



How is the construction sector addressing the Circular Economy? Lessons from current practices and perceptions in Argentina

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How is the construction sector addressing the Circular Economy? Lessons from current practices and perceptions in Argentina

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Abstract. The Construction and demolition (C&D) sector mobilise a significant number of resources and at the same time is responsible for a large fraction of waste worldwide (40%-60%). Although, the environmental impact of these by-products is low, waste generated finishes in landfills, is downgraded and because of its volume it has become a priority at different governmental levels. In this context, the Circular Economy (CE) provides a set of strategies to improve efficient use of resources, thus reducing the environmental footprint of C&D. Most academic literature has focused on China, Europe, or the US, but knowledge about CE practices and perceptions in global south countries is scarce. To reduce this knowledge gap, this study focuses on Argentina and explores what are the perceptions, challenges, and opportunities for adopting CE strategies by the C&D sector. To achieve this goal, a survey was developed and distributed with support from the Argentinean Chamber of Construction (CAMARCO), among members of the chamber and other C&D relevant networks. The survey was carried out in the Autumn of 2021 and 88 C&D firms representing different size, longevity and business cycle responded. The results of the survey show that most of surveyed firms are trying to engage with the concept of CE. Secondly, a lack of digitalisation and information are seen as important barriers to transition to CE. Finally, policy makers should focus on providing financial and tax incentives to secure a better environmental future.

Keywords: Construction and demolition – Circular Economy – Barriers and Opportunities

1. Introduction

The latest report produced by the IPCC provides compelling evidence of how human activities have been affecting the environment and that urgent mitigation actions are needed to secure the scenario of at least 1.5C increase in global temperatures [1]. Furthermore, a similar conclusion can be drawn from the research conducted by the Stockholm Resiliency Centre that indicates that we are currently living beyond Earth's bio-capacity of regeneration, and it is crucial to reduce environmental damage to avoid unlocking irreversible planetary negative consequences [2], [3].

In this dim context, the construction and demolition (C&D) sector plays a critical role and improving its operations can lead to significant environmental benefits [4]–[6]. Firstly, the construction sector is responsible for generating large amounts of GHGs (25%-40% global CO₂), while using significant amounts of material and producing large amounts of waste (20%-70% municipal waste) [4]–[6].



Additionally, building quality affects its water and energy consumption performance and overall, the built environment affects the performance of cities and regions (buildings are responsible for 25%-40% energy use) [4]–[6]. For all these reasons, research and improvements in the C&D will contribute to reach Paris Agreement goals by reducing human's environmental pressure.

During the last decade, the concept of Circular Economy (CE), has been gaining popularity among the private sector, policy makers and academics. Until now, materials have been extracted, then transformed into products to be used and finally discarded. Under this linear economic model, value is created by producing and selling as much product as possible. This logic has proven to be unsustainable and resulted in unwanted consequences that need urgent solutions [7]–[9]. CE is presented as an opposing alternative to the linear economy (“take-make-dispose”) and provides an opportunity to rethink C&D practices to minimize emissions while reducing the amount of materials that are being extracted from nature [10], [11]. However, CE is still found to be in early stages of maturity and further research is needed in different directions to fully comprehend to what extent CE could materialize its promises [12].

The main objective of this article is to provide an initial description of how the concept of CE is perceived and to what extent CE strategies are being used by the C&D sector in Argentina. The analysis of the results provides initial insights about barriers and enablers of CE in the Argentinean context. Although, the results presented in this article are mainly descriptive, to our understanding Latin American (LATAM) economies are underrepresented in the literature on these topics, and these initial results can contribute to guide decision makers while developing a CE action plan. Finally, the methodology and survey used in this study can be replicated with ease in other similar contexts.

The following section provides a background of how the CE has been incorporated into C&D practices and what are the challenges and barriers reported in different contexts. Then the local context is presented. Section 3 describes the methodology used in the study and Section 4 reports on the results of the survey. In the final section of the paper learnings and contributions are presented.

2. Background

This section provides an overview of different efforts to capture how CE has been perceived by the C&D sector in different contexts. Bibliographic reviews point out that most research has been conducted in the context of EU, China and to some extent USA [13]. However, global economic challenges must be addressed globally and decoupling environmental degradation from economic growth must occur systemically across every human settlement in the globe.

