

Article

Benefits and Obstacles of Implementing Circularity by Construction Sector Companies in the West Pomeranian Voivodeship of Poland

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Abstract

The construction sector has a significant impact on natural resources consumption and waste generation. In accordance with circular economy principles, the adoption of secondary materials, encompassing both reused and recycled components, by construction companies is of increasing strategic importance, especially in cities and their surrounding areas. However, enterprises in this sector continue to face substantial challenges related to implementation of these materials. The article aims to investigate the opinions of representatives of companies operating in the construction sector in the West Pomeranian Voivodeship of Poland regarding the benefits and obstacles associated with the implementation of secondary materials, as well as to identify measures that could contribute to the wider use of these materials in practice. The study was conducted using a diagnostic survey method based on computer-assisted web interviews. The sample comprised 46 respondents from the West Pomeranian Voivodeship of Poland. The analysis of the collected opinions emphasized that waste reduction, protection of the environment and natural resources are perceived as the most significant benefits. Among the main obstacles to implement these materials, respondents highlighted the lack of specialized platforms for secondary materials trading, difficulties in materials sorting, including construction and demolition waste, as well as complex bureaucratic procedures. In the respondents' opinion, the measures crucial for facilitating the use of secondary materials include the development of legislation enabling the reclassification of waste as secondary construction materials, ensuring reliable access to these materials, and providing government support. It was revealed that despite broad recognition of environmental benefits, the primary obstacle is the absence of an effective marketplace for secondary materials, pointing to a crucial role for institutional intervention. Recommendations for companies' managers from the construction sector, designers and local policymakers were proposed.

Keywords: circular economy; circular city; secondary materials; used and recycled materials; sustainable development; construction sector; circularity; barriers; benefits



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1. Introduction

The dynamic evolution of the construction sector in recent decades is driven by both the growing demand for infrastructure and the increasing environmental awareness of

society and businesses [1]. One of the major challenges currently faced by the construction industry is achieving sustainable development through the efficient management of natural resources, the reduction in waste generation, and the minimization of the environmental impact of construction processes [2]. Moreover, the need to reduce waste and its environmental impact, as well as improve the efficiency of resource use across the European Union, is conditioned by Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (text with EEA relevance) [3]. Consequently, the potential for reusing existing materials and applying secondary construction materials is increasingly vital for urban-system planning and operation.

The construction sector remains a leading consumer of raw materials and a primary source of waste [4]. Commonly reused or recycled materials include, e.g., secondary aggregates from concrete and brick rubble, structural steel from building dismantling, timber from demolition sites, various plastics, glass and insulation materials [5]. These materials are applicable in structural and finishing components for urban development, as long as they meet the relevant technical requirements and quality standards.

The development of construction waste-processing technologies and increasingly restrictive legal regulations are contributing to a growing interest in secondary materials [6,7]. However, the use of such materials in construction practice raises concerns regarding their durability, safety, availability and economic viability [8,9]. Many of these concerns are subjective and stem from the experiences, knowledge and attitudes of decision-makers within construction companies [10,11]. For this reason, gaining an understanding of how industry practitioners perceive different categories of secondary materials, as well as the factors shaping their willingness to adopt them, is crucial for advancing the transformation of urban systems.

Available research studies focus predominantly on technical and environmental analyses of the conditions for the use secondary materials in the construction sector, while comparatively less attention is being paid to the insights of companies' representatives involved in practical usage of these construction materials in urban areas [12–14]. Nevertheless, representatives of these companies play a key role in decision-making regarding the use of secondary materials and the implementation of solutions in line with the circular economy principles.

This study aims to investigate the opinions of representatives of companies operating in the construction sector in the West Pomeranian Voivodeship of Poland regarding the benefits and obstacles associated with the implementation of secondary materials, as well as to identify measures that could contribute to the wider use of these materials in practice.

The following research questions were formulated:

1. What are the main benefits of using secondary materials as perceived by companies' representatives?
2. What are the most significant obstacles preventing or limiting the wider adoption of circular economy solutions (specifically the use of secondary materials) in local construction practices?
3. What measures do companies' representatives identify as crucial for facilitating the use of secondary materials in construction sector?

The study contributes to the existing literature by providing empirically grounded evidence from a specific Central European region (the West Pomeranian Voivodeship of Poland). This regional case study offers a detailed examination of practitioner perceptions that may help shape policy and management decisions in similar regions across the European Union and beyond. The findings of this research served as the basis for formulating

recommendations aimed at promoting the development of sustainable construction and the more effective use of secondary materials in urban systems.

The article includes Section 2, where results of the available literature review are presented. Section 3 shows the methodology used to conduct the research. The results of the questionnaire survey are presented in Section 4. In order to sum up, the discussion was carried out, conclusions were drawn, and recommendations were proposed in Section 5.

2. Literature Review

Secondary materials are perceived as any materials that are not the primary products from manufacturing and other industrial sectors [15]. These materials encompass a broad spectrum of non-primary resources, including recycled aggregates, industrial by-products, polymers, and supplementary cementitious materials (SCMs), that are increasingly used in the construction sector to address sustainability, resource scarcity, and waste management challenges [12,16–18].

Secondary materials are classified based on their origin (e.g., construction and demolition waste (CDW), industrial by-products, polymers), function (structural vs. non-structural), and application (concrete, pavement, roofing, interior design). The circular economy framework underpins their use, emphasizing resource efficiency, waste reduction, and material recovery across the construction lifecycle [12,16,19]. Selected examples of secondary materials used in construction sector are presented in Table 1.

Table 1. Selected examples of secondary materials used in the construction sector (own elaboration).

Material Type	Description	Typical Applications	Source
Steel	Steel is one of the most efficiently recycled materials in the construction industry—its mechanical properties do not significantly degrade during the recycling process, allowing for infinite reprocessing without quality loss	Structures and building components: steel (industrial halls, bridges, buildings), reinforced concrete, prefabricated elements, roofing sheets, and facade panels	[20,21]
Concrete	As a primary construction material, concrete generates vast amounts of CDW, the recycling of which is one of the most thoroughly researched topics	Structural and non-structural elements; base layers for roads, pedestrian pathways, and maneuvering surfaces; earthworks and hydraulic engineering works; soil stabilization; and aggregates for mortars and concrete	[19,22]
Ceramics	Ceramics, particularly ceramic masonry elements and wall cladding, are extensively investigated as sustainable building materials due to the high volume of waste generated during renovations and demolitions	Fillers and aggregates for concrete and mortar, production of ceramic and ceramic-concrete products, subgrades for road surfaces, and stabilization of weak soils	[23–25]
Plastics	Plastics pose a challenge to recycling systems due to the complexity of their composition, the diversity of polymers, and issues regarding the quality of secondary materials	Installation and insulation construction products; geosynthetics and geotextiles; and composite panels and boards	[26,27]

Table 1. Cont.

Material Type	Description	Typical Applications	Source
Glass	Glass is a material that can be recycled infinitely without loss of quality, making it an attractive raw material for sustainable construction	Raw material for the production of glass products; fillers and aggregates for mortars and concrete; production of foam glass; and architectural elements	[28,29]
Wood	Timber waste from demolitions can be processed into wood-based materials	Fillers and wood-based composites; production of engineered wood products; cellulose-based thermal insulation; structural frames; and cladding materials	[30–32]

CDW comprises a diverse range of materials, such as recycled concrete, ceramic products, glass, metals, and plastics [33]. From a sustainability standpoint, the valorisation of CDW simultaneously supports the reduction in waste disposal, limits the extraction of natural aggregates, and mitigates the environmental impacts associated with the life cycle of construction materials [33]. Bolden et al. [34] investigated the effective use of recycled and waste materials in various construction applications. The potential of waste-based materials to support sustainable and efficient construction by promoting resource conservation and reducing the environmental impact of the building sector was highlighted by Lako and Lako [35]. They observed that the investigated waste-based materials reached their design strength in a shorter period than conventional construction materials. It was stated that recycling building materials reduces Global Warming Potential (GWP) by around 30% to 40% compared to landfilling, and reusing building components and/or materials reduces GWP by about 40% compared to recycling [36]. Examples of secondary materials stored at dedicated warehouse are shown in Figure 1.



Figure 1. Examples of secondary construction materials (own picture).

An extensive literature review on material processing, design processes, and case studies was carried out by Krajewska and Siewczynska [37]. Gruhler et al. [38] developed an orientation framework that integrates the mass and energy perspective of recycling in the construction industry; they considered the energy consumption associated with the sorting and processing of construction and demolition waste. Jegen et al. [39] used a GIS-based bottom-up approach to analyze building and material stocks. Otasowie et al. [40] noticed that trust and credibility, quality assurance, clear regulatory and technical guidelines, sustainable construction goals, awareness and educational initiatives, and professional support within the construction sector are the determinants that could drive clients' acceptance of recycled building materials.

The literature addresses the benefits of using secondary materials in the construction sector. These benefits include environmental sustainability through reduced CO₂ emissions, waste reduction and conservation of primary resources [35,41,42], which is especially important for urban-system operation. Technical improvements related to durability and energy efficiency, adopting Construction 4.0 technologies and modern smart technologies, including artificial intelligence, were mentioned [43–45]. It was noticed that applying building information modelling (BIM) is essential in terms of recording of materials used in buildings [46]. Economic advantages of these materials' adoption were also addressed; attention was paid to cost reduction in material sourcing and waste disposal, improving project profitability and others [47,48]. Moreover, it was stated that the construction and demolition waste market is impacted by the number of regulations [49].

