The results revealed that 66% of participants were aware of the project, while 34% were not.

In response to the question about Bayrampasa Municipality's practices within the scope of the Zero Waste Project, based on information from the municipality's website, it emerged that participants were less familiar with the municipality's practices in neighbourhoods beyond routine activities such as the collection of recycling waste and the provision of recycling waste containers.

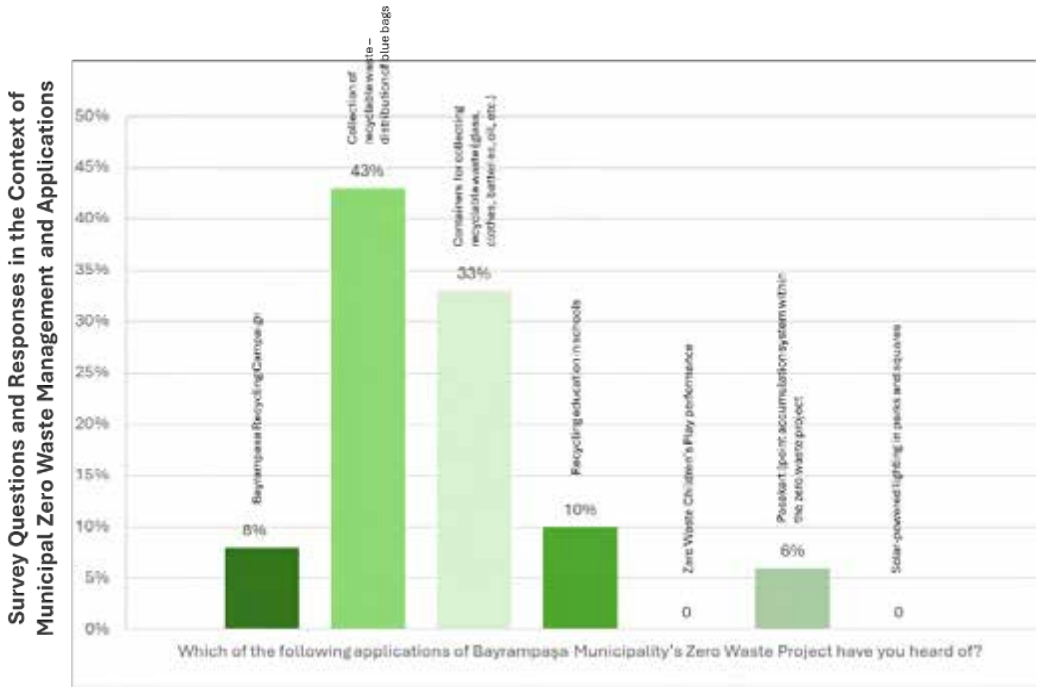

Figure 06. Survey Q&R in the context of Municipal Zero Waste Management and Applications

As an act and routine practice of the municipality in neighbourhoods, the collection of recycling waste (the distribution of blue bags) is recognised by 43%, as are recyclable waste collection containers (33%). The Bayrampasa recycling mobilisation is known by 8% of participants, the recycling education programme in schools by 10%, and the Pasakart scheme (which involves accumulating points within the scope of the zero-waste project) by 6% (Figure 06). The Zero Waste Children's Play Demonstration held at the municipal cultural centre and the solar-powered lighting projects in parks and squares are not known to the participants.

