



Creating materials banks  
from digital urban mining

## **D8.2 MARKET ANALYSIS REPORT.**

Communication of the result obtained in the market analysis as well as the level of acceptance of the target technology.

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## **EXECUTIVE SUMMARY**

This report presents the findings of a comprehensive market analysis conducted to assess the potential adoption and the level of acceptance of the technologies deployed within SUM4Re at the demonstration sites among key stakeholders from the construction industry. The study combines quantitative market indicators; such as market size, growth potential, and competitive landscape, with qualitative insights into stakeholder attitudes, perceived benefits and potential barriers and readiness for technology adoption. The primary objective is to gather information from the stakeholder point of view to understand their needs for an effective market entry of the technologies. Special attention is given to the identification of market segments most receptive to the technology.

The analysis applies the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) framework (Venkatesh, Thong, & Xu, 2012) to evaluate adoption drivers and barriers. Core constructs from the original UTAUT model; performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh, Morris, Davis, & Davis, 2003), were complemented by consumer-focused factors such as hedonic motivation, price value, and habit. This combination enables a more holistic understanding of user acceptance, capturing both functional benefits and experiential or economic considerations that influence decision-making.

Key findings indicate that performance expectancy is the strongest determinant of adoption intent, with stakeholders showing a high likelihood of adoption when clear performance advantages are communicated. Effort expectancy and facilitating conditions also play a significant role, highlighting the need for user-friendly interfaces and adequate technical support. Price value emerges as a critical factor, particularly in cost-sensitive segments, while hedonic motivation influences early adopters seeking innovation-driven experiences.

The report concludes that the market is moderately receptive to the target technology, with substantial growth potential if adoption barriers are addressed proactively. Recommended strategies include targeted communication campaigns emphasizing measurable benefits, tailored pricing models, and the development of robust support infrastructure to foster long-term use.

At last, survey's input evaluates Circularity Mechanisms, Recycling Techniques, and Technological Knowledge within SMEs in the construction industry. In particular, analysing these indicators within the market provides insights into practices for the management of resources, methods and technologies for material recovery and reduction of demolition waste, and the degree in which SMEs integrate technical solutions to support circular economy goals.

## **GLOSSARY**

### **Terms, Abbreviations, and Acronyms**

BIM	Building Information Modelling
CAGR	Compound Annual Growth Rate
CDW	Construction and Demolition Waste
CE	Circular Economy
CEAP	Circular Economy Action Plan
CM	Circularity Mechanisms
DAC	Development Assistance Committee
DPPs	Digital Product Passports
ESPR	Eco-design for Sustainable Products Regulation
EU	European Union
MPs	Material Passports
OECD	Organisation for Economic Co-operation and Development
OSD	Organizational & Strategic Drivers
RT	Recycling Techniques
SAS	Social Acceptance Scale
SDA	Spatial Data Acquisition
SMEs	Small and Medium-sized Enterprises
SWOT	Strengths, Weaknesses, Opportunities and Threats
TAM	Technology Acceptance Model
TK	Technology Knowledge
UTAUT	Unified Theory of Acceptance and Use of Technology
UTAUT2	Unified Theory of Acceptance and Use of Technology 2

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## 1. Introduction

In an increasingly competitive and dynamic global economy, understanding market conditions, consumer preferences, and the factors influencing technology adoption are essential for informed decision-making. Market analysis serves as a critical tool for assessing the potential success of a product, service, or innovation by examining the interplay between market demand, competitive forces, and socio-economic trends (Kotler & Keller, 2022). Beyond simply quantifying market size, such analyses aim to capture qualitative insights that reveal how stakeholders perceive, evaluate, and ultimately accept new technological solutions (Rogers, 2003).

The objective of this study is to understand the target audience disposition and their current circular economy practices in order to offer potential solutions for an improved use/supply of secondary materials and construction and demolition waste management. The focus is in understanding the predisposition to adopt innovative technologies because they are essential for a circular economy, as they enable efficient material recovery for reuse, optimize resource flows, facilitate the management of construction and demolition waste (CDW) and support scalable, transparent, and innovative circular practices.

This report focuses on the communication of findings obtained from a comprehensive market analysis, with particular emphasis on the level of acceptance of the target technology among potential users and stakeholders as well as the barriers they perceive when it comes to introducing new technologies inside their organizations. This report aims to provide actionable insights that can guide decision-makers in tailoring their approach to market entry, promotion, and stakeholder engagement.

### Research objectives:

- a) Insights into SMEs circular economy practices. Establish indicators related to CE practices.
- b) Understanding of SMEs predisposition for innovative technologies adoption for CDW management.
- c) Strategies for enhancing technology adoption among SMEs.

### Methodology:

The research methodology for this report is based on a mixed-methods approach, combining a desk-based analysis to identify drivers and barriers for technology adoption and assess market size as well as revisiting previous studies on technology acceptance from 2020 to 2024 and a qualitative approach through survey to collect new data on circular economy practices within SMEs and potential integration inside the market for the technologies utilized in SUM4Re at the demonstration pilots.

### Data collection was implemented through literature studies and online surveys:

- The identification of barriers and drivers for technology adoption and assessment of market size and best practices for overcoming the barriers through literature review and online survey.
- Non exhaustive revisit of previous research, from 2020 to 2024, about technology acceptance within the construction industry through literature review.
- Online Surveys: two different structured questionnaires were developed using Microsoft Forms and disseminated through the SUM4Re consortium network.
 

The first survey targeted construction professionals and relevant stakeholders from the construction industry in The Netherlands, Spain, Finland, Switzerland, France, Germany, Estonia and Norway aiming to capture perspectives on: 1) circularity mechanisms, 2) recycling techniques and 3) technology knowledge.

The second survey targeted towards the same public aiming to capture stakeholders' input on: 1) Acceptance of technology.

This report is organised in the following manner:

- Chapter 1: Introduction
- Chapter 2: Market analysis
- Chapter 3: Technology acceptance conceptual framework
- Chapter 4: Barriers and drivers for technology adoption
- Chapter 5: Conclusion
- Bibliography

## 2. Market analysis

A market analysis is essential because it helps organizations understand the demand, opportunities, and risks associated with introducing innovative technologies. It also identifies customer segments, market readiness and regulatory alignment. By doing so, it ensures that the value proposition of new technologies directly addresses real-world challenges and supports adoption.

In the construction industry, where circularity is driven by policies such as the EU Waste Framework Directive, EU Industrial Strategy (COM/2020/102), Circular Economy Action Plan (COM/2015/0614) and Eco-design for Sustainable Products Regulation (EU/2024/1781), a market analysis ensures that the technology addresses pressing compliance needs and sustainability goals. It also clarifies the economic incentives, such as cost savings from reduced landfill fees and opportunities in secondary material markets, making adoption more appealing to contractors, developers, and public authorities. This regulations among other factors, are expected to drive demand for technologies that enable the creation, management, and utilization of digital product passports, such as software solutions for data management, platforms for material traceability, and tools for life-cycle assessment.

A thorough analysis also identifies the key customer segments and stakeholders, from municipalities requiring compliance dashboards, to contractors seeking selective demolition planning, to investors needing quality assurance and new market access.

In this way, a market analysis acts as a strategic roadmap, ensuring that technologies for circular economy practices are not only innovative and relevant, but also market-ready and positioned to accelerate sustainable transformation in the construction sector.

### Scope:

This market analysis focuses on the EU construction market, emphasizing the acceptance and intention of adoption of technologies that enhance circular economy practices. The report covers a range of stakeholder groups including construction and demolition companies, material suppliers, contractors, architects, public authorities and end clients or investors.

The market factors included in the scope encompass adoption barriers like technology integration challenges, skills gaps, and fragmented secondary-material markets as well as adoption drivers to provide solutions to the challenges. The temporal scope considers the current landscape, assessing market readiness and existing adoption trends. This ensures the analysis provides both actionable insights for immediate strategy and a forward-looking perspective for long-term planning.

Certain limitations are acknowledged. The report does not extend to non-EU jurisdictions, nor does it provide a detailed assessment of acceptance of specific technologies or digital solutions. Social perception and behavioral aspects of technology acceptance among stakeholders are recognized as central and there are opportunities and barriers identified but are not addressed extensively here, as they fall beyond the scope of the current analysis. Furthermore, the findings are based primarily on secondary data from policy documents, academic literature and only include primary data from two online surveys with a small sample from some of the relevant stakeholders mentioned beforehand.

### 2.1. Market Overview

The market for innovative technologies and tools within the construction industry aimed at enhancing circularity is experiencing significant growth, driven by regulatory mandates, technological advancements and increasing demand for sustainable practices. The global digital circular economy market reached a value of nearly 2,697 M€ in 2024, having grown at a compound annual growth rate (CAGR) of 21.90% since 2019. According to Straits Research (2024) the market is expected to grow from 2,697 M€ in 2024 to €7,423 M€ in 2029 at a rate

of 24.29%. The market is then expected to grow at a CAGR of 23.58% from 2029 and reach 23,064 M€ in 2034.

Similarly, the global digital product passport market, which plays a crucial role in the circular economy by providing detailed product life-cycle data, was valued at 198.9 M€ in 2024 and is expected to grow to 1,145.5 M€ by 2030, with a CAGR of 34.9%.

The digital circular economy market is segmented by application into supply chain and material tracking, resource optimization and efficiency, digital resale and reuse, reverse logistics and remanufacturing, circular economy reporting and compliance, circular waste management and recycling, smart material selection and testing and other applications. The digital resale and reuse market was the largest segment of the digital circular economy market segmented by application. Going forward, the digital resale and reuse segment is expected to be the fastest growing segment in the digital circular economy market.

Keles, Cruz Rios, and Hoque (2025) identified ten digital technologies driving circularity in building construction:

1. Building Information Modeling (BIM)
2. Spatial Data Acquisition (SDA)
3. Artificial Intelligence/machine learning
4. IoT
5. Blockchain
6. Digital twins
7. Augmented/virtual reality
8. Digital platforms and marketplaces
9. Digital Product Passports (DPPs)
10. Additive manufacturing

While BIM and Material Passports (MPs) show strong potential, adoption remains limited and further research is needed to mitigate risks like privacy and cybersecurity. These technological advancements, such as BIM, Digital Twins, MPs and Digital Product Passports (DPPs), have significantly enhanced the ability to track, recover, and reuse materials, while innovations in automated sorting and on-site modular recycling improve efficiency and the quality of recovered materials (European Commission, 2024; Lundin et al., 2024). Therefore, these technological advancements present opportunities for companies to enhance sustainability practices, improve resource efficiency, and comply with emerging regulations.

Moreover, policy incentives at the European level, including the Circular Economy Action Plan (CEAP), the Waste Framework Directive, and the DPP regulation, create mandatory compliance requirements and financial benefits that encourage adoption of circular practices (European Environment Agency, 2022; European Commission, 2015). These regulatory frameworks interact with technology by creating a demand for solutions that enable compliance, reporting, and lifecycle tracking, effectively stimulating investment in innovative platforms and processing equipment.

At the same time, rising economic opportunities further reinforce this demand, as circular construction practices can reduce disposal costs, optimize resource use, and generate revenue from recovered materials, creating attractive business cases for companies (European Commission, JRC, 2024).

Finally, social acceptance and sustainability awareness among clients, developers, and end-users amplify market uptake, as stakeholders increasingly prefer low-carbon, resource-efficient buildings and demand verified secondary materials (Grand View Research, 2024). These drivers interact synergistically: regulatory and policy measures create compliance needs that technological solutions fulfill, which in turn enable economic benefits, while social acceptance accelerates adoption by shaping market preferences. Together, this combination of factors establishes a reinforcing cycle that is expanding the market for innovative circular technologies in the European construction sector.

However, the market also faces challenges that may slow adoption, including regulatory restrictions that differ between member states, high upfront and operational costs, technological limitations such as insufficient sorting or material quality, and knowledge gaps in using secondary materials effectively across supply chains.

In summary, the main drivers for technology adoption are both regulatory requirements and consumer demand for more sustainable construction practices. By contrast, factors that could hinder the growth of the digital circular economy market in the future include data security concerns and lack of skilled personnel.

## 2.2. Survey: “Circular Economy Indicators and material reuse and recycling” outcomes

As part of the technology acceptance study for circular economy (CE), this section focuses on the development and categorization of indicators to evaluate circularity mechanisms (CM), recycling techniques (RT) and technology knowledge (TK) within the small and medium-sized enterprises (SMEs) in the construction sector.