Specific emphasis was placed on strategic positioning and stakeholder relations, promoting the company's sustainability practices [8] and addressing specific client needs [40]. It was also noted that environmental, social, and governance (ESG) reporting is crucial [50].

Based on a review of the available literature and the authors' own observations, the following benefits of using secondary construction materials were determined (Table 2).

Table 2. Selected benefits of applying secondary construction materials (own elaboration).

Category	Identified Benefits
Environmental sustainability	• Waste reduction • Protection of the environment and natural resources (sustainability awareness) • Reduction in CO₂ emissions
Technical and technological development	• Transfer of new technologies, automation and technological development • Recording of materials used in the building (BIM)
Economic and regulatory compliance	• Lower costs associated with the purchase of materials, considering that they do not require extraction or production from scratch • Compliance with the European Union policy • Compliance with the applicable national legislation
Strategic positioning and stakeholder relations	• Promoting the company's sustainability practices • ESG reporting • Addressing specific client needs

Furthermore, a number of obstacles to applying secondary construction materials were listed in available research studies. They deal with regulatory and administrative challenges, including inconsistent standards, lack of harmonization, insufficient incentives, and weak enforcement [51–53]. The construction industry faces multiple obstacles of technical and informational nature that deal with closing the materials loop, including user

preferences, inadequate digitalization, limited availability of information on materials and others [54–56].

Market and logistics challenges are also observed; they deal with the need to have reliable access to secondary construction materials [57,58]. Provision of replacement and repair services, as well as the option to upgrade the product in order to extend its service life, are of particular importance to reuse the construction materials [59]. This requires the availability of appropriate facilities, such as warehouses, within the urban environment. Concerns about the risks and uncertainties involved in adopting secondary materials, and perception of the extra cost being incurred, were considered [60]. Moreover, attention was paid to the organizational challenges related, e.g., to limited management consent to use this type of materials [61,62].

Based on a review of the available literature and the authors' own observations, the following obstacles to circular construction materials adoption were identified (Table 3).

Table 3. Selected obstacles to circular construction materials adoption (own elaboration).

Category	Identified Obstacles
Regulatory and administrative	• Legal limitations and/or restrictions • Complex bureaucratic procedures (including lengthy tendering processes) • Lack of certification procedures for secondary materials
Technical and informational	• Limited information on the physical, chemical and strength properties of materials and/or the variability of these properties depending on their function and operating conditions within the structure • Lack of information on the possibility to recycle materials • Difficulties in sorting materials (including CDW)
Market and logistical	• Limited access to secondary materials and uncertainty of supplies over time • Lack of companies specializing in the delivery of secondary materials • Lack of platforms for secondary materials trading
Organizational and risk-related	• Risks associated with the use of secondary materials and no original warranty • Lack of management consent to use secondary materials

In the available literature, the measures supporting the use of secondary materials by construction sector companies were described. Legal improvements and policy measures were discussed [63]. It was noticed that the use of public funding can have a greater impact than self-financing, although its effect remains less significant than that of debt financing [64]. The advancement of sustainable construction depends on effective policy measures, improved material standards, and increased investment in recycling infrastructure [65]. Several strategies for improving the cost performance of utilizing secondary materials were identified by Ghafoor et al. [47].

Technical and procedural measures, especially the need to apply special procedures for materials to meet specified parameters, were also addressed [66]. It was highlighted that permanent and reliable access to materials [59], as well as information intervention, can positively influence secondary materials adoption [67]. Moreover, it was noticed that technological innovations, particularly carbonation curing, nanosilica additives, and AI-enabled quality control, play a key role in improving the properties and practical applicability of recycled aggregates [68].

Strategic and management measures include, among other things, best-practices sharing between the companies to support the use of secondary construction materials. Such practices related to the processing construction and demolition waste were considered by Gálvez-Martos et al. [69]. The uptake of recycled products can be facilitated through

several strategic measures, including the incorporation of recycled-content credits into sustainability assessment frameworks, government-led regulatory initiatives, improved cooperation among key construction stakeholders, early contractor involvement in the design phase, increased professional training and awareness, and fiscal incentives aimed at reducing the cost disadvantage of recycled products [70].

Secondary construction materials adoption may be supported by inter-company networking and effective communication. Successful collaboration may be ensured using information and communication technologies (ICT) [71]. Stakeholder partnership, transparent decision-making processes, and active public engagement are essential for achieving both operational efficiency and social acceptance [72]. The importance of multi-stakeholder initiatives involving policymakers, industry practitioners, and academia, while providing practical insights for integrating circular economy practices into sustainable construction, was emphasized [62]. Gangsø et al. [73] highlighted that improved access to materials, information, and appropriate regulatory frameworks and standards can increase the intention to incorporate recycled wood into construction projects. Two approaches to implementing sustainable strategies were proposed: establishing government-led platforms to promote strategies and enhancing waste education [47]. Considering that the effectiveness of strategies promoting secondary material use may vary across regions, it is important to investigate which measures are best aligned with the characteristics and needs of companies operating in particular geographical areas.

Based on a review of the available literature and the authors' own observations, the following selected measures supporting the use of secondary materials were recognized (Table 4).

It should be noted that the use of secondary construction materials is especially relevant in cities, and impacts the urban-system framing. Contemporary urban regeneration processes lead to the preservation and adaptation of existing built resources, which help to protect cultural heritage whilst adapting historic buildings to current social and economic needs. This approach strengthens local identity, builds social capital and serves as a factor in enhancing the competitiveness and attractiveness of built environments. Urban regeneration involves different stakeholders, including government, social capital, and property owners [74]. At the same time, regeneration aligns with environmental objectives relating to limiting the consumption of natural resources, reducing greenhouse gas emissions and improving the energy efficiency of buildings. The use of secondary materials reduces the amount of waste sent to landfill, decreases the demand for raw materials and lowers the energy consumption of construction processes in urban systems. Consequently, this leads to a reduction in environmental pressure whilst simultaneously increasing the economic efficiency of the investment [75,76].

Moreover, the well-being of local residents and the quality of the environment are interdependent. A high-quality urban environment promotes health, safety and quality of life, whilst the sustainable management of resources enables economic development without placing an excessive burden on future generations. In this context, the use of secondary construction materials and the regeneration of existing buildings should be seen as tools for achieving intergenerational justice, enabling the preservation of natural, cultural and economic capital for future users of the space [77,78].

The conducted review of the available literature indicates that secondary materials adoption by construction sector companies is a subject of intensive research, although the pace of research varies depending on the type of secondary material. Moreover, despite the fact that different benefits and obstacles of implementing secondary construction materials were already investigated, there is a need for a complex review that reflects the opinions of companies' representatives operating within cities in defined geographical areas.

Considering current changes in the business environment of these companies, investigation of measures that will facilitate the use of secondary materials is also crucial.

Table 4. Selected measures supporting the use of secondary materials by construction sector companies (own elaboration).

Category	Proposed Measures
Legal and Policy Measures	• Developing legislation concerning the reclassification of waste as secondary materials • Strengthening government support (e.g., grants, improved business conditions, and tax incentives)
Technical and Procedural Measures	• Defining procedures for testing the physical, chemical and mechanical properties of secondary materials • Ensuring reliable access to secondary materials (e.g., via suppliers' networks, digital platforms to purchase materials, etc.)
Strategic and Management Measures	• Development of business models supporting circular economy principles • Sharing the best practices and know-how implementation
Networking and Communication Measures	• Establishing a network of partners interested in using secondary materials • Ensuring access to information on the potential use of secondary materials

3. Materials and Methods

The study aimed to explore the opinions of representatives of companies operating in the construction sector in the West Pomeranian Voivodeship of Poland regarding the benefits and obstacles associated with the implementation of secondary materials, as well as to identify measures that could contribute to the wider use of these materials.

A diagnostic survey method based on computer-assisted web interviews was used in the research process. Insights gained from the literature review served as the foundation for the development of the questionnaire survey. The structure of the survey questionnaire was designed using quantitative research methodology, with the aim of providing a multi-faceted profile of the target population and assessing the extent to which respondents are familiar with and engaged in the circular economy in the construction sector.

The questionnaire was structured into three sections:

1. Entity profile. This section included questions needed to identify the basic characteristics of the business unit; there were questions related to entity size, legal and organizational form, as well as area of business activity.
2. Respondent's professional background. In order to ensure high data reliability, this section of the questionnaire included questions related to the respondent's professional position and duration of work experience.
3. Core research questions related to implementation of circular economy solutions. The main body of the questionnaire was focused on the level of awareness and practical application of circular economy solutions in construction sector. This section covered questions regarding already used materials, benefits and obstacles of secondary materials adoption, and others.

The applied structure allowed us to ensure a logical flow of questions and minimize non-response bias, enhancing the objectivity of the empirical data collected. The analysis of professional experience made it possible to evaluate the substantive value of the responses obtained.