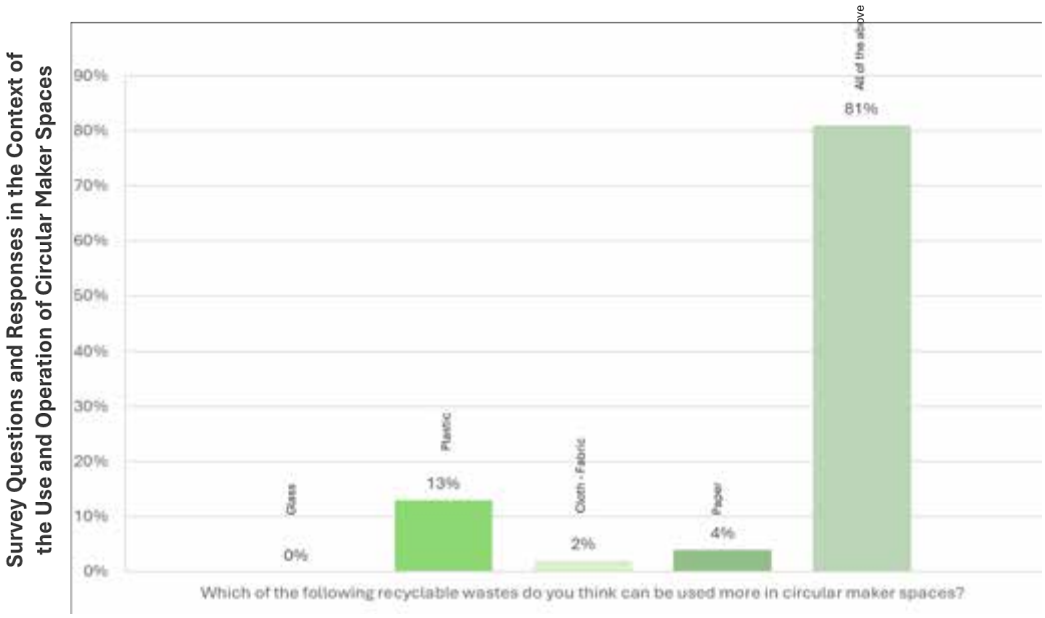

Figure 07. Survey Q&R in the context of the Use and Operations of CMS

Various questions were asked about the materials to be used in circular production spaces, as well as how these spaces would function and be governed. These questions aimed to measure participants' perceptions of circular production spaces. The aim of the questions prepared for those considering materials that can be used in CMSs as part of the zero-waste project is to provide participants with an insight into the production models that will exist in these spaces. The majority of participants (81%) stated that all products (glass, plastic, clothing, and paper) will be used together in these production areas. In addition, 13% of participants only selected plastic, 12% only selected clothes, and 4% only selected paper, saying that these items could be recycled in these places. Nobody marked the glass as recyclable. (Figure 07).

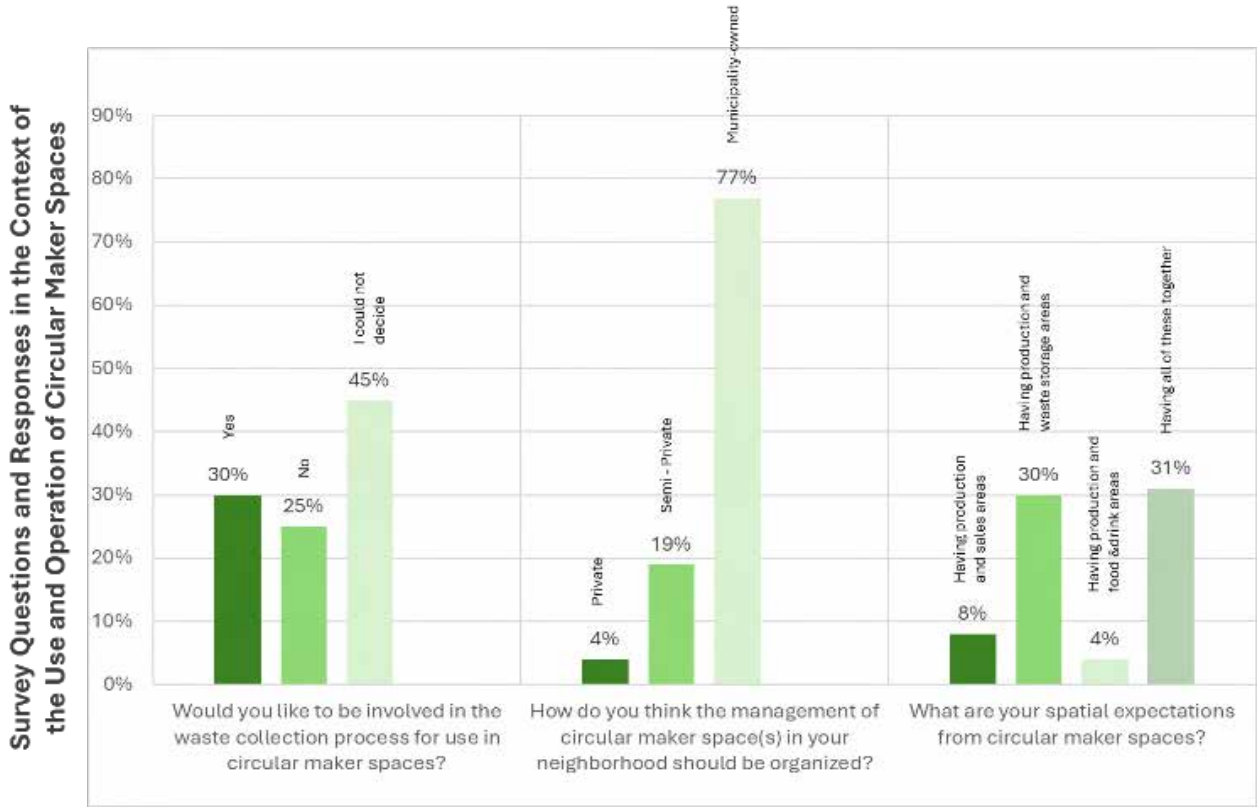

Figure 08. Survey Q&R in the context of the Use and Operations of CMS

In response to the question about participation in the waste collection process, 30% of respondents agreed, 25% disagreed, and 45% were undecided. This shows us that participants tend to act after seeing the process. (Graphic .07) Regarding the question about the management of CMSs, the majority (77%) indicated that the municipality should own them. Meanwhile, 19% of respondents thought that semi-private management would be good, while 4% supported private management. This result shows that urban residents want the municipality to initiate or carry out the expansion process of CMSs. (Figure 08)