According to OECD/DAC an indicator is a: “*Quantitative or qualitative factor or variable of interest, related to the intervention and its results, or to the context in which an intervention takes place*” (OECD, 2022). Indicators play a significant role in measuring performance/effect of actions and operations, which can then lead to devise plans to improve the performance. Karlsen (2023, page 59) mentions that “*measurable indicators [...] are used to track progress towards achieving a particular goal or objective*”. Referring to previous studies, Martin et al. (2024) emphasize the important contribution of robust indicators to CE in assessing circularity of materials, supply chains and organizations. Using indicators is well-suited to measure topics such as CM, RT and TK, as the indicators provide a practical way to identify and structure relevant aspects of the topics. By breaking down complex topics into measurable components, indicators support a systematic understanding of how circular economy practices are perceived and potentially adopted among SMEs in the construction sector. By ranking a set of indicators, we gain insight into which aspects of circular economy (which indicator) are currently perceived as most important or applicable, and also, helping to prioritize areas for further investigation and practical application within the project.

In this study a set of indicators from an established framework (Jayakodi et al., 2024) is adopted and evaluated. The indicators are categorized to fit the project's context, and their relevance is evaluated based on input from participating SMEs. The categorization of indicators is further detailed in the next section.

### 2.2.1. Categorization of indicators

Jayakodi et al. (2024) conducted literature review to identify CE assessment indicators specific to main contractor organisations. Their study covered both the construction project and organization level and identified 18 project-level indicators and 20 organisation-level indicators, with 16 indicators overlapping both levels. The indicators relevant to the project level were identified from research into construction-specific articles whereas the organisation level indicators were derived from non-construction sources. A list of project-level indicators, including those where project-level indicators overlap with organizational indicators are presented in [APPENDIX A](#) together with a brief description, as defined by Jayakodi et al. (2024) and as presented to the respondents in the survey. The appendix also contains dimensions that are associated with the indicators.

This study (SUM4Re) focuses on SMEs in the construction sector and has therefore limited its scope to the indicators identified by Jayakodi et al. (2024) from construction-specific sources. The indicators from the framework were reorganized to better align with the context of this study, which focuses on small and medium-sized enterprises in the construction sector. Since the participating companies in this research are active construction SMEs, the selected

indicators were considered more relevant and accessible for the target respondents in the SUM4Re study.

To structure the data, we have divided the indicators into the following categories:

- **Circularity Mechanisms (CM)** – Indicators related to practices and processes that enable the reuse, recycling, and efficient management of resources to minimize waste and close material loops within construction projects
- **Recycling Techniques (RT)** – Indicators related to specific methods and technologies applied to facilitate material recovery, reuse, and reduction of construction and demolition waste.
- **Technology Knowledge (TK)** – Indicators related to the degree to which organizations adopt, understand, and innovate with digital and technical solutions to support circular economy goals.

In addition to these three categories, a fourth category, *Organizational & Strategic Drivers (OSD)*, was added as a necessary expansion to capture indicators related to framework conditions, human resources, and strategic choices. This aligns with previous findings in the circular economy literature, which point to a significant overlap between project-level and organizational-level indicators (Jayakodi et al., 2024) and emphasize that organizational support, collaboration or regulatory frameworks are often requirements for implementing circular initiatives (Ali et al., 2024; Klein et al., 2020).

- **Organizational & Strategic Drivers (OSD)** – Indicators related to internal capabilities, policies, stakeholder engagement, and strategic initiatives that guide and support the implementation of circular economy principles at the organizational level.

The indicators are placed in different categories as shown in Table 1 Categorization of indicators. The different categories are colour-coded to visually distinguish between them, making it easier to interpret the distribution and thematic focus of the indicators. Some indicators can represent more than one category. In these cases, the indicators are listed under both, with a notation indicating which category is considered the most relevant (“primary”) and which category it also can be relevant for (“secondary”). Each indicator is assigned the colour of its primary category.

Several indicators could arguably fit within both the CM and OSD categories, as they encompass broad aspects of circularity mechanisms and Organizational & Strategic Drivers. However, the categorization presented here reflects our assessment of the most appropriate and representative placement for each indicator.

**Table 1 Categorization of indicators.**

Circularity Mechanisms	Recycling Techniques	Technology Knowledge	Organizational & Strategic Drivers
Managing Supply Chain (primary)	Circular Economy Driven Building Design (primary)	Adaptation of Technologies	Handling Human Resource
Waste Circularity (primary)	Circular economy Driven Building Construction (primary)	Circular economy-driven innovations	Social Circularity
Managing logistics	Waste Circularity (secondary)	Circular Economy Driven Building Design (Secondary)	Circular economy-driven policies and regulations adoption

Land circularity	Material Circularity (secondary)		Circular economy-driven Stakeholder collaboration and management
Material Circularity (primary)	Water Circularity (secondary)		Economic Circularity
Water Circularity (primary)			Circular Economy Services (primary)
Emission Circularity			Managing Supply Chain (secondary)
Energy Circularity			
Circular Economy Services (secondary)			
Circular economy Driven Building Construction (secondary)			

A brief description of the 18 indicators from Table 1 are presented in [APPENDIX A](#). The appendix also contains dimensions that are associated with each of the indicators. The description and the dimensions can be considered to concretize or operationalize the indicators in a given context.

The stakeholder survey was answered by 66 Small and Medium-sized construction companies, but not all of the respondents have answered all the questions. The answers per question ranged from 63-66 unique responses. Each question represented one of the indicators, in total 18 questions. The companies were asked to range the indicators on a scale from 1-10 in response to how relevant the indicators are for the company or its projects, 1 corresponds to no alignment within the company/projects and 10 corresponds to the company/projects aligning 100% with the statement.

The survey represents an analysis which gives a snapshot of the current perspective of the small and medium-sized enterprises in the construction sector. It gives a picture of how the different indicators in relation to Circularity Mechanisms, Recycling Techniques, Technology Knowledge and Organizational Strategic Drivers are perceived and prioritized at a given point in time and offers an insight into the construction sector's readiness and attitude to CE practices.

### 2.2.2. Results

The results show an average score for the different indicators ranging from 5,67 to 6.54. The indicators with average scores are listed in Table 2 The indicators ranged from highest to lowest average score. For each indicator, the average score was calculated based on the number of valid responses received. The indicators are colour-coded as described in the previous section.

**Table 2 The indicators ranged from highest to lowest average score.**

Average Score	Indicator
6,54	Handling Human Resource
6,52	Social Circularity
6,51	Circular Economy Driven Policies and Regulations Adoption

Average Score	Indicator
6,49	Managing Supply Chain
6,37	Adaptation of Technologies
6,32	Circular Economy Driven Innovations
6,31	Circular Economy Driven Stakeholder Collaboration and Management
6,26	Waste Circularity
6,14	Managing Logistics
6,13	Land Circularity
6,03	Circular Economy Driven Building Design
6,00	Material Circularity
5,98	Circular Economy Driven Building Construction
5,98	Circular Economy Services
5,92	Water Circularity
5,89	Emission Circularity
5,83	Economic Circularity
5,67	Energy Circularity

To support the analysis of response variation, boxplots were created for each indicator. A boxplot provides a visual summary of the distribution of responses. The boxplot which can be seen in Figure 1 helps identify indicators with high consistency, those with narrow boxes, short whiskers, and few outliers, and those with greater variation, which may reflect differing levels of understanding or relevance among respondents. The central line within each box represents the median, while the triangle indicates the average score. The boxplot can be seen in a bigger format in [APPENDIX B](#).

An analysis of all the results per indicator shows that there is a responses variation between indicators both in terms of average score and how consistent respondents have been.

The average scores of the indicators ranged from 5.67 to 6.54, allowing for a ranking of the indicators based on perceived relevance among the participating SMEs. The three indicators with the highest average scores, Handling Human Resource (6.54), Social Circularity (6.52), and Circular Economy–Driven Policies and Regulations Adoption (6.51), are all categorized under Organizational & Strategic Drivers (OSD). Indicators within the Technology Knowledge (TK) category, such as Adaptation of Technologies (6.37) and Circular Economy Driven Innovations (6.32), are positioned in the upper-middle range. Indicators from the Circularity Mechanisms (CM) category are more widely distributed, with Managing Supply Chain (6.49) among the higher scores, while Energy Circularity (5.67) and Emission Circularity (5.89) are among the lowest. Recycling Techniques (RT) indicators, such as Circular Economy Driven Building Design (6.03) Circular Economy Driven Building Construction (5.98), are generally found in the lower half of the ranking. This distribution illustrates how average scores can be used to rank indicators across categories and identify which indicators are currently perceived as more or less relevant by the respondents.

If we look at the boxplot indicators such as Social Circularity, Circular Economy Driven Building Design, Economic Circularity, Emission Circularity, and Managing Supply Chain show

relatively tight distributions, suggesting a shared understanding and consistent prioritization among respondents. In contrast, indicators like Circular Economy Driven Building Construction, Material Circularity, and Managing Logistics show wider distributions, indicating greater variation in how these topics are perceived or implemented.

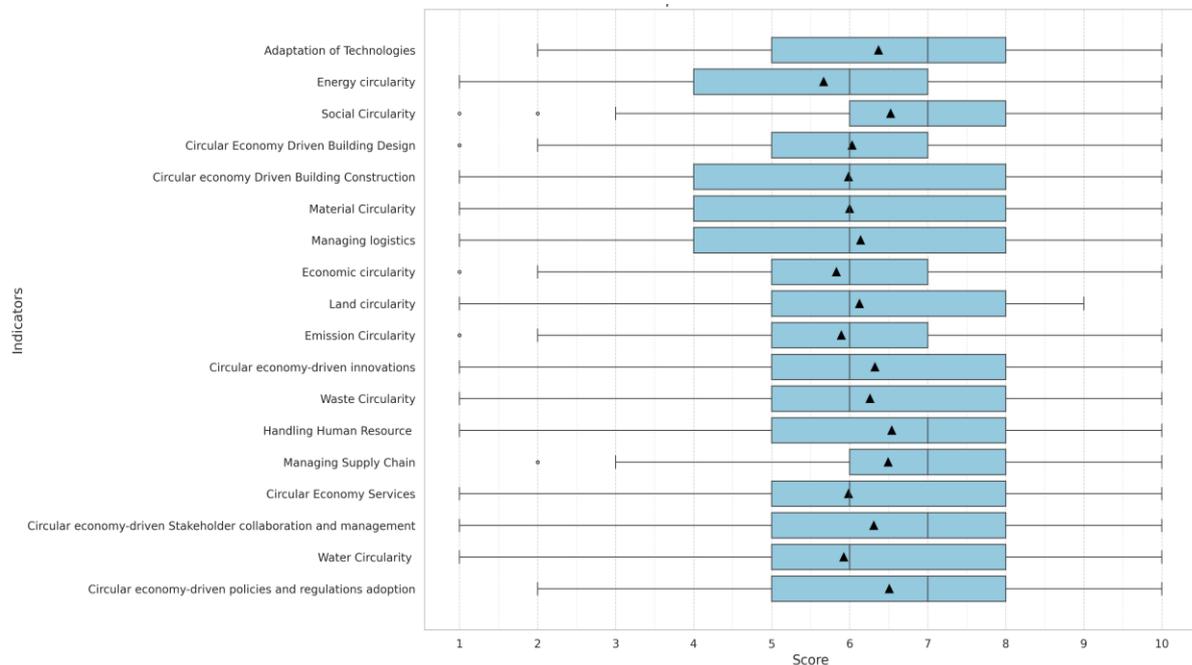


Figure 1 Boxplot of indicator scores.

The plot in Figure 1 helps identify indicators with high consistency, those with narrow boxes, short whiskers, and few outliers, and those with greater variation, which may reflect differing levels of understanding or relevance among respondents. The central line within each box represents the median, while the triangle indicates the average score.

