Identifying Circular Economy Strategies Adopted by Local Governments: The Case of Belgium

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Abstract

The circular economy (CE) is gaining interest as means towards sustainable development. Local governments play a key role in this transition and are adopting CE strategies. There is a lack of empirical knowledge on the strategies adopted to integrate the. The aim of this paper is to provide insights into these strategies. Indeed, previous literature stresses the importance of strategies for local CE transitions but has only provided explorative results about adopted strategies in local governments. With regard to the literature, a quantitative survey is distributed among all 581 Belgian local governments. Cluster analysis is used to identify different strategies for the CE. In total, 309 local governments responded (54%), of which 182 (58,9%) said to have adopted the CE. Clustering the responses resulted in identifying two strategies. Both strategies share important aspects, even though also significant differences are observed. These findings show that strategies differ among local governments and, therefore, will have different consequences for implementation. Research and practice should use this distinction as a starting point for developing more knowledge on the successful implementation of these strategies. The typology can also be used by local governments that have not yet adopted the CE to position themselves. This study provided for the first time a typology of strategies based on a large set of local governments.

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Introduction

According to the sixth IPCC assessment report, the impact of climate change is disproportionately felt in urban areas and has increased in the past years. The report recognizes the important role of local governments in achieving deep emissions reductions by reducing and changing energy and material consumption and material substitution (IPCC, 2023).

The circular economy (CE) has great potential to reduce cities' material and carbon footprints (Christis et al., 2019). This alternative to the linear economy reduces, reuses, recycles, and recovers materials to reduce the need for new resources and energy to ultimately achieve sustainable development (Kirchherr et al., 2017). So-called 'Circular Cities' (CCs) are cities that adopt these principles of the CE in their urban sustainability transition (Paiho et al., 2020). The local level brings together all the stakeholders that need to be engaged in the CE (Levoso et al., 2020; Paiho et al., 2020). Cities are hotspots for creativity and can be hubs for innovation where pilot projects for the CE can be launched (Fratini et al., 2019; Levoso et al., 2020). In addition, local governments can use their policy-making and public spending to promote and facilitate the CE (Levoso et al., 2020). The New Circular Economy Action Plan of the European Commission (2020) recognizes the importance of the local level and has launched a Circular Cities & Regions Initiative (European Commission, 2021). Organizations like the Ellen MacArthur Foundation and the OECD also support local governments in adopting the CE (Ellen MacArthur Foundation, 2017; OECD, 2020). In Europe, local governments are also committing to the Circular Cities Declaration to work together on the transition towards the CE (ICLEI Europe, 2020).

As public sector organizations, local governments are responsible for governing the city. Under the label of New Public Management reforms, local governments have become more business-like, adopting strategic management (Hood, 1991). Therefore, a strategy for adopting the CE is essential

for local governments to move from objectives to implementing and achieving the CE (Fratini et al., 2019; Montenegro Navarro & Jonker, 2018; Paiho et al., 2020).

A literature review on strategies for the CE in the public sector called for more holistic studies (Klein et al., 2020). Interviewing and surveying the Portuguese central public sector resulted in identifying the current implementation of CE strategies and the factors influencing this implementation, such as the organizational culture and CE awareness (Klein et al., 2021, 2022). The adopted strategy of Brussels and the way it was formed has also been studied (Kębłowski et al., 2020). Brussels has great potential to reduce its material and carbon footprint according to a calculation using two possible CE strategies, one focusing on production and the other on consumption (Christis et al., 2019). Using a comparative case study, the CE strategy of Melbourne and Malmö was studied to identify key themes and to observe the main differences related to the local context (Bolger & Doyon, 2019). This study highlighted the importance of strategic planning for adopting the CE at the local level. So far, Prendeville et al. (2018) have studied the largest number of cases. By exploring the strategy of six European cities in different countries and of different sizes, six different strategies were found based on key aspects, integration plans, and objectives. The authors recognized that future research could identify more strategies.

Although the literature has highlighted the importance of CE strategies for local governments, there is a lack of knowledge on different strategies adopted based on a large set of observations (Klein et al., 2020; Levoso et al., 2020; Prendeville et al., 2018). This research aims to fill this gap by studying the strategies adopted by a large set of local governments to answer the question: "What are the different strategies adopted by local governments towards the CE?".

An online quantitative survey was distributed among all 581 Belgian local governments. The survey aimed to question the context, content, and process of the strategic change toward the CE in the local government. Descriptive analysis was used to understand the general results, followed

by a regression analysis that grouped respondents into two groups of different strategies, which were then interpreted.

With a response rate of 53,8%, for the first time, an understanding of the adoption of the CE was obtained from a large set of local governments. In total, 182 out of the 309 local governments (58,9%) that responded declared to have adopted the CE, showing that CE has been translated into the local level, but not yet for all. General results are presented on the different aspects of the adopted strategies that can help further support of local governments in this transition. The cluster analysis identified two different strategies that share important aspects but also showed significant differences. This distinction in strategies is important to be considered by future research that should focus on supporting the integration of the strategies to ultimately achieve the objectives.

The remainder of this paper is structured as follows. First, a literature review is provided on the CE, its application in local governments, and the current knowledge of adopted strategies. Next, the Methodology describes how this study was performed. The Results present the findings from this study that are interpreted and related to the literature in the Discussion. Finally, the Conclusion provides a synthesis of this study.