In another question, participants were asked about their spatial expectations for CMSs. Eighty percent stated that there should be a production and sales area only, 30 percent stated that there should be a production and waste storage area only, and 4 percent stated that there should be a production and food and beverage area only. Thirty-one percent of the participants stated that all these areas should coexist. Regarding the preference for the spatial organization of circular maker spaces, the majority (31%) thought that different functions should be together. The other majority (30%) stated that these spaces should be used only for production and waste storage (Figure 08).

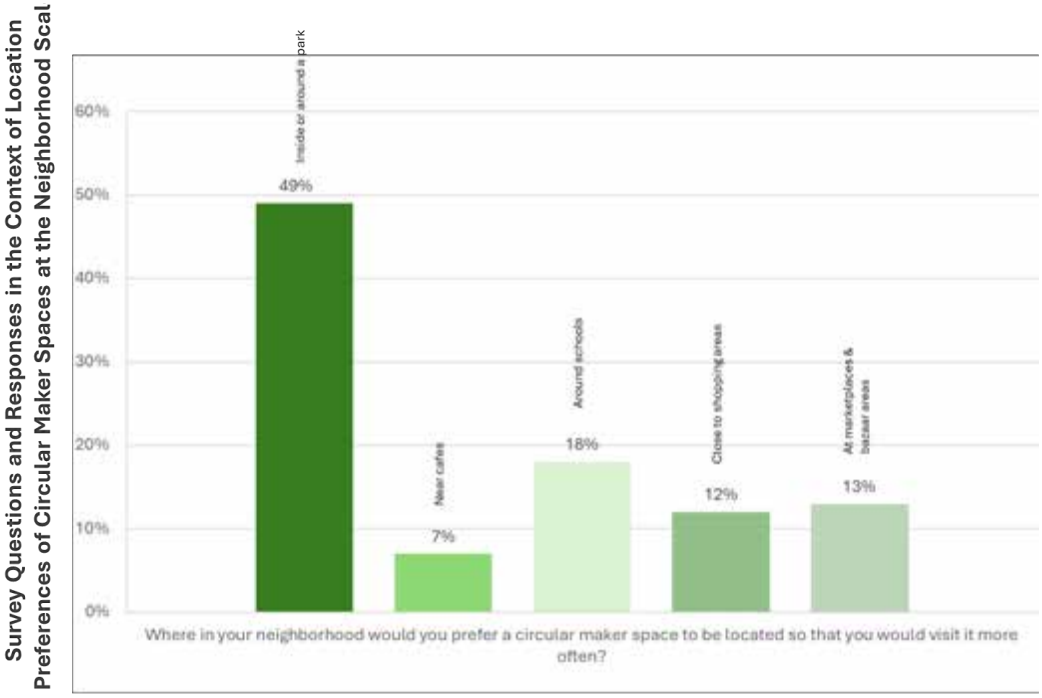

Figure 09. Survey Q&R in the context of Location Preferences of CMS at the Neighbourhood Scale

When asked about their preferred location for CMSs, 49% of participants said they should be in or around the park. The next highest responses were around schools (18%), in marketplaces (local bazaar areas) (13%), near shopping areas (12%), and near cafes (7%). These answers indicated that, while participants imagined circular production spaces alongside the green infrastructure of cities, they also believed these spaces should be combined with social activities (Figure 09).

When asked how neighbourhood-scale circular production spaces could affect their lives, most participants (60%) indicated positive effects, and 25% said they would have a very positive effect. This shows that the presence of CMSs in neighbourhood design is viewed positively. Additionally, 14% of respondents said it would have no impact, while only 1% said it would have a negative impact. Participants did not select the option that a circular maker space would have a "very negative impact" (Figure 10).