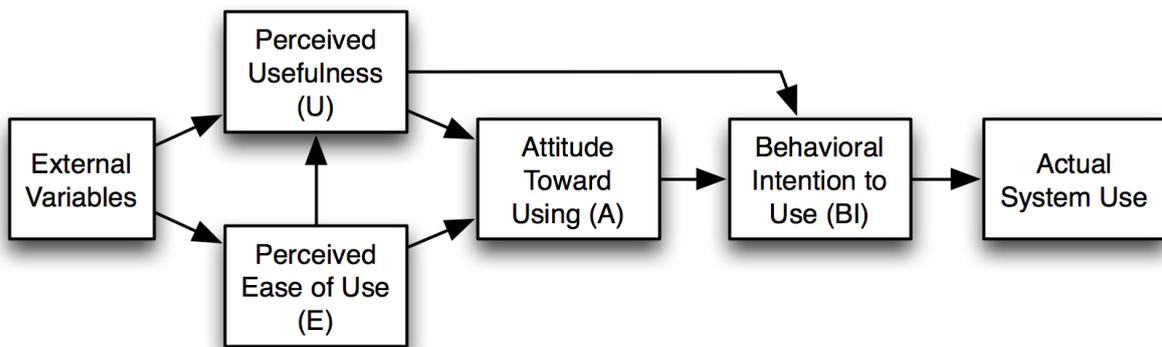
### 2.2.3. Discussion

Several researchers (Jayakodi et al., 2024; Norell & Sehn, 2024; Demirkesen & Ozorhon, 2017) point out that the construction sector is highly unorganised and fragmented. For that reason, it is important to include a broad range of indicators to gain a good understanding of the CE performance across the sector. A wide set of indicators was therefore included in the survey to get a comprehensive understanding of how different drivers of circular economy relate to circularity mechanisms, recycling techniques, technology knowledge and organizational strategic drivers.

To establish robust and relevant indicators for these topics, it is necessary to consider multiple factors simultaneously, not just, for example, circularity mechanisms in isolation. It is important to understand why or how a company prioritizes these aspects, as they are closely linked to strategic choices, value chains, and organizational culture. To analyse the results, we examined which indicators the companies said were suitable for their company and projects, and how much agreement there was across the companies for each indicator.

The results also suggest that the companies are focused on improving their ability (or maintaining the desirable level of their achieved ability) to adapt new technology. The indicators “Handling human resource” and “Adaptation of technologies” are considered by the respondents of this survey study as important circular economic indicators for their companies (as shown in Table 2). Handling human resources can contribute to adapt new technologies. We can look closer at this issue with the help of the Technology Acceptance Model (TAM) (Davis et al., 1989). According to TAM, perceived usefulness and perceived ease of use of the technology play an important role in ensuring actual use of the technology. Providing education

and training possibilities for the employees and creating a work culture for learning to adapt the technologies (to achieve circular economic objectives) effectively – which are some of the central components of handling human resources – can contribute to improve the perception of the usefulness and of the ease of use of the technologies. This improved perception can lead to develop appropriate attitudes and behavioural intention to use the technologies and hence increase technology acceptance (actual use of the technologies) in the companies. Figure 2 illustrates this description. The indicator Handling Human Resource is closely aligned with Perceived ease of use. As it is the indicator with highest average score (of 6.54), it suggests that the SMEs prioritize engaging their workforce in circular economy initiatives relatively easy. This may reflect that human resource-related CE activities are more familiar, accessible, and easier to implement than more technical or infrastructure-heavy solutions. The indicator Adaptation of Technologies is closely aligned with Perceived Usefulness. It reflects the extent to which SMEs recognize the value of adopting digital and technical solutions to support circular economy goals. The relatively high average score of 6.37 suggests that respondents perceive these technologies as beneficial and relevant to their operations. This indicates a positive attitude toward the usefulness of technology in achieving CE objectives, even if full implementation is still in progress.



**Figure 2 Technology Acceptance Model (Davis et al., 1989).**

The analysis of each response per indicator shows that there is a variation between indicators both in terms of average score and how consistent respondents have been. If we look at the boxplot (Figure 1), we can see the distribution of responses for each indicator. This boxplot visualization helps identify indicators with high consistency and those with greater variation, which may reflect different levels of understanding or relevance among respondents. As previously mentioned, indicators such as Social Circularity, Circular Economy Driven Building Design, Economic Circularity, Emission Circularity, and Managing Supply Chain show relatively tight distributions, suggesting a shared understanding and consistent prioritization among respondents. In contrast, indicators like Circular Economy Driven Building Construction, Material Circularity, and Managing Logistics show wider, indicating greater variation in how these topics are perceived or implemented.

This variation may reflect differences in experience, maturity, prioritization or relevance across companies. When an indicator shows both high consistency and a high average score, it may suggest that the topic is both well understood and widely prioritized. Conversely, indicators with low average scores and high variation may point to uncertainty, lack of familiarity, or lower perceived relevance.

Based on this interpretation of the data, it can be said that the industry appears to be more mature or have a stronger degree on prioritization regarding Handling Human Resources and Social Circularity, as they have a higher average score, in relation to Economic Circularity and Energy Circularity, with a low average score.

Interestingly, although Circular Economy Driven Building Design and Circular Economy Driven Building Construction are thematically related, they show different patterns in the data. The design indicator shows higher consistency and a higher average score, while the construction indicator is among those with the most variation. This may reflect the fact that design-related circular practices, such as material selection or design for disassembly, are more familiar and easier to conceptualize, whereas construction practices require more complex implementation, coordination, and resources. It may also indicate that respondents are more involved in planning and design phases than in on-site construction activities.

By collecting information from SMEs and using indicators derived from construction-specific literature, this study provides insights into which indicators are directly relevant for evaluating current practices, barriers, and technology acceptance in construction companies that operate close to projects where CE solutions are implemented in practice.

In this study, a 1–10 scale was used to assess the perceived relevance of each indicator for the participating SMEs. This approach allows for a more nuanced understanding of how circular economy practices are perceived and prioritized across different companies and contexts. Compared to binary or ternary systems (e.g., yes/no or yes/partly/no), which are often used in CE assessment tools, the 1–10 scale provides a spectrum of responses. While binary and ternary systems can indicate whether a practice is present or partially implemented, they do not capture the degree or maturity or prioritization of implementation. In contrast, a 1–10 scale enables respondents to express gradations in relevance and implementation, allowing for the definition of a CE level rather than a simple presence or absence. This also facilitates statistical analysis of variation, which can be essential for understanding CE practices and readiness.

The three indicators with the highest scores suggests that small and medium-sized construction companies are aware of the importance of strengthening the circular economy skills and knowledge of the workforce (Handling Human Resource), acknowledge the social value creation due to circular economy implementation in their projects and organisation (Social Circularity), and believe it is important to implement policies and regulations to promote and support circular economy principles (Policy & Regulation Adoption). The fact that several indicators categorized as Organizational & Strategic Drivers have a higher average score than many of the other indicators suggests that the organisations prioritize or are more mature in terms of internal awareness, strategic alignment, and stakeholder engagement than in the practical implementation of technical and practical circular economy solutions. This is also supported by the score of the indicators in the category Recycling Techniques, which are the category with the lowest acquired average score across the categories, and by the results from the lowest scoring indicator over all, Energy circularity, that suggest that companies make limited use of renewable energy sources and implement energy-saving measures to only a limited extent in their operations.

The relatively high average score for the indicators relevant to Technology Knowledge suggests that the organisations have adopted digital technologies to achieve circular economy objectives and have, to some extent, the ability to carry out research, development and innovations to achieve circular economy objectives. The results indicate that while technology is not yet fully embedded (average scores of 6.32 and 6.37 out of 10), there appears to be an interest and a perceived relevance based on the survey responses, which may serve as a positive indicator for future implementation.

The low score in the category of Recycling Techniques, as mentioned above, might suggest that CE driven building design concepts and building construction methods and techniques are not that well implemented in the SMEs. These findings highlight a potential gap between strategic intent and operational execution, possibly indicating a barrier to technology and circularity adoption. It may also reflect a lack of access to knowledge, tools, or incentives to implement such techniques in practice.

The category Circularity Mechanisms covers a broader range of the CE related practices and includes both some of the lowest scoring indicators but also some high scoring indicators. This variation is expected, given the diversity of topics within the category. The highest scoring indicator in this category, Managing Supply Chain, suggests that CE in the supply chain is perceived as both relevant and actionable. The lowest scoring indicator in the survey was Energy circularity, that suggest that companies make limited use of renewable energy sources and implement energy-saving measures to only a limited extent in their operations. This may reflect structural limitations, lack of incentives, or a perception that energy-related decisions are outside their immediate control.

Even though the average score of the 18 indicators only ranges from 5.67 to 6,54 it does not necessary mean that it is a lack of meaningful variation. It might suggest a general agreement amongst the respondents, and that the indicators are from moderately to highly relevant or are only partially implemented in the companies and their projects. To extract more information from the survey response, it may also be useful to consider several factors, for instance, boxplots that show the variation and spread in the data. For example, indicators with both high average scores and low variation (e.g., Social Circularity) suggest strong consensus and perceived importance, while indicators with similar averages but high variation (e.g., Material Circularity) may indicate uncertainty or differing levels of understanding. The median values, which mostly fall between 6 and 7, further support the interpretation that the typical assessment aligns closely with the average, reinforcing the reliability of the findings.

The indicators analysed in this study also provided a foundation for the development of future tools for assessing and managing circular economy practices in the construction sector. The most relevant indicators, based on both average scores and response consistency, can serve as core elements in CE assessment tools tailored to SMEs. Such tools could support companies in conducting self-assessments, identifying areas for improvement, and tracking progress over time. Additionally, the indicators can be used as a framework for training, maturity assessments, and as a basis for policy development and support schemes, particularly in relation to technology implementation and capacity building.

#### 2.2.4. Concluding remarks

This study identified and evaluated 18 circular economy indicators relevant to small and medium-sized enterprises in the construction sector, based on an established framework and survey data. The findings reveal that indicators related to organizational and strategic drivers, particularly Handling Human Resource, Social Circularity, and Policy & Regulation Adoption, are perceived as the most relevant and/or consistently understood. These results suggest that SMEs demonstrate relatively high maturity or a strong degree of prioritization regarding general/overall organizational awareness, strategic alignment, and stakeholder engagement with CE principles.

Indicators within the Technology Knowledge category, such as Adaptation of Technologies and CE-driven Innovations, also scored relatively high, indicating a certain degree of interest and partial implementation of digital tools and innovation to support CE goals.

In contrast, indicators related to Recycling Techniques, such as CE Driven Building Construction, and indicators related to Circularity Mechanisms, such as Energy Circularity, Emission Circularity and Water Circularity received lower average scores and a some of them also showed a greater variation in responses. These findings highlight a potential gap between strategic intent and operational execution. This may also point to areas where companies lack the tools, knowledge, or incentives to implement CE practices effectively.

Therefore, while the high-scoring indicators can serve as a foundation for CE maturity models and assessment tools, the lower-scoring indicators represent critical areas for future focus. Targeted support, such as training, policy incentives, and practical tools, should be directed toward these areas to help bridge the gap between strategic intent and implementation. Doing

so will strengthen the sector's overall capacity to adopt circular economy practices in a meaningful and scalable way.

### 3. Technology acceptance conceptual framework

For a successful adoption of a new or innovative technology there needs to be user acceptance within the market and its potential users. There can be aspects that hinder or leverage this inclusion inside the market. Consecutively, in this report, different adoption drivers that facilitate or impede the success of a new technology inside the market, SMEs or organization will be discussed and addressed.

User acceptance is shaped by different dimensions that can be isolated or related to each other. The degree on which a person or institution accepts the addition of a new technology to their work scheme depends on various factors and can be analysed according to the UTAUT and UTAUT2 framework. Venkatesh, Morris, Davis, and Davis (2003) developed the UTAUT model to explain technology adoption in organizational settings, identifying four key constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions. Later, Venkatesh, Thong, and Xu (2012) extended this model to consumer contexts, creating UTAUT2, which incorporates consumer-oriented factors such as hedonic motivation, price value, and habit which influence the intention to use and actual usage of technology. In the context of sustainable construction, these factors can help explain how construction professionals decide to adopt digital tools for waste management, material tracking, or circular economy initiatives.

