Barriers to reducing, reusing, and recycling plastic waste in the construction sector: A European perspective for construction companies

Citation for the original published paper (version of record):
Wang, S., Lanau, M., Österbring, M. et al (2026). Barriers to reducing, reusing, and recycling plastic waste in the construction sector: A
European perspective for construction companies. Cleaner Environmental Systems, 20.
http://dx.doi.org/10.1016/j.cesys.2026.100400

Cleaner Environmental Systems 20 (2026) 100400

Contents lists available at ScienceDirect

Cleaner Environmental Systems

journal homepage: www.journals.elsevier.com/cleaner-environmental-systems

Barriers to reducing, reusing, and recycling plastic waste in the construction sector: A European perspective for construction companies

Shuang Wang [a,*], Maud Lanau [a], Magnus Österbring [b], Holger Wallbaum [a], Leonardo Rosado [a]

[a] Department of Architecture and Civil Engineering, Chalmers University of Technology, 412 96, Gothenburg, Sweden
[b] NCC Sverige AB, 412 50, Gothenburg, Sweden

ARTICLE INFO

Keywords:
Plastic
Recycling
Construction sector
Barrier
Circular economy

ABSTRACT

The construction sector has been struggling to implement plastic waste management strategies that promote plastic circularity, and limited understanding persists regarding the barriers to reducing, reusing, and recycling plastic waste. This knowledge gap is compounded by the diversity of plastic products, the unique role of construction companies in the circular economy, and the complexity of the construction plastics' value chain. This study aims to generate knowledge to support construction companies in improving plastic waste management in the European context. We investigate relevant barriers through a life cycle perspective and considering the diversity of construction plastics. By compiling product data, a construction plastic product list was created, covering 38 product types across seven categories with 18 polymer options. In parallel, a literature review and thematic analysis was conducted to construct a life cycle-based and circularity strategy (Reduce, Reuse, Recycle)-categorized barrier overview. The diversity of construction plastics was considered in the barrier analysis, revealing how the relevance of specific barriers varies across products.

A total of 129 barriers to recycling, 124 to reuse, and 39 to reduction were identified. Results highlight that the *Construction* life cycle stage faces the highest number of barriers across all three strategies. These barriers are predominantly activity-related, such as 17 "Collection & Sorting" barriers for recycling, 12 "Design" barriers for reuse, and 4 "Installation" barriers for reduction. The life cycle stage-based, strategy-specific, and product-specific perspectives on barriers provide a structured foundation for construction companies to set strategic priorities and develop targeted and effective plastic waste management strategies.

1. Introduction

The construction sector is the world's most material-intensive sector, consuming around 30.6 billion tons of materials annually (United Nations Environment Programme, 2024a). This extensive material use contributes significantly to climate impact along the life cycle of buildings, which accounts for 37 % of global carbon emissions in 2022 (United Nations Environment Programme, 2024b). Additionally, the sector generates massive amounts of waste. For example, 40 % of the annual waste generated in the European Union (EU) is from the sector (García et al., 2024). To date, bulk materials such as concrete and steel have usually been the focus of interventions to address these environmental challenges (United Nations Environment Programme, 2023). However, plastics are also among the key materials used in the construction sector, which was the second-largest consumer of plastics in the EU in 2022, accounting for 23 % of total plastic use (Plastics Europe, 2024). Their popularity arises from their lightweight, versatility, durability, and cost-effectiveness, making them essential components in insulation, piping, flooring, and various finishing products (Zhao et al., 2022; SOUDER et al., 2024). Despite this widespread use, plastics have been largely overlooked in efforts to reduce waste generation and climate impacts within the sector. Because plastics are much lighter than other construction materials, they do not stand out in waste statistics, which are typically measured by mass. Although their overall contribution to emissions and waste is smaller than that of concrete or steel, plastics remain environmentally relevant due to their high emission factors (Construction Industry Development Board Malaysia, 2021). Globally, the plastics life cycle is projected to account for about 5 % of carbon emissions by 2040 (OECD, 2024; Luciani et al., 2013)% arising from virgin plastic production, 30 % from product manufacturing, and 9

* Corresponding author.
E-mail addresses: shuang.wang@chalmers.se (S. Wang), maud.lanau@chalmers.se (M. Lanau), magnus.osterbring@ncc.se (M. Österbring), holger.wallbaum@chalmers.se (H. Wallbaum), rosado@chalmers.se (L. Rosado).

https://doi.org/10.1016/j.cesys.2026.100400
Received 20 June 2025; Received in revised form 20 January 2026; Accepted 25 January 2026
Available online 26 January 2026

% from end-of-life processing (Zheng and Suh, 2019).

To mitigate virgin plastic demand and the associated emissions, it is essential to manage plastic waste strategically to advance plastic circularity in the construction sector. 3R (Reduce, Reuse, and Recycle), which originates from the waste hierarchy in the EU Waste Framework Directive, provides a structured approach for this purpose (Lazarevic et al., 2010). The growing policy attention reflects this importance, as the European Commission plans to introduce mandatory requirements for recycled content and waste reduction measures for construction plastics (European Comission, 2020). Industry actors are also contributing to these goals. For instance, manufacturers in the construction sector already accounted for more than 40 % of total recycled plastic consumption in the EU in 2022 (Plastics Europe, 2024). However, this contribution mainly supports plastic circularity at the overall industry level rather than within the construction sector itself. The origin of the recycled plastics used in construction products is often unclear, as the recycled pellets may be sourced from mixed or unidentified waste streams. Nevertheless, progress in reducing, reusing, and recycling its own plastic waste remains limited. For instance, its recycling rate of post-consumer plastic waste was only 17.4 % in 2022, ranking the second lowest among all plastic application sectors in the EU, even though it was the second largest generator of plastic waste (Plastics Europe, 2024). Therefore, the construction sector should place greater emphasis on reducing, reusing, and recycling plastic waste from construction and demolition activities, positioning itself not only as a consumer of recycled or reused plastics, but also a provider and a smarter user of plastics.

Improving plastic waste management in the European construction sector remains challenging, partly due to limited knowledge of the barriers that impede the reduction, reuse, and recycling of plastics. Santos et al. (2023) conducted the only review to date on barriers to recycling construction, renovation, and demolition plastic waste, summarizing barriers in several key factors, such as economical limitations and logistical barriers. In addition, limited insights into barriers can be found in other studies, although these were primarily aimed at addressing different objectives, such as quantifying construction plastic waste (Berry et al., 2022; Hernandez et al., 2023). There is a growing body of research on barriers to implementing circular economy in the construction sector in general, which may also be relevant to construction plastics (Mhatre et al., 2023; Wuni, 2022).

Despite the diversity of construction plastics, whether in terms of function (such as pipe and insulation) or polymer type (such as polyvinyl chloride (PVC)), barriers for plastics were usually discussed in general terms. However, not specifying a particular plastic product function or polymer type may limit applicability of research findings to practical solutions (King and Locock, 2022). Furthermore, the characteristics of plastic products determined by their applications and properties may influence the relevance of barriers to reducing, reusing, and recycling different types of plastic products (van Stijn et al., 2023).

Another factor that needs to be considered is the role of construction companies in addressing barriers for reducing, reusing, and recycling plastic waste. A construction company manages and executes construction projects, acting as both the end user of plastic products and a generator of plastic waste. This dual role makes it well positioned to develop effective waste management strategies for plastics. European construction companies are increasingly required to meet stricter on-site waste management regulations. For example, Sweden's Avfallsförordning (the Waste Ordinance) (2020:614), which is based on the EU Waste Framework Directive, requires on-site sorting of specific waste streams, including plastic. They are also aware of the challenges of managing plastic waste at construction sites which become increasingly small and dense (Jansson et al., 2019). Last but not least, they need to reduce the climate impacts of their building projects and are looking to managing plastic waste properly as a contribution, engaging in related initiatives. In Sweden, for example, several recycling initiatives have been established and tested with participation of construction companies: the Swedish Flooring Trade Association's recycling system for plastic flooring, the Nordic Plastic Pipe Association's recycling system for plastic pipes, and CirEm, an innovation project aiming at developing a circular system for plastic packaging from the construction industry (Almasi et al., 2020; Jansson et al., 2021; Jónsdóttir et al., 2023). Given this context, barriers should be interpreted in ways that offer construction companies practical insights into how these barriers can be addressed in their operations.

The third factor that needs to be considered is the complexity of construction plastics' value chain. If this study was conducted solely from the perspective of construction companies, its scope would naturally be limited to the construction stage. As highlighted by the OECD (OECD, 2020), resource efficiency and circular economy policies must target all stages of the value chain to avoid burden-shifting and ensure system-wide improvement. Similarly, barriers to reducing, reusing, and recycling plastic waste cannot be fully understood by examining only the construction stage. Moreover, since material flows connect different actors along the value chain, considering the entire value chain allows this study to capture the interactions of material flows across lifecycle stages, which is essential when examining material circularity. To account for this complexity, adopting a life cycle perspective can help systematically identify barriers across the value chain, preventing fragmentation while enabling the development of targeted strategies. For example, Ghafoor et al. (2024) investigated cost barriers affecting the use of secondary materials in the construction sector across six life cycle stages. However, most studies on barriers to implementing circular economy in the construction sector focused only on the end-of-life stage or design stage (Véliz et al., 2022; Jayarathna et al., 2025), while a few authors identified several barriers in other stages such as material supply and manufacturing when focusing on the end-of-life stage (Santos et al., 2023).

Therefore, three factors may influence identifying and addressing barriers to reducing, reusing, and recycling plastic waste in the construction sector: diversity of construction plastics, the role of construction companies, and complexity of construction plastics' value chain. Yet, these factors have been largely overlooked in previous research. This study aims to generate knowledge for construction companies to improve plastic waste management in the European context by investigating barriers to reducing, reusing, and recycling plastics in the construction sector, integrating a life cycle perspective and considering the diversity of construction plastics.

2. Methods

This study was made in three workflows (See Fig. 1). Workflow 1 focused on developing a list of construction plastic products used in buildings, providing a systematic understanding of their diversity. Workflow 2 covered the development of an overview of barriers to reducing, reusing, and recycling plastics in the construction sector, specifying barrier types in different life cycle stages. Workflow 3 integrated the diversity of construction plastics into barrier analysis, assessing the relevance of barrier across different products.

2.1. Study scope

The term construction plastics refers to plastic products primarily made of plastics and used in building construction. Bioplastics (bio-based and biodegradable plastics) were excluded due to their limited market share, accounting for only 0.9 % of European plastic production (Plastics Europe, 2024). Moreover, plastics in composites, such as window frames made of wood-plastic composites and pipes made of fiber-reinforced plastic, were excluded from the scope due to the major technical challenges associated with their reuse and recycling (De et al., 2024). In this study, three circularity strategies were considered, Reduce (waste reduction), Reuse (waste reuse), and Recycle (waste recycling). Reduce refers to reducing waste generated at construction and demolitions sites through waste prevention measures; Reuse refers to

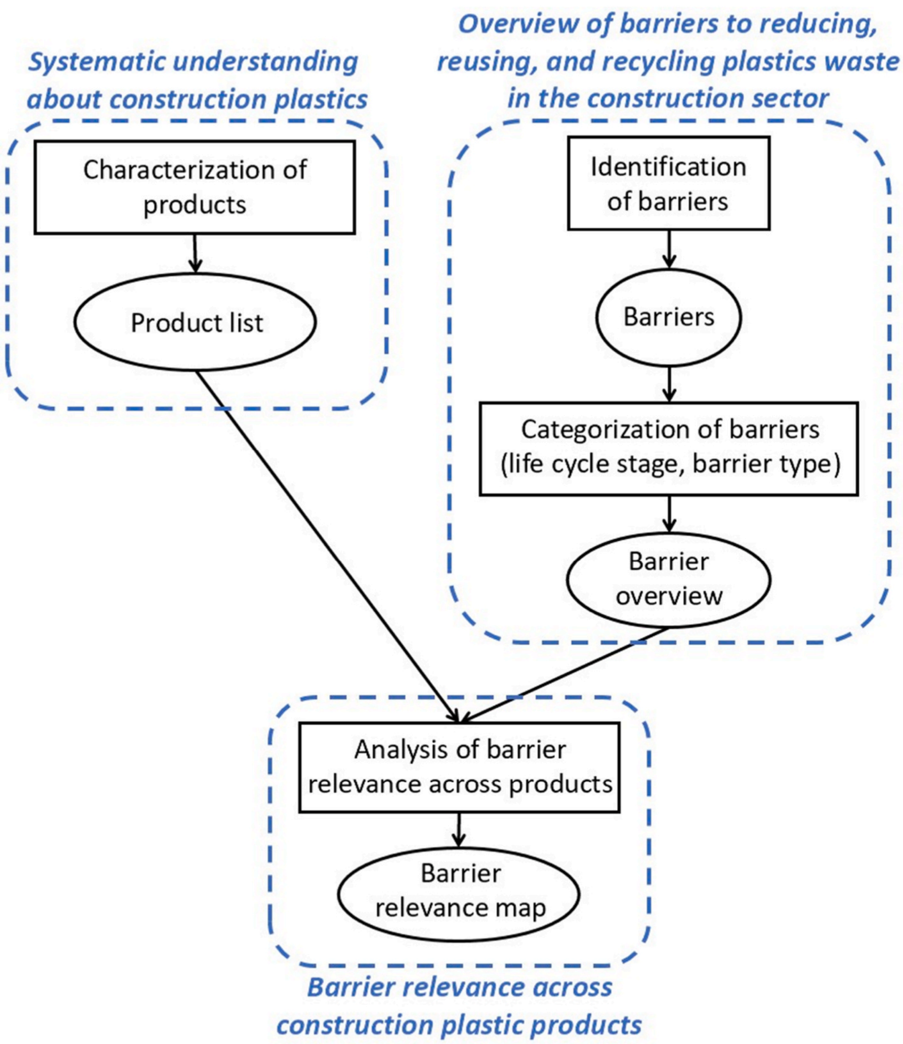

Fig. 1. Method framework (rectangle = process; oval = data).

processing plastic waste to obtain products without converting it back into raw material; and Recycle refers to processing plastic waste into pellets that can be used as raw material for manufacturing new plastic products (namely mechanical recycling) (Potting et al., 2017). Current mechanical recycling of plastics is commonly employed to clean single-type plastic waste such as polypropylene (PP), and mixed plastic waste requires sorting to produce high quality recycled pellets (Al-Salem et al., 2009; Ignatyev et al., 2014). Downcycling and chemical recycling were excluded. Downcycling incorporates plastic waste into construction materials, such as aggregates in bricks, tiles, and roads, which does not inherently replace virgin plastics (Cirino et al., 2023), while chemical recycling has a very limited market share and limited economic feasibility (Plastics Europe, 2024; Chen et al., 2021).