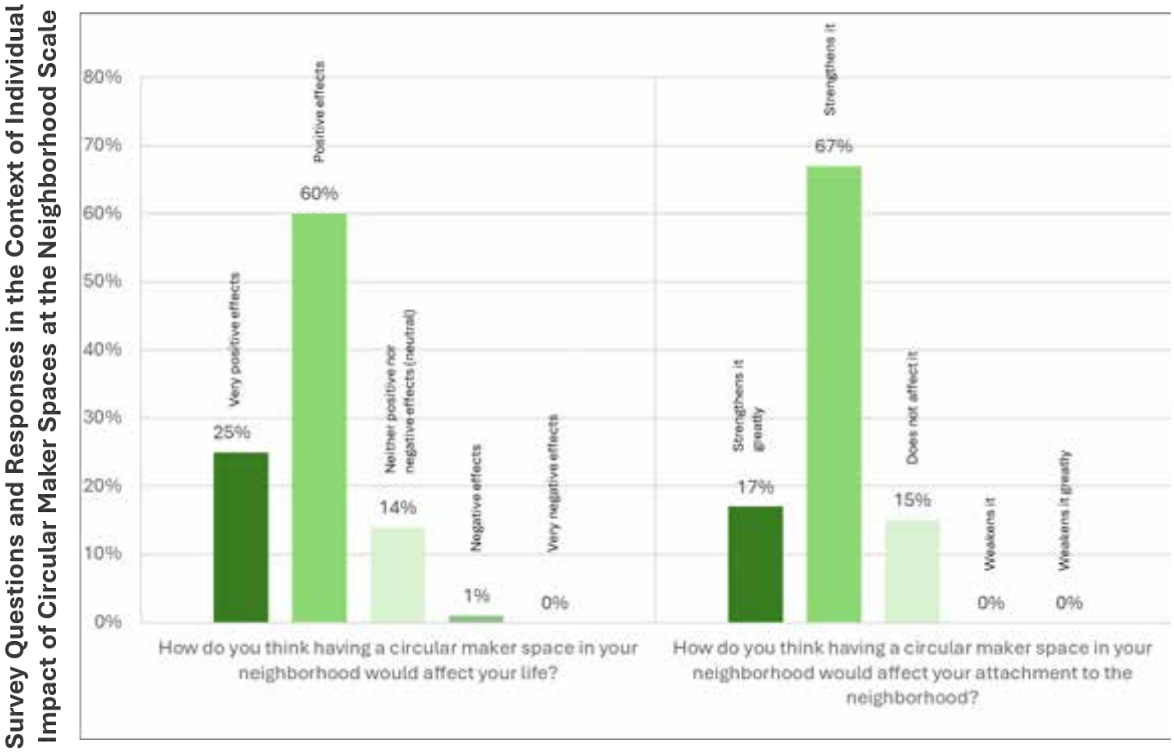

Figure 10. Survey Q&R in the context of Individual Impact of CMS at the Neighbourhood Scale

Additionally, participants stated that a circular maker space in their neighbourhood would have a mostly positive effect on the bond they have established with the neighbourhood. They stated that their bond with the neighbourhood would strengthen by 17%, and 67% said it would strengthen. Fifteen percent of participants think that CMSs will not affect the bond they establish with the place. None of the participants expressed a negative opinion on this issue. This demonstrates that CMSs can foster relationships and a sense of belonging in the neighbourhood (Figure 10).

As a result, the participants perceive circular production spaces as a tool that can strengthen existing socioeconomic and environmental factors in neighbourhoods. In this context, the local government is expected to play an active role in these areas. Lastly, it was revealed that the participants were not sufficiently informed about zero waste projects that could contribute to the municipality's circular economy practices and circular production spaces.

As part of the qualitative research, neighbourhood residents were asked to describe their vision for the circular maker space. A wide variety of responses were received. Analysis of the responses indicated that participants exhibited varying levels of awareness, interest, and imagination regarding the concept of circular production. The responses were associated with six different concepts. These concepts are safe and environmentally friendly, environmental sustainability, social interaction, location of the space, management and organization, uncertainty, and hesitation, respectively. (Figure 11)

Many participants emphasized that CMSs should adapt to their environment. They stressed the importance of avoiding environmental harm. This shows that a circular maker space is perceived as both a technical process and a social value that raises ecological awareness. However, participants had different opinions about the location and structure of CMSs. Some argued that this type of building should be located independently and safely.

Others imagined it as an aesthetically pleasing, well-maintained open space in public areas such as parks. While some participants described circular production spaces on a mesoscale, most envisioned them as part of the neighbourhood's urban space on a microscale.