In China, a survey to 77 stakeholders working with C&D residuals revealed that one of the main barriers they faced was the lack of client demand, and government support was suggested as one of the most influential factors to facilitate the transition towards CE [14], [15].

Using a similar methodology applied to the Australian context, [16] shows that technical barriers were found to be the most important. When looking at specific factors it was observed that lack of consistent data, and high costs with sorting and processing waste were some of the top ranked barriers. The study suggests that Waste Trades are a viable sustainable strategy to reduce waste in the C&D sector. In the USA, [17] deploy a survey to describe the state of practice of CE strategies. The results of the survey on 130 firms show that prefabrication, selective demolition, and open-loop recycling were the most disseminated actions. Among the identified bottlenecks, the study showed that costs and lack of clear business models hinder the transition to the CE.

Within the UK, [18] examine the level of awareness of the C&D sector with an online survey. From a total of 110 valid responses, they found that at industrywide level there was a lack of awareness, and that the lack of consensus regarding how CE is applied in the built environment is major barrier. Incentives to design for end-of-life and developing market mechanisms can contribute to accelerate the transition towards the CE. Respondents suggested that stronger business cases were needed to show the financial benefits of CE.

Finally, [19] use an innovative method to prioritize barriers in Guangzhou, China. Using a survey of 288 firms, the study concluded that current C&D is lacking control mechanisms. The most ranked barriers can be associated with lack of state incentives, a poor regulatory framework, and insufficient education on CE.

There has been limited academic research done about CE practices in the C&D sector in Latin American countries [20]. A comparative study [21] between Brazil, the EU and the USA shows that Brazil was performing well below the other countries: in the EU more than 80% of C&D waste is recycled, in the USA 30%, and estimates in Brazil were about 8%. Moreover, the study highlights the need to work with same definitions and provide consistent statistics to reduce uncertainties.

In Chile, [22] discuss the willingness of firms to pay for C&D waste. A survey to 55 firms provided evidence that knowledge about CE, productivity and state actions affect the willingness to pay for C&D waste and 42% of firms said to understand how to deal with their waste and that they have CE in mind. Another survey to 314 C&D stakeholders in Chile showed that 33% of the sample considered to have high or very high knowledge about CE and that 46% think that the progress done by their organization to implement CE strategies is very low or low [23]. No articles about Argentina were found at the time this article was written. Consequently, new knowledge could be extracted from exploring to what extent and how CE is being incorporated in other contexts such as Latin America and the Caribbean countries (LAC) [13], [24].

3. Case study

Argentina is the 3rd largest economy of LAC with a total GDP of 382 thousand million USD, it represents about 9,2% of the LAC economy. As in any other country, the C&D sector has a significant role in the economy. It is estimated that the contribution of the sector in terms of Gross Value Added (GVA) is approximately 3,6% and is responsible for the formation of 60% of the Gross Fixed Capital of the country.

The C&D sector employs 420 thousand workers (6% of the total workforce), but this number is an underestimation since 75% of the workforce in the sector is informal and estimates indicate that there are approximately 23 thousand C&D firms [25]. Single worker firms represent 35%-40% of the total amount of firms. When looking at the firms by their size in terms of employees, the most common structure is small firms that have between 0 and 9 employees (73%). The second biggest category is firms with 10 to 19 employees (12,3%) and 20 to 29 employee firms are found in 9,2% of the cases. The Metropolitan Area of Buenos Aires (AMBA), where 40% of the population is located holds a similar proportion of C&D firms (39%), then the central region is the location of 34% of firms, and the remaining 27% is distributed similarity across the rest of the country.

At a national level the government issues annually, construction permits equal to 8 million m² and 67% of the value generated comes from residential projects, 17% from public projects and 16% from non-residential projects. Argentina, like many other countries in the global south, face housing deficit not only in terms of number of units but also in terms of quality. The Ministry of Infrastructure estimated that 33% of the houses were inadequate (3,3 million units) and the Argentinean Chamber of Construction CAMARCO estimated that 1,2 million new units were needed in 2018. On top of that other infrastructure developments such as roads, railroads, powers supplies, pipes, among others are needed to continue developing the country's society.