In order to generate knowledge for construction companies to improve their plastic waste management, plastic products were investigated from the perspective of construction companies as end users. Building on the barrier overview for the construction sector, this study interprets barriers specifically from the perspective of construction companies.

2.2. Characterization of products

To provide a systematic understanding about construction plastics and their diversity, construction plastic products used in the construction sector were characterized based on function, application, and polymer option. Product information was searched and compiled from reports, websites, manufacturers' product lists, and Environmental Product Declarations (EPDs), which enabled the development of this characterization.

The development of product categories drew on reports published by Environmental protection Agency in Sweden (Ahlm et al., 2021; Fråne et al., 2021, 2022). As shown in Fig. 2, product categories such as the Pipe category were developed based on their function of transporting fluids and gases.

Products within each category were further divided into different product types based on their specific applications. When relevant industry associations were available, such as the European Plastic Pipes & Fittings Association for the Pipe category, they were used as the starting point. These associations provide information on the main product applications, such as hot water pipes for hot water supply and potable water pipes for drinking water supply. In some cases, the corresponding polymer options were explained as well. More information about each product type's polymer options was obtained by reviewing the product lists of manufacturers that were members of the identified associations. For categories where no relevant associations were found, products listed in previous studies served as the basis for further identification (Ahlm et al., 2021; Fråne et al., 2021, 2022). The product lists of manufacturers producing these items were reviewed to determine their polymer options, and additional product types were identified through this process. The Packaging category required a different approach.

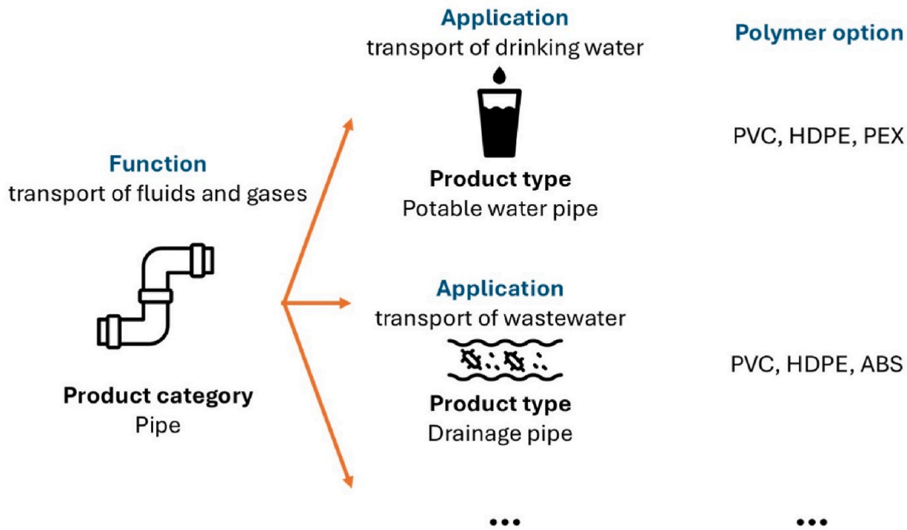

Fig. 2. Characterization of construction plastic products with the Pipe category as an example (PVC: polyvinyl chloride; HDPE: high density polyethylene; PEX: cross-linked polyethylene; ABS: acrylonitrile butadiene styrene).

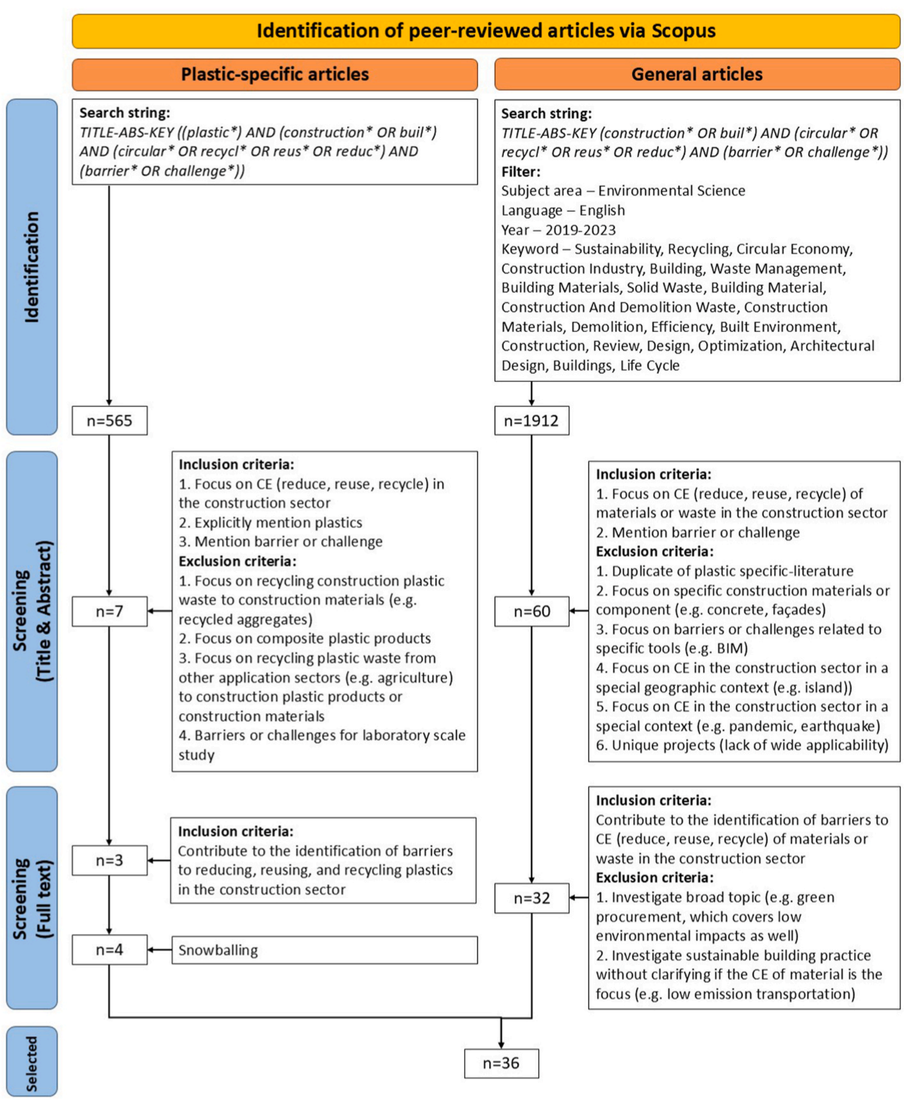

Fig. 3. Flow diagram of peer-reviewed article search and selection.

Various construction products' EPDs were reviewed to identify different types of packaging and their corresponding polymer options. The full data sources were listed in Appendix A.

2.3. Identification of barriers

A systematic literature review was conducted to identify barriers (Snyder, 2019), and the process was based on the PRISMA framework (Page et al., 2021).

2.3.1. Body of literature

The literature search was conducted in September 2023 to determine the body of literature for barrier identification. Scopus was used as the search database for peer-reviewed articles (including conference papers) considering its dominant coverage of barriers to CE compared to other literature databases (Wuni, 2022). As seen in Fig. 3, there were two rounds of search, one targeting articles specifically related to construction plastics and another focusing on articles generally related to the construction sector. Such two-round literature search ensured the body of literature was rich enough for barrier identification, since only 4 plastic-specific articles were identified after screening processes with an additional step of snowballing. Another search broadened the scope, but filters were applied to keep the articles entering the screening processes manageable. Moreover, stricter inclusion and exclusion criteria were used to ensure that the barriers identified from the selected articles to be more applicable to construction plastics. Thus, an additional 32 peer-reviewed articles were selected.

This study also covered grey literature (reports published by international governmental and non-governmental organizations) by using two custom search engines "IGO Search" and "NGO Search", which are projects of the International Documents Taskforce and the Government Documents Roundtable of the American Library Association. As seen in Fig. 4, grey literature search followed similar structure of peer-reviewed article search. Considering that some grey literature might not be captured with the applied search strings, additional keyword searches were conducted directly on the webpages of organizations identified as relevant from the initial search results. Thus, one plastic-specific and four general grey literature documents were selected.

The resulting body of literature included 36 peer-reviewed articles and five grey literature documents (see Appendix B.).

2.3.2. Barrier identification

NVivo software, which supports the visualization of emerging themes in literature and enables the creation of a snapshot of each theme (O'neill et al., 2018), was used to identify barriers from the body of literature. By skimming the literature within NVivo based on the keywords of barrier and challenge and the narrative context, relevant contents in different forms (e.g. sentences in the text, phrases in figures, entries in tables) were identified as barriers. This identification process followed a group of exclusion criteria (See Table 1) to ensure the barrier relevance to plastics and study scope.

During the identification, each barrier was assigned to the three circularity strategies according to the scope of retrieved literature and the definitions of these three circularity strategies. Identified barriers varied in forms and formulation styles (e.g. describing the same barriers in different words) and required further analysis to construct the barrier overview.

2.4. Categorization of barriers

Identified barriers were analyzed from a life cycle perspective, using thematic analysis, a method that organizes qualitative data into a series of patterns or themes (Braun and Clarke, 2006). Life-cycle stages of construction plastics were used as themes for the first deductive coding. The second inductive coding identified themes related to barrier types in each life cycle stage.

2.4.1. Categorization into life-cycle stages

The life cycle stages of construction plastics used in this study were adapted from the *EN 15804:2012+A2:2019 (Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products)* standard, with modifications made to suit the study scope (see Fig. 5a). For example, the Product stage was divided into Raw *Material Supply* and *Manufacturing* life cycle stages, while certain modules such as B6 (Operational energy use) were excluded. Transport modules were not considered as a separate life cycle stage in this study but integrated in other life cycle stages. In total, six life cycle stages were included and each stage covered activities contributing to reducing, reusing, and recycling plastic waste. The meaning of each activity was shown in Table 2.

As shown in Fig. 5b, the six life cycle stages are connected through flows including virgin pellets, recycled pellets, reused products, products, installed products, used products, and waste. Some life cycle stages may be skipped in certain life cycle variations of construction plastics. One example is that reused plastic products can go through the *Construction* life cycle stage directly from the *Waste Processing* life cycle

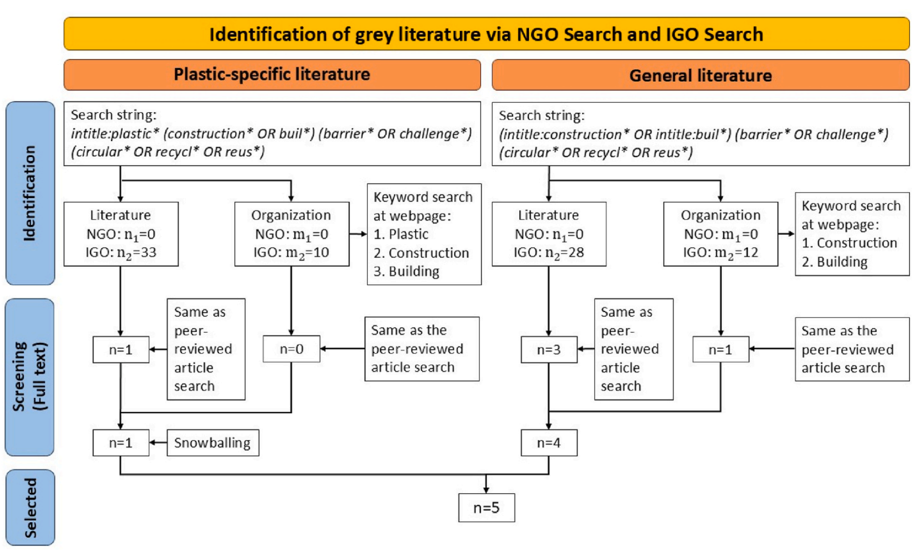

Fig. 4. Flow diagram of grey literature search and selection.

Table 1
Exclusion criteria of barrier identification.

Exclusion criteria	Reason	Example of excluded barrier
Barriers not applicable to the European context	The EU has relatively advanced practice about circular economy in the construction sector.	" … records of amounts and types of CDW produced were seldom kept" (Alite et al., 2023)
Barriers specific to an approach	This study focuses on barriers to reducing, reusing, and recycling plastic waste, rather than approach that could contribute to the circularity.	"When dealing with RL, some authors have noticed the lack of support from the management, as well as immaturity and low investment in knowledge management, information systems, and continuous planning owing to changes in the materials' source location" (Charef et al., 2021)
Barriers at the building level	These barriers cannot be applied to plastic, which is at material or product level.	"The long lifecycle of buildings exceeds the lifespan of industrial products and also results in multiple changes of ownership" (Charef et al., 2021)
Barriers at region or city level are excluded	These barriers cannot be applied to plastic, which is at material or product level.	"Inappropriate urban planning can cause numerous rebuilding of infrastructural projects, thus requiring more resources and creating higher amounts of wastes. Lack of support, along with undefined national goals and targets for transitioning to CE are another reason for non-adoption of circular practices. Support from decision makers in terms of incentives and subsidies to motivate stakeholders to use circular practices is lacking at present." (Mhatre et al., 2023)
Unclear barriers	These barriers lack explanation in the original literature, thus they are difficult to interpret.	"… distribution capacity …" (Santos et al., 2023)
Broad or general barriers	These barriers are too general or broad and can be applied to any circular economy related studies.	"… lack of global consensus about CE …" (Gherman et al., 2023)

stage, skipping the *Manufacturing* life cycle stage. Another example is that plastic waste generated at the construction sites can go to the *Waste processing* life cycle stage directly from the *Construction* life cycle stage. Moreover, recycled pellets from other application sectors (e.g. packaging and agriculture) enter the life cycle at the *Manufacturing* life cycle stage, while some recycled pellets at the *Waste Processing* life cycle stage exit and enter other sectors. These flows are out of study scope.