Open-Ended Questions and Responses in the Context of How City Residents Envision Circular Maker Spaces

	Scope	Number of Responses	Short Definition
	Safe and Environmentally Friendly	1	The expectation for the space to be independent, safe, and isolated from environment
	Enviromental Sustainability	2	Zero-waste managment and environmentally sustainable facility concept
	Social Interaction	3	Spaces for co-production, solidarity, and social interaction
	Location of the Space	3	Located inside the park or in public spaces with an aesthetic design
	Managment and Organisation	2	Serious management attitude and awareness-raising information
	Uncertainty and Hesitation	2	Participants who have no idea or have a negative perception

Figure 11. Open Ended Survey Q&R in the context of How City Residents Envision Circular Maker Spaces

Furthermore, some participants described CMSs as places where not only waste is collected or recycled, but people also come together, work together, and produce social benefits. They also emphasized the importance of incorporating sales spaces into CMSs. This perspective demonstrates that society can develop and embrace a socio-economic perspective, along with circular economy practices and circular production spaces. Some participants emphasized the importance of promoting CMSs and highlighted their educational function and potential to raise public awareness. These responses reveal that communication strategies and physical design are integral to the process.

Some participants were unfamiliar with the concept of circular maker space, could not visualize the space, or thought it was not suitable for their neighbourhood. This shows that society has not yet embraced the concept. Various communication strategies are needed to improve this situation.

The results of the open-ended survey question illustrate that awareness of CMSs varies at the neighbourhood level. These spaces are considered not only physical structures but also spaces for social interaction and environmental awareness. In this context, it has become clear that a holistic strategic planning approach focused on design, education, social participation, and awareness is needed to implement circular production practices at the neighbourhood scale.

02.2. GIS-based Multi-Criteria Analysis (MCDA) for Site Selection

Multi-criteria decision analysis (MCDA) helps decision makers analyse possible actions or alternatives based on multiple, often incomparable, factors or criteria. Geographic information system (GIS)-based MCDA provides a powerful tool by enabling the evaluation of objective and subjective criteria together in decision-making processes. This type of analysis uses decision rules to combine criteria and rate or rank alternatives (Eastman, 2009; Figueira et al., 2005; Malczewski, 1999a; Greene et al., 2011). According to the literature, the main factors affecting the selection of multi-criteria decision analysis methods are the effects of elements such as the number of decision makers, stage of the decision process, number of targets and alternatives, level of uncertainty, risk toler-

ance, measurement scales, experience level, and technical resources on method selection (Greene et al., 2011).

The summary table provides an explanation of each factor in relation to the relevant literature and is structured to guide the selection of methods in decision-support processes. This method was developed to increase the contextual sensitivity of decision analysis, evaluate the suitability of techniques, and ensure transparency and repeatability in analytical processes. It also enables one to perceive the difficulties related to location selection from a broad perspective. (Figure 12).

This study developed a multi-criteria decision analysis (MCDA) evaluation framework of the Analytic Hierarchy Process Table (AHP) to help select locations for circular production spaces. The AHP Table comprises various factors grouped under three main headings.

1. Natural factors: This group evaluates topographic features and suitability for settlement, such as dominant areas and landslide risk areas, as well as distance to water resources and slope.
2. Social and Economic Factors: This group discusses distances to local economic activities, residences, public spaces, and buildings.
3. Access factors: This group includes distances to pedestrian paths, green spaces, public transportation networks, and main transportation axes.

Each factor and subfactor is graded by dividing it into distance-based suitability classes. During the analysis process, the weight of each factor on the total decision is expressed as a percentage. (Figure 14).

Factor	Explanation	Key References
Number of Decision Makers	MCDA techniques designed for individual decision-making can be modified for group settings, typically requiring consensus-building through negotiation or aggregation strategies.	Malczewski (1999b, 2006a); Hwang & Lin (1987); Balram & Dragicevic (2006); Joerin et al. (2009); Rinner (2001)
Decision Phase	Decision-making generally consists of two key phases: problem structuring and evaluation/recommendation, each demanding specialized tools and methodologies.	Anderson et al. (2003); Bouyssou et al. (2006); Turban & Aronson (2001)
Number of Objectives	Single-objective problems are addressed through methods like MCE or MADM, whereas multi-objective decision making (MODM) involves recognizing conflicts or synergies among objectives and organizing criteria accordingly.	Jankowski (1995); Malczewski (1999a, 2004); Eastman et al. (1995)
Number of Alternatives	When alternatives are few, the problem is discrete; when options are numerous or continuous, such as all possible land parcels, it falls within a screening or suitability analysis framework.	Chakhar & Mousseau (2007); Eastman (2009); Malczewski (1999a)