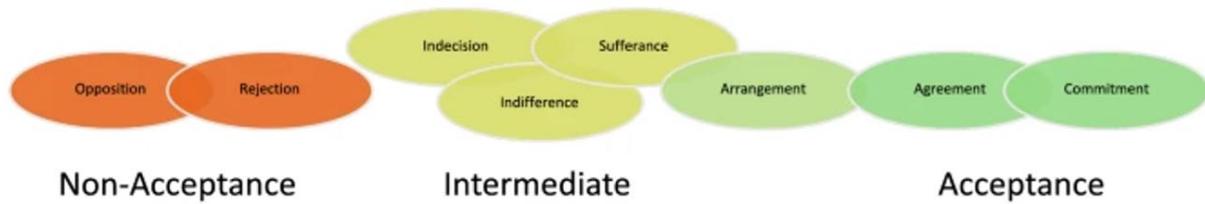
These factors that influence the intention to use and actual use of technology can be defined in the following manner according to the UTAUT and its extension UTAUT2 which provide a structured framework for understanding technology adoption (Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh, Thong, & Xu, 2012):

- Performance expectancy (usefulness): The degree to which using a technology will provide benefits to consumers in performing certain activities. It is considered the strongest predictor of behavioural intention to adopt and use a technology. In other words, if people believe that using the system or technology will improve their efficiency, productivity, or outcomes, they are more likely to adopt it.
- Effort expectancy (ease of use): The degree of ease associated with consumers' use of technology. If a technology is easy to learn and use, people are more likely to adopt it. If people initially find a technology too complex, they may reject it before realizing its benefits.
- Social Influence: The extent to which consumers perceive that people important for them (e.g., family, friends, colleagues, organizations) believe they should use a particular technology. It captures the role of peer pressure, social norms, and external expectations in shaping behavioural intention to adopt a system or practice. Relevant when individuals are uncertain about the usefulness of the technology, so they look to others' opinions.
- Facilitating conditions: Consumers' perceptions of the resources and support available to perform a behaviour. It reflects whether people believe they have the infrastructure, knowledge, compatibility, and assistance necessary to use a technology or adopt a practice. If individuals perceive that barriers are low and support is strong, adoption is more likely.
- Hedonic Motivation: The fun or pleasure derived from using a technology. It captures the intrinsic enjoyment people experience when adopting or using a system, beyond purely functional benefits.
- Price value: Consumers' cognitive exchange between the perceived benefits of using a technology and the monetary cost of using it. It reflects whether users believe that the value gained justifies the cost. If the benefits outweigh the costs, behavioural intention to adopt is higher.
- Habit: The extent to which people tend to perform behaviours automatically because of learning. It reflects the role of past experience and routinized behaviour in shaping both behavioural intention and actual technology use.

Table 3 Technology adoption drivers (Venkatesh, Thong, &amp; Xu, 2012).

Technology Adoption Drivers	Examples among Key Stakeholders
<b>Performance expectancy</b>	Contractors may adopt a digital material tracking platform because it improves efficiency in sorting and reusing construction and demolition waste.  Stakeholders might adopt circular economy practices or digital tools if they expect these will reduce costs, improve sustainability, or enhance project outcomes.
<b>Effort expectancy</b>	A waste management app that is easy to learn and requires minimal training.
<b>Social Influence</b>	Construction firms implement recycling tools because clients, regulatory bodies, or industry peers expect sustainable practices.
<b>Facilitating conditions</b>	Companies adopt secondary materials because suppliers, standards, and technical guidance are available, and staff are trained in their use.
<b>Hedonic Motivation</b>	Engineers enjoy using an interactive platform that gamifies waste reduction or shows real-time environmental impact.
<b>Price value</b>	Contractors choose recycled concrete because, although slightly more expensive upfront, it reduces overall project costs and avoids landfill fees.
<b>Habit</b>	Teams consistently separate and reuse materials on-site because it has become a standard routine.

When analyzing public perceptions of the adoption of new technologies in the construction industry, it is essential to consider that social acceptance is not a binary phenomenon, but rather a continuum that ranges from total rejection to active commitment. The model proposed by the Social Acceptance Scale (SAS) classifies these attitudes into three main levels going from non-acceptance through intermediate to acceptance, which are in turn broken down into eight specific categories: opposition, rejection, indecision, indifference, forced tolerance or sufferance, arrangement, agreement, and commitment. This structure, developed by Gier-Reinartz and Harms (2024), makes it possible to differentiate resistance, neutrality, and support for innovations, thus facilitating the design of communication strategies and public policies that promote their adoption.



**Figure 3 Social Acceptance Scale (SAS).**

Therefore, the successful adoption of innovative technologies in the construction industry relies heavily on user acceptance among potential adopters, whether individuals, SMEs, or larger organizations. Various factors can either facilitate or impede this inclusion in the market. Understanding these factors is critical for designing effective strategies that promote the uptake of digital tools, especially those aimed at enhancing sustainability and circularity in construction. In the context of sustainable construction, these constructs help explain how professionals evaluate and integrate technologies for waste management, material tracking, or circular economy initiatives.

By capturing resistance, neutrality, and support, the SAS allows policymakers, industry stakeholders, and technology developers to design tailored communication strategies and interventions that foster public engagement and promote the uptake of novel construction technologies. Integrating insights from UTAUT/UTAUT2 with the SAS provides a comprehensive understanding of both individual and collective factors that influence the adoption of sustainable digital tools, thereby enhancing the effectiveness of implementation strategies within the construction sector.

**Table 4 Stance towards the adoption of new technologies based on the Social Acceptance Scale (SAS).**

Attitude	Description
<b>Opposition</b>	Active and direct resistance, with arguments or actions against the idea or proposal.
<b>Rejection</b>	Refusal to accept, but without necessarily engaging in active confrontation.
<b>Indecision</b>	Doubt or inability to take a clear position.
<b>Indifference</b>	Lack of interest or concern; neutrality.
<b>Sufferance</b>	Passive acceptance out of obligation, without real support.
<b>Arrangement</b>	Willingness to cooperate or accept under certain conditions.
<b>Agreement</b>	General acceptance of the idea or proposal.
<b>Commitment</b>	Active and lasting involvement, with genuine support.

### 3.1. Survey “Insights for Circular Economy Project” outcomes

The instrument for the survey consists in a questionnaire prepared by the SUM4Re WP8 leaders and it contains 50 questions regarding the areas of:

1. Circular Economy Practices
2. Degree of Social Acceptance of the Project
3. Technology Acceptance

The targeted respondents were:

- Research entities (universities, research centers).
- Public administrations.
- Engineering companies.
- Constructors/builders.
- Engineers.
- Architects.
- Urban planners.
- Construction companies.
- Demolition companies.
- Construction material suppliers.
- General society (young people, students, unemployed people, citizens...)

It was developed in both Spanish and English and the number of answers were 63 and 20, respectively. Details about the content of the answers in English can be found on APPENDIX C.

Key findings from the surveys:

- Performance expectancy is the strongest determinant of adoption.
- Price value is critical when it comes to implementing a new technology in an enterprise.
- Facilitating conditions and effort expectancy are also key when it comes to invest in a new technology.

### 3.2. SWOT Analysis

SWOT analysis can be described as a process that is used to analyse and characterize internal and external conditions of organizations. SWOT analysis is comprised of the following four aspects:

1. Strengths
2. Weaknesses
3. Opportunities
4. Threats

The first letters of the four aspects form the name SWOT. The first two aspects (strength and weakness) are about the internal nature / characteristics of organizations. The last two aspects (opportunities and threats) are about the external nature / circumstances of organizations.

Study of the internal nature of the organization

Organizations can be viewed and studied in several ways and from different perspectives. For example, Bolman & Deal (2021) talk about four frames: (1) Structural frame (2) Political frame, (3) Human resources frame, (4) Symbolic frame. Morgan (2006) uses nine images of organization such as machines, brains, organisms, cultures, psychic prisons, systems of politics, transformation, and tools of domination.

In this study we apply two perspectives to look at organizations. They are structural and cultural perspectives (Ekambaram, 2024). The choice of these two perspectives is inspired and influenced by Bolman & Deal (2021) and Morgan (2006). The structural perspective represents structural aspects and formal systems of organizations, such as technology,

organizational infrastructure, routines, reporting systems, line of authority and organizational structure. The cultural perspective deals with informal and social systems in organizations such as norms, values, interpersonal relationship, attitudes and behaviour. These two perspectives – along with the reflection on conversations with organizations that are involved in reuse and recycling of building materials and sustainable construction – served as a basic guidance to devise the questions related to “Strengths” and “Weaknesses” in the questionnaire.

#### Study of the external nature of the organization

External conditions of business organizations such as the competitive environment affect operations of organizations. Porter’s five forces model is used to analyse the competitive environment of organizations. This model focuses on the following five elements (Porter, 1979): (1) Threat of new entrants (2) Threat of substitute (3) Bargaining power of customers (4) Bargaining power of suppliers (5) Competitive rivalry. This model – along with the reflection on conversations with organizations that are involved in reuse and recycling of building materials and sustainable construction – served as an inspiration / guidance to devise the questions related to “Opportunities” and “Threats” in the questionnaire.

The questionnaire study regarding this SWOT analysis gave 66 responses. Respondents could choose more than one alternative answer from a set of alternative answers. The respondents could also give their own responses, if there were any (an open question). [APPENDIX D](#) presents the survey questions.

#### 3.2.1. Strengths and weaknesses

Table 5 presents the results associated with the following question: What is your organization’s strength when it comes to material reuse and recycling?

**Table 5 Strengths.**

Strengths	Percentage
The organization has adequate strategic focus on material reuse and recycling	Ca. 48%
It has an organizational culture (or work culture) that supports material reuse and recycling	Ca. 46%
It has an organizational culture (or work culture) that supports innovation	Ca. 36%
It has a solid knowledge and experience on material reuse and recycling	Ca. 33%
It has strategic focus on innovation	Ca. 30%
It has formal systems (for example, reporting systems and routines) that support material reuse and recycling	Ca. 25%
It has adequate infrastructure (for example, storage space, technology, machinery, transport facilities) to work with material reuse and recycling	Ca. 23%
It has enough money to invest in to promote material reuse and recycling	Ca. 18%

Table 6 presents the results associated with the following question: What is missing (or what can be improved) in your organization when it comes to implementing material reuse and recycling? In other words, weaknesses that organizations have, when it comes to material reuse and recycling.

**Table 6 Weaknesses.**

Weaknesses	Percentage
The organization does not have a solid knowledge and experience on material reuse and recycling	Ca. 33%
It does not have adequate infrastructure (for example, storage space, technology, machinery, transport facilities) to work with material reuse and recycling	Ca. 31%
It cannot prioritize material reuse and recycling due to lack of money (cost aspects)	Ca. 28%
It does not have strategic focus on innovation	Ca. 26%
It does not have formal systems (for example, reporting systems and routines) that support material reuse and recycling	Ca. 23%
It does not have adequate strategic focus on material reuse and recycling	Ca. 23%
It does not have an organizational culture (or work culture) that supports innovation	Ca. 12%

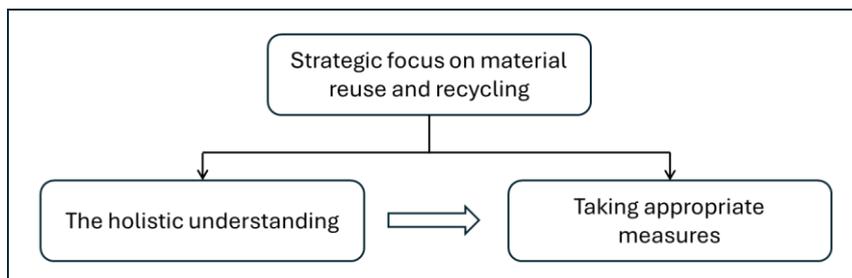
We will start our analysis and discussion by first looking at the three most chosen aspects of strengths. They are:

- Having adequate strategic focus on material reuse and recycling.
- Having an organizational culture (or work culture) that supports material reuse and recycling.
- Having an organizational culture (or work culture) that supports innovation.

After looking at these aspects, we will move on to consider other aspects of strengths and weaknesses.

Strategic focus on material reuse and recycling

The responses suggest that organizations see material reuse and recycling are of strategic value, and that the organizations understand the benefits of focusing on material reuse and recycling at a top management level. This strategic focus is important since the top management has deciding power, mandate and possibilities to take appropriate measures to enhance material reuse and recycling in the organization. In addition, the top management would have an overview or a holistic understanding of the organization (for example, its functioning with respect to its mission, vision, strategy and market condition), which could enable the top management to make right decisions when it comes to taking appropriate measures to facilitate material reuse and recycling in the organization. The holistic / systemic understanding takes into consideration not only the elements that constitute a system (in this case, an organization), but also how the elements interact with each other (Senge, 2006). The following figure illustrates the effect / influence of having a strategic focus.