An online questionnaire was used, which allowed for maintaining the anonymity of respondents and the efficient aggregation of quantitative data. The questionnaire consisted

of closed-ended questions in which respondents selected or rated individual options using a Likert scale [79], where the assigned numerical values allowed for their subsequent quantification. Prior to distribution, the questionnaire was reviewed by two experts—an architect and a materials science specialist—who confirmed the relevance and appropriateness of its content.

The research was conducted between August and December 2025. A total of 60 companies operating in the West Pomeranian Voivodeship of Poland were selected purposefully for questionnaire distribution, focusing on individuals with knowledge or experience in the fields of materials management and sustainable development. The target group included construction companies, architects, material manufacturers, investors, demolition and waste management firms, consulting companies, and public authorities responsible for construction and circular economy policies. This choice was made to encompass different perspectives related to the implementation of secondary materials in the construction sector in cities.

Invitations containing a link to the online questionnaire were distributed via email. To enhance the response rate and ensure diverse perspectives, follow-up reminders were sent, and a snowball sampling approach was adopted, whereby respondents were invited to forward the survey to other qualified professionals. Moreover, the link to the questionnaire was available on social media platforms (Facebook) of the Faculty of Civil and Environmental Engineering of the West Pomeranian University of Technology in Szczecin and the Northern Chamber of Commerce. It should be noted that participation in the questionnaire was voluntary.

A group of 46 respondents filled in the questionnaire (response rate 77%). All answers were verified considering the completeness of filling in the questionnaire. The collected empirical data were subjected to quantitative analysis using basic measures of descriptive statistics:

- Arithmetic mean: used to determine the hierarchy of importance of individual factors within the study population;
- Standard deviation: used as a measure of dispersion (variation) in responses, allowing for an assessment of the degree of unanimity or diversity of opinion among respondents.

Data analysis allowed us to receive the answers to set research questions. In order to sum up, the discussion was carried out, recommendations were developed and conclusions were drawn.

4. Results

Within the first section of the questionnaire, respondents characterized the entities' profiles. All respondents represented entities located in the West Pomeranian Voivodeship of Poland.

The survey covered entities of different sizes, measured by the number of employees (Figure 2). The largest group consisted of representative of micro-enterprises employing fewer than 10 people (16 responses, 35%). Large enterprises employing more than 250 people also accounted for a significant share (10 responses, 22%). Medium-sized enterprises were represented to a lesser extent: 26–50 employees (eight responses, 17%), 51–100 employees (six responses, 13%) and 101–250 employees (six responses, 13%). No representatives of enterprises employing between 11 and 25 people were recorded in the sample. It should be noticed that the study captures a diverse range of companies' operational scales, from agile, small-scale units to highly structured corporate environments.

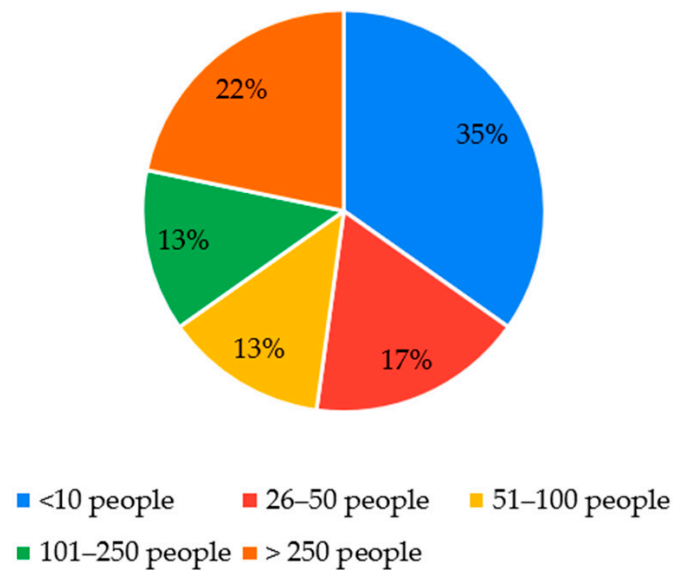


Figure 2. Companies' sizes; percentage of responses (own elaboration).

Considering the entity type, the vast majority of respondents represented companies (36 responses, 78%), illustrated in Figure 3. The remainder of the sample consisted of respondents of entities classified as "other" (eight responses, 18%), that included representatives of private sector, self-build, government departments, or universities. The sample also comprised representatives of organizations involved in public procurement activities (two responses, 4%). No employee of associations, clusters, foundations or local government bodies took part in the survey. This means that the responses primarily reflect the perspectives of practitioners working for companies operating in the construction sector.

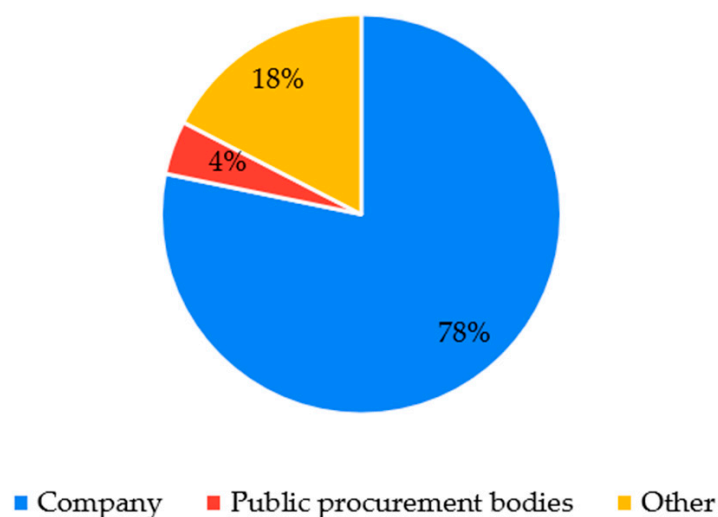


Figure 3. Types of entities; percentage of responses (own elaboration).

Respondents were asked to provide the areas of professional activity of the entity (Figure 4). It was possible to indicate more than one area of activity. The most frequently cited area was the execution of construction works (32 responses). A considerable proportion of the respondents represented companies specializing in finishing works (12 responses), while 10 respondents were affiliated with firms providing design services in architecture, structural engineering, installations, and environmental engineering. A smaller number of responses were recorded for investment activities (eight responses), environmental consultancy and advisory services (six responses) and the "other" category

(six responses). Demolition services, waste management and resource recovery, and the production of materials or components were mentioned least frequently (two mentions each). This structure confirms the dominance of enterprises directly involved in the execution of construction works. The activities reported under the “other” category included house demolition undertaken in collaboration with specialized companies, design and self-build activities, education and scientific research, and property trading. The professional profile of the companies is heavily weighted toward practical implementation rather than manufacturing or specialized services like waste recovery. This may suggest that the findings of this study may be particularly relevant to companies involved in on-site operations and project development phases.

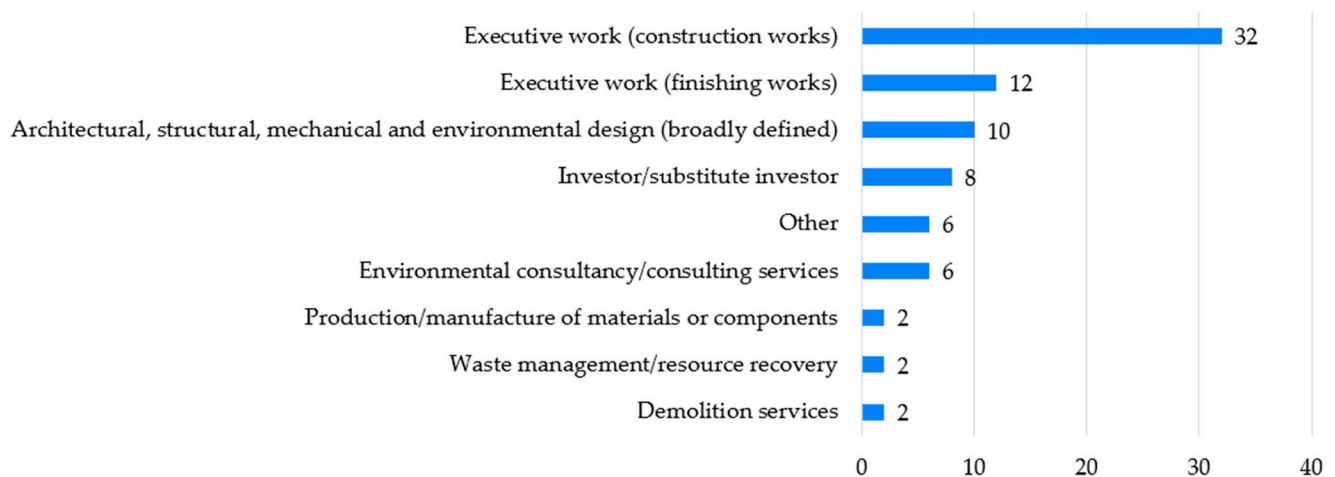


Figure 4. The entities' areas of activity; number of responses (own elaboration).