Literature

The Circular Economy

The 'Circular Economy' (CE) gained interest in the last decade thanks to the Ellen MacArthur Foundation (Ellen MacArthur Foundation, 2015). However, this concept is not new and is based on principles like cradle-to-cradle, which have been studied for many years. Due to the increased attention to this concept, many definitions have been adopted, and a general definition is missing (Kirchherr et al., 2017). In 2017, Kirchherr et al. reviewed 144 definitions and came up with a more holistic one, defining CE as "an economic system that replaces the 'end-of-life' concept with

reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes. It operates at the micro level (products, companies, consumers), meso level (eco-industrial parks), and macro level (city, region, nation, and beyond), with the aim to accomplish sustainable development, this simultaneously creating environmental quality, economic prosperity, and social equity, to the benefit of current and future generation. It is enabled by novel business models and responsible consumers." (Kirchherr et al., 2017, p. 299). Although this definition is criticized by some, it is widely adopted (Figge et al., 2023). This definition shows that the ultimate goal is to achieve sustainable development.

The CE requires a system change in our consumption and production patterns. A successful transition requires more than just waste management and recycling. According to the review of Kirrcherr et al. (2017), the concept is most associated with a combination of reducing, reusing, and recycling activities. These activities are also called R-strategies, and different variations exist (e.g. Bocken et al., 2016; Potting et al., 2017). The R-strategies imply a hierarchy between different loops, depending on their sustainability (Sauvé et al., 2016). The CE promotes "high-value material cycles instead of recycling only for low-value raw materials as in traditional recycling" (Ghisellini et al., 2016).

Circular Economy Strategies

Besides research contributing to implementing the CE in business models, several studies addressed strategy integration. Especially the barriers and enablers for this integration have been studied. Previous research showed that these drivers and enablers differ across the implementation stage (Piila et al., 2022). A survey of the implementation of CE strategies in Spanish SMEs found two types of barriers, each requiring a different strategy to overcome them (Ormazabal et al., 2018). Further research on SMEs in Italy showed a focus on waste management, while few resource-

saving practices were observed (Mura et al., 2020). The main barrier here was the cost. A survey among Dutch SMEs on integrating the CE in business strategies found the importance of a manager's perception (Eikelenboom & de Jong, 2022). The integration was enabled when managers perceived the CE as an opportunity and when there was interaction between stakeholders in the network. These studies provide some first insights into implementing the CE in an organization's strategy that can be used as a starting point for considering the implementation in local governments.

The Circular Economy at the local level

The importance of the local level has been highlighted in the last decades as these are places where many opportunities and threats to the CE come together (European Commission, 2014). According to a report by the Ellen MacArthur Foundation (2017), cities consume 75% of the natural resource worldwide while producing 50% of global waste. Moreover, urban areas consume around 76% of the global energy supply, making them responsible for the majority of the related CO_2 emissions (IPCC, 2014). As more urbanization is expected in the coming years, environmental issues will remain critical, and inequalities will keep growing (United Nations, 2016).

At the same time, cities have many opportunities to contribute to the CE. They are growth engines producing 80% of the GDP while only housing 55% of the global population (Ellen MacArthur Foundation, 2017). They are the main consumption nodes (Christis et al., 2019). Therefore, the CE has great potential to reduce cities' ecological footprint, increase resource security, improve the health of citizens, and ultimately reduce greenhouse gas emissions (Williams, 2021). Local governments can use citizens' creativity to experiment, set up pilot projects, and become hubs for innovation (Fratini et al., 2019; Levoso et al., 2020). A city brings together the local stakeholders needed to implement system changes to close loops. Local governments are closest to citizens

allowing them to implement policies that fit the local context and can use their public spending to implement changes (Levoso et al., 2020).

Based on case studies and interviews in frontrunner local governments, three groups of barriers are identified to adopting the CE; the need for better knowledge, funding, and regulation (Montenegro Navarro & Jonker, 2018). For each barrier, several ways to overcome them are proposed. Paiho et al. (2020) also discuss important challenges and enablers and provide steps to adopt the CE in cities. A four-step implementation methodology is provided by Levoso et al. (2020). This study stresses the importance of stakeholder engagement, which can be challenging for local governments. Based on experiences in maker spaces, Coskun et al. (2022) provide an overview of key engagement-related challenges and strategies to overcome these.

More research is needed to make the CE transition of local governments meaningful and to avoid the concept becoming a buzzword used for greenwashing and city-branding (Frattini et al., 2019; Montenegro Navarro & Jonker, 2018; Prendeville et al., 2018).

Strategies for the Circular Economy in local governments

Both academic and applied research have identified strategy as a key enabler for local governments in their CE transition (Ellen MacArthur Foundation, 2019; European Investment Bank, 2018; Fratini et al., 2019; Martelloni et al., 2019; Montenegro Navarro & Jonker, 2018; OECD, 2020; Paiho et al., 2020). An explorative study by Prendeville et al. (2018) looked at the circular strategy adopted in six European cities of different sizes in different countries. Based on the aspects of the CE considered, integration plans, objectives, enablers, and barriers, different strategies were observed among the cases. In these cities, the CE was often part of the sustainability plan, and financing initiatives were the main barrier. The most important aspects of these strategies were leadership, vision, experimenting, knowledge, and stakeholder engagement. In 2019, Bolger and

Doyon compared the strategies of Melbourne and Malmö (Bolger & Doyon, 2019). Both strategies were found to be different because of the different urban situations. The study highlighted the importance of strategic planning for the CE and the lack of knowledge. The strategy of both cases focused on governing by example, especially concerning the construction and building. A study to measure the potential of circular strategies in cities was performed by Christis et al. (2019). The impact on Brussels's material and carbon footprint was calculated for two strategies, one focusing on production to reduce the material intensity of products and the second focusing on consumption. The results show the biggest potential for the CE in the food and housing sector. Another study on Brussels analyzed how the circular strategy of the region was formulated (Kębłowski et al., 2020). Results showed that this strategy was mainly a continuation of existing interests and the long-standing urban development agendas.