**Figure 4 Effect of strategic focus**

The results suggests that organizations understand that having a strategic focus is important for implementing any measures to promote material reuse and recycling successfully. Several research studies point out the importance of having a strategic focus – which indicates the top management’s engagement and focus – to achieve a desired condition or change in organizations (Idogawa et al., 2023; ACMP, 2014; Kotter, 1995; Burke & Litwin, 1992).

#### Organizational / work culture

The results also show that many organizations recognize the importance of having an organizational culture that supports material reuse and recycling. According to Hogan & Coote (2014, page 1610)

“Organizational culture generally refers to the organizational values communicated through norms, artifacts, and observed in behavioural patterns”.

Organizational culture plays a significant role in the functioning of the organization. The practice / day-to-day work in the organization is guided by the established organizational culture. If the practice of the material reuse and recycling is embedded in the organizational / work culture, then the culture can be considered as an impetus (and a strengthening factor) to materialize effective material reuse and recycling.

As the results indicate, organizational culture that supports innovation, is also a notable strength when it comes to material reuse and recycling. Innovative thinking plays a pivotal role in promoting circularity and sustainability in construction – including material reuse and recycling (Sanchez-García et al., 2024). Developing an organizational culture that promotes material reuse and recycling as well as innovation can be seen as a positive combination that can contribute to continuously explore better solutions to facilitate material reuse and recycling. It is to be noted that two of the three most answered responses (as strengths) are about organizational culture. This shows the importance of focusing on organizational culture. Several researchers have emphasized the significance of organizational culture – for example Edgar Schein (Schein, 2017).

#### Strategy and culture

We will look more into the connection between the three most answered responses with respect to strengths. There are links between strategy and culture in an organizational context. A description given by Asch (2024) is relevant to consider in this regard:

“The relationship between culture and strategy is not one of subordination but mutual reinforcement. Strategy emerges from culture—it is shaped by the values, beliefs, and behaviours that define the organization. For example, a company with a culture prioritizing innovation will naturally develop a strategy focusing on exploring new markets, investing in research and development, and fostering creativity. The strategic choices made by such an organization are a direct reflection of its cultural values.

Conversely, culture is reinforced by strategy. When a strategy is implemented, it reinforces the cultural norms that align with that strategy. For instance, a company that adopts a customer-first strategy will see its culture of customer service become even more ingrained. Employees will internalize the importance of serving the customer, and this mindset will permeate every aspect of the organization.

This dynamic creates a feedback loop: strategy shapes culture, and culture, in turn, refines strategy. Over time, the two become indistinguishable, with strategy acting as the expression of culture in action.”

Scholz (1987) also points out the link between corporate culture and strategy. When we look at those who answered strategic focus as a strength, then we see that 62% of them chose culture for reuse as a strength, and 48% chose culture for innovation as a strength. These two (culture-related) aspects are the most selected aspects by those who selected strategic focus

as a strength. This same pattern exists when we compare the link between these three aspects. That is, the same pattern exists when we look at culture that support material reuse and recycling, and culture that supports innovation with respect to the other two aspects. Thus, this result suggests that the strategic focus influences and / or is influenced by developing an organizational culture that supports material reuse and recycling and innovation in organizations.

#### Strategic focus on innovation and culture that supports innovation

Another example of the link between strategy and culture is illustrated by a result that takes into consideration innovation: 67% of those who chose strategic focus on innovation as a strength, chose organizational culture that supports innovation as a strength. This result points out the connection between strategy and culture (for innovation) in organizations.

As we have seen, a well-defined strategy presents a shared objective that brings employees together and establishes a framework for the organization's values and actions and hence contributes to develop an appropriate organizational culture.

#### Knowledge (ability to adapt and practice material reuse and recycling)

The results show that 33% of the respondents chose knowledge regarding material reuse and recycling as strength. We will have a closer look at this result with respect to other aspects.

##### *Knowledge and strategy*

When we look closely at the result, 70% of those who chose knowledge regarding material reuse and recycling as a strength, chose strategic focus on material reuse and recycling as strength. This result can be interpreted as that strategic focus on material reuse and recycling can lead to ensure adequate knowledge on material reuse and recycling. Research conducted Smith et al. (2010, page 22) suggests the following:

“Business strategy is a key driver of knowledge capabilities, and that both business strategy and knowledge capabilities impact organizational effectiveness.”

Pemsel et al. (2016) og Zhang et al. (2024) – also point out the relevance of having a strategic focus on knowledge sharing and learning in organizations.

When we look at weaknesses (Table 6 Weaknesses.) then we will see that 33% of the respondents mentioned that their organizations do not have solid knowledge on material reuse and recycling. However, 33% of the respondents said that this very aspect is a strength for their organizations. This seems puzzling. A closer look at the result shows the following:

- 45% of those who chose lack of having a solid knowledge on reuse and recycling as weakness, also chose strategic focus on material reuse and recycling as strengths.

This means that there is some extent of strategic focus on reuse and recycling, but the focus has not yet been manifested to ensure a solid knowledge on material reuse and recycling in the organization. In a slightly different manner, it can also be interpreted / formulated that the strategic focus does not (adequately) cover the knowledge aspect.

##### *Knowledge and culture*

When it comes to strengths, 60% of those who chose having adequate knowledge on material reuse and recycling as strength, chose also organizational culture for material reuse and recycling as a strength. This result indicates a link between these two aspects. This link can be described as follows:

- Organizational culture facilitates knowledge development.
- The knowledge and experience of material reuse and recycling and the awareness of the importance of material reuse and recycling can reinforce the culture that promote material reuse and recycling in organization.

Several research studies have emphasized the importance of establishing an appropriate organizational / work culture to implement or enhance knowledge management activities – for example Lam et al. (2021), Ekambaram (2024).

#### Investing money and infrastructure with respect to strategic focus

Results indicate that the strategic focus on material reuse and recycling led organizations to investing money and establishing infrastructure to promote material reuse and recycling. This is shown by the following result:

- 91% of those who mentioned that their organizations have enough money to invest in to promote material reuse and recycling, also said that their organizations have adequate strategic focus on material reuse and recycling.
- 71% of those who mentioned that their organizations have adequate infrastructure (for example, storage space, technology, machinery, transport facilities) to work with material reuse and recycling, also mentioned that their organizations have adequate strategic focus on material reuse and recycling.

At the same time, the results suggest that the strategic focus on material reuse and recycling has not been fully translated into allocation of money and establishment of infrastructure:

- Only 35% of those who chose the strategic focus on material reuse and recycling as a strength, chose adequate investment of money and establishment of appropriate infrastructure for material reuse and recycling as strengths.

These results suggest the following explanation:

- The strategy could be well-drafted, but the process of implementing the strategy has been going on, and hence the strategy has not yet been materialized fully in connection with the investment and infrastructure.
- The strategy has been poorly implemented and followed up, which led to no observable effect on investment and infrastructure related to material reuse and recycling.

#### An overall picture of construction industry / organizations with respect to the aspects

Consider the aspects that we have looked at as strengths and weaknesses (strategic focus on material reuse and recycling, organizational culture that supports innovation, etc.). Having the aspects is considered as strength and lacking them is considered as weakness. We will now look at the responses that each aspect has got both as strength and weakness. These results (Table 7 An overall picture of strengths and weaknesses.) can give a general / overall picture of organizations' internal condition about material reuse and recycling.

**Table 7 An overall picture of strengths and weaknesses.**

Aspect	Strength (having the aspect)	Weakness (lacking the aspect)
Adequate strategic focus on material reuse and recycling	Ca. 48%	23%
Organizational culture (or work culture) that supports innovation	Ca. 36%	12%
a solid knowledge and experience on material reuse and recycling	Ca. 33%	33%
Strategic focus on innovation	Ca. 30%	26%
Formal systems (for example, reporting systems and routines) that support material reuse and recycling	Ca. 25%	23%

Adequate infrastructure (for example, storage space, technology, machinery, transport facilities) to work with material reuse and recycling	Ca. 23%	31%
Enough money to invest in to promote material reuse and recycling	Ca. 18%	28%

If we try to interpret and generalize this result, then we can see that the construction industry/organizations have (at least, to some extent) made their strategic focus and culture as their strengths to work with and promote material reuse and recycling. But the structural part (adequate infrastructure and investing enough money) seems to be weak (for many organizations) when it comes to material reuse and recycling. Furthermore, it seems that the aspects such as ensuring adequate knowledge and formal systems are in the process of becoming strengths.

### 3.2.2. Opportunities and threats

Table 8 Opportunities presents the results associated with the following question: What are the opportunities for your organization to grow or be in a good position in the market, when it comes to material reuse and recycling?

**Table 8 Opportunities.**

Opportunities	Percentage
Policies, rules and / or regulations are favourable for material reuse and recycling	Ca. 43%
Material reuse and recycling is good for your organization's competitive position	Ca. 41%
There is demand for material reuse and recycling	Ca. 23%
Most of your customers are loyal to your organization / products	Ca. 23%
Your organization have a good and harmonious relationship with your suppliers (in connection with your work involving material reuse and recycling)	Ca. 18%
Collaboration with other important actors who focus on circular economy in the industry (Collaboration that can strengthen your organization's market position)	Ca. 18%
Access is difficult for new actors (potential competitors) to enter into the market where you are in, by producing their products with material reuse and recycling	Ca. 11%
No substitutes for your products (that you produce with material reuse and recycling) are available in the market	Ca. 8%

Table 9 presents the results associated with the following question: What are the difficulties or hindrance for your organization to have a good position in the market, when it comes to material reuse and recycling? In other words, threats that the organizations perceive and experience.

Table 9 Threats.

Threats	Percentage
There is no or very little demand for material reuse and recycling	Ca. 38%
Material reuse and recycling decrease your organization's competitive position	Ca. 28%
Policies, rules and / or regulations hinder material reuse and recycling	Ca. 26%
No adequate collaboration with other important actors who focus on circular economy in the industry (Collaboration that can strengthen your organization's market position)	Ca. 23%
Access is easy for new actors (potential competitors) to enter into the market where you are in, by producing their products with material reuse and recycling	Ca. 18%
Substitutes for your products (that you produce with material reuse and recycling) are available in the market	Ca. 15%
Most of your customers are not loyal to your organization / products	Ca. 10%
Your organization do not have a good and harmonious relationship with your suppliers (in connection with your work involving material reuse and recycling)	Ca. 8%

As the results indicate, organizations consider that policies, rules and / or regulations related to material reuse and recycling, and the organization's competitive position are the two most significant opportunities (see Table 8 Opportunities). These two opportunities can be seen as interconnected. The following description is one of the ways to interpret the interrelation: When we look at those who chose policies, rules and regulations, we see that majority of them (42% of them) chose material reuse and recycling is good for their organizations' competitive position. This can suggest that organizations believe that policies, rules and regulations that are favourable for material reuse and recycling can influence and shape the market situation and improve their competitive position.

Relevant policies, rules and regulations direct, guide and encourage organizations to focus on material reuse and recycling. That is, policies, rules and regulations contribute to construct a framework for the functioning of the organization and shape its priorities, decisions and practice, which in turn can directly or indirectly impact the market condition and the competitive environment.

It is interesting to note that policies, rules and / or regulations can also be seen as a threat. See Table 9 *Threats*.. There can be several explanations for it. Some of them are:

- Technical capabilities are / can be far greater than the ones that the legislation allow the companies to apply and practice. Consider the following example: When it comes to the reuse of recycled asphalt in new asphalt layers, legislation only allows asphalt companies to use 15% in the last layer – the one that is in contact with the tire. However, technically, the company can incorporate up to 30%, without compromising any relevant mechanical requirements. Hence, there is a gap between the legislation and technical capabilities.
- Another challenge related to legislation is that there is no restriction or enforcement, at least in some countries, to adhere to certain percentage of circularity when constructing or renovating buildings. It is free choice. This can impede promoting circularity including material reuse and recycling in construction. In other words, lack of detail or concretization can hinder promoting material reuse and recycling.

- Regulations change, and they are not always clear. The unclearness or vagueness can cause various individual, subjective interpretations that can lead to unexpected challenges. Regulations can be perceived as increasingly cumbersome and demanding, and this can make difficulties for organizations to adopt the regulations.
- There is a need for time to face the changes and adaptations.