Barriers were coded to six life cycle stages according to three criteria, activity, material status, and related actor (See Table 3). Barriers that influence the whole life cycle as a system were coded to the category "system" rather than each life cycle stage.

2.4.2. *Categorization into barrier types*

Barriers in each life-cycle stage were further categorized into different barrier types by exploring the connections between them and identifying underlying themes. Each barrier was reviewed individually and assigned keywords indicating the related activity (e.g. production), material status (e.g. waste), or other terms that best captured its core meaning (e.g. support). Barriers sharing the same keywords were clustered, resulting in the identification of three cluster of themes (See Fig. 6). The first cluster is activity-related themes, such as Installation, which is the installation of construction plastic products in the life cycle stage *Construction*. The second cluster is material-related themes, such as Price, which applies for both products from the *Manufacturing* life cycle stage and recycled pellets from the *Waste Processing* life cycle stage. The third cluster is themes that either indirectly affect activities or influence the entire life cycle stage, such as Decision-making, which impacts the whole *Construction* life cycle stage.

Each identified theme is a barrier type, consisting of one or multiple barriers identified from literature. All barriers were reformulated to ensure consistency and align with the context of reducing, reusing, and recycling plastic waste in the construction sector. When multiple barriers expressed the same idea, these barriers were synthesized into a single barrier.

2.5. *Explorative analysis of barrier relevance across products*

This study investigated one barrier in detail, conducting an explorative analysis to assess whether the diversity of construction plastics influences the barrier's relevance. This analysis aimed to determine whether the barrier is generalizable across different plastic products or particularly critical for specific types.

To generate knowledge for construction companies to improve plastic waste management, one barrier at the *Construction* life cycle stage was selected for this analysis. The analysis was made for waste recycling, which is the most common practice. It consisted of two steps. First, the barrier relevance was defined in three types, not relevant, can be managed, and relevant. Second, each product type and each product category were analyzed based on their function, application, polymer option and waste management practices.

Plastic waste collected from the construction sites is typically sent to waste management companies for off-site sorting before being delivered to the recycling facilities. Nevertheless, waste management practices (e.g., sorting capacity) can vary across European countries due to national regulations and available infrastructure. Therefore, the Swedish context was used as an illustrative example for this analysis.

3. Results

3.1. *Plastic product list*

To develop a systematic understanding of construction plastics, a list of construction plastic products is presented (see Fig. 7). There are 38 types of construction plastic products across seven product categories made from 18 polymers.

3.1.1. *Product category*

The seven product categories indicate the seven main functions of plastic products used in building construction, ranging from the Packaging category with the function of protecting products during transport to the Envelope category with the function of shielding and regulating the indoor environment.

3.1.2. *Product type*

Each product category covers two to nine product types, reflecting their diverse applications. The diversity in product types has direct implications for waste collection strategies at construction sites. For example, the Pipe category, which has the highest number of product types (8), includes potable water pipes and floor heating pipes, each requiring distinct handling methods due to their physical differences. Potable water pipes are rigid and large and might need to be cut into smaller sections to accommodate limited space at construction sites. In contrast, floor heating pipes are flexible and smaller, making it more efficient to roll them up for storage and transport. These differences highlight the need for tailored collection strategies based on the material properties and spatial constraints of each product type. The Packaging category, which also has eight product types, emphasizes such need again.

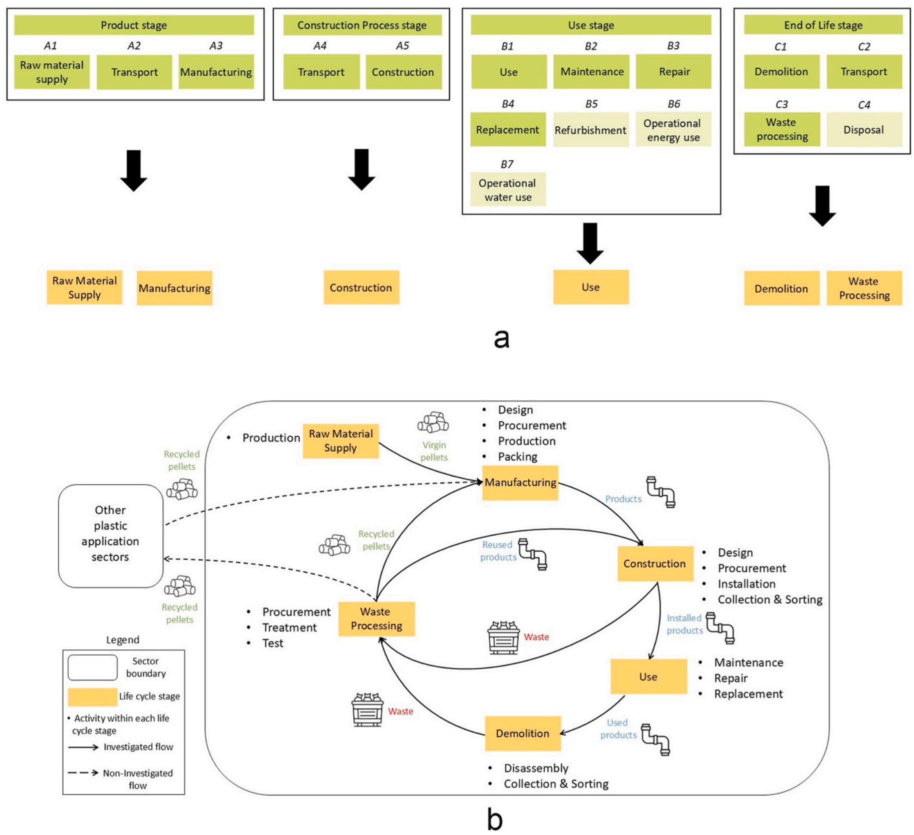

Fig. 5. a. Life cycle stages of construction plastics (adapted from EN15804); b. Life cycle of construction plastics with activities and flows.

Table 2
Activities in each life cycle stage and their descriptions.

Life cycle stage	Activity description
Raw Material Supply	**Production**: Production of virgin pellets that are recyclable.
Manufacturing	**Design**: Product design considering reducing plastic waste and reusing and recycling plastic waste at the end of life; **Procurement**: Procurement of recycled pellets sourced from construction or demolition plastic waste; **Production**: Production of plastic products with recycled pellets and plastic products designed for reducing plastic waste and reusing and recycling plastic waste at the end of life; **Packing**: Packing construction products with plastics.
Construction	**Design**: Building design considering reducing plastic waste and reusing and recycling plastic waste at the end of life; **Procurement**: Procurement of plastic products with recycled content and reused plastic products and plastic products designed for reducing plastic waste and reusing and recycling plastic waste at the end of life; **Installation**: Installation of plastic products considering reducing plastic waste and reusing and recycling plastic waste at the end of life; **Collection & Sorting**: On-site collection and sorting of plastic waste into different fractions.
Use	**Maintenance**: Maintenance of plastic products; **Repair**: Repair of plastic products; **Replacement**: Replacement of plastic products
Demolition	**Disassembly**: Disassembly of plastic waste from the building; **Collection & Sorting**: On-site collection and sorting of plastic waste into different fractions.
Waste Processing	**Procurement**: Procurement of plastic waste from construction and demolition sites **Treatment**: Treatment of plastic waste into recycled pellets and reused plastic products which will be used in the construction sector **Test**: Quality test of recycled pellets and reused plastic products

Table 3
Barrier categorization into life cycle stages: coding criteria and examples.

Criteria	Barrier example	Coded life cycle stage
Activity	" … costs of labor and time-intensive nature of deconstruction … " (Gherman et al., 2023)	Demolition
Material status	"Virgin materials are cheaper than secondary materials" (Oluleye et al., 2023)	Waste Processing
Related actor	"Designers and engineers do not pose the required knowledge and data on material reclamation and use of secondary materials." (Mhatre et al., 2023)	Construction

3.1.3. Polymer option

Each product type has one to five main polymer options, resulting in a total of one to seven polymer options per product category. The diversity of polymer options within a product category has direct implications for waste sorting strategies at construction sites and subsequently influences the complexity of off-site sorting and recycling processes. For instance, the Packaging category represents the highest polymer diversity, and the Profile category shows the lowest polymer diversity, respectively. The Packaging category, with eight polymer options, may require multiple waste containers for the proper sorting at construction sites. In contrast, the Profile category has only one polymer option of PVC and thus requires no sorting. These differences highlight the need for tailored sorting strategies based on polymer diversity of each product category.

3.2. Barrier overview

Fig. 8 shows the overview of identified barriers to reducing, reusing, and recycling plastic waste in the construction sector across the life cycle of construction plastics, categorized by barrier types (See full list in

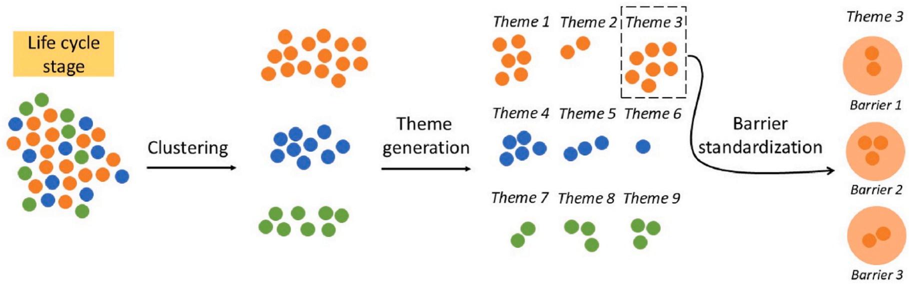

Fig. 6. Inductive coding process of barriers in one life cycle stage (dot: barrier identified from literature; circle: standardized barrier; Three colors: three clusters of themes including activity-related, material-related, and others).

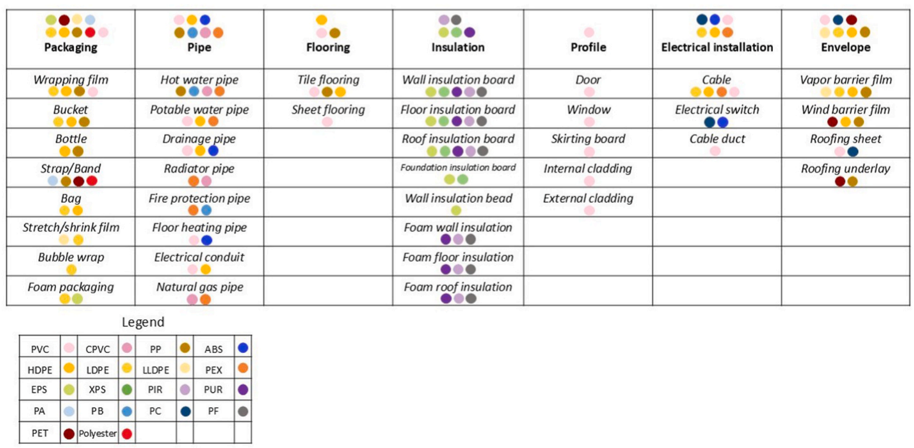

Fig. 7. Plastic products used in building construction characterized in terms of product category (columns), product types, and polymers (colored dots). (PVC: polyvinyl chloride; CPVC: chlorinated polyvinyl chloride; PP: polypropylene; ABS: acrylonitrile butadiene styrene; HDPE: high density polyethylene; LDPE: low density polyethylene; LLDPE: linear low density polyethylene; PEX: cross-linked polyethylene; EPS: expandable polystyrene; XPS: extruded polystyrene; PIR: polyisocyanurate; PUR: polyurethane; PA: polyamide (Nylon); PB: polybutylene; PC: polycarbonate; PF: phenol-formaldehyde; PET: polyethylene terephthalate).

Appendix C.). While the majority of identified barriers are stage-specific, there are a group of system-wide barriers that affect the life cycle as a whole.

In total, considerably more barriers were identified for waste recycling (129 barriers) and waste reuse (124 barriers) than for waste reduction (39 barriers). Waste reduction is defined as actions taken before product becomes waste. Thus, the life cycle stages *Demolition* and *Waste Processing* are not relevant, which can result in fewer barriers.

3.2.1. Barrier distribution across life cycle

For all three circularity strategies, barriers are primarily concentrated at the *Construction* life cycle stage. This highlights the central role of the *Construction* life cycle stage in all three circularity strategies. In contrast, no barrier was identified for the *Use* life cycle stage, indicating the research gap in applying circularity strategies during the use of installed plastic products.

Beyond this overall pattern, the three circularity strategies diverge in how barriers are distributed across the life cycle. For waste reduction, barriers were identified only in the *Manufacturing* and *Construction* life cycle stages, whereas waste recycling and waste reuse have wider and similar barrier distribution across the life cycle. A key difference between them emerges at the *Manufacturing* life cycle stage. Notably, only one barrier was identified at the *Raw Material Supply* life cycle stage, and it belongs to waste recycling.

The barrier distribution across the life cycle can be further explained by reviewing the barrier type clusters. The *Construction* life cycle stage shows the greatest variety of activity-related and “others” barriers, with four barrier types for both. This suggests that the *Construction* life cycle stage faces barriers from a wider range of activities, including Design, Procurement, Installation and Collection & Sorting. The *Waste Processing* and *Manufacturing* life cycle stages display the highest diversity in material-related barriers with respectively six and five barrier types. This reflects their role in adding value to materials, meeting different product requirements. For example, reused products or recycled pellets delivered by the *Waste Processing* life cycle stage face barriers in Quality (inferior quality), Price (higher price), Information (limited information about the product), Availability (limited and unstable product availability from limited suppliers), Accessibility (limited product accessibility for customers), and Standard & Certification (lack of standard or certification for products). The difference between waste reuse and recycling in the *Manufacturing* life cycle stage comes from both activity-related and material-related barriers. For waste recycling, there are Procurement barriers, as recycled pellets are used for manufacturing products. This is accompanied by Price (higher price of products with recycled content), Information (limited information about the recycled content in product), and Marketing (lack of marketing strategies for products with recycled content).

Overall, these differences illustrate how life cycle stages present different barriers aligned with their involved activities and output flows.

3.2.2. Barrier distribution across types

The three most frequent barrier types are Collection & Sorting, Design, and Procurement, which are all activity-related barrier types. While Design and Procurement apply to all three circularity strategies, Collection & Sorting is only relevant for waste reuse and recycling. This is because activities related to managing plastic waste that has already been generated fall outside the defined scope for waste reduction.