According to [26], Argentina lacks reliable information at a national level regarding total amount of waste generated, its characteristics or how it has been treated. In any case, the National Strategy to Manage Urban Solid Waste Streams [27] estimated that Argentina generates 15 thousand tons of waste per day and that that approximately 44% is disposed of inadequately (3%-6% are C&D waste). Currently, there is only one authorized waste treatment facility located in the City of Buenos Aires that receives per day 600 fully loaded trucks with waste material.

4. Materials and Methods

An initial literature exploration about what CE strategies exist and how they are being implemented in C&D projects, combined with semi-informal interviews to different C&D stakeholders, was used to define a survey to capture how CE is perceived by C&D firms. CAMARCO, the largest C&D trade union at national level, facilitated access to its affiliates but also helped gain trust and reach out to other C&D firms.

After several iterations with the stakeholders a survey about CE in the sector was formulated. The survey met two main requirements. First, since it was unique in its kind, it was not very technical or specific. It was assumed that the knowledge level of the sector regarding CE was low and consequently we wanted to avoid lack of answers. Secondly, since the survey was going to be delivered online, it could not take more than 10 minutes to answer it, to avoid a high non completion rate.

The survey was online on the 15th of November and remained open for a month. It is relevant to notice that to maximize the number of answers, the survey was launched during a set of sustainability seminars offered by CAMARCO. Moreover, CAMARCO offered a discount voucher for a training course on completion of the survey.

4.1. Survey questionnaire

The survey had 23 questions distributed in 4 modules: (i) Characteristics, (ii) Perceptions about CE, (iii) Current practices and (iv) Barriers and opportunities. The survey was developed to ensure the maximum number of answers and module iii was only programmed to be answered for those firms that were engaging with the concept of CE.

The *Characteristics module* contained seven initial questions that provided a description of the sample and the sector. It included questions such as: number of years in business, the number of employees, the province where the firm had projects, what type of projects they worked on and in what stages of the life cycle they work.

The *CE perceptions module* was intended to capture the overall intention of C&D firms to engage with Circular Economy strategies. The first question of the module directly asked what the firm's position towards CE was and gave three options: "no interest", "we are working to integrate the concept" and "CE is an integral part of the firm". These choices force the respondent to reveal as clearly as possible the firm's position. Using the same valuation system, the next question aimed to capture the firm understanding about CE, based on the statements in [23]: "is fundamental to reduce waste and avoid landfilling", "is fundamental to reduce emissions", "it will help enter new markets", "it will help reduce costs by avoiding new materials", "it contributes to increase the firm's productivity", and "it should be fully integrated in our firm". The module ended asking whether clients demanded better environmental practices.

Before looking at specific CE practices (module iii), we asked if the firms were working with some of the 5Rs: (R1) Refuse, (R2) Reduce, (R3) Reuse, (R4) Repair and (R5) Recycle. In this case, for each R the firm had to choose between 5 levels ("Not relevant" to "We apply it"). Ideally, the more engaged with the concept, the more 5Rs the firms should be engaging with. The module ended asking whether clients demanded better environmental practices.

The *Current practices module* was only answered by those firms that declared to work with, or that were trying to integrate, CE practices. The first question was to understand what strategies the firms had used to integrate CE practices. In this case, multiple options were allowed and a box to include other options was offered. Next, the firms were given 5 options to evaluate a selection of CE strategies for C&D. Again, the valuations were, "We have not heard the term" to "We apply the strategy in all the projects". Different CE strategies for C&D described in [17], [28]–[30] were selected for evaluation: (S1) Industrial Symbiosis, (S2) Selection of material from origin, (S3) Using durable materials, (S4) Design for disassembly, (S5) Design to reduce waste, (S6) Layer construction and (S7) Material passports. In the Practices module three, a specific investigation on data collection and availability was made. It was important to know if the C&D firms collected data about: (i) water usage, (ii) waste composition, (iii) energy consumption, (iv) waste weight and (v) recycled material used. Moreover, a

control variable to understand the degree of digitalization was introduced: if they had statistics about the time duration of projects. The module was closed with three “Yes/No” questions: (i) Does the firm works with local products? (ii) Does the firm have statistics about waste material produced? And (iii) Does the firm know where the waste material ends?