Within the second section of the questionnaire, respondents revealed their professional background. An analysis of the respondents' positions held within the company shows that they occupied a variety of decision-making roles (Figure 5). The largest group consisted of senior management—directors, CEOs and deputy directors (14 responses, 30%). “Other” specialist roles also accounted for a substantial share of the respondents (12 responses, 26%), including owners, investors, contractors, construction engineers, managerial staff, academic and teaching personnel. Respondents also indicated their roles as department heads and departmental staff members (10 responses each, 22% each). The relatively high proportion of management and executive staff among the respondents suggests that the survey captured the perspectives of individuals actively involved in shaping strategic and operational decisions within their organizations.

An analysis of the respondents' work experience in the industry indicates that the group surveyed had significant professional involvement (Figure 6). The largest group consisted of respondents with over 15 years of experience in the construction industry (24 responses, 52%). Other groups were represented to a lesser extent—eight respondents (17%) reported 6–10 years of experience, six respondents had less than 2 years of experience (13%), the same number of responses was given for the period of 2–5 years of experience (13%), whilst the smallest group comprised respondents with 11–15 years of experience (two responses, 4%). The findings show that the majority of respondents possessed substantial professional experience.

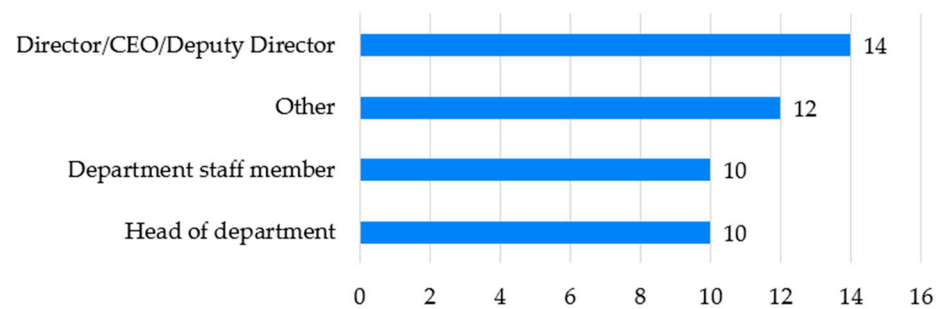


Figure 5. Positions held by respondents; number of responses (own elaboration).

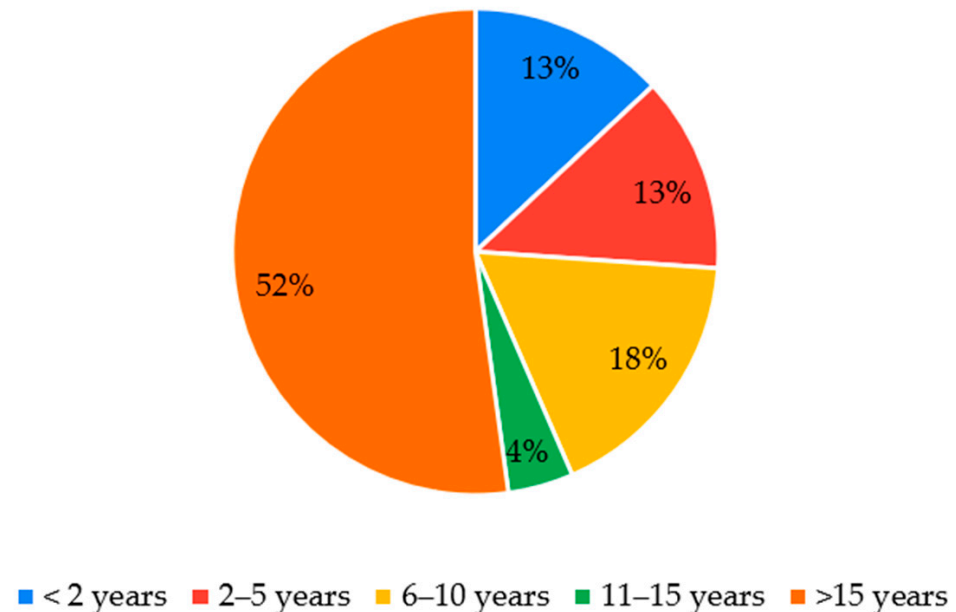


Figure 6. Work experience in the industry; percentage of responses (own elaboration).

More than half of the respondents (22 people, 48%) stated that the companies they are employed in already use circular economy solutions, including secondary materials (Figure 7). In addition, 11 respondents (24%) indicated a willingness to implement such solutions in the future. Thirteen people (28%) stated that they were unsure about the use of circular economy solutions within their organizations. This suggests a persistent gap in either knowledge on availability of secondary materials, or a lack of internal corporate policy regarding circularity. None of the respondents stated a lack of interest in using such solutions. These results may indicate a generally positive attitude among respondents towards the concept of the circular economy.

Respondents who stated that they already used circular economy solutions (22 people) were asked to indicate secondary materials adopted by entities they are employed (Figure 8). It was possible to select several options. The most frequently cited material was steel (16 responses), followed by wood (13 responses). Plastics and concrete also played a significant role (12 responses each), confirming their importance in construction practice. The reuse of glass (nine responses), ceramics (six responses) and textiles (four responses) was reported less frequently. One response concerned “other” materials, such as office supplies. The distribution obtained may suggest that companies primarily focus on construction and finishing materials with an established market position.

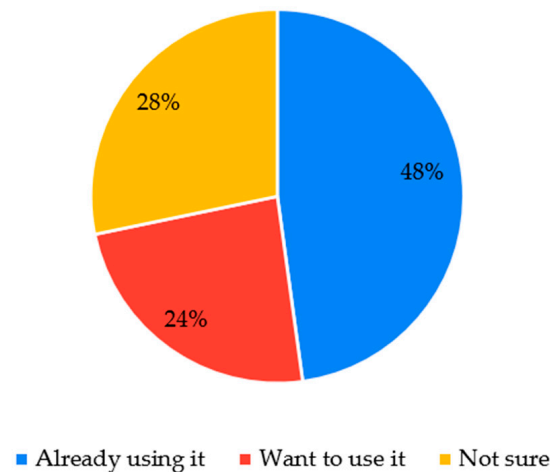


Figure 7. Familiarity with the use of circular economy solutions in the entity, particularly regarding secondary materials; percentage of responses (own elaboration).

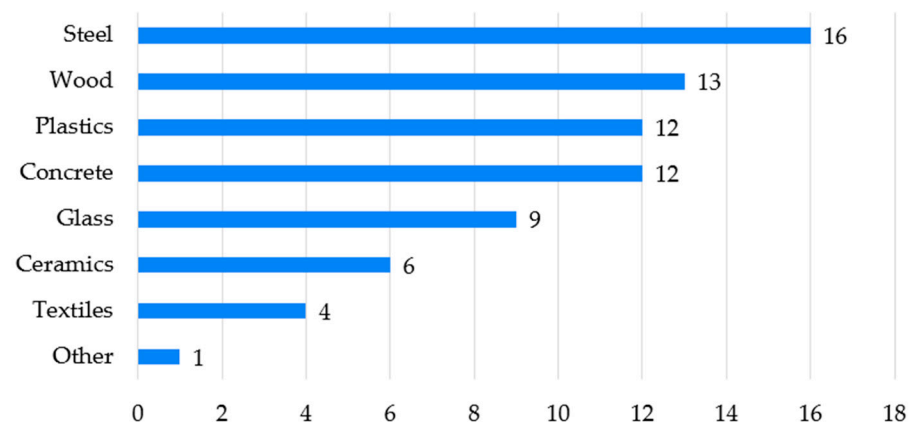


Figure 8. Kinds of materials already used by entities; number of responses (own elaboration).

The vast majority of respondents (34 people, 74%) stated that they were aware of the need to use secondary construction materials (Figure 9). A lack of such awareness was indicated by eight respondents (17%), whilst four people (9%) stated they were unsure on this matter. These results may indicate a relatively high level of regulatory and environmental awareness within the surveyed group.

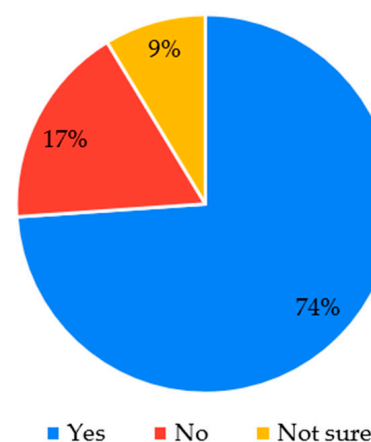


Figure 9. Awareness of the requirement to use secondary construction materials; percentage of responses (own elaboration).

Respondents were asked to rate benefits of using secondary materials, applying the scale from 1 to 5, where 1 represents the lowest level of importance, and 5 the highest level (Figure 10).