Having no common understanding and adaptation of policies rules and regulations can further cause problems for the whole supply chain in the construction industry, especially when it comes to collaboration. A single contractor-company cannot do much about adapting material reuse and recycling alone in a construction project. It is also to be noted that, material reuse and recycling can lead to additional cost.

The major threat regarding material reuse and recycling that were mentioned by the respondents is lack of demand for material reuse and recycling. This threat can also diminish the competitive power of organizations – which was mentioned as the second major threat by the respondents. It is also to be noted that lack of clear policies, rules and regulations can also hinder creating a wider awareness, a sense of necessity and practice of material reuse and recycling in the industry and society.

### 3.2.3. Concluding remarks

A short summary of the results of the SWOT analysis is presented below:

The major strengths that the respondents mention are:

- Adequate strategic focus on material reuse and recycling
- Organizational culture (or work culture) that supports material reuse and recycling
- Organizational culture (or work culture) that supports innovation

The major weaknesses that the respondents mention are:

- Not having a solid knowledge and experience on material reuse and recycling
- Not having adequate infrastructure (for example, storage space, technology, machinery, transport facilities) to work with material reuse and recycling
- Not be able to prioritize material reuse and recycling due to lack of money (cost aspects)

The major opportunities that the respondents mention are:

- Policies, rules and / or regulations are favourable for material reuse and recycling
- Material reuse and recycling is good for your organization's competitive position

The major threats that the respondents mention are:

- There is no or very little demand for material reuse and recycling.
- Material reuse and recycling decrease your organization's competitive position.
- Policies, rules and / or regulations hinder material reuse and recycling.

The results as a whole suggest that policies, rules and regulations influence organizations' strategy to focus on material reuse and recycling. Organizations consider that having a strategic focus on material reuse and recycling is a major strength, since the organizations seem to believe that the policies and regulations shape (and will shape) the market condition and the competitive dynamic. The organization – specially the top management – is aware of this situation and has a strategic focus accordingly. This awareness and strategic focus would reflect on the culture of the organization. This positive culture is considered by the organization as a strength.

Though the cultural side of the organization is in a way tuned to work effectively with material reuse and recycling, the structural side is not ready yet, it seems. An example in this regard is that the organizations consider lack of infrastructure and lack of investment of money with

respect to material reuse and recycling as weaknesses. A possible explanation of this situation is that the organizations might see that there is no or very little demand for material reuse and recycling (a major threat). Furthermore, as the results indicate, the competitive situation is not completely promising. This can lead the organizations to be reluctant (and not adequately motivated) to invest money in ensuring adequate infrastructure and relevant knowledge and training regarding material reuse and recycling. This is a major risk that can lead to several negative consequences when it comes to material reuse and recycling – for example, lack of proper knowledge can lead to costly mistakes and failures.

However, there are possible solutions. The results suggest that clear policies, rules and regulations, and a systematic implementation (including proper follow-up) of them can contribute to make the structural side of the organizations ready to implement material reuse and recycling effectively. That is, the systematic implementation of clear policies, rules and regulations can contribute to shape the attitudes and behaviour of relevant key actors / stakeholders and thus influence the market condition to become more favourable towards material reuse and recycling. This can direct and motivate organizations to invest adequate money (to for example establish relevant infrastructure, technology, training / educational programs and formal systems) to implement and practice material reuse and recycling effectively. This situation can lead to further benefits for these organizations, such as helping them to improve collaboration with other important actors who focus on circular economy in the industry. This improved collaboration can strengthen these organizations' market position. It is to be noted that several respondents chose inadequate collaboration with other important actors who focus on circular economy in the industry as a threat.

## 4. Barriers and drivers for technology adoption

In this chapter, we will briefly address the barriers, challenges and obstacles when it comes to adoption of innovative technologies for circular economic practices within the construction industry. Furthermore, from the surveys, there were extracted some challenges the respondents foresee for the technologies utilized in SUM4Re.

At the same time, solutions or general strategies for the given barriers that could potentially foster the adoption of new technologies within the workplace, will be provided. These solutions will be referred as adoption drivers.

Adoption drivers are the set of economic, regulatory, technological, environmental and social factors that encourage or facilitate the uptake of new practices, technologies or innovations. They represent the underlying reasons why individuals, organizations, or industries choose to implement change. According to Rogers (2003), adoption is influenced by perceived advantages, compatibility with existing practices, ease of implementation, and visibility of results. In the context of the circular economy and construction industry, adoption drivers typically include economic incentives (e.g., cost savings through resource efficiency and waste reduction), regulatory requirements (such as recycling targets and waste management legislation), market opportunities (competitive advantage and access to green finance), technological availability (innovations in material recovery and recycling), environmental concerns (carbon reduction and resource conservation), and social pressures (reputation, stakeholder expectations, and client demand) (Ajayi et al., 2015).

Conversely, adoption barriers are the economic, regulatory, technical, organizational and cultural factors that hinder or slow down the uptake of new practices, technologies, or innovations. They represent the challenges or constraints that prevent individuals, firms, or industries from fully adopting change. Common barriers include high upfront costs, lack of financial incentives, limited technological infrastructure, regulatory uncertainty, lack of awareness or expertise, resistance to organizational change, and concerns about performance risks. In the circular economy construction context, barriers often involve the fragmented nature of the industry, limited markets for secondary materials, insufficient waste management infrastructure and the perception that sustainable solutions are costly or disruptive to traditional processes (Ajayi et al., 2015).

Adoption barriers	Category	Adoption drivers
High investment costs, uncertain return of investment, lack of financial incentives, higher perceived costs, market volatility, short-term cost orientation.	<b>Economic and financial</b>	Cost savings, revenue generation, Access to green finance, increased asset value, operational efficiency, reduced disposal costs.
Technological immaturity, integration challenges, skills and knowledge gap, limited interoperability between digital systems.	<b>Technical and technological</b>	Advanced sorting technologies, BIM integration, MPPs and digital tracking platforms, IoT and data analytics.
Regulatory uncertainty and inconsistency, fragmented policies across regions, slow regulatory adaptation to innovation.	<b>Regulatory and policy</b>	Compulsory recycling and recovery targets, landfill taxes, GPP, CE policies, incentives for tools integration.
Resistance to change, limited knowledge, perceived complexity, low social recognition of CE practices, risk aversion.	<b>Organizational and cultural</b>	Stakeholder demand, industry influence, reputational benefits, community and social pressure, ease of use, user-friendly interfaces.

**Figure 5. Adoption barriers and adoption drivers for the uptake of innovative technologies.**

Besides, in the context of the construction market, common barriers include competition with raw materials cost or linear economy practices as well as awareness of the potential while there can also be seen as a new business opportunity and adapting to current regulations.



**Figure 6 Market related adoption barriers and drivers.**

Within the SUM4Re context, there will be shown potential solutions to overcome the barriers drawn from literature review and survey, that could potentially hinder the adoption of an innovative technology within an SME or organisation. The following concerns as listed and shown in Table 10.

**Table 10 Barriers and strategies for technology adoption extracted from stakeholder’s survey.**

Barriers	Specific strategies for SUM4Re technologies’ adoption
Technology is perceived as too complex.	Provide training activities, workshops and user-friendly interfaces.
Lack of peer, organizational or societal pressure/support to adopt.	Engage key stakeholders. Promote successful results from pilot sites.
Limited access to resources, infrastructure, training or regulatory clarity.	Offer regulatory and technical clarity through guidelines. Develop partnerships with suppliers and recycling facilities.
Technology is not engaging, enjoyable or emotionally rewarding to use.	Gamify platforms. Design interactive dashboards or apps with visual progress tracking.
Unfavourable price value.	Provide cost-benefit analyses, highlight long-term savings, and offer financial incentives, subsidies or discounts.
Lack of habit and organizational inertia.	Encourage gradual adoption with small, repetitive tasks. Integrate new processes into standard workflows. Use reminders or automatic prompts within platforms. Guidance and training for substantial cultural change.
Concerns about benefits, quality, reliability or safety.	Certify technologies with industry standards. Provide testing data, warranties and references from early adopters.

	Pilot results to demonstrate efficiency and usefulness.
<b>Preference for traditional methods or scepticism about new practices.</b>	Run awareness campaigns, workshops, and demonstrations showing successful outcomes from pilot sites and previous experiences.
<b>Uncertainty and risk perception.</b>	Expert guidance and consultancy. Provide tools to model potential risks, costs, and benefits before adoption. Share examples from other projects or companies that successfully mitigated risks using the technologies.

In short, Circular Economy technology adoption is primarily pushed by regulation and sustainability commitments, and pulled by cost savings, efficiency, and market competitiveness. Successful adoption also requires organizational readiness, cultural openness, and user-friendly technology.

## 5. Conclusion

The transition toward a circular economy in the European construction sector is progressing but remains uneven. Evidence from recent studies highlights a strong policy foundation, anchored in the European Union Waste Framework Directive, the Circular Economy Action Plan (CEAP, COM/2015/0614), and the forthcoming Digital Product Passport (DPP), that provides a clear trajectory toward waste reduction, recycling, and the uptake of secondary raw materials. In particular, the 70% recovery target for CDW and mandatory requirements for traceability tools establish both obligations and opportunities for stakeholders.

Market and stakeholder analyses demonstrate that acceptance of secondary construction materials is still constrained by concerns over performance reliability, lack of harmonised standards, and limited market transparency. Clients, contractors, and designers often view reprocessed materials as riskier choices, underscoring the need for quality assurance, certification schemes, and incentive mechanisms to foster trust.

Innovative technologies are emerging as critical enablers for overcoming these barriers. Building Information Modelling (BIM), Material Passports (MPs), digital twins, and blockchain-enabled traceability platforms provide new means of tracking material flows, facilitating selective demolition, and supporting secondary material marketplaces. While pilot projects and systematic reviews confirm the technical feasibility and potential environmental gains of these tools, their adoption is slowed by challenges such as interoperability, data governance, upfront costs, and the skills gap in the construction workforce.

Stakeholder perception studies further indicate that awareness and willingness to adopt circular practices are increasing, yet practical uptake depends on regulatory clarity, procurement rules, and business model alignment. Collaborative platforms, capacity-building initiatives, and EU-level harmonisation of standards appear as the most effective levers for creating functioning secondary material markets.

Results from the study on CE-indicators and SWOT analysis point out, among other things, the importance of (1) bridging the gap between strategic intent and implementation/operationalization of circularity measures and (2) improving policies and regulations (connected to promoting circularity aspects and measures) and implementing them effectively.

In conclusion, achieving a circular construction sector requires a dual approach: strengthening the policy and market framework to enhance trust in secondary materials, while simultaneously supporting the scaling of digital and intelligent technologies that can operationalize circular principles on the ground. The synergy between regulation, technological innovation, and stakeholder acceptance will ultimately determine the pace and depth of the sector's transition toward a sustainable, resource-efficient future.