Finally, the *Barriers and opportunities module* contained two questions about barriers and opportunities. In both cases, the firms were given three possible answers: “Irrelevant”, “Neutral” and “Relevant”. Following [14], [31], [32] a list of factors was selected, including eight enablers and eight barriers presented in a matrix form. In this matrix, the firms marked their valuation for each factor. The different barriers were transformed to numeric values (1-5) and averaged to synthesize the results of this module. **Figure 1** contains the enablers and barriers evaluated.

5. Results

A total of 107 answers were collected during November and December 2021. A total of 19 observations were ignored in this summary because most of the answers were incomplete. Based on the response about their perception of CE, only 75 firms answered module 3. **Table 1** to **Table 4** show a summary of the main questions of the survey.

5.1. Firm Characteristics

The surveyed C&D firms intervene in different stages of the building life cycle: 25% of the firms declared to intervene during the construction stage, 16% have active roles during the design stages and 11% engage during the maintenance stage. Approximately 6% of the surveyed firms work during the demolition stage.

Most of the surveyed firms work with residential projects (41%), the second and third most frequent type of projects are industrial and commercial developments (16% & 13%, respectively). The rest of the firms work with infrastructure or public space projects. On average these firms have been working for 16 years, with median age being 10 years and the oldest firm with 80 years in the sector. As pointed in the description of the case study, most of the firms are in the Central region and the AMBA. The survey shows similar geographical distribution for the population of firms in Argentina. 42% of firms being in the center and 27% in the Buenos Aires province. Patagonia is the third most represented region with 16%. Further details of the module are found in **Table 1**.

Table 1. Firm characteristics module, in detail. Summary of main questions

Firm Characteristics							
Age of firm	Less than 5	Between 6-10	Between 11-25	Between 26-100	Average	Total	
	30	17	21	19	15,9	87	
Employees	Less than 10	Between 11-20	Between 21-50	Between 51-100	More than 101	Total	
	40	8	13	10	17	88	
Life cycle engagement	Development	Design	Construction	Maintenance	Specialised services	Demolition	
	12,0%	15,8%	25,1%	11,0%	31,3%	4,8%	
Built-up typology	Single family house	Multifamily house	Gated urbanization	Commercial	Industrial	Infrastructure	Public spaces
	19,5%	20,3%	8,4%	13,5%	15,9%	11,6%	10,8%

5.2. General perceptions of CE

Most firms declared that they were positive towards the concept of CE, with 80% stating that they are actively working to implement the concept (66) and 10% (9) state that CE practices are an integral part of their daily practices. The remaining firms (8) indicated that they are not interested in exploring or

working with the concept of CE. As expected, in Buenos Aires the place where most firms have projects, all firms were working or have implemented CE strategies, whereas no firms working on the north of the country (lower GDP), answered to have incorporated CE strategies.

In 20% of the cases the customers never have environmental demands and 43% of the firms rarely face these types of demands. Only 7% of the firms face this demand in most of the projects. Results show that firms agree that CE can contribute to reducing environmental damage and reducing costs (88% and 90%), but they also believe that adopting CE strategies will contribute to enter new markets or improve the productivity (53% and 61%).

Overall (R4) repairing is the CE component that is more integrated, followed by (R2) reducing the number of materials and products used. (R5) -for their practices. Further details of the module are found in **Table 2**.

5.3. Current practices

When looking at the CE strategies used: the most popular one was (S3) “Using durable materials” and (S5) “Design to reduce” waste with 25% and 19% of firms applying it respectively. It is important to highlight that the C&D firms were particularly not knowledgeable about: “Material passports” (62%) “Industrial symbiosis” (51%) or “Designing for disassembly” (40%). Besides these specific strategies, 86% of the firms try to work with local materials and products. Further details of the module are found in **Table 3**.