Existence of Constraints	Constraints can limit available options or impose minimum requirements, such as ensuring contiguity or connectivity in spatial analysis.	Eastman (2009); Chakhar & Mousseau (2008)
Risk Tolerance	Risk-tolerant decision makers might optimise for alternatives that satisfy fewer criteria, whereas risk-averse individuals tend to favor options that meet all specified conditions	Eastman (2005, 2009); Chen et al. (2001)
Uncertainty	Decision models can process criteria and weight assignments using a deterministic approach or incorporate uncertainty through probabilistic methods or fuzzy logic techniques.	Jiang & Eastman (2000); Malczewski (1999a); Shepard (2005)
Measurement Scales and Units	The feasibility of normalizing heterogeneous criteria such as monetary values and qualitative data onto a unified scale depends on methodological approaches and the comfort level of decision makers with numerical representation.	Chakhar & Mousseau (2008); Joerin et al. (2001)
Experience	The methodological choices in decision-making are shaped by the expertise and background of the decision maker and the analyst, particularly due to the varied assumptions embedded in MCDA approaches.	Belton & Stewart (2002)
Computational Resources	The choice of methodological approaches can be influenced or constrained by the availability of suitable software and hardware, and financial limitations.	Malczewski (1999a); Weistroffer et al. (2005)
Direction of Problem Solving	Most issues are examined with a forward-thinking mindset, but analyzing past choices through preference disaggregation provides insight into underlying value judgments.	Jacquet-Lagrèze & Siskos (2001); Siskos (2005)

Figure 12: Summary of Factors Influencing Multi-Criteria Decision Analysis (Greene et al. ,2011)