The number of barriers within these three barrier types differs across

Cluster	Barrier type	Raw Material Supply			Manufacturing			Construction			Use			Demolition			Waste Processing		
Activity-related	Production	1			3	1													
	Design				1			8	12	8									
	Procurement				3			5	2	2							4	4	
	Packing						1												
	Installation							1	5	4									
	Collection & Sorting							17	16					16	16				
	Disassembly													8	11				
	Treatment																7	4	
	Test																1	5	
Material-related	Quality				1			2	2					4	4		2	2	
	Price				1												1	1	
	Information				1													1	
	Marketing				1														
	Scale							1	1					1	1				
	Availability				1	1	1										3	1	
	Accessibility																1	1	
	Standard & Certification																1	1	
Others	Responsibility				1														
	Documentation							1	1										
	Decision-making							1	1					1	1				
	Data							1	1					1	1				
	Timing								1										
	Service																1		
System	Awareness	1	1	1	Goal&Target			1	1	1	Health&Security				1				
	Benefit	2	2	2	Information-sharing			1	1	1	Performance			1	1	1			
	Burden	1	1	1	Education			1	1	1	Scale			1	1	1			
	Culture	3	3	3	Cooperation			1	1	1	Research			1					
	Competition		1	1	Business model			1	1	1	Digitality			1	1	1			
	Regulation	3	3	3	Market			1	1		Support			1	1	1			
	Benchmark	1	1	1	Investment			1	1	1									
	Demonstration	1	1		Supply chain			2	1	1									

Fig. 8. Overview of barriers to reducing, reusing, and recycling plastic in the construction sector, categorized by life-cycle stages and three clusters of barrier types (Purple column: waste recycling; Green column: waste reuse; Blue column: waste reduction; Numbers: the numbers of barriers).

waste reduction, reuse, and recycling. For example, the three circularity strategies share eight barriers in Design (*Construction*), associated with designing for reduction or reuse or recycling (See Fig. 9). However, waste reuse faces additional barriers in applying reused plastic products in buildings. This difference arises from the nature of materials used. Reused plastic products come in varying sizes, forms, and types, resulting in additional barriers during building design. In contrast, products made from recycled pellets closely resemble virgin products in form and dimensions. Thus, barriers tend to occur during procurement, such as negative perception of products with recycled content. These differences in barrier numbers across barrier types, which are activity-related, suggest that construction companies should target different activities when planning to apply reused products or products with recycled content. Similar differences can be found in other activity-related barrier types. For example, waste reuse faces more barriers in Installation (*Construction*) and Disassembly (*Demolition*), while waste recycling shows more barriers in Procurement (*Construction*) and Treatment (*Waste Processing*).

Collection & Sorting, which is shared only by waste reuse and recycling, stands out among all barrier types, showing the highest barrier intensities at both the *Construction* and *Demolition* life cycle stages. This reflects the wide scope of issues related to on-site collection and sorting. Notably, these two life cycle stages share nearly all barriers within this barrier type (See Fig. 10). Some relate to operational factors such as assets and skilled workers. Others are associated with broader structural factors, such as regulation and incentives. This highlights the need for coordinated interventions at the *Construction* and *Demolition* life cycle stages, such as workforce training. However, there are two

Recycle	Reuse	Reduce
Lack of **awareness** to design building for reducing/ reusing/recycling plastic waste		
De-prioritization to design building for reducing/ reusing/recycling plastic waste (compared to energy performance)		
Lack of **incentive** to design building for reducing/ reusing/recycling plastic waste		
Lack of **knowledge** to design building for reducing/ reusing/recycling plastic waste		
Lack of **guideline/guidance** to design building for reducing/ reusing/recycling plastic waste		
Lack of **skilled workers** to design building for reducing/ reusing/recycling plastic waste		
Lack of **management support** to design building for reducing/ reusing/recycling plastic waste		
Increased **cost** to design building for reducing/ reusing/recycling plastic waste		
	Lack of **established benefits** of applying reused plastic products in building	
	Lack of **demand** for building with reused plastic products	
	Difficulty in the **design adaptation** with reused plastic products	
	Lack of **time** for designing with reused plastic products	

Fig. 9. Barriers in Design at the Construction stage for three circularity strategies.

<table>
<tr><th colspan="2">Recycle</th><th colspan="2">Reuse</th></tr>
<tr><th>Construction</th><th>Demolition</th><th>Construction</th><th>Demolition</th></tr>
<tr><td colspan="4">Lack of awareness of on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Negative perception on on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Lack of established benefits of on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Lack of demand for on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Lack of incentive for on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Lack of supportive regulation for on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Lack of assets for on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Lack of space for on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Increased cost for on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Lack of knowledge for on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Lack of skilled worker for on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Lack of training for on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Lack of guidelines/guidance for on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Lack of supervision for on-site collection and sorting of plastic waste</td></tr>
<tr><td colspan="4">Lack of management support on-site collection and sorting of plastic waste</td></tr>
<tr><td>Intesive work environment for on-site collection and sorting of plastic waste</td><td></td><td>Intesive work environment for on-site collection and sorting of plastic waste</td><td></td></tr>
<tr><td colspan="2">Lack of integration of on-site collection and sorting of plastic waste in bidding process</td><td></td><td>Lack of integration of on-site collection and sorting of plastic waste in bidding process</td></tr>
</table>

Fig. 10. Differences in barriers in Collection & Sorting at the Construction and Demolition stages for waste recycling and reuse.

exceptions. First, intensive work environment is highlighted only at the *Construction* life cycle stage. Second, the lack of integration of on-site collection and sorting of plastic waste into the bidding process is identified as a barrier for all but waste reuse at the *Construction* life cycle stage.

Not only Sorting & Collection but also Design and Procurement span multiple life cycle stages, and such pattern is observed across many other barrier types. Among all life cycle stages, *Manufacturing* and *Construction* share the highest number of barrier types with other life cycle stages, suggesting their central role in reducing, reusing, and recycling plastic waste.

3.2.3. *Barriers viewed from the construction company perspective*

Located at the *Construction* life cycle stage, construction companies receive inputs from multiple upstream stages (e.g. *Manufacturing*) and deliver outputs to multiple downstream stages (e.g. *Waste Processing*). These flow connections not only expose them to barriers occurring at other stages but also make their own barriers relevant beyond the *Construction* life cycle stage. This suggests that construction companies may need to consider barriers in a broader life cycle context when addressing them.

Taking waste recycling as an example, input flows are “products” (products with recycled content and products designed for recycling), and output flows are “installed products” and “waste”.

3.2.3.1. Products with recycled content. This input flow arrives from the *Manufacturing* life cycle stage through the activity of procurement, thus barriers in Procurement are particularly relevant for construction companies to address (e.g. “Negative perceptions on plastic products with recycled content”). Moreover, construction companies can help address material-related barriers occurring at the *Manufacturing* life cycle stage. For example, construction companies can inform manufacturers about the product information they need to make procurement decisions, thus helping overcome the barrier “Limited information provided for the recycled content in plastic products” (Information).

3.2.3.2. Products designed for recycling. This input flow also arrives from the *Manufacturing* life cycle stage, where recycling potential is created there. Not only are barriers in Procurement relevant for construction companies to address, but barriers in Installation are also important. Construction companies can cooperate with manufacturers to ensure products are installed in ways that preserve the recycling potential.

3.2.3.3. Installed products. This output flow leaves for the *Use* life cycle stage and barrier in Documentation is relevant for it. Construction companies can collaborate with actors at the *Use* life cycle stage, such as researchers studying efficient use of plastic products in buildings and companies responsible for maintenance, repair and replacement, to identify what information about plastic products should be documented during construction. Such documentation can facilitate plastic circularity during the use phase.

3.2.3.4. Waste. This output flow leaves for the *Waste Processing* life cycle stage after the activity of waste collection and sorting. To drive this flow, construction companies should not only target barriers in Collection & Sorting but also cooperate with actors at the *Waste Processing* life cycle stage (e.g., waste management companies or recyclers) to address material-related barriers such as Quality. As the *Demolition* life cycle stage shares this the barrier type Collection & Sorting, collaboration between construction companies and actors at that life cycle stage can support joint efforts to overcome it.

3.3. *Barrier relevance map*

The barrier, “Mixed plastic waste”, which emerges at the *Construction* life cycle stage was selected for the explorative analysis. In Sweden, available facilities can sort and recycle certain types of mixed plastic waste.

The Site Zero plastic sorting plant, although currently focused on packaging waste, has the technical capacity to sort PP, HDPE, LDPE, PET, EPS, and PVC. This means that if these six types of plastic waste were mixed, they could still be sorted and recycled. In addition, ÅtervinningsIndustrierna, the Swedish trade association for private recycling companies, documents companies that recycle various construction plastics (Återvinningsindustrierna (Recycling Industries)). For example, one company specializing in pipe waste can sort and recycle PE, PP, PVC, ABS, and PS.

Based on these practices, the selected barrier was assessed to determine whether it is relevant, or can be managed, or not relevant for different plastic products (See Fig. 11). This generates insights that can help construction companies develop effective on-site collection and sorting plans for plastic waste, thereby facilitating recycling.

If plastic waste is sorted and collected by product category (e.g. Packaging) at construction sites, this barrier is relevant only for five product categories (Packaging, Pipe, Insulation, Electrical installation, and Envelope). This is because their mixed waste possibly contains more than one polymer that cannot be sorted out with the established practices. For example, mixed packaging waste possibly contains three polymers that cannot be sorted out (LLDPE, PA, and polyester). In contrast, this barrier can be managed for one product category (Flooring), as all three involved polymers can be sorted out (HDPE, PVC, and PP) using techniques such as near-infrared sorting. The barrier, "Mixed plastic waste", is not relevant for the Profile category at all, which has only one polymer option (PVC).

If plastic waste is sorted and collected by product type (e.g. wrapping film) at construction sites, the barrier is relevant to only 11 product types. For example, hot water pipes can be made from PP, PB, CPVC, or PEX, and the mixture of these polymers cannot be well separated as only PP can be sorted out. There are another 17 product types, which have multiple polymer options, but the barrier can be managed for them as they have only one polymer or do not have any polymers that cannot be sorted out. For the remaining ten product types, which have single polymer option, this barrier is not relevant at all.

The varying relevance of the barrier "Mixed plastic waste" across different construction plastic products suggests that the recyclability of mixed plastic waste depends on the characteristics of individual plastic products, indicating the need for tailor-made strategies in sorting and collecting construction plastic waste.

4. Discussion

4.1. Implications of a life cycle-based barrier categorization

Before discussing its implications, the life cycle-based barrier categorization deserves some reflections. Indeed, the current study adopted a product-level life cycle perspective based on EN 15804:2012+A2:2019, which was developed for the life cycle assessment of construction products and focuses on material flows and tangible operations across stages. In contrast, several previous studies that also adopted a life cycle framework included "Project Design" as an individual life cycle stage to investigate circular economy practices (Benachio et al., 2020). This project-level perspective is well suited to evaluating circularity at the scale of the building as a whole. However, in this paper, the life cycle is not intended to describe the sequence of activities but to investigate how materials move across stages and where barriers to circularity emerge. Therefore, rather than being treated as a standalone stage, "design" is treated in this paper as an activity occurring in multiple life cycle stages (e.g., to be manufactured, building products must first be designed). This framing enables the identification of barriers related not only to project-level decisions during construction, but also to product design and manufacturing practices that influence recyclability and waste management downstream.

Through the life cycle-based categorization of barriers identified from the literature review, this study provides a clear overview of how barriers are distributed across six life cycle stages of construction plastics. This categorization highlights that the *Construction* life cycle stage faces the largest number of stage-specific barriers. This life cycle stage-based perspective enables construction companies to explicitly identify which barriers they can proactively address in order to reduce, reuse, and recycle plastic waste more effectively. While Shooshtarian et al. (2022a) also identified barriers at the *Construction* life cycle stage, the role of construction companies was fragmented across different stakeholder groups (e.g., construction workers, project managers), each mapped to different life cycle stages. Similarly, Liu et al. (2021) categorized barriers by stakeholder type, with groups such as design organizations, construction units, and contractors broadly corresponding to the *Construction* life cycle stage. In their framework, these stakeholder groups were treated independently, despite the fact that many of their barriers overlap. In contrast to these approaches, this study further groups barriers into different types under three clusters (activity-related, material-related, and others) within each life cycle stage, explicitly detailing the underlying issues associated with each barrier type. This enables the identification of actionable entry points for intervention. The barrier type Collection & Sorting offers a particularly clear example for construction companies, with 17 specific actionable entry points (e.g., limited space) that directly support the development of more effective waste management strategies for reuse and recycling. Previous studies have either identified "lack of on-site sorting" as a barrier without unpacking its underlying causes (Shooshtarian et al., 2022a), or have identified individual contributing issues such as the lack of equipment for the on-site sorting (Abarca-Guerrero et al., 2022) and the lack of recycling culture on-site (Berry et al., 2022). This study identifies these contributing issues and systematically groups them together under the barrier type Collection & Sorting.

Adopting the life cycle perspective offers two additional important insights. First, it reveals how different life cycle stages are

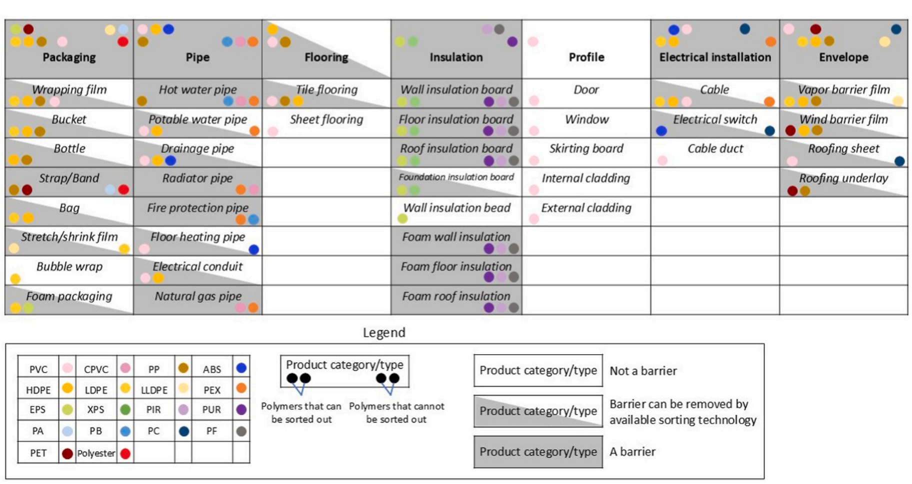

Fig. 11. Barrier relevance map for plastic products used in building construction: mixed plastic waste.

interconnected through material flows, helping construction companies understand their interdependencies with other actors. This understanding allows them to identify barriers they can help remove for other life cycle stages and to recognize from which actors they may need support to overcome their own barriers, especially for material-related barriers. Second, the life cycle perspective highlights that some barrier types are shared across multiple life cycle stages, indicating opportunities for coordinated action among actors to address these challenges collectively.