Klein et al. (Klein et al., 2020) studied strategies adopted by public sector organizations, of which local governments are part. A literature review showed the lack of research on this topic and called for research taking a broader look than just public procurement. Interviews within the Portuguese central public sector were used to identify factors influencing the implementation of circular strategies (Klein et al., 2021). Issues were found related to the organizational culture and awareness among staff. Leadership was found to be a key element for the implementation. Using a survey, the current strategy of the Portuguese central public sector was also studied, showing low levels of implementation (Klein et al., 2022). The implementation was highest for waste collecting, recycling, and dematerialization, leaving great potential for further CE implementation.

The current literature shows limited, mainly exploratory research on strategies based on a small number of cases. There is a need to gather empirical data from a large set of local governments to discover more strategies (Prendeville et al., 2018). This study tries to fill this gap by surveying adopted strategies from a large set of local governments.

Methodology

To study different strategies for the CE adopted by local governments, a quantitative survey was performed in October 2022 across all Belgian municipalities. Belgium includes 581 municipalities and was selected because of two reasons. First, it provides a relevant population to study the CE as it has been adopted in policy programs across all levels of governance. In accordance with the ambition of the European Commission about the CE, the national and regional governments have adopted circular ambitions (Belgian Federal Government, 2016; European Commission, 2020). Belgium consists of three regional governments; Brussels, Flanders, and Wallonia, with each having a different plan for the CE (Brussels-Capital Region, 2016; Flemish Regional Government, 2018; Wallonia Public Service, 2021). At the local level, currently, 4 Belgian local governments have formalized their ambition for the CE by signing the Circular Cities Declaration (ICLEI Europe, 2020). The second reason is the relative heterogeneity across the local governments although their geographic proximity. This heterogeneity comes from the influence of policies from the different regional governments and differences in size and number of inhabitants.

Because research on the CE in local governments is very limited, a new survey was developed based on a review of the literature to identify relevant aspects to the question. In order to study the new strategy, the survey was structured according to the theory of Pettigrew (1985), defining a strategic change in terms of context, content, and process (Pettigrew, 1985). For each aspect, two questions were included. After asking the municipality's name, the respondent's function, and if the CE was considered, first two questions were asked about the context.

For the internal context, a question was asked about the four main barriers to adopting the CE (Montenegro Navarro & Jonker, 2018). Furthermore, the motivation for adopting the CE was questioned based on pressures, reputation, and triple-bottom-line motivations (Elkington, 1997;

Fratini et al., 2019; Prendeville et al., 2018). For the environmental aspect, a distinction was made between tackling climate change, material scarcity, and other environmental problems because previous research has observed different environmental motivations for the CE (Prendeville et al., 2018). The external context was not questioned, as information on size and number of inhabitants was found online (Belgian Federal Government, 2022).

Next, two questions were used to survey the content of the strategy, starting with a question regarding the aspects of the CE that are considered, based on the key aspects for cities distinguished by Paiho et al. (2020). Secondly, the importance of the six key product value chains, according to the New Circular Economy Action Plan, were questioned (European Commission, 2020).

To understand the process of implementing the new strategy, a question was asked regarding the involvement of stakeholder groups based on the quadruple helix (Carayannis & Campbell, 2009). Moreover, the different instruments local governments can use for the CE, according to Montenegro Navarro and Jonker (2018), were questioned. An overview of the elements used in each question is given in Table 1. The survey only included closed questions using Likert scales to measure the degree of importance of each element to the CE policy of the local government. Similar to previous research, a 5-point Likert scale was adopted, ranging from 1 = "Not at all important" to 5 = "Extremely important" (Klein et al., 2022; Longoni & Cagliano, 2015). The initial survey was developed in English but was translated into the three national languages in Belgium, i.e., Dutch, French, and German. Each translation was checked by at least three researchers that are native speakers. A two-step test phase was used, starting with a test phase among non-experts. After refining the survey, it was tested with three persons that work for a local government. Doing a test with the targeted audience allowed to check comprehensibility. For the test, respondents filled out the survey in the presence of the researcher using the think-aloud methodology (Koro et al., 2012).

An online survey in Qualtrics was used in this study sent by email. A contact list was created with the email addresses of the mayor, general director, and alderperson responsible for the CE, sustainability, or environment of all 581 Belgian municipalities. These contact details were found on the web pages of the municipalities. The survey was emailed to all these addresses at the beginning of October 2022. The email asked to have the person best aware of the CE or sustainable policy of the municipality to complete the survey. After two weeks, a reminder was sent to those who did not respond yet, and a third reminder was sent after three more weeks.

In total, 509 responses were received. After cleaning the data for missing data and selecting a single observation for each municipality, 309 responses remained. Out of 581 municipalities, this represents a response rate of 53,81% which is high compared to similar studies (Eikelenboom & de Jong, 2022 (12%); Klein et al., 2022 (41%); Longoni & Cagliano, 2015 (16%); Mura et al., 2020 (16%); Ormazabal et al., 2018 (13%); Park & Krause, 2021 (37%)). When multiple responses for a municipality were received, the selection was based on three criteria. The first preferring a positive response for having the CE in its policy over a negative because suggesting more knowledge, and the second preferring more complete answers. For nine municipalities, similar responses were received, so the selection was based on preferring the highest position of the respondent, as this person might have a better overview of the CE policy.

The response rate was highest for the Brussels region (63,16%), where 12 out of the 19 municipalities responded. The two other regions had a response rate of 53,81% for Flanders and 50,76% for Wallonia. Responses mainly came from people working in the administration (70%), being general directors, heads of departments, municipal officers, and project collaborators. The other 30% of the responses came from mayors, alderpersons, and cabinet members. To the question of whether the CE was considered in the municipality's policy, 182 responded positively (58,9%). For the Brussels region, the biggest proportion of municipalities was considering the CE in its

policy (83,33%), followed by Wallonia (61,96%) and Flanders (54,60%). The overall mean scores for the different elements can be found in the right column of Table 2.