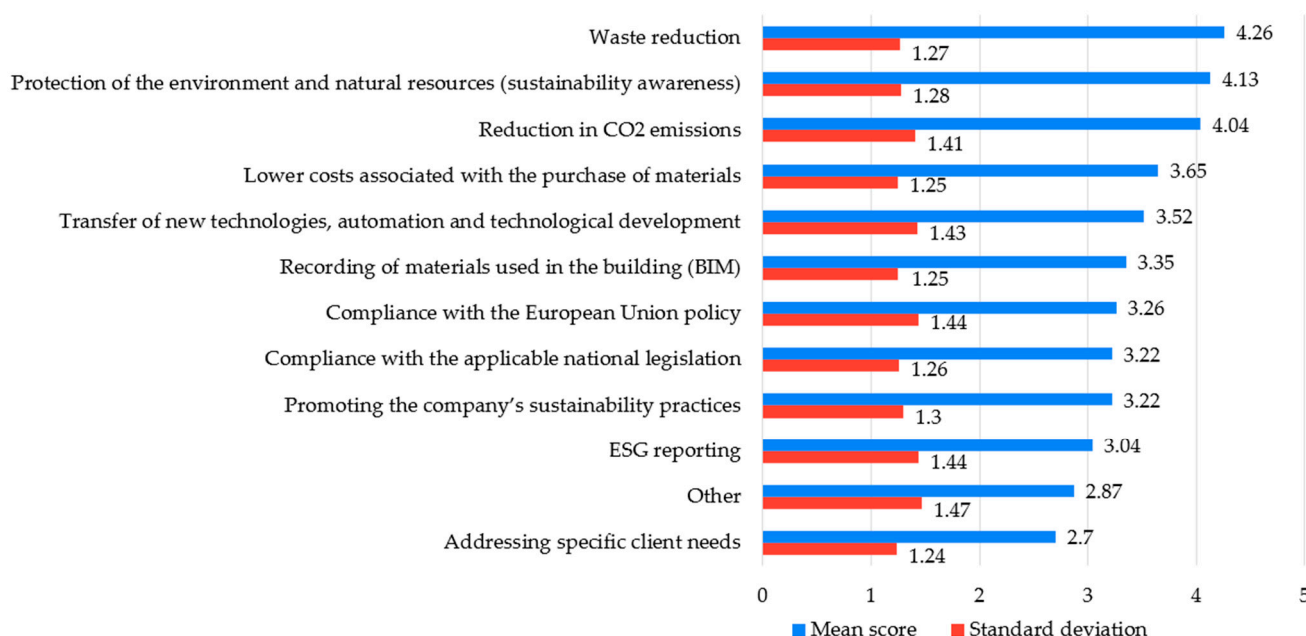


Figure 10. Benefits of using secondary construction materials (own elaboration).

The analysis of mean scores shows that respondents placed the greatest emphasis on aspects related to environmental sustainability. Waste reduction received the highest mean scores (4.26), followed by the protection of the environment and natural resources (4.13), and the reduction in CO₂ emissions (4.04). The high ratings assigned to the identified benefits confirm the dominant role of environmental considerations in shaping perceptions of the legitimacy of using secondary materials.

Economic benefits, as well as technical and technological benefits, such as lower costs associated with materials purchase (3.65), the transfer of new technologies, automation and technological development (3.52), and the recording of materials used in the building (BIM) (3.35), received moderately high ratings. Regulatory aspects were rated slightly lower, including compliance with the European Union policy (3.26) and compliance with the applicable national legislation (3.22).

The lowest ratings were given to benefits addressing specific client needs (2.70) and the “other” category (2.87), which may suggest that the market still imposes only limited requirements for the use of secondary materials.

Furthermore, respondents assessed the obstacles associated with the use of secondary materials, applying the scale from 1 to 5, where 1 represents the lowest level of importance, and 5 the highest level (Figure 11).

In the opinion of the respondents, the highest-rated obstacle was the lack of specialized platforms for secondary materials trading, which received a mean score of 4.00. This may point to a significant institutional gap in the organization of the secondary construction materials market and limited opportunities for their effective distribution.

Other highly rated obstacles were difficulties in sorting materials, including CDW (3.91), and complex bureaucratic procedures (3.87). These results may highlight the significance of technical and administrative obstacles, which can effectively limit the implementation of circular economy solutions.

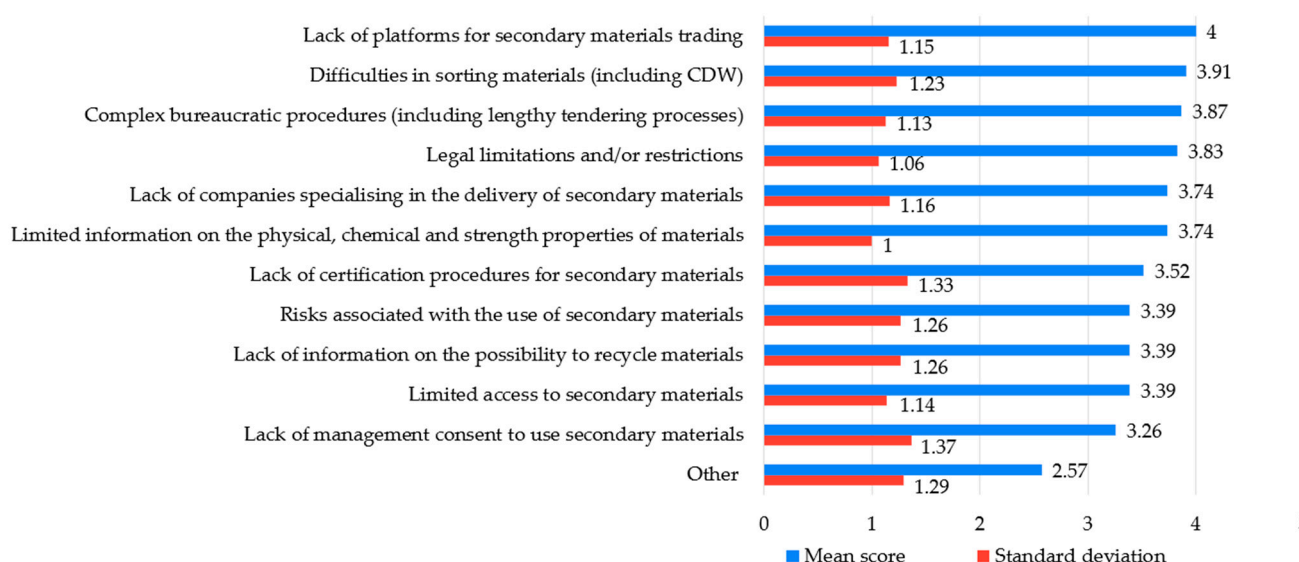


Figure 11. Obstacles associated with the use of secondary construction materials (own elaboration).

Relatively high mean scores were also recorded for legal limitations and/or restrictions (3.83) and the lack of companies specializing in the delivery of secondary materials (3.74). This may reflect the perceived lack of market maturity and regulatory obstacles that require intervention at the governing and institutional levels.

According to the respondents, limited information on the physical, chemical and strength properties of materials (3.74), and the absence of certification procedures for secondary materials (3.52) also constitutes a significant obstacle. This may generate design and construction uncertainty, as well as increase the perceived risk of using such solutions.

Obstacles such as the risks associated with the use of secondary construction materials, a lack of information on the possibility to recycle materials and limited access to materials received similar mean scores of 3.39, indicating their moderate but still-noticeable significance.

The lowest-rated obstacle included responses classified as “other” (2.57), suggesting that the catalogue of obstacles proposed in the survey largely corresponds to the actual problems identified by respondents.

Respondents were also asked to rate identified measures that could contribute to the wider use of secondary materials in practice, applying the scale from 1 to 5, where 1 represents the lowest level of importance, and 5 the highest level (Figure 12).

The highest-rated measure was the development of legislation concerning the reclassification of waste as secondary materials, which received a mean score of 4.35. This result may highlight the key role of the legal framework in the process of promoting secondary materials and may point to the need for clear and supportive legal regulations that eliminate formal and interpretative barriers.

Measures related to ensuring reliable access to secondary materials through suppliers' networks and digital platforms also received very high ratings (4.30). A similar level of importance was attributed to strengthening government support, including grants, improvements to the business conditions and tax incentives (4.26). These results may highlight the importance of both network development and policy/financial instruments in the investment decision-making process.

Respondents also attributed a significant role to the establishment of the network of partners interested in the use of secondary materials (4.22). This highlights the importance of cooperation between market participants, including manufacturers, contractors, designers and other organizations.

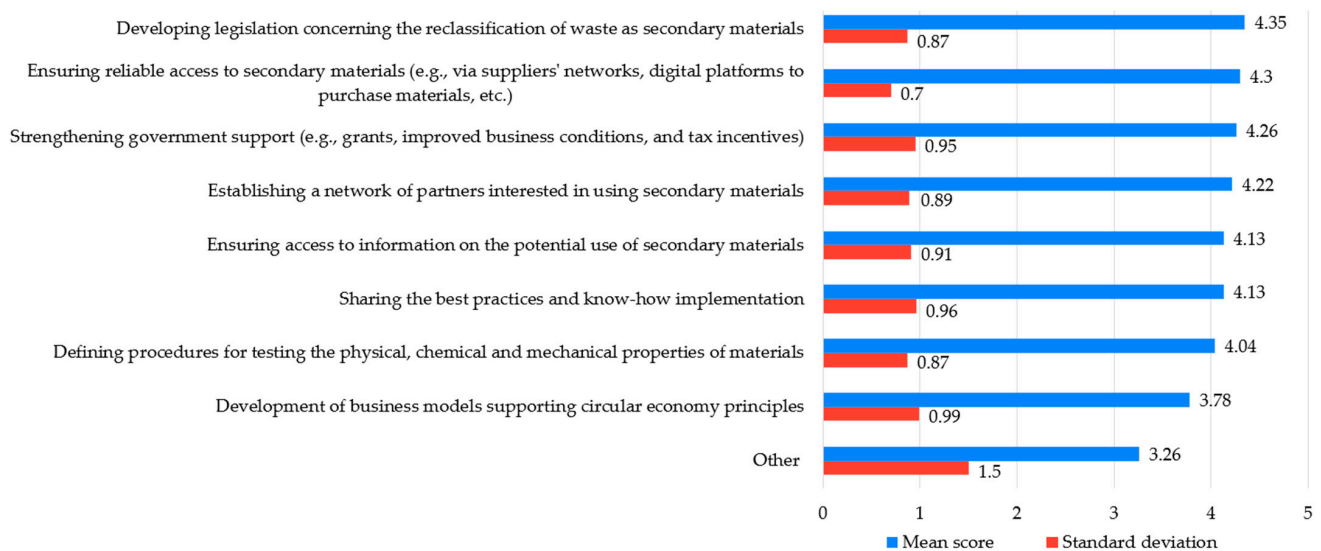


Figure 12. Measures supporting decisions on the wider use of secondary materials in practice (own elaboration).