Another important implication of the barrier type analysis is that for certain types, such as Design and Collection & Sorting at the *Construction* life cycle stage, the underlying issues are already well uncovered. Thus, it is easier to develop targeted strategies for addressing these barrier types. In contrast, the remaining barrier types at the *Construction* life cycle stage, such as Decision-making and Data and Documentation currently contain only one identified barrier. This could indicate two different situations. In some cases, the barrier type may be relatively straightforward. For example, Decision-making reflects the decision-making of economic benefits over environmental benefits. In other cases, however, the limited number of barriers may reflect the fact that the underlying issues remain underexplored and require further investigation. The Data barrier type is a good example of this latter case. While it is defined as the lack of data about plastic waste (availability, quantity, quality), its underlying causes are not yet fully mapped. One of the potential causes could be the lack of standardized data formats, which creates barriers to data conversion. For instance, construction companies usually have the Bills of Quantities, listing items used for the project measured in different units such as number and length. For the quantification of plastic flows, these Bills of Quantities need to be converted to Bills of Materials, listing the mass of each item (Häkkinen et al., 2019).

4.2. Implications across circularity strategies

This study provides a structured overview of how different barriers affect three circularity strategies, waste reduction, reuse, and recycling. The overview shows that waste reuse and recycling face a similar number of barriers, although waste recycling involves a wider variety of barrier types. In contrast, barriers to waste reduction are less frequently discussed but represent more systemic and upstream challenges.

In the reviewed literature, waste recycling is by far the most discussed strategy (Ma et al., 2020; Ding et al., 2023; Luciano et al., 2022), including several studies specifically on construction plastics (Santos et al., 2023; Gardner, 2020; Bendix et al., 2022). Fewer studies address waste reuse (Sigrid Nordby, 2019; Knoth et al., 2022), and none focus solely on waste reduction. Some studies discuss multiple circularity strategies simultaneously, such as the 3R framework, yet often without clearly distinguishing which barriers apply to which strategy (Shooshtarian et al., 2022a; Guerra and Leite, 2021). This lack of differentiation complicates the interpretation of findings, as some barriers identified for 3R are specific to certain circularity strategies rather than all three. By distinguishing the relevance of barriers across circularity strategies, this study refines existing knowledge on how different barriers shape reduction, reuse, and recycling practices.

With this differentiation, a meaningful comparison of circularity strategies across life-cycle stages, and even across activities within each stage, becomes possible. The results show that waste reuse and recycling are relevant across almost all life cycle stages except *Use*, whereas waste reduction is primarily associated with the *Manufacturing* and *Construction* life cycle stages. This pattern illustrates that the application of each circularity strategy depends on its position within the life cycle and on the types of barriers that dominate those life cycle stages. Although waste reuse and recycling overlap in their life cycle stage relevance, they differ in barrier distribution and intensity. These differences suggest that even when circularity strategies operate at the same life cycle stages, they require distinct approaches to overcome their respective barriers and advance implementation.

4.3. Linking plastic product diversity to barrier relevance in developing waste management strategies

This study presents a detailed classification of construction plastic products, distinguishing them by product function, product application and polymer options. This structured understanding reflects how construction plastic waste is increasingly managed in practice in countries such as Sweden, where industry initiatives like Återvinningsindustriern (Återvinningsindustrierna (Recycling Industries)) have established specialized groups of recycling companies that each focus on a specific type of plastic waste based on its product function (e.g. pipe). Such practice demonstrates that classification at the product-function level is not only feasible but also becomes institutionalized. Waste management companies serve as intermediaries between construction companies and recycling sectors and, as such, typically operate with a working knowledge of plastics categorized by product function. In contrast, construction companies, despite being the primary source of plastic waste, seldom integrate this structured understanding into their waste management practice. However, such knowledge is essential for them, as it enables the development of waste management strategies that align more closely with how plastic waste is sorted, processed, and recycled in practice. Beyond reflecting current practices, this study also contributes new insights by going a step further than industry practice. It differentiates between product applications within each function (e.g., hot water pipe and drainage pipe) and specifies polymer options for each application (e.g. PVC, HDPE, and ABS for drainage pipe). This level of granularity is critical, as plastic recycling is polymer-dependent, and different applications require the unique properties of specific polymers. Initiatives like VinylPlus, which promote sustainable PVC use and recycling, are built around such polymer-specific strategies.

This study demonstrates how the relevance of barriers, such as "Mixed plastic waste" varies significantly across different plastic products. Previous studies have acknowledged this variation, but often in fragmented or anecdotal ways. For example, Santos et al. (2023). Highlight the relevance of the barrier "Lack of recycling facilities" for certain plastic products (e.g., PVC pipes and PP straps) in the Canadian context, but without offering a structured framework. Similarly, Bendix et al. (2022) provide some product-specific insights, such as the limited suitability of mechanical recycling for PIR/PUR insulation materials. However, their analysis captures only a partial spectrum of construction plastics. In parallel, a few studies have investigated individual plastic products in depth, such as carpets and electrical installations (Farjana et al., 2023; Luciani et al., 2013). While these studies provide valuable technical insights, they are limited in scope and do not support broader strategic planning across the construction plastic product range. In contrast, the barrier relevance map developed in this study offers a structured and comprehensive overview of how barriers affect different plastic products. This not only deepens understanding but also offers a practically grounded foundation for construction companies to set strategic priorities and implement targeted actions in their efforts to reduce, reuse, and recycle plastic waste.

4.4. Implications for construction companies

When making efforts to overcome barriers, construction companies should first consider which material flows (e.g. waste or product with recycled content) they aim to address, as these determine where their efforts should be primarily distributed to. Building on their established role in managing waste, they should now prioritize developing effective strategies for plastic waste flows, which contain the biggest potential for advancing plastic circularity in the construction sector.

For waste reuse and recycling, efforts should primarily focus on barriers in Collection & Sorting. However, addressing the barrier of Scale, "Limited scale of plastic waste", is a necessary first step. To design targeted actions, construction companies first need to quantify and characterize plastic waste based on product categories (e.g., pipe) or polymer options (e.g., HDPE). This knowledge provides the foundation for improving waste quality by addressing issues of mixed plastic waste or plastic waste with impurities, collaborating with waste management companies and recyclers at the *Waste Processing* life cycle stage. As these become better understood, companies can assess and demonstrate the environmental and potential cost benefits of improved on-site sorting scenarios. These actions help to overcome barriers in Collection & Sorting such as "Lack of established benefits of on-site collection and sorting of plastic waste".

For waste reduction, the focus should be on barriers in Design and Installation. Developing knowledge on how to minimize plastic use and waste through design choices and installation practices is essential. Collaboration with product manufacturers can support this process.

Many of these actions require collaboration beyond the *Construction* life cycle stage. Addressing data gaps, market incentives, and standardization issues calls for coordination with designers, manufacturers, recyclers, and policymakers to ensure coherent progress toward plastic circularity in the construction sector.

4.5. Assumptions and limitations

In this study, although the literature review was conducted at a global level, a contextual filter was applied to focus on European countries with relatively mature waste management systems. In these systems, there is separate collection of plastic waste at construction sites. This narrows the scope of the findings and may limit their direct applicability to countries with less developed or differently structured waste management systems. However, the insights generated by this study may still offer useful guidance for those contexts as they progress toward more advanced waste management practices.

The literature sources for barrier identification were constrained in scope. The search for grey literature was limited to two search engines (IGO Search and NGO Search), resulting in five relevant documents. Other potential sources, such as national environmental protection agencies' websites were not included, and may contain valuable information. Moreover, only English-language documents were reviewed. It is likely that relevant documents in other languages exist, and their inclusion could uncover additional barriers with national/geographic dependencies. Nevertheless, the number and diversity of barriers explored in this research were deemed sufficient to provide a good overview.

A material-specific limitation applies. Most barriers identified from literature pertain to implementing circular economy in the construction sector broadly, rather than being specific to construction plastics. Exclusion criteria were therefore applied to retain only barriers relevant to construction plastics, but further validation through practitioner interviews or surveys would be valuable. As one of the first studies dedicated to this topic, the present research primarily aims to establish a foundation for future empirical work that can refine and expand these findings.

Finally, the construction product list does not cover all plastic products and their polymer options. The seven major categories were defined based on a review of existing literature and their production scales in the EU (SOUDER et al., 2024). Certain smaller items, such as pipe fittings and other accessories, were excluded. While their inclusion would have allowed for an even more comprehensive overview of construction plastic products, their exclusion is not believed to impact the results of this study. Indeed, these products are used in relatively small quantities and do not justify the creation of separate categories, such as plastic spacer used for insulation installation. Similarly, there may be additional polymers used for manufacturing construction plastic products, but their applications are very limited. An example is Ethylene Vinyl Chloride (EVC), a close relative to PVC that is sometimes used as an alternative to PVC in cables.

5. Conclusions

This study aims to generate knowledge for construction companies to improve plastic waste management in the European context by investigating barriers to reducing, reusing, and recycling plastics in the construction sector. Through desk research and a structured literature review, the variety of construction plastics were characterized by product function, application, and polymer option, while barriers were categorized by life cycle stages and three circularity strategies (Reduce, Reuse, and Recycle). There are 38 types of construction plastic products across seven product categories made from 18 polymers, reflecting the high diversity and complexity of plastic use in construction. The life cycle-based barrier categorization showed that the *Construction* life cycle stage has the highest number of barriers and shares the highest number of barrier types with other life cycle stages, indicating its central role in reducing, reusing and recycling plastic waste in the construction sector. Moreover, the stage-based comparison revealed that waste reuse and recycling face a similar number of barriers, although waste recycling involves a wider variety of types, whereas waste reduction is less discussed but represent more systemic and upstream challenges. Considering plastic variety in barrier analysis showed that barriers differ in relevance across plastic products, emphasizing the need for tailor-made strategies for different plastic products.

By integrating the life cycle and circularity strategy perspectives, this study offers the first structured framework for analyzing barriers to plastic circularity in the construction sector. It provides foundational knowledge on how barriers differ and interconnect, serving as a base for future research and practical action. For practice, the findings highlight that construction companies' efforts should focus on scale, collection and sorting, and quality for recycling and reuse plastic waste, and design and installation for reducing plastic waste, supported by collaboration with other life-cycle actors.

Although the analysis draws primarily from literature not specific to plastics, exclusion criteria were applied to ensure relevance. Further empirical validation through practitioner engagement can refine these findings. Overall, this study provides an early yet comprehensive foundation for advancing plastic circularity in construction through more coordinated and informed actions.

Further research is recommended to investigate the quantity and composition of plastic waste in building construction, in order to develop targeted waste management strategies at construction sites, and to assess the economic and environmental impacts of those strategies.

CRediT authorship contribution statement

Shuang Wang: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Maud Lanau:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Magnus Österbring:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization. **Holger Wallbaum:** Writing – review & editing, Validation, Supervision, Project administration, Funding acquisition. **Leonardo Rosado:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This study is part of the project "Improving Resource-Efficiency in the Circular Value Chain of Plastic in Construction" financed by Formas (2021–02505).

Appendix A. Data sources for product types and polymer options

Table A
Data sources of product types and polymer options for each product category

Product category	Data sources
Pipe	- Industry associations: The European Plastic Pipes & Fittings Association (European Plastic Pipes & Fittings Association); Plastics Pipe Institute (Plastics Pipe Institute); British Plastics Federation (British Plastics Federation, 2017; British Plastics Federation, 2024); Plastic Pipe and Fittings Association (Plastic Pipe and Fittings Association) - Manufacturers' product list (Aliaxis; Uponor, 2020)
Flooring	- Industry associations: European Resilient Flooring Manufacturers' Institute (European Resilient Flooring Manufacturers' Institute) - Manufacturers' product list (Forever Plast SpA; Gerflor; Tarketta; Tarkettb)
Insulation	- European Extruded Polystyrene Insulation Board Association (European Extruded Polystyrene Insulation Board Association); PU Europe (PU Europe); European Manufacturers of Expanded Polystyrene (European Manufacturers of Expanded Polystyrene) - Manufacturers' product list (Kingspan)
Profile	- British Plastics Federation (British Plastics Federation); VinylPlus (VinylPlus, 2025) - (Ahlm et al., 2021; Fråne et al., 2021, 2022)
Electrical Installation	- (Ahlm et al., 2021; Fråne et al., 2021, 2022) - Manufacturers' product list (Prysmian Group; Schneider Electric Netherlands)
Envelope	- (Ahlm et al., 2021; Fråne et al., 2021, 2022) - Manufacturers' product list), ((Corotop; Dakota Group; Euroventa; Euroventb; Exolon Group; Tyvek, 2024; GuttaWerke)
Packaging	- Environmental Product Declarations of various construction products (EPD Danmark, 2024; EPD International, 2017; EPD International, 2020; EPD International, 2021; EPD International, 2022a; EPD International, 2022b; EPD International, 2023; EPD International, 2024; EPD International, 2025; EPD-Norway, 2023; Institut Bauen und Umwelt e.V. (IBU), 2015; Kiwa, 2023; Kiwa, 2024; NSF International, 2023)