To test the representativity of this sample, t-tests were used comparing the proportion of each region and province in the final sample to the true population. No significant differences were observed, confirming the representativity of the sample. Moreover, the sample is representative regarding the mean surface size of municipalities, while there is an overrepresentation of municipalities with a higher number of inhabitants. This suggests a non-response bias where smaller municipalities were less likely to respond. This was expected as smaller municipalities have fewer staff, so they could be less likely to find someone who wants to complete the survey. Also, the self-selection nature of this survey might provide biases as municipalities that work on the CE might be more likely to respond. A late-response bias was checked by comparing municipalities that responded before a reminder to the ones that responded after. No significant differences were observed. To reduce the probability of common-method bias, the anonymity of responses was guaranteed at the start, and clear questions were adopted (Podsakoff et al., 2003).

The results of the survey were analyzed in R. After cleaning and pseudonymization of the data, a descriptive analysis was performed. Next, a cluster analysis was performed using a two-step procedure as in previous research (Longoni & Cagliano, 2015). The first step was to use hierarchical clustering to determine the optimal number of clusters, which was two in this case. Secondly, the K-means algorithm was used to determine the clusters, which is a more robust methodology (Hair et al., 2013). The cluster analysis was performed on the normalized data, where for each question, the respondent's mean was deducted from its answers. This implies that a positive value signifies that the element is more than averagely important, and vice versa for a negative value. Using t-tests, significant differences between the centers of both clusters were

determined and used for interpreting the different responding behavior of the two groups. Finally, the two groups are compared in terms of mean size and number of inhabitants.

Table 1: Overview of survey elements questioned using Liker-scale for importance

		Elements	Reference
Context	1) Barriers	**Funding** (for investing, financing initiatives, hiring people)	Adapted from (Montenegro Navarro & Jonker, 2018)
		Knowledge and awareness (about what the concept is, why it is important, how to realize it, too narrow vision of circularity)	
		Regulation, taxation, and policies (short-term focused, promoting consumption, made in isolation)	
		Political support	
	2) Motivation	Pressure from **citizens** or other local stakeholders	Bottom-up vs. top-down (Prendeville et al., 2018)
		Pressure from higher levels of **governments** (regional, national, European)	
		Economic opportunities (for businesses, creating jobs)	Triple Bottom Line (Elkington, 1997)
		To tackle **climate** change	
		To tackle **material** scarcity	
		To tackle other **environmental** issues (pollution, biodiversity loss)	
		To improve the **social** situation (inclusion, quality of life, equality)	
		To improve the municipality's image/**reputation**	(Fratini et al., 2019)
Content	1) Circular aspects	**Conservation** (keeping products in use for as long as possible to avoid the need for new products and new materials)	(Paiho et al., 2020)
		Reuse and closing of material cycles (no more waste, but materials kept at their highest value in the economy for as long as possible)	
		Sharing of resources (sharing goods to reduce the need for goods and thereby the materials needed and waste generated)	
		Servitization and virtualization (digitalizing goods or providing them as a service to reduce the need for materials)	
		Efficiency (improving the efficiency of production so that minimal inputs are needed and no resources are wasted)	
		Renewable resources (using renewable resources instead of primary raw materials)	
		Local production (to minimize the impact of transport)	

	2) Product value chains	**Electronics & ICT**	New Circular Economy Action Plan (European Commission, 2020)
		Batteries & vehicles	
		Packaging	
		Plastics	
		Textiles	
		Construction & buildings	
		Food, water & nutrients	
Process	1) Stakeholders	**Businesses**	Quadruple helix (Carayannis & Campbell, 2009)
		Knowledge Institutions	
		Governments	
		Civil Society	
	2) Instruments	**Funding** (providing financial support or helping to find funding from external sources)	Adapted from (Montenegro Navarro & Jonker, 2018)
		Informing (educating stakeholders to raise awareness, studying the local material flows, gathering data and monitoring, and sharing good practices)	
		Legislation and taxation (by lobbying together with other cities for better regulation, improving the local regulation, and using taxation to provide incentives)	
		Strategic positioning (defining a clear vision, mission, strategy, and ambition together with stakeholders and political support)	
		Leading by **example** (using circular public procurement, breaking internal silos)	
		Stimulate **innovation** (create experimentation zones)	
		Stimulating **bottom-up** initiatives by citizens (with financial support, providing training, offering locations or materials)	
		Connecting stakeholders (to stimulate (interdisciplinary) collaboration)	

Results

This section provides an overview of the results of this study. First, a general overview of the survey results is provided before presenting the results of the cluster analysis.

Descriptive Results

Out of the 182 municipalities that answered 'yes' to having adopted the CE in their policies, 124 responses were used for further analysis to avoid using observations with a lot of missing data. An overview of the mean score and standard deviation for every element can be found in Table 2. The table also shows the mean score of the normalized data, where the respondent's mean score for each question is deducted from its scores to observe which elements were scored higher than average importance (positive value) and which ones were lower. In addition, the ranking of importance is added for the elements in each question.

Starting with the internal context, the main barriers for Belgian local governments are 'A lack of funding for investing, hiring people, and financing initiatives' and 'A lack of knowledge and awareness about the CE'. This reflects the results from for-profit organizations where a lack of resources and competencies were also the main barriers (Piila et al., 2022). The lack of knowledge and awareness was also found to be a key barrier to the circular strategy of Melbourne and Malmö in the study of Bolger and Doyon (2019), in the Portuguese central public sector (Klein et al., 2021), and in European frontrunner cities (Montenegro Navarro & Jonker, 2018). Funding as the most important barrier to adopting the CE was also observed in the case studies of Prendeville et al. (2018). Similarly, Mura et al. (2020) found that financial costs are the main barrier to adopting the CE in SMEs. However, 'Political support' and 'Regulation, taxation, and policies' are less important to these municipalities. Motivations for adopting the CE are mainly related to 'Tackling climate change' and 'Other environmental issues like pollution and biodiversity loss'. Another

environmental issue, 'Material scarcity' scored lower importance, although being the main foundation of the CE (Ghisellini et al., 2016). For the other two dimensions of the triple bottom line, 'Improving the social situation' has, on average, a higher level of importance than 'Creating economic opportunities', not representing a business focus for the CE. High importance is also given to 'Improving the municipality's reputation'. At the same time, both bottom-up and top-down pressures have a low mean score, showing that the CE is adopted because local governments see it as a solution more than an obligation, which was also observed in the Portuguese public sector (Klein et al., 2021). Previous research also found that SMEs adopt circular strategies to improve the company image and reputation (Ormazabal et al., 2018). These results provide some insights into the internal context of the CE within local governments, forming a key determinant for its strategy (Bolger & Doyon, 2019).