Table 2. General perceptions of CE module in detail. Summary of main questions

CE perception							
How is CE perceived?	No interest	Working on	Integral use				Total
	8	71	9				88
Do clients have environmental demands?	Never	Few times	Sometimes	All projects			Total
	18	38	26	6			88
Relevance of SRs	No relevance	Never	Neutral	Trying	Integral use	Total	
(R1) Refuse	0	11	15	48	12	86	
(R2) Reduce	1	6	11	51	16	85	
(R3) Reuse	1	17	19	39	8	84	
(R4) Repair	0	7	16	38	25	86	
(R5) Recycle	1	14	20	40	11	86	

Table 3. Current practices of CE module in detail. Summary of main questions

CE practices							
Strategies	Never heard of it	Not interested	Working to integrate	Only in few projects	Apply integrally	Irrelevant	Total
Industrial Symbiosis	38	1	13	9	1	12	74
Local materials	12	1	22	22	6	11	74
Durable materials	5	0	23	19	23	4	74
Design for disassembly	24	4	19	14	3	11	75
Designing-out waste	6	0	27	15	18	9	75
Building in layers	26	4	20	12	4	9	75
Material passport	43	1	14	10	0	7	75

5.4. Information availability

To track environmental progress and be able to make informed decisions, information needs to be taken into consideration. This means that data and statistics about the projects need to be produced to measure the effect of different strategies. In 60% of the cases, the firms did not know where their waste materials ended and only 23% of them had data about the waste produced after a project. Regarding the control

variable (duration of the project), 37% of the firms had data of all their projects and 12% had a database in place and used the information. Although 20 firms stated to collect this information, they are not using it (27%) and only 14% of the firms were not interested or did not collect information about the duration of their project.

When it comes to tracking and recording specific information, most firms stated that they do not have data, but there was intention of having it in place. Energy consumption and waste composition information are the domains where more positive responses were found. In 24% of the cases, firms collect information or have a data base of energy consumption and 15% about waste composition. Water usage and waste weight are the least developed statistics. Further details of the module are found in **Table 4**.

Table 4. Information availability module in detail. Summary of main questions

Information availability						
Knowledge domains	No interest	No data	Data, but no use	All projects	DB and usage	Total
Duration of project	4	14	20	28	9	75
Energy consumption	7	40	10	13	5	75
Waste composition	7	44	12	8	4	75
Usage of reused materials	10	43	11	7	4	75
Water use	10	48	8	5	4	75
Weight of waste material	13	46	7	4	5	75

5.5. Barriers and opportunities

The highest value of the averaged results was environmental concerns, followed by cost reduction (3.9 and 3.3 respectively). The lowest ranked reasons were client demands and tax advantages (2.4 in both cases). The most relevant factors were the lack of markets to recover materials and the lack of governmental support (75% and 73% of firms found these factors relevant). As a third factor lack of information was considered relevant for 68% of firms. The most irrelevant factors were the value of waste materials, that is not demanded by clients and fragmentation of the supply chain.

When looking at what factors contribute the most to transition to the CE, 82% of the firms believe that having financial incentives in place is a relevant factor and secondly to provide schemes to return materials (80%). It is important to highlight that design tools and tutorials was the lowest ranked motive with 63% of the firms acknowledging it as a relevant driver.