Appendix B. Body of literature for barrier identification

Table B
List of body of literature for barrier identification

	Title	Author
First-round search (Peer-reviewed articles)	Circular economy for durable products and materials: the recycling of plastic building products in Germany—status quo, potentials and recommendations	Bendix et al. (2022)
	Determining the Feasibility of a Circular Economy for Plastic Waste from the Construction Sector in New Zealand	Berry et al. (2022)
	Recycling Construction, Renovation, and Demolition Plastic Waste: Review of the Status Quo, Challenges and Opportunities	Santos et al. (2023)
	Quantifying and managing plastic waste generated from building construction in Auckland, New Zealand	Hernandez et al. (2023)
Second-round search (Peer-reviewed articles)	Zero Waste Systems: Barriers and Measures to Recycling of Construction and Demolition Waste	Abarca-Guerrero et al. (2022)
	Construction Waste Minimization: A Narrative Review	Alhawamdeh and Lee (2021)
	Construction and demolition waste management in Kosovo: a survey of challenges and opportunities on the road to circular economy	Alite et al. (2023)
	Understanding the challenges of construction demolition waste management towards circular construction: Kuwait Stakeholder's perspective	Al-Raqeb et al. (2023)
	Current state and barriers to the circular economy in the building sector: Towards a mitigation framework	Bilal et al. (2020)
	Barriers to implementing the circular economy in the construction industry: A critical review	Charef et al. (2021)
	How is the construction sector addressing the Circular Economy? Lessons from current practices and perceptions in Argentina	Cohen et al. (2022)
	Reuse of building elements in the architectural practice and the European regulatory context: Inconsistencies and possible improvements	Condotta and Zatta (2021)
	Barriers and countermeasures of construction and demolition waste recycling enterprises under circular economy	Ding et al. (2023)
	User perspectives on reuse of construction products in Norway: Results of a national survey	Fufa et al. (2023)
	Transitioning the Swedish building sector toward reuse and circularity	Gerhardsson et al. (2020)
	Drivers and barriers towards circular economy in the building sector: Stakeholder interviews and analysis of five european countries policies and practices	Giorgi et al. (2022)
	Circular economy in the construction industry: An overview of United States stakeholders' awareness, major challenges, and enablers	Guerra and Leite (2021)
	Barriers, success factors, and perspectives for the reuse of construction products in Norway	Knoth et al. (2022)
	Circular design: Reused materials and the future reuse of building elements in architecture. Process, challenges and case studies	Kozminska (2019)
	Explore potential barriers of applying circular economy in construction and demolition waste recycling	Liu et al. (2021)
	Critical issues hindering a widespread construction and demolition waste (CDW) recycling practice in EU countries and actions to undertake: The stakeholder's perspective	Luciano et al. (2022)
	Challenges in current construction and demolition waste recycling: A China study	Ma et al. (2020)
	Circular economy adoption barriers in built environment- a case of emerging economy	Mhatre et al. (2023)
	A review on barriers, drivers, and stakeholders towards the circular economy: The construction sector perspective	Munaro and Tavares (2023)

(continued on next page)

Table B (*continued*)

	Title	Author
	Significant barriers influencing green design application among the contractors in construction industry	Ming et al. (2021)
	Towards a circular economy: a review of the current challenges and potential for recycling construction waste materials in New Zealand	Mohamed and Brown (2023)
	The challenges of green supply chain management (GSCM) system implementation in civil construction project	Nusa et al. (2023)
	Barriers and opportunities to reuse of building materials in the Norwegian construction sector	Sigrid Nordby (2019)
	Assessment of symmetries and asymmetries on barriers to circular economy adoption in the construction industry towards zero waste: A survey of international experts	Oluleye et al. (2023)
	Components reuse in the building sector – A systematic review	Rakhshan et al. (2020)
	Transformation towards a circular economy in the Australian construction and demolition waste management system	Shooshtarian et al. (2022a)
	Analysis of factors influencing the creation and stimulation of the Australian market for recycled construction and demolition waste products	Shooshtarian et al. (2022b)
	Challenges and Opportunities for Circular Economy Promotion in the Building Sector	Tirado et al. (2022)
	Towards a Circular Building Industry	Janson et al. (2022)
	Modeling Barriers to a Circular Economy for Construction Demolition Waste in the Aysén Region of Chile	Véliz et al. (2022)
	Mapping the barriers to circular economy adoption in the construction industry: A systematic review, Pareto analysis, and mitigation strategy map	Wuni (2022)
	Development of the Circular Economy Design Guidelines for the Australian Built Environment Sector	Zaman et al. (2023)
First-round search (Grey literature)	State of play for collected and sorted plastic waste from construction	Gardner (2020)
Second-round search (Grey literature)	Circular construction in practice	Bukowski and Fabrycka (2019)
	Circular Buildings: constructing a sustainable future	de Graaf et al. (2022)
	Construction and demolition waste: challenges and opportunities in a circular economy.	European Environment Agency (2020)
	Circular Economy in the Nordic Construction Sector	Høibye and Sand (2018)

Appendix C. Barrier overview

Table C
Barrier overview

Life cycle stage	Barrier type	Barrier	Recycle	Reuse	Reduce	References
Material Supply	***Activity-related***					
	Production	Lack of research on the new recyclable construction plastic material	✓			Liu et al. (2021)
Manufact-uring	***Activity-related***					
	Production	Lower production efficiency with recycled pellets	✓			Bendix et al. (2022)
		Greater risk of environmental pollution from production with recycled pellets	✓			Mhatre et al. (2023)
		Lack of technology to produce products designed for disassembly	✓			Munaro and Tavares (2023)
		High cost for changing production system for products designed for reuse		✓		Knoth et al. (2022)
	Design	Lack of product design for recycling	✓			Mohamed and Brown (2023)
	Procurement	Lack of awareness of using recycled pellets for plastic products	✓			(Shooshtarian et al., 2022a), (Liu et al., 2021)
		Lack of interest in using recycled pellets for plastic products	✓			Shooshtarian et al. (2022a)
		Negative perception on using recycled pellets for plastic products	✓			(Mhatre et al., 2023), (Alite et al., 2023), (Charef et al., 2021)
	Packing	High rate of plastic packaging			✓	Shooshtarian et al. (2022a)
	Material-related					
	Quality	Inferior quality of plastics products with recycled content	✓			(Wuni, 2022), (Luciano et al., 2022), (Bendix et al., 2022), (Zaman et al., 2023), (Bukowski and Fabrycka, 2019)
	Price	Higher price of plastic products with recycled content	✓			(Wuni, 2022), (Liu et al., 2021), (Munaro and Tavares, 2023), (Bukowski and Fabrycka, 2019)
	Information	Limited information provided for the recycled content in plastic products	✓			(Shooshtarian et al., 2022b), (Bukowski and Fabrycka, 2019)
	Marketing	Lack of marketing strategy for plastic products with recycled content	✓			Bukowski and Fabrycka (2019)
	Availability	Insufficient suppliers of products with recycled content or products designed for reduce/reuse/recycle	✓	✓	✓	Wuni (2022)
	Others					
	Responsibility	Lack of producer-based responsibility	✓			(Mhatre et al., 2023), (Wuni, 2022), (Liu et al., 2021)

(*continued on next page*)

Table C (*continued*)

Life cycle stage	Barrier type	Barrier	Recycle	Reuse	Reduce	References
Construction	***Activity-related***					
	Design	Lack of awareness to design building for reducing/reusing/recycling plastic waste	✓	✓	✓	All: (Zaman et al., 2023); Recycle: (Liu et al., 2021), (Bukowski and Fabrycka, 2019) Reuse: (Guerra and Leite, 2021), (Mohamed and Brown, 2023)
		De-prioritization to design building for reducing/reusing/recycling plastic waste (compared to energy performance)	✓	✓	✓	Janson et al. (2022)
		Lack of incentive to design building for reducing reusing/recycling plastic waste	✓	✓	✓	All: (Ming et al., 2021); Recycle: (Wuni, 2022), (Oluleye et al., 2023), (Munaro and Tavares, 2023); Reuse: (Wuni, 2022), (Oluleye et al., 2023), (Knoth et al., 2022), (Munaro and Tavares, 2023)
		Lack of knowledge to design building for reducing/reusing/recycling plastic waste	✓	✓	✓	All: (Ming et al., 2021); Recycle: (Mhatre et al., 2023), (Wuni, 2022), (Ma et al., 2020), (Shooshtarian et al., 2022b), (Bukowski and Fabrycka, 2019); Reuse: (Mhatre et al., 2023), (Knoth et al., 2022), (Guerra and Leite, 2021), (Alhawamdeh and Lee, 2021), (Kozminska, 2019)
		Lack of guideline/guidance to design building for reducing/reusing/recycling plastic waste	✓	✓	✓	(Gherman et al., 2023), (Munaro and Tavares, 2023)
		Lack of skilled workers to design building for reducing/reusing/recycling plastic waste	✓	✓	✓	All: (Charef et al., 2021), (Ming et al., 2021); Reuse: (Knoth et al., 2022), (Guerra and Leite, 2021)
		Lack of management support to design building for reducing/reusing/recycling plastic waste	✓	✓	✓	Oluleye et al. (2023)
		Increased cost to design building for reducing/reusing/recycling plastic waste	✓	✓	✓	All: (Charef et al., 2021), (Munaro and Tavares, 2023); Reuse: (Guerra and Leite, 2021), (Condotta and Zatta, 2021), (Kozminska, 2019), (Rakhshan et al., 2020)
		Lack of established benefits of applying reused plastic products in building		✓		Alhawamdeh and Lee (2021)
		Lack of demand for building with reused plastic products		✓		Kozminska (2019)
		Difficulty in the design adaptation with reused plastic products		✓		(Charef et al., 2021), (Kozminska, 2019), (Rakhshan et al., 2020)
		Lack of time for designing with reused plastic products		✓		Condotta and Zatta (2021)
	Procurement	Lack of awareness to procure plastic products with recycled content	✓			Mohamed and Brown (2023)
		Increased cost to procure plastic products with recycled content	✓			(Wuni, 2022), (Liu et al., 2021), (Munaro and Tavares, 2023), (Bukowski and Fabrycka, 2019)
		Lack of incentive to procure plastic products with recycled content	✓			Bukowski and Fabrycka (2019)
		Lack of supportive regulation for the procurement of plastic products with recycled content	✓			(Oluleye et al., 2023), (Liu et al., 2021), (Zaman et al., 2023), (Bukowski and Fabrycka, 2019)
		Negative perception on plastic products with recycled content	✓	✓		Recycle: (Santos et al., 2023), (Mhatre et al., 2023), (Wuni, 2022), (Charef et al., 2021), (Gherman et al., 2023), (Liu et al., 2021), (Munaro and Tavares, 2023), (Mohamed and Brown, 2023), (Shooshtarian et al., 2022b), (Bukowski and Fabrycka, 2019); Reuse: (Mhatre et al., 2023), (Charef et al., 2021), (Knoth et al., 2022), (Guerra and Leite, 2021), (Condotta and Zatta, 2021), (Kozminska, 2019), (Munaro and Tavares, 2023), (Mohamed and Brown, 2023), (Rakhshan et al., 2020), (Bukowski and Fabrycka, 2019)
		Lack of trust in the suppliers of reused plastic products		✓		Rakhshan et al. (2020)
		Incorrect estimation of required plastic products			✓	Shooshtarian et al. (2022a)
		Lack of procurement of plastic products in standard size and quality			✓	Shooshtarian et al. (2022a)
	Installation	Lack of installation practice considering plastic products' end-of-life	✓	✓		Bukowski and Fabrycka (2019)
		Difficulty in adapting installation process with reused plastic products		✓		Sigrid Nordby (2019)
		Increased installation cost with reused plastic products		✓		(Sigrid Nordby, 2019), (Knoth et al., 2022), (Guerra and Leite, 2021), (Kozminska, 2019)
		Lack of knowledge to install reused plastic products		✓		(Knoth et al., 2022), (Alhawamdeh and Lee, 2021), (Rakhshan et al., 2020)
		Lack of standard installation process for reused plastic products		✓		Kozminska (2019)
		Higher investment cost for installation technologies that reduce plastic waste			✓	Alhawamdeh and Lee (2021)

(*continued on next page*)

Table C (*continued*)

Life cycle stage	Barrier type	Barrier	Recycle	Reuse	Reduce	References
		Inconsistency between design and installation process			✓	Shooshtarian et al. (2022a)
		Lack of knowledge on installation technologies that reduce plastic waste			✓	Alhawamdeh and Lee (2021)
		Negative perception on installation technologies that reduce plastic waste			✓	Alhawamdeh and Lee (2021)
	Collection & Sorting	Lack of awareness of on-site collection and sorting of plastic waste	✓	✓		Recycle: (Berry et al., 2022), (Gherman et al., 2023), (Shooshtarian et al., 2022a), (Liu et al., 2021), (Abarca-Guerrero et al., 2022), (Al-Raqeb et al., 2023); Reuse: (Gherman et al., 2023)
		Negative perception on on-site collection and sorting of plastic waste	✓	✓		(Abarca-Guerrero et al., 2022), (Alhawamdeh and Lee, 2021), (Al-Raqeb et al., 2023)
		Lack of established benefits of on-site collection and sorting of plastic waste	✓	✓		Charef et al. (2021)
		Lack of demand for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Gherman et al., 2023), (Abarca-Guerrero et al., 2022); Reuse: (Gherman et al., 2023)
		Lack of incentive for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Hernandez et al., 2023), (Véliz et al., 2022), (Gherman et al., 2023), (Alhawamdeh and Lee, 2021), (Munaro and Tavares, 2023)); Reuse: (Mohamed and Brown, 2023)
		Lack of supportive regulation for on-site collection and sorting of plastic waste	✓	✓		(Santos et al., 2023), (Véliz et al., 2022), (Gherman et al., 2023), (Liu et al., 2021), (Abarca-Guerrero et al., 2022), (Ma et al., 2020), (Luciano et al., 2022), (Giorgi et al., 2022), (Munaro and Tavares, 2023), (Mohamed and Brown, 2023), (Janson et al., 2022)
		Lack of assets for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Gherman et al., 2023), (Oluleye et al., 2023), (Abarca-Guerrero et al., 2022), (Mohamed and Brown, 2023); Reuse: (Mohamed and Brown, 2023)
		Lack of space for on-site collection and sorting of plastic waste	✓	✓		(Santos et al., 2023), (Hernandez et al., 2023), (Gherman et al., 2023)
		Increased cost for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Santos et al., 2023), (Mhatre et al., 2023), (Wuni, 2022), (Shooshtarian et al., 2022a), (Liu et al., 2021), (Ma et al., 2020), (Luciano et al., 2022), (Alhawamdeh and Lee, 2021), (Al-Raqeb et al., 2023), (Mohamed and Brown, 2023); Reuse: (Mohamed and Brown, 2023)
		Lack of knowledge for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Véliz et al., 2022), (Abarca-Guerrero et al., 2022), (Bukowski and Fabrycka, 2019); Reuse: (Mohamed and Brown, 2023), (Rakhshan et al., 2020)
		Lack of skilled worker for on-site collection and sorting of plastic waste	✓	✓		(Mhatre et al., 2023), (Alhawamdeh and Lee, 2021)
		Lack of training for on-site collection and sorting of plastic waste	✓	✓		(Santos et al., 2023), (Berry et al., 2022), (Hernandez et al., 2023), (Liu et al., 2021)
		Lack of guidelines/guidance for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Mhatre et al., 2023), (Wuni, 2022), (Oluleye et al., 2023), (Mohamed and Brown, 2023); Reuse: (Mohamed and Brown, 2023)
		Lack of supervision for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Berry et al., 2022), (Véliz et al., 2022), (Abarca-Guerrero et al., 2022), (Luciano et al., 2022); Reuse: (Mohamed and Brown, 2023)
		Lack of management support on-site collection and sorting of plastic waste	✓	✓		(Gherman et al., 2023), (Alhawamdeh and Lee, 2021), (Mohamed and Brown, 2023)
		Intensive work environment for on-site collection and sorting of plastic waste	✓	✓		Mohamed and Brown (2023)
		Lack of integration of on-site collection and sorting of plastic waste in bidding process	✓			Santos et al. (2023)
	Material-related					
	Quality	Plastic waste with impurities	✓			(Santos et al., 2023), (Ding et al., 2023)
		Mixed plastic waste	✓			(Gardner, 2020), (Bukowski and Fabrycka, 2019)
	Scale	Limited scale of plastic waste	✓	✓		Recycle: (Santos et al., 2023); Reuse: (Mhatre et al., 2023)
	Others					
	Documentation	Lack of documentation of new and used plastic products	✓	✓		(Sigrid Nordby, 2019), (Munaro and Tavares, 2023)
	Decision-making	Decision-making of economic benefits over environmental benefits	✓	✓		Recycle: (Véliz et al., 2022), (Gherman et al., 2023), (Bukowski and Fabrycka, 2019); Reuse: (Charef et al., 2021), (Mohamed and Brown, 2023)
	Data	Lack of data about plastic waste's quantity and availability	✓	✓		Recycle: (Santos et al., 2023), (Charef et al., 2021), (Oluleye et al., 2023), (Shooshtarian et al., 2022a), (Ma et al., 2020), (Tirado et al., 2022); Reuse: (Charef et al., 2021), (Oluleye et al., 2023), (Kozminska, 2019), (Tirado et al., 2022)
	Timing	Difficulty in timing the delivery and use of reused plastic products during construction		✓		(Knoth et al., 2022), (Rakhshan et al., 2020)
Demolition	***Activity-related***					