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## APPENDICES

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## APPENDIX A Description of indicators

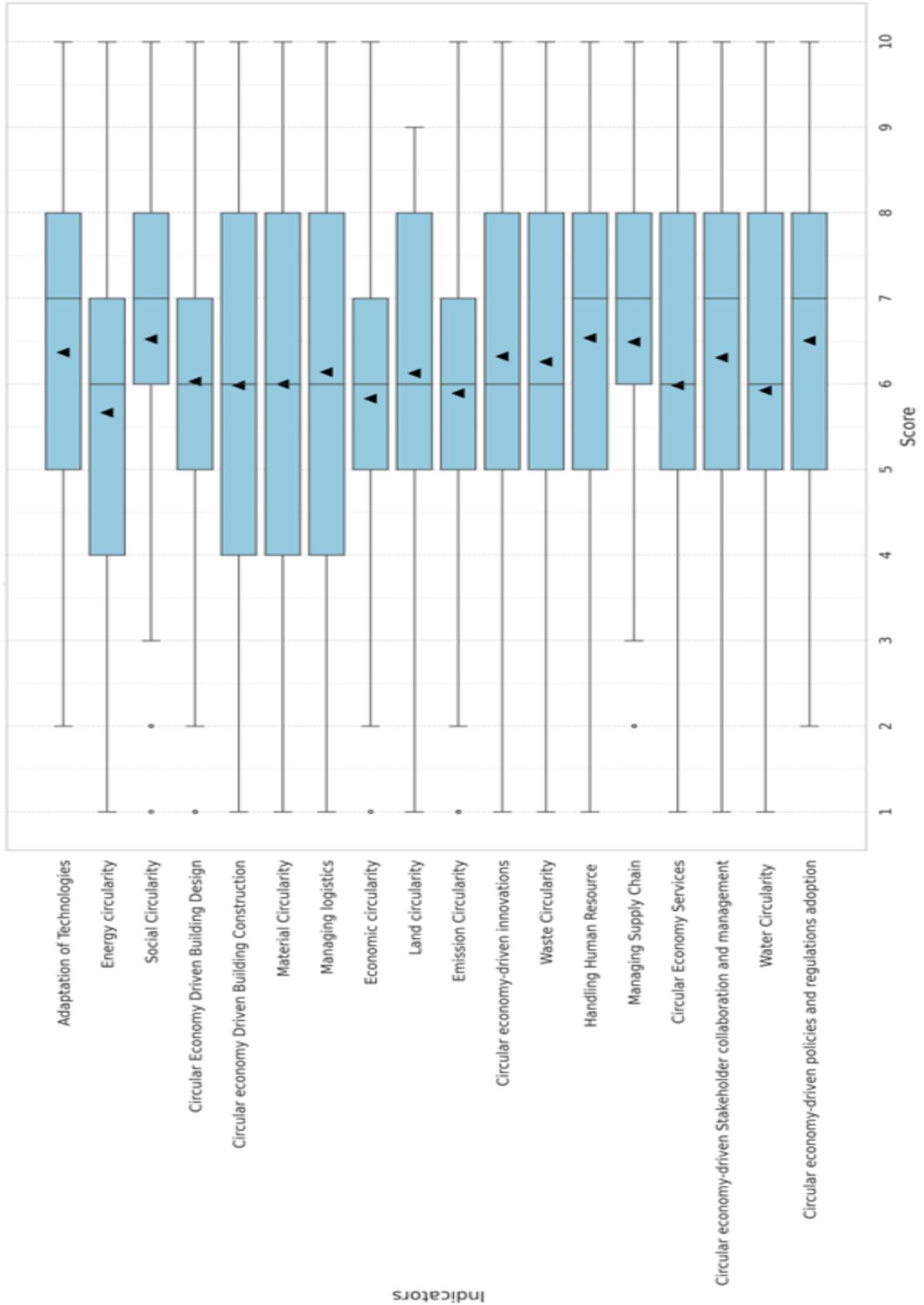
Indicator	Description	Dimensions
Adaptation of Technologies	The degree of adoption of digital technologies to achieve circular economy objectives in your projects / organisation.	<ul style="list-style-type: none"> <li>• Smart devices for staff</li> <li>• Integrated web services to improve the business performance</li> <li>• BIM based construction</li> <li>• AR for reuse and recycle practices</li> <li>• Addictive manufacturing</li> <li>• IoT for construction site controlling</li> <li>• Material passport</li> </ul>
Energy circularity	The degree of renewable energy produced on-site or nearby, renewable energy consumption and energy-saving mechanisms to total energy consumption in your projects / organisation.	<ul style="list-style-type: none"> <li>• Total energy consumption</li> <li>• On-site energy generation</li> <li>• Energy from local sources</li> <li>• Renewable energy consumption</li> <li>• Energy saving due to active and passive energy saving mechanisms</li> </ul>
Social Circularity	The degree of social value creation due to circular economy implementation in your projects / organisation.	<ul style="list-style-type: none"> <li>• Use of local workforce</li> <li>• Community participation to CE activities</li> <li>• Quality of life of the community</li> <li>• Health assurance of the community</li> <li>• Impact on animal and living species</li> <li>• Community consultation on CE</li> </ul>
Circular Economy	The degree of adoption of circular economy-driven	<ul style="list-style-type: none"> <li>• Design for disassembly</li> <li>• Design for maintenance</li> <li>• Design for Recovery</li> </ul>

Indicator	Description	Dimensions
Driven Building Design	building design concepts to your projects / organisation.	<ul style="list-style-type: none"> <li>• Design for product life extension</li> <li>• Design for remanufacturing</li> <li>• Design for conservation</li> </ul>
Circular economy Driven Building Construction	The degree of adoption of circular economy-driven building construction methods/techniques in your projects / organisation.	<ul style="list-style-type: none"> <li>• Prefabricated elements</li> <li>• Modular construction</li> </ul>
Material Circularity	The degree of material from cyclical sources, locally sourced, and rapidly renewable materials to the total amount of materials used in your projects / organisation.	<ul style="list-style-type: none"> <li>• Total materials</li> <li>• Virgin materials</li> <li>• Reused materials</li> <li>• Recycled materials</li> <li>• Rapidly renewable materials</li> <li>• Locally sourced materials</li> <li>• Bio-based materials</li> <li>• Reusable materials</li> <li>• Recyclable materials</li> <li>• Hazardous materials</li> <li>• Non-hazardous materials</li> </ul>
Managing logistics	the degree of adoption of circular economy in the logistics management process in your projects / organisation.	<ul style="list-style-type: none"> <li>• Availability waste treatment infrastructure</li> <li>• Appropriate waste treatment infrastructure</li> <li>• Transportation channels for reverse logistics</li> <li>• Organisation own waste treatment infrastructure</li> <li>• Sustainability mobility initiatives</li> </ul>
Economic circularity	the degree of monetary value creation due to circular economy implementation in your projects / organisation.	<ul style="list-style-type: none"> <li>• CE related incomes</li> <li>• CE related expenses</li> <li>• CE project investments</li> </ul>

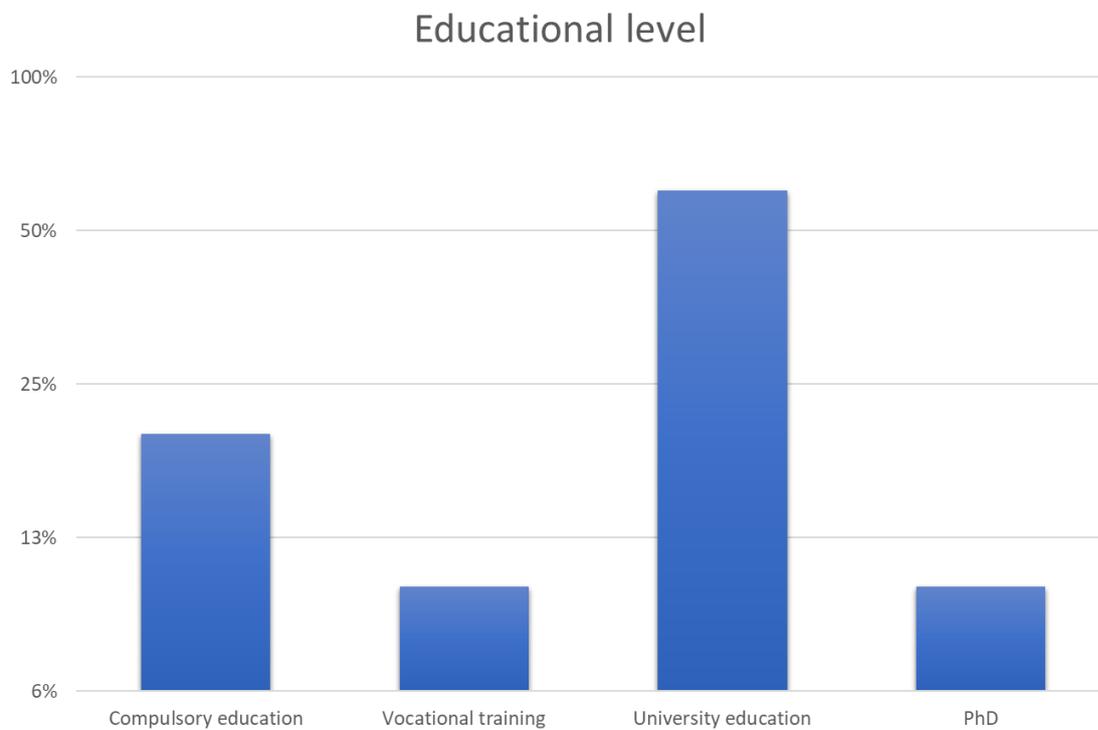
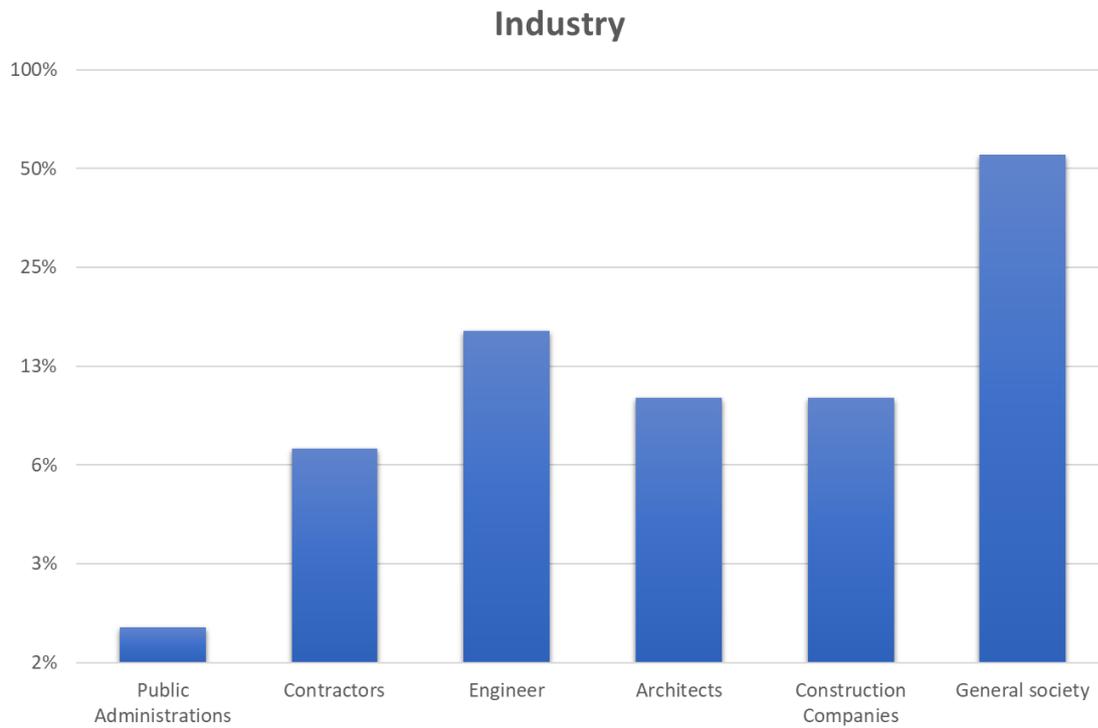
Indicator	Description	Dimensions
Land circularity	the degree of adaptive re-utilization of land and land conservation to the total area of the land in your projects / organisation.	<ul style="list-style-type: none"> <li>• Adaptive reuse of the land for new purpose</li> <li>• Conservation of the land</li> <li>• Improvement of the land</li> </ul>
Emission Circularity	The degree of energy direct and energy indirect greenhouse gas emission reduction to the total emissions in your projects / organisation.	<ul style="list-style-type: none"> <li>• Total greenhouse gases emission</li> <li>• Energy direct greenhouse gases emission</li> <li>• Energy indirect greenhouse gases emission</li> <li>• Emission of ozone depletion substances</li> <li>• Eco friendly fuels</li> </ul>
Circular economy-driven innovation	The ability to carry out research and development and innovations to achieve circular economy objectives in your projects / organisation.	<ul style="list-style-type: none"> <li>• Research and development on circular economy</li> <li>• Construction related circular economy innovations</li> </ul>
Waste Circularity	The degree of waste goes through the cyclical paths to the total waste generated in your projects / organisation.	<ul style="list-style-type: none"> <li>• Total waste</li> <li>• Waste for landfilling</li> <li>• Waste for incineration</li> <li>• Waste for reuse</li> <li>• Hazardous waste</li> <li>• Non-hazardous waste</li> <li>• Wastewater for reusing</li> <li>• Wastewater for recycling</li> </ul>
Handling Human Resource	The ability to strengthen the circular economy skills and knowledge of the workforce in your projects / organisation.	<ul style="list-style-type: none"> <li>• Circular economy related training</li> <li>• Circular economy related skill development programs</li> <li>• Decent work environment</li> <li>• Work satisfaction</li> </ul>