The content of the CE strategy adopted by Belgian local governments is characterized by focusing on 'Local production'. This result is logical, given that local governments have an impact on this. 'Renewable energy' is rated second highest, which fits with climate change as the main motivation. Furthermore, 'Reuse' and 'Conservation' are rated more than averagely important, focusing on the highest R-strategies (Stahel, 2016). The most important product value chains are 'Food, water & nutrients' and 'Construction and building', corresponding to the recent popularity of the circular bio-economy and circular building. A study about the CE in the Brussels Region showed the highest potential in the food and housing value chains to reduce the material and carbon footprints (Christis et al., 2019).

For the process of implementing the strategy, Belgium municipalities give, on average similar and high levels of importance to the four groups of stakeholders, recognizing the importance of the quadruple helix in the local transition towards the CE (Carayannis & Campbell, 2009; Levoso et al., 2020; Paiho et al., 2020). The importance of interaction among stakeholders was also found to

be a key element for integrating the CE into an organization's strategy (Eikelenboom & de Jong, 2022). This also reflects that strategies are not only business-focused for the CE but have a broader scope. Among the instruments that local governments can use, 'Leading by example' has the highest average score, followed by helping to provide 'Funding' and 'Informing'. Generally, the public sector is expected to play an exemplary role for organizations. Supporting the provision of funding and information shows the commitment of local governments to support overcoming the two main barriers to adopting the CE (see before).

Table 2: Overview of results for the survey elements

		Elements	Mean	Mean(Normalized)	SD	Rank
Context	**1) Barriers**	**Funding**	3.78	0.24	0.96	1
		Knowledge	3.60	0.04	0.92	2
		Regulation	3.40	-0.17	0.96	4
		Political support	3.44	-0.12	1.09	3
	2) Motivation	**Citizens pressure**	3.29	-0.40	0.97	7
		Governments pressure	3.26	-0.43	0.97	8
		Economic	3.59	-0.10	1.04	5
		Climate	4.07	0.38	0.89	1
		Material	3.58	-0.11	1.01	6
		Environment	4.01	0.32	0.84	2
		Social	3.88	0.19	0.89	3
		Branding	3.83	0.14	0.89	4
Content	**1) Circular aspects**	**Extend**	3.69	0.06	0.92	4
		Reuse	3.70	0.06	0.97	3
		Share	3.55	-0.09	0.94	5
		Service	3.41	-0.23	0.99	7
		Efficient	3.45	-0.19	1.04	6
		Renewable	3.72	0.08	1.05	2
		Local	3.94	0.31	0.92	1
	2) Product	**ICT**	3.37	-0.11	0.96	5
		Vehicles	3.41	-0.07	0.95	4
		Packaging	3.44	-0.03	1.05	3

		Plastics	3.33	-0.15	1.15	6
		Textile	3.18	-0.30	1.05	7
		Building	3.72	0.24	0.95	2
		Food	3.90	0.42	0.90	1
Process	1) Stakeholders	**Business**	3.94	0.01	0.99	3
		Knowledge	3.85	-0.08	0.97	4
		Government	3.96	0.03	0.81	2
		Society	3.97	0.04	0.79	1
	2) Instruments	**Finance**	4.27	0.31	0.71	2
		Informing	4.25	0.29	0.66	3
		Legal	3.82	-0.14	0.85	6
		Strategy	3.90	-0.06	0.80	4
		Example	4.28	0.32	0.66	1
		Innovation	3.49	-0.47	0.99	8
		Bottom-up	3.86	-0.10	0.84	5
		Connect	3.79	-0.17	1.00	7

Clusters

To select the optimal number of clusters, the clValid function in R was used. Hierarchical clustering was performed using the Euclidean distance metric. The internal validation measures showed an optimal for making two clusters. For two clusters, a connectivity index of 2.93 was obtained, a Dunn index of 0.63, and a Silhouette value of 0.30. The positive Silhouette function implies some level of confidence for the clustering assignment. However, as was expected, the value is rather small because of the high number of variables. Next, the kmeans function in R was used to classify the observations into two clusters. This provided a close to equal split of the 124 observations in 64 (52%) observations in cluster 1 and 60 (48%) observations in cluster 2. An overview of the centers for both clusters is provided in Table 3, and a visualization in Graph 1.