(*continued on next page*)

Table C (*continued*)

Life cycle stage	Barrier type	Barrier	Recycle	Reuse	Reduce	References
	Disassembly	Lack of awareness for disassembly of plastic waste from building Lack of established benefits of disassembly of plastic waste from building		✓		Bukowski and Fabrycka (2019) Rakhshan et al. (2020)
		Lack of supportive regulation for disassembly of plastic waste from building	✓			Shooshtarian et al. (2022a)
		Lack of assets for disassembly of plastic waste from building		✓		British Plastics Federation (2024)
		Lack of space for disassembly assets		✓		British Plastics Federation (2024)
		Increased cost for disassembly of plastic waste from building	✓	✓		Recycle: (Santos et al., 2023), (Gherman et al., 2023), (Shooshtarian et al., 2022a), (Luciano et al., 2022), (Munaro and Tavares, 2023); Reuse: (Gherman et al., 2023), (Rakhshan et al., 2020)
		Lack of knowledge for disassembly of plastic waste from building	✓	✓		Recycle: (Shooshtarian et al., 2022a), (Munaro and Tavares, 2023); Reuse: (Rakhshan et al., 2020)
		Lack of skilled worker for disassembly of plastic waste from building	✓	✓		Recycle: (Charef et al., 2021), (Luciano et al., 2022); Reuse: (Charef et al., 2021)
		Lack of guidelines/guidance for disassembly of plastic waste from building	✓			(Oluleye et al., 2023), (Shooshtarian et al., 2022a)
		Additional time for disassembly of plastic waste from building	✓	✓		Recycle: (Shooshtarian et al., 2022a); Reuse: (Sigrid Nordby, 2019), (Guerra and Leite, 2021), (Rakhshan et al., 2020)
		Lack of integration of disassembly of plastic waste from building in bidding process	✓	✓		Tirado et al. (2022)
		Health and safety risks during disassembly	✓	✓		Recycle: (Charef et al., 2021), (Gherman et al., 2023); Reuse: (Charef et al., 2021)
		Complexity of building composition		✓		(Munaro and Tavares, 2023), (Rakhshan et al., 2020)
	Collection & Sorting	Lack of awareness of on-site collection and sorting of plastic waste	✓	✓		Recycle: (Abarca-Guerrero et al., 2022), (Al-Raqeb et al., 2023); Reuse: (Bukowski and Fabrycka, 2019)
		Negative perception on on-site collection and sorting of plastic waste	✓	✓		Recycle: (Abarca-Guerrero et al., 2022), (Alhawamdeh and Lee, 2021), (Al-Raqeb et al., 2023); Reuse: (Charef et al., 2021), (Alhawamdeh and Lee, 2021)
		Lack of established benefits of on-site collection and sorting of plastic waste	✓	✓		Charef et al. (2021)
		Lack of demand for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Gherman et al., 2023), (Abarca-Guerrero et al., 2022); Reuse: (Gherman et al., 2023)
		Lack of incentive for on-site collection and sorting of plastic waste	✓	✓		(Hernandez et al., 2023), (Véliz et al., 2022), (Gherman et al., 2023), (Alhawamdeh and Lee, 2021), (Munaro and Tavares, 2023)
		Lack of supportive regulation for on-site collection and sorting of plastic waste	✓	✓		(Santos et al., 2023), (Véliz et al., 2022), (Gherman et al., 2023), (Liu et al., 2021), (Abarca-Guerrero et al., 2022), (Ma et al., 2020), (Luciano et al., 2022), (Gardner, 2020), (Giorgi et al., 2022), (Munaro et al., 2021)
		Lack of assets for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Oluleye et al., 2023), (Abarca-Guerrero et al., 2022); Reuse: (Oluleye et al., 2023)
		Lack of space for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Santos et al., 2023), (Hernandez et al., 2023), (Gherman et al., 2023); Reuse: (Hernandez et al., 2023)
		Increased cost for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Santos et al., 2023), (Mhatre et al., 2023), (Wuni, 2022), (Charef et al., 2021), (Shooshtarian et al., 2022a), (Ma et al., 2020), (Luciano et al., 2022), (Al-Raqeb et al., 2023), (Munaro and Tavares, 2023); Reuse: (Wuni, 2022), (Charef et al., 2021), (Al-Raqeb et al., 2023), (Munaro and Tavares, 2023)
		Lack of knowledge for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Véliz et al., 2022), (Abarca-Guerrero et al., 2022), (Bukowski and Fabrycka, 2019); Reuse: (Véliz et al., 2022)
		Lack of skilled worker for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Mhatre et al., 2023), (Alhawamdeh and Lee, 2021); Reuse: (Alhawamdeh and Lee, 2021)
		Lack of training for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Santos et al., 2023), (Hernandez et al., 2023); Reuse: (Hernandez et al., 2023)
		Lack of guidelines/guidance for on-site collection and sorting of plastic waste	✓	✓		(Mhatre et al., 2023), (Oluleye et al., 2023)
		Lack of supervision for on-site collection and sorting of plastic waste	✓	✓		Recycle: (Véliz et al., 2022), (Abarca-Guerrero et al., 2022), (Luciano et al., 2022); Reuse: (Véliz et al., 2022), (Al-Raqeb et al., 2023)
		Lack of management support on-site collection and sorting of plastic waste	✓	✓		Recycle: (Gherman et al., 2023), (Alhawamdeh and Lee, 2021); Reuse: (Charef et al., 2021), (Gherman et al., 2023), (Alhawamdeh and Lee, 2021)
		Lack of integration of on-site collection and sorting of plastic waste in bidding process	✓	✓		Recycle: (Santos et al., 2023); Reuse: (Tirado et al., 2022)
	Material-related					
	Quality	Plastic waste with impurities	✓	✓		Recycle: (Santos et al., 2023), (Ding et al., 2023); Reuse: (Charef et al., 2021)

(*continued on next page*)

Table C (*continued*)

Life cycle stage	Barrier type	Barrier	Recycle	Reuse	Reduce	References
		Mixed plastic waste	✓	✓		Recycle: (Gardner, 2020), (Bukowski and Fabrycka, 2019); Reuse: (Bukowski and Fabrycka, 2019)
		Deteriorated quality of plastic waste	✓	✓		Recycle: (Wuni, 2022), (Charef et al., 2021), (Oluleye et al., 2023); Reuse: (Wuni, 2022), (Charef et al., 2021)
		Contamination with hazardous materials	✓	✓		Recycle: (Santos et al., 2023), (Charef et al., 2021), (Gherman et al., 2023), (Bendix et al., 2022), (European Environment Agency); Reuse: (Charef et al., 2021), (Mohamed and Brown, 2023)
	Scale	Limited scale of plastic waste	✓	✓		Recycle: (Santos et al., 2023); Reuse: (Mhatre et al., 2023)
	Others					
	Decision-making	Decision-making of economic benefits over environmental benefits	✓	✓		Charef et al. (2021)
	Data	Lack of data about plastic waste's quantity and availability	✓	✓		Recycle: (Santos et al., 2023), (Charef et al., 2021), (Oluleye et al., 2023), (Shooshtarian et al., 2022a), (Ma et al., 2020), (Tirado et al., 2022); Reuse: (Charef et al., 2021), (Oluleye et al., 2023), (Kozminska, 2019), (Tirado et al., 2022)
Waste Processing	***Activity-related***					
	Procurement	Lack of availability of plastic waste	✓	✓		Recycle: (Santos et al., 2023), (Mhatre et al., 2023), (Liu et al., 2021), (Ma et al., 2020); Reuse: (Oluleye et al., 2023), (Knoth et al., 2022), (Kozminska, 2019)
		Limited channels for plastic waste acquisition	✓			(Oluleye et al., 2023), (Ding et al., 2023)
		Expensive transportation and storage cost for plastic waste	✓	✓		Recycle: (Santos et al., 2023); Reuse: (Knoth et al., 2022), (Munaro and Tavares, 2023)
		Lack of logistics for plastic waste acquisition	✓	✓		Recycle: (Charef et al., 2021), (Oluleye et al., 2023), (Shooshtarian et al., 2022a), (Al-Raqeb et al., 2023); Reuse: (Charef et al., 2021), (Oluleye et al., 2023), (Giorgi et al., 2022)
		Lack of storage space for plastic waste		✓		(Gherman et al., 2023), (Knoth et al., 2022), (Fufa et al., 2023), (Giorgi et al., 2022), (Rakhshan et al., 2020)
	Treatment	Lack of assets for processing plastic waste into recycled plastic pellets/reused plastic products	✓	✓		Recycle: (Santos et al., 2023), (Wuni, 2022), (Oluleye et al., 2023), (Shooshtarian et al., 2022a), (Liu et al., 2021), (Munaro and Tavares, 2023), (Mohamed and Brown, 2023); Reuse: (Oluleye et al., 2023), (Kozminska, 2019), (Mohamed and Brown, 2023)
		High cost for processing plastic waste into recycled plastic pellets/reused plastic products	✓	✓		Recycle: (Alite et al., 2023), (Liu et al., 2021), (Ma et al., 2020), (Ding et al., 2023), (Munaro and Tavares, 2023), (Bukowski and Fabrycka, 2019); Reuse: (Véliz et al., 2022), (Charef et al., 2021), (Guerra and Leite, 2021), (Giorgi et al., 2022), (Munaro and Tavares, 2023)
		Lack of subsidies for processing plastic waste into recycled plastic pellets	✓			(Liu et al., 2021), (Ma et al., 2020)
		Lack of knowledge about advanced technology for processing plastic waste	✓			Shooshtarian et al. (2022a)
		Lack of knowledge about processing plastic waste into reused plastic products		✓		(Knoth et al., 2022), (Gerhardsson et al., 2020), (Rakhshan et al., 2020)
		Lack of supportive regulation for processing plastic waste into recycled plastic pellets	✓			Janson et al. (2022)
		Limited research on technology and assets for processing plastic waste into recycled plastic pellets	✓			(Liu et al., 2021), (Ding et al., 2023), (Mohamed and Brown, 2023)
		Lack of technology for processing plastic waste into recycled plastic pellets/reused plastic products	✓	✓		Recycle: (Santos et al., 2023), (Mhatre et al., 2023), (Wuni, 2022), (Mohamed and Brown, 2023); Reuse: (Mhatre et al., 2023)
	Test	Lack of regulations for testing reused plastic products		✓		Giorgi et al. (2022)
		Lack of technology for non-destructive material testing	✓			Mhatre et al. (2023)
		Lack of assets for testing reused plastic products		✓		Knoth et al. (2022)
		Lack of method for testing reused plastic products		✓		Knoth et al. (2022)
		High cost for testing reused plastic products		✓		Giorgi et al. (2022)
		Long time for testing reused plastic products		✓		Giorgi et al. (2022)
	Material-related					
	Quality	Inferior quality of recycled plastic pellets/reused plastic products	✓	✓		Recycle: (Santos et al., 2023), (Ding et al., 2023); Reuse: (Wuni, 2022), (Oluleye et al., 2023)
		Unstable quality of recycled plastic pellets/reused plastic products	✓	✓		Recycle: (Ding et al., 2023), (Bukowski and Fabrycka, 2019); Reuse: (Kozminska, 2019)
	Price	Lack of price competitiveness compared to virgin pellets/new plastic products	✓	✓		Recycle: (Santos et al., 2023), (Mhatre et al., 2023), (Oluleye et al., 2023), (Liu et al., 2021), (Bendix et al., 2022); Reuse:

(*continued on next page*)

Table C (*continued*)