Ensuring access to information on the potential use of secondary materials, as well as sharing best practices and know-how implementation, were also highly rated (both measures received a mean score of 4.13). These results may indicate that increasing the transparency of knowledge and dissemination of proven solutions can significantly reduce decision-making uncertainty.

A slightly lower, though still-high, rating was given to defining procedures for testing the physical, chemical and mechanical properties of secondary materials for the purpose of their classification (mean score 4.04). This may demonstrate the importance of standardizing and normalizing testing as a measure in building confidence in the quality of secondary materials.

The development of business models (3.78) and responses mentioned as “other” (3.26) received the lowest ratings. This may suggest that respondents expect regulatory and technical changes to a greater extent than individual management initiatives.

Respondents were subsequently asked to identify the materials they considered most suitable for recycling and/or reuse (Figure 13). It was possible to indicate several options.

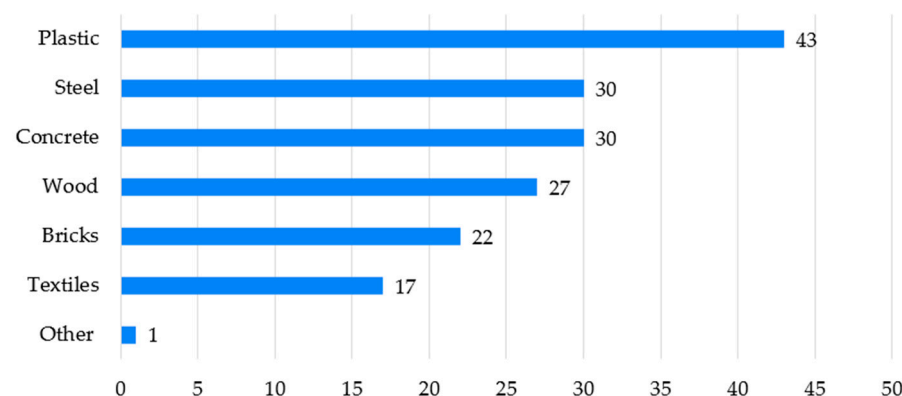


Figure 13. Materials perceived as the most suitable for recycling and/or reuse; number of responses (own elaboration).

Plastics were by far the most frequently cited material suitable for recycling and/or reuse, chosen by 43 respondents. Steel and concrete also received a high number of responses (30 each), followed by wood (27) and bricks (22). Textiles (17) and responses

in the “other” category (1) were mentioned much less frequently. These results show the prevailing perception of construction materials and commonly used plastics as the most promising in the context of the circular economy in the construction sector.

Respondents also assessed the possible growth of the market for secondary materials in the construction sector over the next decade (Figure 14).

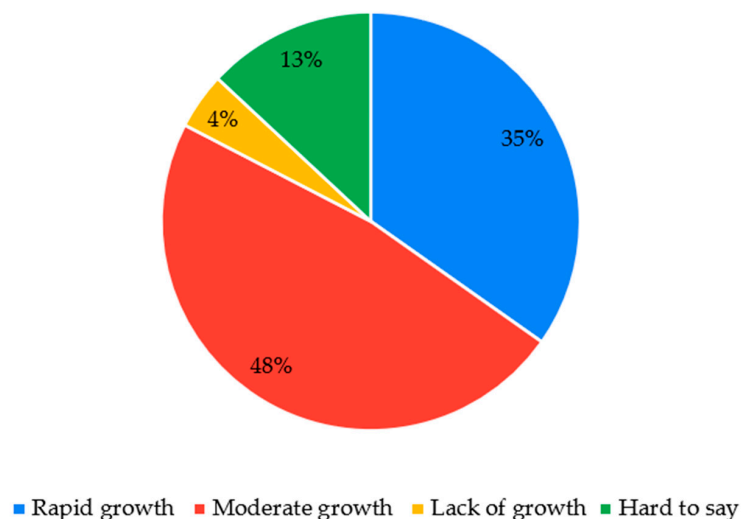


Figure 14. Possible growth of the market for secondary materials in the construction sector over the next decade; percentage of responses (own elaboration).

The majority of respondents positively assessed the prospects for the development of the market for secondary materials in the construction sector. The most frequently selected response was “moderate growth”, chosen by 22 respondents (48%), while 16 respondents (35%) predicted intensive growth of this market. Only two people did not expect growth, and six respondents selected the answer “hard to say”. The results suggest a predominance of cautious optimism, whilst recognizing factors that may limit the pace of the sector’s transformation.

5. Discussion and Conclusions

The research study addresses the issue related to the usage of secondary materials in the construction sector. The main empirical contributions of the study include:

- The identification of the benefits, barriers, and supporting measures associated with the implementation of secondary materials in the construction sector,
- The analysis of the perceptions of construction companies’ representatives from the West Pomeranian Voivodeship of Poland regarding these benefits, barriers, and supporting measures.

It was possible to answer the set research questions. The obtained results provide valuable insights regarding the current level of practitioners’ knowledge, experiences, and perceived challenges related to the benefits and obstacles associated with the use of secondary construction materials, as well as measures that could contribute to the wider use of these materials in urban areas. The research study delivers empirical evidence derived from the West Pomeranian Voivodeship of Poland, a specific region in Central Europe.

Based on the research findings, the following conclusions can be drawn:

1. The high proportion of respondents who indicated that they are either currently using (48%) or planning to adopt (24%) circular economy solutions reflects a growing awareness of and readiness for this transition within the construction sector. However, the substantial share of undecided respondents (28%) suggests a continued

need for education and the dissemination of practical knowledge regarding circular economy practices.

2. The secondary materials most frequently used by respondents, namely steel, wood, plastics, and concrete, suggest that companies tend to prioritize materials with well-established technological applications. The less frequent use of other materials may be attributed to technological, regulatory, and logistical barriers.
3. A relatively high level of awareness of the requirement to use secondary construction materials was observed among respondents, with 74% indicating familiarity with this obligation. Nevertheless, the presence of negative (17%) and uncertain (9%) responses points to persisting information gaps that may hinder the effective implementation of relevant regulations.
4. The high ratings assigned to environmental benefits, particularly waste reduction (mean score 4.26) and the protection of the environment and natural resources (4.13), indicate that respondents primarily perceive the circular economy as a means of achieving environmental objectives. Although economic, regulatory, and technological benefits were also recognized, they were considered of secondary importance.
5. According to the respondents, the most significant obstacles to the use of secondary materials include the lack of platforms for trading such materials (mean score 4.00), difficulties in material sorting (3.91), and complex bureaucratic procedures (3.87). These findings suggest that the main challenges are systemic in nature, underscoring the importance of public institutions and policymakers in addressing these barriers.
6. Respondents clearly emphasized the importance of developing an appropriate legal framework (mean score 4.35), ensuring permanent access to secondary materials (4.30), and providing governmental support (4.26). These results confirm that the effective implementation of circular economy principles requires coordinated efforts involving market actors, public authorities, and private-sector stakeholders.
7. The types of secondary construction materials most frequently identified by respondents indicate that recycling and reuse initiatives should primarily target high-volume structural materials, such as plastics, steel, and concrete. Given their substantial contribution to construction waste streams, these materials offer the greatest potential for circular utilization.
8. Respondents generally anticipate continued growth in the market for secondary construction materials over the next decade, with 48% expecting moderate growth and 35% predicting rapid expansion. The relatively low proportion of negative assessments (4%) further suggests that market growth is perceived as a likely trend, although its pace and magnitude will depend on the successful implementation of supportive regulations and market mechanisms.

However, it should be mentioned that the research results have several limitations, including the relatively small sample size (46 responses), the purposive nature of the sample selection, and the regional scope of the study. Therefore, the findings should be interpreted with caution when extending them beyond the studied context, as the implementation of circular economy practices and the use of secondary materials are shaped by local economic, social, institutional, and regulatory conditions. Future research should encompass multiple regions and countries to enable more comprehensive comparisons of the conditions influencing the implementation of circular economy practices. Such an approach would facilitate the identification of both common patterns and context-specific determinants, thereby improving the external validity and generalizability of the findings. Expanding the geographical scope would also support a more robust analysis of how factors such as company size, professional role, years of experience, and the current use of recycled materials influence the adoption of circular economy principles. Moreover, broader spatial

coverage would provide valuable insights into the transferability of successful practices across different regional and national contexts.