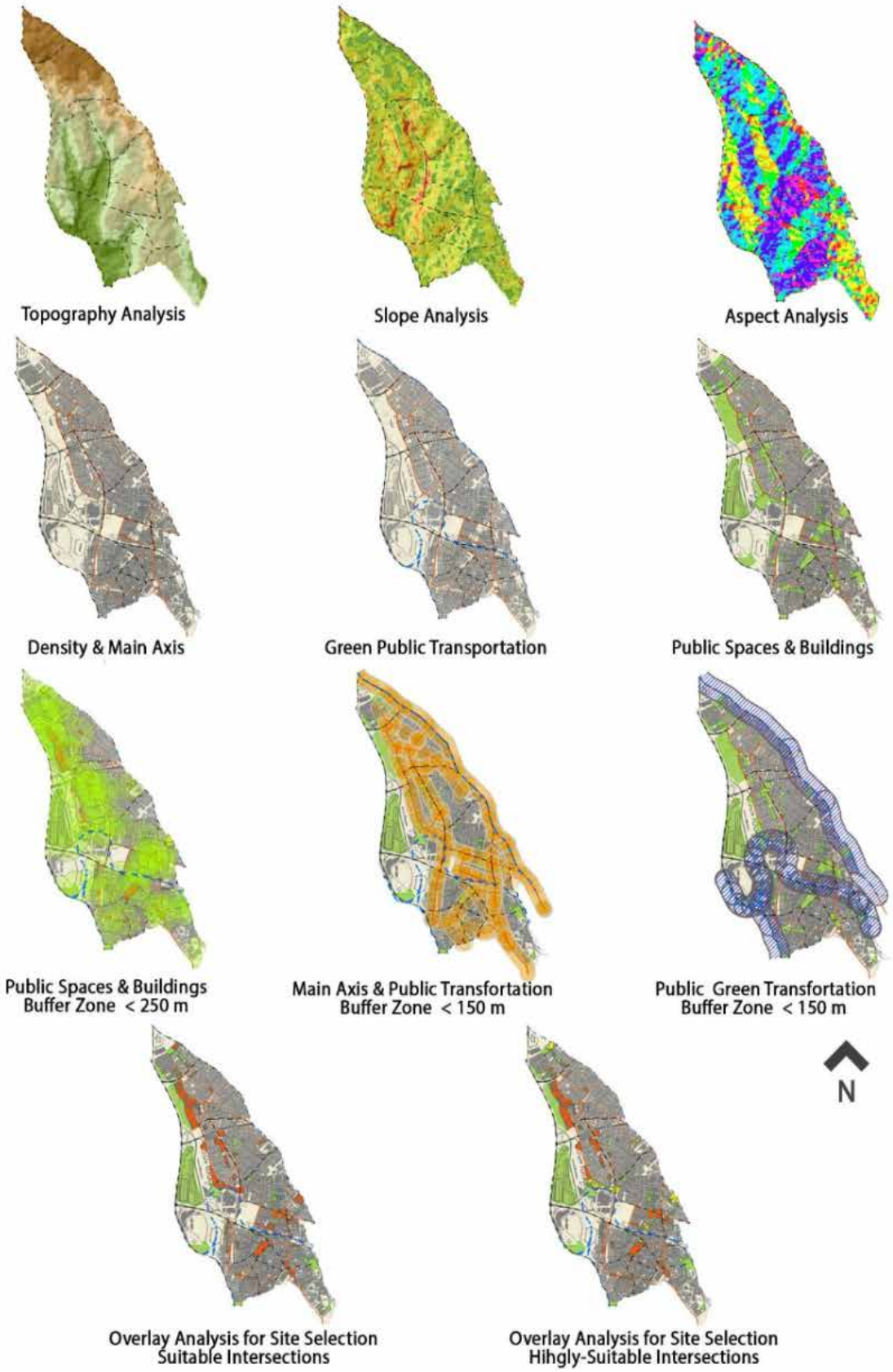

Figure 13. GIS Based Analysis of Bayrampasa / Istanbul

	Criteria / Factor	Subcriteria	Suitable Class	Rank	Weighting order
Natural Factors	Slope	0-1 %	High Suitable	5	13%
		1-5 %	Suitable	4	
		5-8 %	Moderately Suitable	3	
		8-10 %	Less Suitable	2	
		> 10 %	Not Suitable	1	
	Hydrology	> 1000	High Suitable	5	7%
		500-1000	Suitable	4	
		250-500	Moderately Suitable	3	
		100-250	Less Suitable	2	
		0-100	Not Suitable	1	
	Geology	Very Solid Foundation	High Suitable	5	10%
		Solid Foundation	Suitable	4	
		Average Solid Foundation	Moderately Suitable	3	
		Soft Foundation	Less Suitable	2	
		Very Soft/Weak Foundation	Not Suitable	1	
Social and Economic Factors	Proximity to Housings	0-100	High Suitable	5	10%
		100-250	Suitable	4	
		250-500	Moderately Suitable	3	
		500-1000	Less Suitable	2	
		> 1000	Not Suitable	1	
	Proximity to Public Spaces and Buildings	0-100	High Suitable	5	17%
		100-250	Suitable	4	
		250-500	Moderately Suitable	3	
		500-1000	Less Suitable	2	
		> 1000	Not Suitable	1	
	Proximity to Local Economic Activities	0-100	High Suitable	5	8%
		100-250	Suitable	4	
		250-500	Moderately Suitable	3	
		500-1000	Less Suitable	2	
		> 1000	Not Suitable	1	
Accessibility Factors	Proximity to Pedestrian Paths	0-100	High Suitable	5	15%
		100-250	Suitable	4	
		250-500	Moderately Suitable	3	
		500-1000	Less Suitable	2	
		> 1000	Not Suitable	1	
	Proximity to Public Transportation	0-100	High Suitable	5	10%
		100-250	Suitable	4	
		250-500	Moderately Suitable	3	
		500-1000	Less Suitable	2	
		> 1000	Not Suitable	1	
	Proximity to Main Axis	0-100	High Suitable	5	10%
		100-250	Suitable	4	
		250-500	Moderately Suitable	3	
		500-1000	Less Suitable	2	
		> 1000	Not Suitable	1	

Figure 14. AHP (Analytic Hierarchy Process) Table for GIS-Based Site Selection for CMS in Bayrampasa

Figure. 15 GIS Based MCDA Analysis - Overlay Analysis for Highly Suitable Areas for CMSs in Bayrampasa / Istanbul

These factors were determined using sustainable strategic planning principles. The goal is to make them accessible to different groups and support sustainable transportation methods. GIS allows MCDA to support complex land-use planning, site selection, and resource management decisions. (Malczewski, 1999, p. 1).

In addition, the analysis included the main axes in the district and their surroundings, taking into account the importance of adapting cyclical production spaces to economic activities and local elements in the neighbourhoods. Public spaces and buildings accessible to city residents were prioritized during the analysis process. Then, all these layers were overlapped according to the determined sub-factors, and suitable and highly suitable areas were identified for the site selection analysis. The analysis revealed that the yellow areas shown in Figure 13 are highly suitable. These areas are located 100 m away from green transportation networks, 150 m away from the main axes, and at the intersection of public spaces and buildings. (Figure 15)

As a result, the analyses consider the importance of taking a holistic approach to evaluating environmental, social, and economic factors when choosing the location of circular production spaces. Using the superimposed layers in line with the determined sub-factors, it was determined that the yellow zones, located 100 meters away from green transportation networks, 150 meters away from main roads, and at the intersections of public areas, are highly suitable for such production activities (Figure 15). These findings demonstrate the effectiveness of data-driven, multi-criteria decision support systems in sustainable urban planning.

03. Discussion – What are the possibilities for LAM?

The circular maker spaces discussed in the study are believed to be vital instruments in spreading the CE model during the transition process, helping to accelerate it. The results of the surveys conducted in this context sup-

port this hypothesis. Here, an important question arises: how can CMSs be appropriated into urban spaces on a local scale? This section discusses the potentials and constraints of the appropriation process.