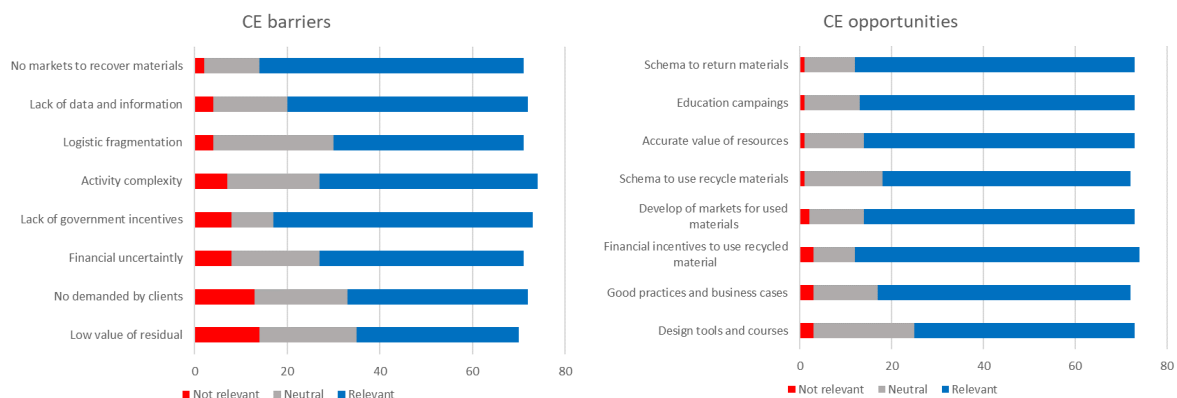


Figure 1. Barriers and enablers of CE

6. Discussion

Research about CE in South America is still at early stages, and these results at a national level help to provide an initial description of the C&D sector and its progress towards the CE in the Argentinean context. Namely, they give evidence of which firms are approaching the CE concept and what are the main barriers and enablers faced by the sector. The results show that there is a high percentage of firms working to incorporate the concept of CE (80%), while the rest is equally distributed among those that declare to be actively working with the concept and those that are not interested in engaging with CE. Although several firms were found familiar with some CE terms or strategies, in practice, CE strategies are not in place yet and basic information to transition to the CE is not being captured by firms.

The findings of the study suggest that the ecosystem of firms is in early stages of adopting the CE: still researching and exploring the concept instead of applying various strategies. However, among the most used strategies firms have stated that they work to minimize waste and use durable materials as much as possible. To some extent this could be motivated to reduce costs or increase their returns. Also, it is important to highlight that the objectives, definition and form of the CE are still unclear [33] and some of these strategies might be already in place but firms are not familiar with the label given by the academic community or policy makers [34].

Results about data collection and digitalization show that a small percentage of firms is capturing and/or using critical information (only 30% of the firms do not produce statistics about the duration of their projects and another 19% not using this information), means that even less produce or use information about resource usage or waste produces. Although enhancing digitalization techniques can potentially improve the overall sector productivity and how resources are being managed, a small percentage of firms has reflected positively in their capabilities of using information about waste and resources [35], [36].

Finally, results show that consumers are not putting enough pressure for firms to start adopting CE strategies voluntarily. Based on these results, firms have declared that the introduction of financial or taxation incentives are the most important factors to enhance CE practices. At the same time, by exploring the answers in different regions, it was noted that firms working in Buenos Aires present themselves as more environmentally friendly, thus advertisement and education campaigns could improve the knowledge of the rest of the country.

6.1. Limitations

The main limitation of the present study relies on the methodology adopted. Since the survey was online and we wanted to capture how the CE was perceived in the country, there was a trade-off between the desired number of answers and how detailed we wanted them to be. Moreover, as research in the country and sector is still limited, the survey covered basic topics of CE, which took space from more in-depth questions

Additionally, since the survey relies on self-declared answers from an employer of a firm, it is difficult to understand to what extent these answers reflect the firm's position towards CE or the workers personal beliefs about the firms. Ideally, to overcome this subjectivity future studies should be based on firm's statistics provided to an Environmental Protection Agency.

This study has mostly reached C&D firms, but the industry is characterized by other stakeholders: consumers, public officers, or furniture designers and so forth. To adequately characterize the sector and comprehend how CE is being integrated into practices, it is important to engage with the stakeholders as broadly as possible. For instance, sub-contractors are found to be less aware than other actors [18]. Finally, since the C&D sector in Argentina operates under high levels of informality, environmental policies should work towards introducing the concept of CE and sustainability practices to informal firms.

6.2. Future work

In the future, the survey results can be used to produce synthetic indicators able to capture relevant information about the four different modules explored in the survey. These indicators can contribute to

track progress in CE and evaluate a theoretical framework to define policies to enhance CE in different contexts [37].

As a closing question, in the survey, firms indicated if they would allow the project members to contact them and conduct a more in-depth interview about CE in the C&D sector. About 60% of the respondents provided their contacts. These interviews can lead to more relevant insights for policy makers.

Finally, this article has described a survey that can be replicated in other contexts where information is limited. By using a similar questionnaire, a comparative study of the region can contribute to further understand differences across contexts and what policies could be developed to enhance CE practices.

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