Cluster centers for elements
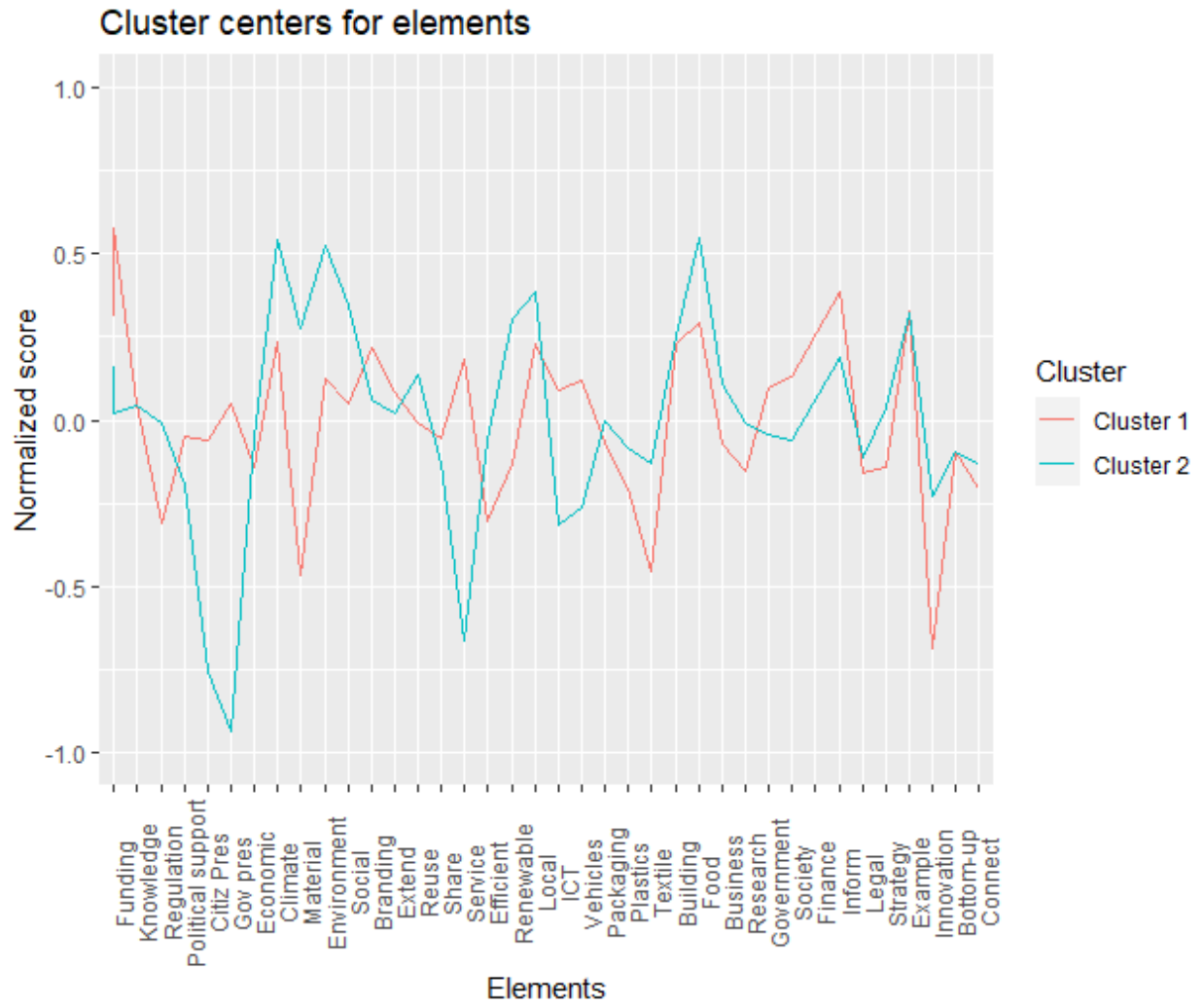
Graph 1: Line chart plotting cluster centers for normalized score on the survey elements

Table 3: Cluster centers for the survey elements with ranking

		Elements	Full	Cluster 1	Cluster 2
Context	**1) Barriers**	**Funding**	0.24	0.31 (1)	0.16 (1)
		Knowledge	0.04	0.05 (2)	0.04 (2)
		Regulation	-0.17	**-0.31 (4)**	**-0.01 (3)**
		Political support	-0.12	-0.05 (3)	-0.19 (4)
	2) Motivation	**Citizens pressure**	-0.40	**-0.06 (6)**	**-0.76 (7)**
		Governments pressure	-0.43	**0.05 (5)**	**-0.94 (8)**
		Economic	-0.10	-0.14 (7)	-0.06 (6)
		Climate	0.38	**0.23 (1)**	**0.54 (1)**
		Material	-0.11	**-0.47 (8)**	**0.28 (4)**
		Environment	0.32	**0.13 (3)**	**0.53 (2)**
		Social	0.19	**0.05 (4)**	**0.34 (3)**
		Branding	0.14	0.22 (2)	0.06 (5)
Content	**1) Circular aspects**	**Extend**	0.06	0.09 (3)	0.02 (4)
		Reuse	0.06	-0.01 (4)	0.14 (3)
		Share	-0.09	-0.05 (5)	-0.13 (6)
		Service	-0.23	**0.18 (2)**	**-0.66 (7)**
		Efficient	-0.19	**-0.30 (7)**	**-0.06 (5)**
		Renewable	0.08	**-0.13 (6)**	**0.30 (2)**
		Local	0.31	0.23 (1)	0.39 (1)
	2) Product value chains	**ICT**	-0.11	**0.09 (4)**	**-0.32 (7)**
		Vehicles	-0.07	**0.12 (3)**	**-0.27 (6)**
		Packaging	-0.03	-0.07 (5)	0.00 (3)
		Plastics	-0.15	-0.21 (6)	-0.08 (4)
		Textile	-0.30	**-0.46 (7)**	**-0.13 (5)**
		Building	0.24	0.23 (2)	0.25 (2)
		Food	0.42	**0.29 (1)**	**0.55 (1)**
Process	**1) Stakeholders**	**Business**	0.01	**-0.07 (3)**	**0.11 (1)**
		Knowledge	-0.08	**-0.15 (4)**	**-0.01 (2)**
		Government	0.03	**0.10 (2)**	**-0.04 (3)**
		Society	0.04	**0.13 (1)**	**-0.06 (4)**