The qualitative and quantitative data presented in this empirical study reveal many potentials for the development of local appropriation models for CMSs, but also constraints at different scales.

Firstly, the expectations of local residents regarding CMSs and the current practices of the municipality were examined as part of the empirical research conducted in the context of the Local Community Comprehensive Tool (LCCT). According to the survey data, CMSs are perceived as environmentally sensitive spaces that support green transformation. In parallel, the findings revealed that in future urban scenarios, CMSs are envisioned as spaces that merge with urban space, are easily accessible, are dominated by technology, and will create added value for neighborhoods and residents while implementing CE principles. These expectations demonstrate that CMSs are seen as potential spaces to support local economic development in neighborhoods.

On the other hand, the municipality's existing practices (Pasakart, etc.) promote waste recycling and support residents to gain added value from it, but are not well known by residents. This highlights various constraints that will occur in the process of transition to CE while highlighting various failures in the governance forms of local government. In general terms, these constraints point to a lack of cooperation and communication between local government and residents.

Furthermore, residents' expectations from the municipality regarding CE implementations and the management of CMSs reveal that local government is one of the most important actors in meeting expectations in this process. The presence of the local government as a mediator is an important element as the process of finding a place for CMSs in urban space will be a multi-actor process. Indeed, issues such as inequality, power relations, accountability, and adaptation to changing needs over time are important in the governance process. In this context, these concerns of local residents have also revealed the importance of the unity of management models and implementations in the integration of CMSs at the local scale. This highlights the importance of shaping these practices within a framework of just city understanding, equality, diversity, and democracy (Fainstein, 2010) in order to gain social acceptance.

Conversely, the fact that residents perceive CMSs as a means of strengthening their sense of belonging to the neighbourhood suggests that these spaces could be supported locally. It is important to consider the nature of space, which is defined by the idea that 'space is permeated with social relations; it is not only supported by social relations, but also produced by, and produces, social relations' (Lefebvre, 1991: 286, cited in Hayden, 1995: 31; Low, 1996). Apart from the physical production process of CMSs, integrating these spaces into the urban landscape through participatory processes is important for redefining the meaning of urban spaces for residents. Additionally, this process fosters place attachment and the perception of CMSs as places that transcend urban spaces.

This is because place attachment emphasises the emotional relationship that people develop with specific places. In this case, it significantly affects how urban residents experience, perceive and engage with these spaces, shaping their identities and well-being. Strong place attachment plays an important role in protecting and maintaining these places (Scannel & Gifford, 2010). At the same time, residents must see CMSs as social empowerment platforms that go beyond spaces focusing on CE principles. The process must also be transparent and diverse to support social well-being.The presence of CMSs in neighbourhoods is the most important factor in ensuring their sustainability in urban spaces.

As supported by the survey results, it is clear that these places will support social empowerment and contain possibilities for a diverse and just future. The location of CMSs, their easy accessibility, support from green city networks, and enabling activity for different socio-economic groups also support local implementation in this regard. The second part of the study is a GIS-based, multi-criteria analysis that considers the suitability of CMSs for urban spaces. Taking a holistic and analytical approach, this analysis provides important findings on these spaces within the framework of strategic, sustainable urban planning. Supported by qualitative data, this offers possibilities for achieving the ideal result in terms of site selection.

Developing existing applications in line with CE principles and integrating CMSs with local government will initially help these spaces flourish on a local scale. Understanding these principles, ensuring their adoption by society, and managing this process are important for the success of the applications. Additionally, the different functions of these spaces encourage residents to use them more frequently. These CMSs support local appropriation at the neighbourhood level. At the same time, this situation also demonstrates the different potential of CMSs.

04. Result

In a nutshell, the acceleration and dissemination of CMSs in cities regarding the implementation of CE principles process should be managed through bottom-up, transparent, and democratic methods by local authorities. This process should be able to create added value in neighbourhoods and enable various functions and spaces to be combined within the context of local appropriation. The study concluded that the local appropriation process of CMSs has the potential to support socio-economic empowerment and environmental improvement. As a result, the study revealed that the local appropriation process of CMSs has the potential to support socio-economic empowerment and environmental improvement. This result is a significant finding in terms of supporting the sustainable development of future cities.

In the context of the study, it provides an important roadmap for integrating circular economy (CE) strategies in cities, offering an inclusive and holistic perspective. Ultimately, it aims to address the lack of literature on the subject by offering insights into future scenarios for the sustainable development of cities in terms of the implementation of circular economy (CE) principles.

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