Furthermore, the representativeness of the sample should be considered when interpreting the findings, as respondents were largely drawn from micro-enterprises and the private sector. Therefore, the conclusions are most directly relevant to these stakeholder groups and may not fully encompass the perspectives of larger corporations or public institutions, which often operate under different organizational and regulatory conditions [64]. Expanding future research to include these actors would enhance the comprehensiveness and external validity of the findings.

While analyzing the research results, the attention should be paid to the fact that respondents most frequently mentioned steel, concrete, wood and plastics as the materials best suited for recycling or reuse. This is consistent with the findings of numerous studies in which these materials are identified as key construction waste streams, both in terms of volume and environmental potential [2,80,81]. At the same time, the relatively lower ratings for textiles and ceramics confirm findings in the literature, according to which these materials present greater technological and logistical challenges in terms of recycling and reuse, particularly in the context of building construction [82,83]. However, it should be noted that respondents' views may be shaped by a range of regulatory, ethical, and practical factors.

Considering the above, the impact of secondary materials application by construction companies on urban-system framing should be highlighted. Adoption of these materials affects the development of more circular, resilient and sustainable cities. Growing awareness and readiness within the construction sector companies to apply secondary materials may impact the decisions on these materials obtaining, storage and supply in urban systems. It also supports the development of local recycling industries, creates new employment opportunities, and encourages innovation in material recovery and building design. It is important to emphasize that a circular city requires new physical infrastructure. Instead of zoning vast tracts of land for distant dumpsites, urban planners must integrate localized "circular hubs" or material recovery facilities closer to the city centre. This entails the implementation of adaptive zoning frameworks that support the sorting, processing, and storage of secondary materials within urban areas while mitigating adverse impacts on residential environments. In a mature urban structure, the use of secondary materials fosters cross-sectoral cooperation. Waste from one industry (e.g., fly ash from local power stations or slag from metal processing) becomes a standardized raw material for urban concrete producers. Therefore, the city ceases to be a collection of isolated businesses and functions instead as a local ecosystem.

The need for localized "circular hubs" is directly supported by the survey findings rather than being a purely theoretical projection. Respondents rated the lack of specialized platforms for secondary materials trading as the single highest-scoring obstacle (mean score 4.00), and simultaneously rated "ensuring consistent access to secondary materials, including through suppliers' networks and digital platforms" as one of the most important supporting measures (4.30). This paired result (a market-infrastructure gap identified as the top obstacle, and infrastructure/network access identified as a near-top-priority solution) provides an empirical justification for embedding physical "circular hubs" and digital material-exchange platforms within urban systems, rather than treating this as an abstract planning recommendation. The importance of ICT-based decision-support tools was also highlighted by Ye et al. [71].

The "material bank" framing is corroborated by respondents' own practice: 48% of respondents (22 of 46) reported already applying circular economy solutions involving secondary materials, with steel (16 responses), wood (13), plastics and concrete (12 each)

cited as the materials currently reintegrated into construction activity. Moreover, when asked which materials were perceived as best suited to recycling or reuse irrespective of current practice, plastics (43 mentions), steel and concrete (30 each) and wood (27) dominated the responses. This convergence between materials already circulating and materials perceived as most reusable indicates that bulk structural and finishing materials (precisely those embedded in the existing urban building stock) constitute the practical resource base for material banks in cities of the West Pomeranian Voivodeship (Poland), reinforcing the conceptual claim with sector-specific evidence rather than a generic reference to “buildings as material banks”.

The proposed need for cross-sectoral cooperation platforms is likewise grounded in respondent priorities: the creation of partner networks for secondary materials use received a mean importance score of 4.22, while sharing best practices and improving access to information each scored 4.13. Combined with the finding that legal reclassification of waste as a secondary material was rated the most important supporting measure overall (mean score 4.35), these results show that respondents view institutional and networked infrastructure, not company-level initiative alone, as the primary lever for embedding circularity into urban systems. This is consistent with the opinions of 28% of respondents (13 of 46) who remained unsure whether their own organization already used circular solutions, and the 24% who intended to adopt them in the future, suggesting that urban-scale hubs and information platforms could specifically target this “undecided” segment by lowering the informational and logistical barriers identified above.

Finally, the case for investing in urban-embedded circular infrastructure is strengthened by respondents’ outlook on market trajectory: 22 of 46 respondents (48%) anticipated moderate growth and 16 (35%) anticipated intensive growth in the secondary materials market over the next decade, with only two respondents expecting no growth. This empirically observed optimism, rather than an assumed trend, supports the argument that cities should proactively zone for circular hubs and material recovery facilities now, ahead of anticipated demand, instead of retrofitting infrastructure reactively.

When companies are concerned and prioritize circularity, buildings and infrastructure are no longer end-points of consumption but “material banks” that store valuable resources for future cycles. A circular urban economy requires skilled workers for material auditing, careful dismantling, remanufacturing, logistics, and secondary material certification. Therefore, there is a clear need for targeted education and awareness-raising initiatives. This, in turn, highlights the importance of developing cooperation platforms, including digital solutions, to facilitate collaboration among the various stakeholders involved in the adoption and use of secondary materials.

In the surveyed respondents’ viewpoint, the main benefits of using secondary construction materials include reducing waste reduction (mean score 4.26) and the protection of the environment and natural resources (4.13), which collectively strengthen climate resilience. The integration of secondary materials into the urban construction sector represents far more than a sustainable waste-management strategy. It functions as a structural nexus where climate mitigation and urban adaptation converge. By reducing the energy demand for virgin elements, turning buildings into modular, adaptable structures, and closing localized loops within the urban metabolism, secondary materials provide the physical blueprint required to construct resilient, low-carbon cities capable of withstanding future environmental disruptions.

Moreover, based on respondents’ opinions on perceived obstacles, the role of community and government involvement in urban transformation should be emphasized. A circular economy cannot operate solely on material performance and structural engineering; it requires a highly synchronized socio-institutional ecosystem. Transformation towards

using secondary construction materials in cities requires an integrated socio-technical approach where municipal governance frameworks provide the regulatory security, private markets deliver the logistical scalability, and civil society provides the democratic legitimacy and cultural trust necessary to re-engineer the urban metabolism. Therefore, collaboration among local authorities, civil society, and private sector stakeholders is indispensable, as public acceptance and active community engagement are key determinants of successful urban regeneration projects.

Based on the survey results, the main areas for further improvements were identified:

- Strengthening education and knowledge transfer to increase awareness of the need to use secondary construction materials. This can be done, for example, by developing the skills of management and technical staff, implementation of pilot/demonstration projects, incorporating circular economy principles into the company's strategy, development of local circular construction strategies, continuous updating of knowledge on circular construction, professional training, etc.
- Promoting and broadening the use of secondary construction materials by creating better organizational and legal conditions. This can be done, for example, by standardization of material assessment and qualification procedures, better communication and building a competitive advantage implementing secondary materials, specifying certified recycled materials, creating designs with locally available secondary materials, establishing minimum content targets for secondary materials, etc.
- Improving regulatory communication and guidance to better achieve benefits of implementing circular economy practices by different stakeholders. This can be done, for example, by assessment of benefits across the entire life cycle of a building, prioritizing secondary materials during the design phase, minimizing material consumption through efficient design, incorporating life cycle assessment into design decisions, etc.
- Removing systemic barriers to reduce obstacles related to the implementation of secondary construction materials. This can be done, for example, by establishing reliable supply chains, active use of public support instruments, providing financial incentives, prioritizing design for adaptability and long-term flexibility, introducing green public procurement requirements, investing in local infrastructure (e.g., warehouses), improving construction and demolition waste management, etc.
- Strengthening institutional and market support supporting reliable supply chains to effectively implement circular economy solutions. This can be done, for example, by developing collaboration networks and strengthening cooperation among stakeholders, creating and utilizing digital platforms, implementing digital resource transparency, establishing collaboration with material suppliers and recycling companies, monitoring of progress using circular economy indicators, etc.

Urban transformation should be strategically planned, considering the involvement of different actors. Based on the survey results analysis and own observations, the recommendations for managers from construction sector companies operating within cities of defined geographical areas were proposed (Table 5). Moreover, the recommendations for urban planners and local policymakers were developed (Tables 6 and 7).

To sum up, the analysis carried out indicates that the modernisation and regeneration of old urban buildings using secondary materials is one of the key instruments for achieving the objectives of sustainable development in urban systems. These activities go beyond traditionally understood renovation processes, encompassing the comprehensive regeneration of areas that have deteriorated in social, economic, environmental and cultural terms. Regeneration contributes to improving residents' quality of life by increasing access to services, raising living standards, enhancing safety and combating social exclusion. At

the same time, it stimulates the development of the local economy, enhances the investment and tourist appeal of urban areas, and promotes the creation of new jobs.

Table 5. Recommendations for companies' managers from the construction sector (own elaboration).