	Finance	0.31	**0.58 (1)**	**0.02 (4)**
	Informing	0.29	**0.39 (2)**	**0.19 (2)**
	Legal	-0.14	-0.16 (6)	-0.11 (6)
2) Instruments	**Strategy**	-0.06	**-0.14 (5)**	**0.04 (3)**
	Example	0.32	0.33 (3)	0.32 (1)
	Innovation	-0.47	**-0.69 (8)**	**-0.23 (8)**
	Bottom-up	-0.10	-0.10 (4)	-0.10 (5)
	Connect	-0.17	-0.21 (7)	-0.13 (7)

The numbers in bold show where the cluster centers are significantly different (p<0.05)

Table 4: Descriptive results of external context for clusters

Characteristics	Cluster 1	Cluster 2	Full sample
#observations	64 (52%)	60 (48%)	124
#rural	**9 (31%)**	**20 (69%)**	29
#urban	**55 (58%)**	**40 (42%)**	95
#Walloon	**21 (37%)**	**36 (63%)**	57
#Flemish	**38 (63%)**	**22 (37%)**	60
#Brussels	5 (71%)	2 (29%)	7
Mean population	35902	28820	32475
Mean surface (km²)	**49,10**	**71,77**	60,07

The numbers in bold show where values are significantly different among the clusters (p<0.05)

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For the internal context, the clusters show no significant difference for the two most important barriers, being 'A lack of funding' and 'A lack of knowledge and awareness'. Only for 'A lack of appropriate regulation, taxation, and policies' a significant difference in the mean score of importance was found between the two clusters. In cluster 1, this barrier has the lowest importance, while in cluster 2, 'A lack of political support' is the least important barrier. The most important motivations for both clusters are 'Tackling climate change', 'Tackling other environmental issues', and 'Improving the social situation'. Both clusters also score 'Improving the municipality's reputation' higher than average. On the contrary, the clusters differ in what is least important. Cluster 1 has the lowest average scores for 'Tackling material scarcity' and 'Creating economic opportunities'. For cluster 2, both pressures scored lowest on average.

The content of the strategy of both clusters is characterized by having the highest rates of importance for 'Local production', 'Conservation', and 'Reuse and closing of material cycles'. For cluster 1, 'Servitization and virtualization' are also more than averagely important, while for cluster 2, 'Renewable resources' are highly important. Both clusters mainly focus on the 'Food, water & nutrients', and 'Construction & buildings' product value chains. In cluster 1, 'Batteries & vehicles' and 'Electronics & ICT' have a significantly higher average importance score. For cluster 2, 'Packaging' and 'Plastics' are in places three and four of the highest mean importance.

For the implementation process, both clusters differ significantly in the mean importance given to the different stakeholder groups. Cluster 1 has the highest values for 'Society' and 'Government', while cluster 2 has 'Businesses' as the most important group. Both clusters gave the highest average importance scores to 'Informing' and 'Leading by example' while giving the lowest scores to 'Stimulating Innovation', 'Connecting stakeholders', and 'Legislation and taxation'. In cluster 1, 'Funding' is also a main instrument, while for cluster 2, 'Strategic positioning' is among the most important instruments.

Discussion

This section discusses and interprets the results of the cluster analysis. First, the similarities of both clusters are discussed, followed by their main differences defining two different strategies.

Similarities

The two clusters share the most important barriers to adopting the CE. This shows that not 'A lack of political support' or the 'A lack of appropriate Regulation, taxation, and policies' are the main barriers, but 'A lack of funding' and 'A lack of knowledge and awareness'. Both also have the highest mean score of importance for 'Tackling climate change', 'Tackling other environmental issues', and 'Improving the social situation', showing CE adoption is driven by environmental and social opportunities and not by pressure. The content of the circular strategies focuses on 'Local production' and the highest R strategies ('Conservation', 'Reuse and closing material cycles'). Especially the 'Food, water & nutrients' and 'Construction & buildings' are the most important value chains, as observed in the general results. Both clusters have the highest average importance scores for 'Leading by example' and 'Informing' while being lowest for 'Stimulating innovation', 'Connecting stakeholders', and 'Legislation and taxation' as key implementation instruments.

The results imply that Belgian local governments adopt the CE to address sustainability issues by giving the good example and building awareness, which is currently lacking. They focus on local implementation of the highest R-strategies, especially in the bio- and building industry, but are constrained by a lack of resources.

Differences

Both clusters contain significant differences in mean scores of importance given to the elements and the order of importance. These differences are discussed below to interpret the clusters. A title was also given to the strategy. However, it is recognized that this title only contains part of the information and should be used carefully.

Strategy cluster 1: Enable society-driven smart circularity

In this cluster, 'A lack of appropriate regulation, taxation, and policies' is the least important barrier. 'Tackling material scarcity' and 'Economic opportunities' are also ranked least important, not reflecting the initial focus of the CE (Ghisellini et al., 2016). The strategies of these local governments include 'Servitization and virtualization' among the most important circular aspects and also focus on 'Electronics & ICT' and 'Batteries & vehicles' reflecting some links with the smart transition (Prendeville et al., 2018). The implementation process gives the highest importance to 'Civil Society', implying consumer-based, bottom-up action, with the support of 'Governments' as the second main stakeholder. 'Funding' is a main instrument in the strategy of the local governments in this cluster, reflecting an enabling role as local government (OECD, 2020). Prendeville et al. (2018) also observed a similar strategy in Barcelona, where the smart and circular agenda were strongly linked, and the approach had shifted to more inclusion of citizens. If we look at the characteristics of these clusters, a significantly larger proportion of Flemish (63%) and Brussels (71%) local governments are in this cluster. The mean number of inhabitants is not significantly different from cluster 2, but the average size of this cluster is significantly smaller. By making a distinction between 'rural' municipalities with a population density lower than 150 inhabitants/km² and urban municipalities with a higher population density, a significantly larger proportion of urban local governments is part of cluster 1 (European Commission, 2012). This fininding correlates to having a similar mean number of inhabitants, while having a significantly smaller surface.