Indicator	Description	Dimensions
Managing Supply Chain	The degree of adoption of circular economy in the supply chain management process in your projects / organisation.	<ul style="list-style-type: none"> <li>• Eco-suppliers Number</li> <li>• Accurate material estimation and procurement</li> <li>• Suppliers to minimise excess packaging</li> <li>• Suppliers to provide small quantity of materials</li> </ul>
Circular Economy Services	The degree of providing value-added services for stakeholders engage in your projects / organisation.	<ul style="list-style-type: none"> <li>• Take back products</li> <li>• Sharing economy</li> <li>• Product as a service</li> <li>• Product life extension</li> </ul>
Circular economy-driven Stakeholder collaboration and management	the degree of stakeholder collaboration and management to achieve circular economy objectives in your projects / organisation.	<ul style="list-style-type: none"> <li>• Stakeholder meetings</li> <li>• Stakeholder trainings</li> </ul>
Water Circularity	The degree of on-site sourced water and cycle-sourced water to the total amount of water consumed in your projects / organisation.	<ul style="list-style-type: none"> <li>• Total water consumption</li> <li>• Reused water</li> <li>• Recycled water</li> <li>• Water saving due to water saving mechanisms</li> <li>• Water efficiency</li> </ul>
Circular economy-driven policies and regulations adoption	The extent to which policies and regulations are implemented to promote and support circular economy principles within your projects / organisation.	<ul style="list-style-type: none"> <li>• Environment policies, regulations, and taxation</li> </ul>

APPENDIX B Boxplot of indicator Scores



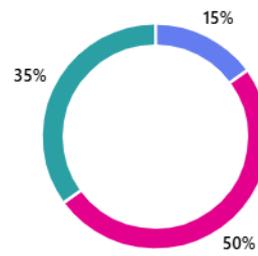
**APPENDIX C Detailed results from the survey: Insights for Circular Economy Project (English)**



6. What is your position within the company? (0 punto)

[Más detalles](#)

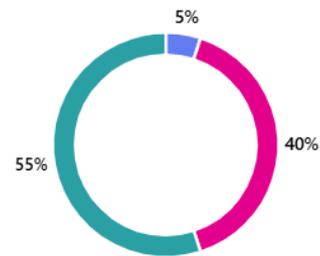
● CEO	3
● Middle-level management	10
● Operational position	7



7. Age (0 punto)

[Más detalles](#)

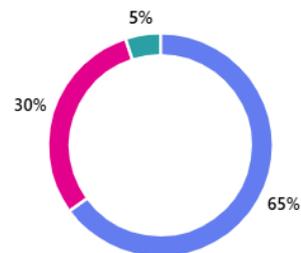
● Between 18 and 25 years old	1
● Between 26 and 45 years old	8
● Between 46 and 67 years old	11
● Over 67 years old	0



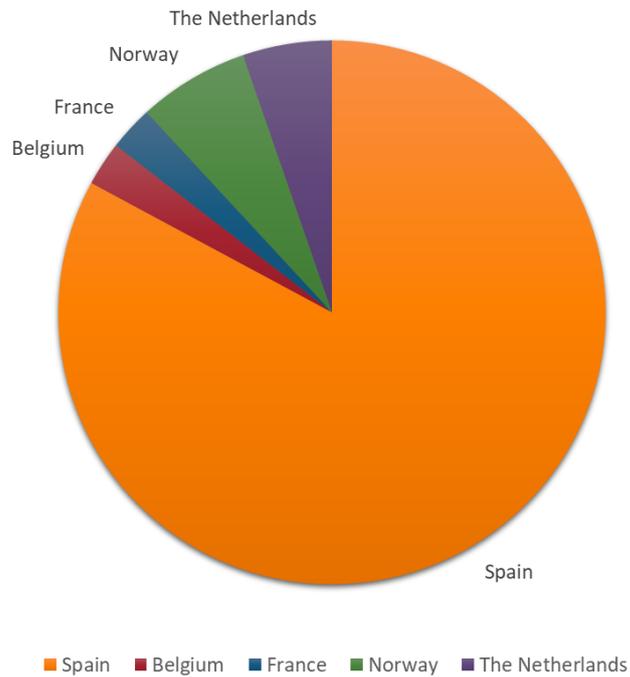
8. Gender (0 punto)

[Más detalles](#)

● Man	13
● Woman	6
● Prefer not to say	1
● Non-binary	0



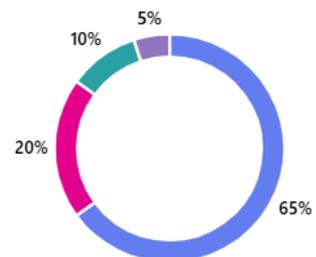
### Country



42. Do you know the technological tools commonly used in your sector? (0 punto)

[Más detalles](#)

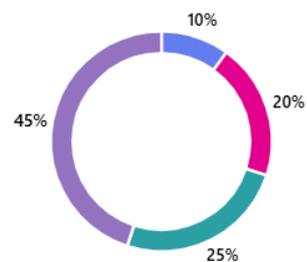
- I have updated information on that matter. 13
- I'm interested, but I don't have time to update myself on that subject 4
- I know some / I have no active interest in it 2
- No / I'm not interested 1



43. How do technological tools influence your work? (0 punto)

[Más detalles](#)

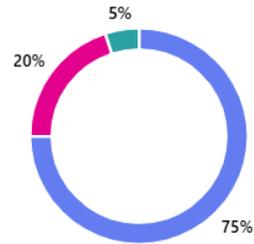
- They are not applicable in any case 2
- I use them occasionally, but they are not a primary tool. 4
- They are frequently used 5
- They are essential for my work 9



44. Would you be willing to learn new technologies in your workplace? (0 punto)

[Más detalles](#)

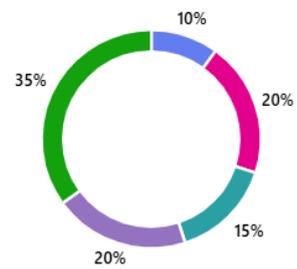
● Yes	15
● Maybe	4
● No, I don't think they are necessary	1
● No	0



45. How willing is your company to implement technological tools? (0 punto)

[Más detalles](#)

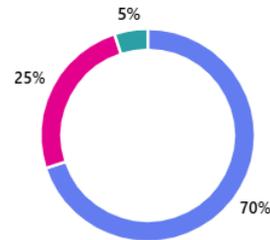
● Our work system is artisanal and we are not interested in including them	2
● Our work system is artisanal, but we incorporate these tools when we can.	4
● We apply them occasionally, but it is not systematic	3
● All our departments apply these tools to a possible extent.	4
● We follow an active policy of searching for and applying innovative technological tools	7



46. Has your company recently introduced innovative technology? (0 punto)

[Más detalles](#)

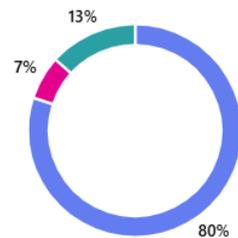
● Yes	14
● No	5
● I don't know	1



47. If the answer is yes, what impact has it had? (0 punto)

[Más detalles](#)

● Positive impact	12
● Negative impact	1
● It didn't have an impact	2



48. Do you think the inclusion of innovative technologies is positive for your company? (0 punto)

[Más detalles](#)



49. Why?

16 Respuestas

1	anonymous	Because it helps the optimization of the work
2	anonymous	Because it creates markets for secondary materials
3	anonymous	Since I represent an industry association, we are not a production company that sells goods. Our members process physical materials though, and my company must stay up to date on the technologies used. The technologies most used by my company are online applications that give easier access to relevant technical and regulatory information.
4	anonymous	It improves efficiency, reduces waste, and enhances sustainability
5	anonymous	It enhances efficiency, sustainability, and cost reduction
6	anonymous	It enhances cost reduction
7	anonymous	It depends on cost and applicability to our projects
8	anonymous	positive impact on efficiency and sustainability
9	anonymous	aumenta la precisión      Translation: Increases accuracy
10	anonymous	Per migliorare i processi produttivi      Translation: To improve production processes
11	anonymous	It enhances sustainability
12	anonymous	We are an innovative company
13	anonymous	It helps being more efficient
14	anonymous	Development, testing new things and learn from that.
15	anonymous	We need to be innovative and learn how to use new technologies to be competitive
16	anonymous	In my field of work, the translation AI systems that are being introduced do not offer a good quality, they create more workload in some cases and they are the excuse to reduce jobs and worsen work conditions in our sector.

## APPENDIX D SWOT Analysis

The questions in the questionnaire are presented below:

If your organization is already involved in material reuse and recycling, then please answer the following 4 questions that deal with internal and external conditions of your organization in connection with material reuse and recycling.

(1) What is your organization's strength when it comes to material reuse and recycling? Please choose relevant answers by putting a cross (x) at the end of your answers. You can choose as many relevant answers as you want.

- The organization has adequate strategic focus on material reuse and recycling \_\_\_\_
- It has enough money to invest in to promote material reuse and recycling \_\_\_\_
- It has a solid knowledge and experience on material reuse and recycling \_\_\_\_
- It has formal systems (for example, reporting systems and routines) that support material reuse and recycling \_\_\_\_
- It has adequate infrastructure (for example, storage space, technology, machinery, transport facilities) to work with material reuse and recycling \_\_\_\_
- It has an organizational culture (or work culture) that supports material reuse and recycling \_\_\_\_
- It has an organizational culture (or work culture) that supports innovation \_\_\_\_
- It has strategic focus on innovation \_\_\_\_
- If any other, please write here:

.....

(2) What is missing (or what can be improved) in your organization when it comes to implementing material reuse and recycling? Please choose relevant answers by putting a cross (x) at the end of your answers. You can choose as many relevant answers as you want.

- The organization does not have adequate strategic focus on material reuse and recycling \_\_\_\_
- It cannot prioritize material reuse and recycling due to lack of money (cost aspects) \_\_\_\_
- It does not have a solid knowledge and experience on material reuse and recycling \_\_\_\_
- It does not have formal systems (for example, reporting systems and routines) that support material reuse and recycling \_\_\_\_
- It does not have adequate infrastructure (for example, storage space, technology, machinery, transport facilities) to work with material reuse and recycling \_\_\_\_

- It does not have an organizational culture (or work culture) that supports material reuse and recycling \_\_\_\_
- It does not have an organizational culture (or work culture) that supports innovation \_\_\_\_
- It does not have strategic focus on innovation \_\_\_\_
- If any other, please write here:  
.....

(3) What are the opportunities for your organization to grow or be in a good position in the market, when it comes to material reuse and recycling? Here, we are talking about opportunities outside of your organization. Please choose relevant answers by putting a cross (x) at the end of your answers. You can choose as many relevant answers as you want.

- Policies, rules and / or regulations are favourable for material reuse and recycling \_\_\_\_
- Material reuse and recycling is good for your organization's competitive position \_\_\_\_
- There is demand for material reuse and recycling \_\_\_\_
- Access is difficult for new actors (potential competitors) to enter into the market where you are in, by producing their products with material reuse and recycling \_\_\_\_
- Your organization have a good and harmonious relationship with your suppliers (in connection with your work involving material reuse and recycling) \_\_\_\_
- Most of your customers are loyal to your organization / products \_\_\_\_
- No substitutes for your products (that you produce with material reuse and recycling) are available in the market \_\_\_\_
- Collaboration with other important actors who focus on circular economy in the industry (Collaboration that can strengthen your organization's market position) \_\_\_\_
- If any other, please write here:  
.....

(4) What are the difficulties or hindrance for your organization to have a good position in the market, when it comes to material reuse and recycling? Here, we are talking about difficulties and hindrances outside of your organization. Please choose relevant answers by putting a cross (x) at the end of your answers. You can choose as many relevant answers as you want.

- Policies, rules and / or regulations hinder material reuse and recycling \_\_\_\_
- Material reuse and recycling decreases your organization's competitive position \_\_\_\_
- There is no or very little demand for material reuse and recycling \_\_\_\_
- Access is easy for new actors (potential competitors) to enter into the market where you are in, by producing their products with material reuse and recycling \_\_\_\_

- Your organization do not have a good and harmonious relationship with your suppliers (in connection with your work involving material reuse and recycling) \_\_\_\_
- Most of your customers are not loyal to your organization / products \_\_\_\_
- Substitutes for your products (that you produce with material reuse and recycling) are available in the market \_\_\_\_
- No adequate collaboration with other important actors who focus on circular economy in the industry (Collaboration that can strengthen your organization's market position) \_\_\_\_
- If any other, please write here:

.....





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