Recommendation	Description
1. Incorporating circular economy principles into the company's strategy	It is recommended that the use of secondary materials should become part of the company's long-term development strategy. Incorporating circular economy principles into business objectives enables the systematic planning of activities, reduces the risks associated with decision-making, and enhances coherence between the environmental, economic and reputational aspects of the company's operations.
2. Developing the skills of management and technical staff	A key activity is investing in the upskilling of staff, particularly management, designers and those responsible for procurement and investment implementation. Training should cover issues relating to the technical properties of secondary materials, applicable legal regulations, certification procedures and the assessment of risks associated with their use.
3. Standardizing of material assessment and qualification procedures	It is recommended to implement internal procedures enabling the assessment of the quality, technical parameters and suitability of secondary materials. Standardizing decision-making processes, based on clearly defined technical and environmental criteria, can reduce uncertainty and increase confidence in such solutions in investment practice.
4. Establishing reliable supply chains	It is recommended to establish long-term partnerships with suppliers, demolition contractors, waste management companies and manufacturers of recycled materials. Reliable partnerships help to ensure continuity of supply, cost predictability and better planning of implementation processes.
5. Utilizing digital platforms	Managers should consider actively using existing or emerging digital platforms that facilitate trading of secondary construction materials. These tools can perform not only a commercial function but also an informational one, supporting material tracking, ESG reporting, and the analysis of an investment's environmental footprint.
6. Assessing of benefits across the entire life cycle of a building	It is recommended to use an approach based on life cycle assessment (LCA) and life cycle costing (LCC) when assessing the cost-effectiveness of using secondary materials. This approach allows for a more comprehensive consideration of environmental and economic benefits, which are not always visible in a short-term analysis of investment costs.
7. Active use of public support instruments	Managers should monitor available public support programmes, including grants, tax relief and preferential financing terms for pro-environmental projects. The use of support instruments can significantly lower financial barriers and accelerate the implementation of solutions based on secondary materials.

Table 5. *Cont.*

Recommendation	Description
8. Better communication and building a competitive advantage	It is recommended to actively communicate initiatives relating to the use of secondary materials both within the organization and externally, in dealings with customers and business partners. Transparent communication regarding sustainability can enhance the company's image and constitute a key element of its competitive advantage.
9. Developing collaboration networks	It is recommended to strengthen collaboration networks among key stakeholders, including construction companies, designers, material suppliers, waste management organizations, and public authorities. Effective cooperation can facilitate knowledge exchange, improve the availability and quality of secondary materials, and support the development of common technical standards and quality assurance procedures.
10. Progressive implementation and pilot projects	It is recommended to begin implementing secondary materials through small-scale pilot projects. This approach allows for the acquisition of practical experience, risk assessment and the gradual building of trust in new solutions without placing an excessive organizational burden.

Table 6. Recommendations for urban planners (own elaboration).

Recommendation	Description
1. Prioritizing secondary materials during the design phase	Material selection should consider secondary materials from the earliest stages of design. Designers should evaluate materials based not only on their technical performance but also on their content, embodied carbon, environmental impact, and potential for future recovery.
2. Prioritizing design for deconstruction and adaptability	It is recommended to design buildings and infrastructure in a way to facilitate future disassembly rather than demolition. Modular construction, reversible connections, standardized components, and adaptable building layouts increase the potential for recovering high-quality materials at the end of a building's service life.
3. Implementing digital resource transparency (material banks)	City planners should create a digital inventory of the urban materials to manage resources effectively. It is recommended to utilize GIS at the local or regional level to map the type, quantity, and condition of materials within existing buildings, as well as use BIM to track resource consumption and waste generation throughout a project's life, optimizing transport and recovery paths.
4. Design for adaptability and long-term flexibility	Flexible building layouts and adaptable structural systems extend the functional lifespan of buildings by allowing future modifications without extensive demolition. This approach reduces material consumption and minimizes construction and demolition waste.

Table 6. *Cont.*

Recommendation	Description
5. Specifying certified recycled materials	It is recommended to specify certified secondary construction materials. Material specifications should be based on verified technical performance and compliance with relevant standards.
6. Minimizing material consumption through efficient design	Resource efficiency should be a primary design objective. Structural optimization, lightweight design, and material-efficient construction systems reduce the overall demand for raw materials while maintaining structural safety and functionality.
7. Incorporating life cycle assessment into design decisions	It is recommended to evaluate design alternatives using LCA to quantify environmental impacts over the entire life cycle of a building. LCC may complement environmental assessments by identifying economically efficient circular design solutions.
8. Creating designs with locally available secondary materials	Designers should prioritize secondary materials available within the local or regional market. Shorter transportation distances reduce environmental impacts while strengthening local circular supply chains and recycling industries.
9. Collaborating with material suppliers and recycling companies	Early collaboration with manufacturers, suppliers, demolition contractors, and recycling companies enables designers to identify suitable secondary materials and better understand their technical characteristics, availability, and limitations.
10. Continuous updating knowledge on circular construction	Designers should continuously improve their knowledge of circular design principles, emerging secondary materials, evolving technical standards, and innovative construction technologies. Ongoing professional development is essential for increasing confidence in specifying secondary materials and implementing circular design strategies.

Table 7. Recommendations for local policymakers (own elaboration).

Recommendation	Description
1. Developing local circular construction strategies and legal framework	It is recommended to integrate circular economy principles into local development plans and construction policies. Dedicated legal framework, strategies, practical guidelines should, e.g., establish measurable targets for reducing construction waste and increasing the use of secondary materials in both public and private construction projects.
2. Introducing green public procurement requirements	Public authorities should incorporate circular procurement criteria into public construction tenders by requiring or incentivizing the use of certified recycled materials. Tender evaluation should be shorter, more clear and consider life-cycle environmental performance in addition to initial investment costs, thereby encouraging sustainable construction practices.

Table 7. *Cont.*

Recommendation	Description
3. Establishing minimum content targets for secondary materials	It is recommended to introduce minimum content requirements for selected publicly funded construction and infrastructure projects. Gradual implementation allows the construction industry to adapt while creating stable demand for secondary materials.
4. Investing in local infrastructure	Financial support should be directed towards facilities for the collection, sorting, processing, and certification of construction and demolition waste. Well-developed local infrastructure (e.g., warehouses) improves the availability, quality, and competitiveness of secondary construction materials while reducing transportation-related environmental impacts.
5. Providing financial incentives	Local policymakers should introduce economic instruments that encourage the use of secondary materials, including grants for circular construction projects, tax incentives, reduced landfill charges for recoverable construction waste, and financial support for innovative technologies, e.g., used for materials recycling.
6. Supporting demonstration projects	Pilot/demonstration projects involving municipal buildings and public infrastructure should showcase the practical application of secondary materials. Demonstration projects provide technical evidence, increase stakeholder confidence, show best practices, and encourage wider market adoption.
7. Strengthening organization of cooperation among stakeholders	Local governments should strengthen coordination and foster collaboration among architects, engineers, contractors, demolition companies, recycling enterprises, universities, material suppliers, circular economy hubs and other entities. Multi-stakeholder cooperation enhances knowledge exchange and supports the development of local circular supply chains.
8. Improving construction and demolition waste management	Policies should prioritize selective demolition, on-site material separation, efficient waste collection and sorting systems to maximize the recovery of reusable and recyclable materials. Improved waste management directly increases the supply of high-quality secondary resources.
9. Supporting education and professional training	Local authorities should organize training programmes, workshops, and awareness campaigns for professionals involved in the construction sector. Increasing knowledge of circular construction principles and the performance of secondary materials can reduce resistance to their adoption.

Table 7. Cont.

Recommendation	Description
10. Monitoring progress using circular economy indicators	Municipalities should establish monitoring systems that assess the quantity of construction waste generated, recycling rates, secondary material utilization, and greenhouse gas emissions associated with construction activities. Reliable performance indicators enable evidence-based policy adjustments and continuous improvement.

The authors are aware that the current dataset of 46 respondents from a single voivodeship is not sufficient to perform deeper subgroup analysis using inferential statistics, factor analysis, and qualitative components. Cross-regional comparisons would also significantly expand this line of research. Therefore, the authors plan further studies to build on the results obtained and focus on the development of dedicated digital platforms for secondary construction materials trading, as well as on the detailed technical properties of these materials, which were identified by respondents as key areas requiring further attention. In the next studies the application of inferential statistical methods, including *t*-tests, ANOVA or the Mann–Whitney U test [84,85], will be taken into account to verify whether the opinions expressed by respondents differ significantly depending on company size, respondents' professional roles, work experience, or the current use of secondary materials in the company, as the sample size of the present study did not allow for such analysis to be conducted with sufficient statistical power. Factor analysis will be taken under consideration as well, as it could enable the identification of underlying dimensions among the benefits, obstacles and measures examined in this study, provided that a larger dataset is obtained, and new series of in-depth interviews with selected practitioners will allow the quantitative findings to be supplemented and better contextualized. The authors will make efforts to expand the survey to other voivodeships or countries, which would enable a comparative analysis of regional and international differences in the adoption of circular economy solutions in the construction sector, and would allow the conclusions drawn from this study to be verified on a broader scale. Moreover, in-depth research on regulatory issues concerning both the national and international environment will be considered.

The results of this research may provide valuable insights for managers of companies involved in the construction sector, including demolition contractors, waste management enterprises, design firms, and other industry participants.

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