The results show that urban, Flemish, and Brussels local governments have more often an enabling strategy focused on civil society and digital transformation towards the CE.

Strategy cluster 2: Promote CE among businesses to reduce waste

For cluster two, 'A lack of political support' has the lowest average importance score, showing that for these municipalities, there is more support for the CE by politicians. Both pressures are also among the least important motivations for adoption, reflecting a positive attitude toward the relevance of the CE. This strategy includes a focus on the use of 'Renewable resources' among the most important circular aspects and scores 'Plastics' and 'Packaging' among the most important product value chains. These findings relate to a focus on reducing plastic and packaging by using renewable resources. Therefore, producers are key, reflected by the highest importance given to 'Businesses' as the main stakeholder group for CE implementation. These local governments promote the CE by providing 'Strategic Positioning', which is highly important in this group. Prendeville et al. (2018) observed a similar strategy in Glasgow, where the business-centric narrative was also dominant. Waste management was also the most implemented circular practice in Italian SMEs and the Portuguese central public sector, reflecting a low implementation level with much further potential for the CE (Klein et al., 2022; Mura et al., 2020). For the characteristics of this cluster, a significantly higher proportion of Walloon local governments is part of this cluster. On average, the responses in this cluster come from municipalities with a larger surface area. The proportion of rural municipalities in this cluster is also significantly higher.

This implies that local governments of rural and Walloon municipalities more often adopt the second strategy with a focus on reducing waste on the producer side.

Conclusion

The adoption of strategies is a key step in the CE transition of local governments (Fratini et al., 2019; Montenegro Navarro & Jonker, 2018; Paiho et al., 2020). Current literature has only considered circular strategies of a small number of cases in an explorative way, lacking the ability to generalize (Prendeville et al., 2018). This study provides for the first time a distinction between two circular strategies based on a large number of local governments. A quantitative survey was conducted to question the context, content, and process of this strategic change across Belgian local governments (Pettigrew, 1985).

The results show that 182 (58,9) of the local governments that responded are currently considering the CE. This shows that European ambitions for the CE have been translated into local strategies, supporting the relevance of research on local strategies for the CE. However, this finding also implies that more needs to be done to integrate the CE in all local governments to achieve climate neutrality by 2050 (European Commission, 2019).

Based on the responses, two local strategies are observed that share multiple similarities in what is most important. The context of both strategies is characterized by the high importance of a lack of funding, knowledge, and awareness as the main barriers to adopting the CE. This implies that local governments support the adoption of the CE but have difficulties finding the cognitive and financial resources to do it. The motivation for adopting the CE results from social and environmental challenges, with tackling climate change as the most important challenge. Both strategies focus on high R strategies and local production, mainly in the bio- and building economy. To address the lack of knowledge and awareness, local governments include informing as a key instrument in their strategy and are committed to leading by example. These results imply that local governments need to be financially supported and informed to make their operations circular and create awareness

across stakeholders. This support is especially needed in the key value chains identified in their strategies. However, this focus could also imply ignoring relevant aspects of the circular economy that might be omitted because local governments are unaware of the circular potential in this domain.

Keeping in mind these similarities, significant differences are also observed between the two strategies. A first strategy is described as enabling a society-driven smart, circular transition. This strategy differs from the classical view of circularity, giving low importance to tackling material scarcity, economic opportunities, and businesses. Here, the most important stakeholder groups are the civil society, followed by governments, implying bottom-up change enabled by governments through the provision of financing, for example. This strategy focuses more on servitization and virtualization in the electronics and ICT value chains and for batteries and vehicles, reflecting a focus on digital, smart solutions.

The second strategy fits better with the classical view on CE and can be described as promoting circularity among businesses to reduce waste. Here, companies are the key stakeholder groups, and the strategy focuses on using renewable resources in packaging and the plastic industry to reduce waste. For this strategy, the CE is promoted by the local government because of the belief that it can provide solutions to waste issues.

The first strategy is mainly adopted by local governments in the Brussels and Flemish region and has, on average, a higher population density. Rural and Walloon local governments more often adopt the more classic view of CE. The two strategies imply the importance of recognizing that not all local governments adopt the same approach for the CE.

These results provide insights into the strategies of a large set of local governments and help in understanding the current situation of the CE adoption across Belgian local governments. By identifying the most important aspects in the context, content, and process of their strategies, the

scientific and practical support of local governments can be better fitted to their strategy. At the same time, it allows to see currently omitted aspects of the CE in Belgian local governments. The two strategies provide a new typology of circular strategies that provides a more nuanced view of different strategies adopted by local governments.

Nevertheless, this study has some important limitations. Even though the strengths of quantitative research, it fails to provide an in-depth understanding of the strategies and the context. Multiple case studies can complement these more general findings. Using only one person's response to determine the local government's strategy makes these results also vulnerable to personal perceptions. Different perceptions might exist in a local government and could be studied by future research. The focus on Belgium makes these results also country-specific. Therefore, future research can replicate this study in a different geographic area to see if similar strategies are observed or to determine the influence of national governments on local strategies. Finally, the results were found to be biased because of an overrepresentation of larger municipalities and might suffer from a self-selection bias.

The further adoption of the CE has to be supported by more research on different strategies and to study how these strategies are emerging and evolving through time with longitudinal studies. The fit between strategies and their local context should also be further explored, looking at different geographical areas, political influences, economic aspects, size, etc. Furthermore, the next steps in the CE adoption have to be studied to learn how strategies are best integrated in internal management and policy-making. Studying the implementation of strategies in the management control of local governments can provide useful lessons about ensuring the objectives are met. Ultimately, the relationship between strategy and performance needs to be studied for local governments to see which circular strategies contribute to sustainable development.

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