Life cycle stage	Barrier type	Barrier	Recycle	Reuse	Reduce	References
						(Mhatre et al., 2023), (Gherman et al., 2023), (Munaro and Tavares, 2023), (Janson et al., 2022)
	Availability	Limited availability of recycled plastic pellets/reused plastic products	✓	✓		Recycle: (Wuni, 2022), (Ding et al., 2023), (Munaro and Tavares, 2023); Reuse: (Mhatre et al., 2023), (Wuni, 2022), (Knoth et al., 2022), (Munaro and Tavares, 2023), (Rakhshan et al., 2020)
		Insufficient suppliers of recycled plastic pellets	✓			Wuni (2022)
		Unstable availability of recycled plastic pellets	✓			Bendix et al. (2022)
	Accessibility	Lack of accessibility of recycled plastic pellets compared to virgin pellets	✓	✓		Mhatre et al. (2023)
	Information	Lack of product information provided for the reused plastic products		✓		(Ding et al., 2023; Luciano et al., 2022; Gardner, 2020; Plastic Pipe and Fittings Association)
	Standard & Certification	Lack of standard and certification for recycled plastic pellets/reused plastic products	✓	✓		Recycle: (Mhatre et al., 2023), (Charef et al., 2021), (Liu et al., 2021), (Ding et al., 2023), (Shooshtarian et al., 2022b); Reuse: (Mhatre et al., 2023), (Véliz et al., 2022), (Charef et al., 2021), (Oluleye et al., 2023), (Sigrid Nordby, 2019), (Knoth et al., 2022), (Guerra and Leite, 2021), (Gerhardsson et al., 2020), (Giorgi et al., 2022), (Kozminska, 2019), (Munaro and Tavares, 2023), (Rakhshan et al., 2020), (Janson et al., 2022), (Høibye and Sand, 2018)
	Others					
	Service	Lack of service for disassembly and collection and sorting of plastic waste	✓			Liu et al. (2021)
System	Awareness	Lack of awareness of reducing, reusing, and recycling plastic waste	✓	✓	✓	(Wuni, 2022), (Charef et al., 2021)
	Benefit	Lack of evidence for the environmental benefits of reducing, reusing, and recycling plastic waste	✓	✓	✓	(Charef et al., 2021), (Gherman et al., 2023)
		Lack of evidence for the financial benefits of reducing, reusing, and recycling plastic waste	✓	✓	✓	(Mhatre et al., 2023), (Wuni, 2022), (Charef et al., 2021)
	Burden	Additional burden for reducing, reusing, and recycling plastic waste	✓	✓	✓	(Wuni, 2022), (Charef et al., 2021)
	Culture	Low risk culture	✓	✓	✓	(Wuni, 2022), (Charef et al., 2021)
		“Resistance to change” culture	✓	✓	✓	(Wuni, 2022), (Charef et al., 2021), (Guerra and Leite, 2021), (Zaman et al., 2023)
		Short-termism culture	✓	✓	✓	All: (Mhatre et al., 2023), (Gherman et al., 2023), (Bukowski and Fabrycka, 2019), (de Graaf et al., 2022); Recycle: (Shooshtarian et al., 2022b)
	Competition	Competition with other circularity strategies (Recycle)		✓	✓	Reuse (Fufa et al., 2023), (Munaro and Tavares, 2023); Reduce: (Munaro and Tavares, 2023)
	Regulation	Lack of supportive regulation for reducing, reusing, and recycling plastic waste	✓	✓	✓	All: (Wuni, 2022), (Charef et al., 2021), (Guerra and Leite, 2021); Recycle: (Bukowski and Fabrycka, 2019); Reuse: (Sigrid Nordby, 2019), (Knoth et al., 2022), (Bilal et al., 2020), (Fufa et al., 2023), (Munaro and Tavares, 2023), (Mohamed and Brown, 2023), (Rakhshan et al., 2020), (Janson et al., 2022), (Bukowski and Fabrycka, 2019); Reduce: (Bilal et al., 2020)
		Inadequate enforcement of regulation for reducing, reusing, and recycling plastic waste	✓	✓	✓	(Wuni, 2022), (Oluleye et al., 2023), (Munaro and Tavares, 2023), (Ming et al., 2021)
		Incompatible regulations for reducing, reusing, and recycling plastic waste	✓	✓	✓	(Janson et al., 2022), (Bukowski and Fabrycka, 2019)
	Benchmark	Lack of benchmarking process for reducing, reusing, and recycling plastic waste	✓	✓	✓	Oluleye et al. (2023)
	Demonstration	Lack of demonstration projects	✓	✓		Recycle: (Wuni, 2022), (Liu et al., 2021), (Janson et al., 2022); Reuse: (Fufa et al., 2023), (Gerhardsson et al., 2020)
	Goal & Target	Lack of goals and targets for reducing, reusing, and recycling plastic waste	✓	✓	✓	All: (Wuni, 2022), (Munaro and Tavares, 2023); Recycle: (Liu et al., 2021), (Abarca-Guerrero et al., 2022)
	Information-sharing	Lack of information-sharing among actors along the value chain	✓	✓	✓	All: (Wuni, 2022), (Gherman et al., 2023), (Oluleye et al., 2023), (Alhawamdeh and Lee, 2021), (Bilal et al., 2020), (Munaro and Tavares, 2023); Recycle: (Shooshtarian et al., 2022b);
	Education	Lack of education for reducing, reusing, and recycling plastic waste	✓	✓	✓	(Wuni, 2022), (Charef et al., 2021), (Oluleye et al., 2023), (Munaro and Tavares, 2023), (Bukowski and Fabrycka, 2019)
	Cooperation	Lack of cooperation among actors along the value chain	✓	✓	✓	All: (Wuni, 2022), (Charef et al., 2021), (Zaman et al., 2023), (Høibye and Sand, 2018); Recycle: (Gherman et al., 2023), (Shooshtarian et al., 2022b); Reuse: (Gherman et al., 2023), (Knoth et al., 2022)
	Business model	Lack of business models for reducing, reusing, and recycling plastic waste	✓	✓	✓	All: (Mhatre et al., 2023), (Wuni, 2022), (Oluleye et al., 2023), (Guerra and Leite, 2021), (Munaro and Tavares, 2023); Reuse: (Janson et al., 2022)

(*continued on next page*)

Table C (*continued*)

Life cycle stage	Barrier type	Barrier	Recycle	Reuse	Reduce	References
	Market	Lack of established market for recycled plastic pellets/reused plastic products	✓	✓		Recycle: (Mhatre et al., 2023; Återvinningsindustrierna (Recycling Industries); Abarca-Guerrero et al., 2022; Luciani et al., 2013; Uponor, 2020; European Resilient Flooring Manufacturers' Institute; Gerflor); Reuse: (Wuni, 2022), (Knoth et al., 2022), (Al-Raqeb et al., 2023), (Cohen et al., 2022), (Gerhardsson et al., 2020), (Munaro and Tavares, 2023), (Mohamed and Brown, 2023), (Rakhshan et al., 2020)
	Investment	High investment cost for reducing, reusing, and recycling plastic waste	✓	✓	✓	All: (Véliz et al., 2022), (Charef et al., 2021), (Gherman et al., 2023), (Bilal et al., 2020), (Bukowski and Fabrycka, 2019), (European Environment Agency, 2020); Recycle: (Mhatre et al., 2023), (Mohamed and Brown, 2023); Reuse: (Guerra and Leite, 2021)
	Supply chain	Fragmented supply chain	✓	✓	✓	All: (Wuni, 2022), (Oluleye et al., 2023), (Munaro and Tavares, 2023); Recycle& Reuse: (Mohamed and Brown, 2023)
		Lack of supply chain for recycled plastic pellets	✓			Santos et al. (2023)
	Health & Security	Health and safety risks from contaminated materials		✓		(Charef et al., 2021), (Gherman et al., 2023), (Mohamed and Brown, 2023), (Rakhshan et al., 2020)
	Performance	Lack of performance assessment for reducing, reusing, and recycling plastic waste	✓	✓	✓	(Wuni, 2022), (Bilal et al., 2020)
	Scale	Lack of economy scale of reducing, reusing, and recycling plastic waste	✓	✓	✓	(Wuni, 2022), (Høibye and Sand, 2018)
	Research	Lack of research on recycling plastic waste	✓			Liu et al. (2021)
	Digitality	Lack of digital tools for reducing, reusing, and recycling plastic waste	✓	✓	✓	Oluleye et al. (2023)
	Support	Lack of support from government	✓	✓	✓	All: (Mhatre et al., 2023), (Bilal et al., 2020); Recycle: (Luciano et al., 2022), (Shooshtarian et al., 2022b);

Data availability

Data will be made available on request.

References

Abarca-Guerrero, L., Lobo-Ugalde, S., Méndez-Carpio, N., Rodríguez-Leandro, R., Rudin-Vega, V., 2022. Zero waste systems: barriers and measures to recycling of construction and demolition waste. Sustainability 14 (22). https://doi.org/10.3390/SU142215265.

Ahlm, M., Boberg, N., Hytteborn, J., Miliute-Plepiene, J., Nielsen, T., 2021. Kartläggning av plastflöden i byggsektorn- Råvara, produkter, avfall och nedskräpning (mapping of plastic flows in the construction sector - raw materials, products, waste and litter) [Online]. Available: https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1579215&dswid=5175. (Accessed 19 July 2022).

Al-Raqeb, H., Ghaffar, S.H., Al-Kheetan, M.J., Chougan, M., 2023. Understanding the challenges of construction demolition waste management towards circular construction: kuwait Stakeholder's perspective. Cleaner Waste Syst. 4, 100075. https://doi.org/10.1016/J.CLWAS.2023.100075.

Al-Salem, S.M., Lettieri, P., Baeyens, J., 2009. Recycling and recovery routes of plastic solid waste (PSW): a review. Waste Manag. 29 (10), 2625–2643. https://doi.org/10.1016/J.WASMAN.2009.06.004.

Alhawamdeh, M., Lee, A., 2021. Construction waste minimization: a narrative review. Int. J. Environ. Sustain. 18 (1), 1–33. https://doi.org/10.18848/2325-1077/CGP/V18I01/1-33.

Aliaxis. Aliaxis UK product catalogue [Online]. Available: https://www.aliaxis.co.uk/en/products/product-catalogue?. (Accessed 22 December 2025).

Alite, M., et al., 2023. Construction and demolition waste management in Kosovo: a survey of challenges and opportunities on the road to circular economy. J. Mater. Cycles Waste Manag. 25 (2), 1191–1203. https://doi.org/10.1007/S10163-022-01577-5.

Almasi, A., Miliute-Plepiene, J., Anderson, S., Berglund, R., 2020. Cirkulära plastgolv (circular plastic floors) [Online]. Available: https://ivl.diva-portal.org/smash/record.jsf?aq2=%5B%5B%5D%5D&c=3&af=%5B%5D&searchType=SIMPLE&sortOrder2=title_sort_asc&query=cirkul%C3%A4ra&language=sv&pid=diva2%3A1549497&aq=%5B%5B%5D%5D&sf=all&aqe=%5B%5D&sortOrder=author_sort_asc&onlyFullText=false&noOfRows=50&dswid=-8085. (Accessed 29 October 2025).

Återvinningsindustrierna (Recycling Industries). Sortering och återvinning av plastfraktioner inom byggsektorn (sorting and recycling of plastic fractions in the construction sector) [Online]. Available: https://www.recycling.se/sortering-och-atervinning-av-plastfraktioner-inom-byggsektorn/. (Accessed 29 January 2024).

Benachio, G.L.F., Freitas, M. do C.D., Tavares, S.F., 2020. Circular economy in the construction industry: a systematic literature review. J. Clean. Prod. 260, 121046. https://doi.org/10.1016/J.JCLEPRO.2020.121046.

Bendix, P., Achenbach, H., Weißhaupt, P., Eckert, D., Oehme, I., Berg, H., 2022. Circular economy for durable products and materials: the recycling of plastic building products in Germany—Status quo, potentials and recommendations. J. Mater. Cycles Waste Manag. 24 (4), 1432–1443. https://doi.org/10.1007/S10163-022-01406-9.

Berry, T.A., Low, J.K., Wallis, S.L., Kestle, L., Day, A., Hernandez, G., 2022. Determining the feasibility of a circular economy for plastic waste from the construction sector in New Zealand. IOP Conf. Ser. Earth Environ. Sci. 1122 (1). https://doi.org/10.1088/1755-1315/1122/1/012002.

Bilal, M., Khan, K.I.A., Thaheem, M.J., Nasir, A.R., 2020. Current state and barriers to the circular economy in the building sector: towards a mitigation framework. J. Clean. Prod. 276. https://doi.org/10.1016/J.JCLEPRO.2020.123250.

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3 (2), 77–101. https://doi.org/10.1191/1478088706QP063OA.

British Plastics Federation. Construction [Online]. Available: https://www.bpf.co.uk//innovation/Construction.aspx. (Accessed 19 December 2025).

British Plastics Federation, 2017. Warm water underfloor heating systems-guidance notes [Online]. Available: https://www.bpfpipesgroup.com/media/62329/Warm-water-underfloor-heating-systems.pdf. (Accessed 18 December 2025).

British Plastics Federation, 2024. Domestic hot & cold water supply and central heating systems [Online]. Available: https://www.bpfpipesgroup.com/media/74515/domestic-hot-cold-water-supply-and-central-heating_issue-5.pdf. (Accessed 18 December 2025).

Bukowski, H., Fabrycka, W., 2019. Circular construction in practice [Online]. Available: www.sokolowsky.pl. (Accessed 12 September 2025).

Charef, R., et al., 2021. Barriers to implementing the circular economy in the construction industry: a critical review. Sustainability 13 (23), 12989. https://doi.org/10.3390/SU132312989, 2021, Vol. 13, Page 12989.

Chen, H., Wan, K., Zhang, Y., Wang, Y., 2021. Waste to wealth: chemical recycling and chemical upcycling of waste plastics for a great future. ChemSusChem 14 (19), 4123–4136. https://doi.org/10.1002/CSSC.202100652.

Cirino, E., et al., 2023. Assessing benefits and risks of incorporating plastic waste in construction materials. Front. Built Environ. 9. https://doi.org/10.3389/FBUIL.2023.1206474.

Cohen, J., Rosado, L., Gil, J., 2022. How is the construction sector addressing the Circular Economy? Lessons from current practices and perceptions in Argentina. IOP Conf. Ser. Earth Environ. Sci. 1078 (1). https://doi.org/10.1088/1755-1315/1078/1/012008.

Condotta, M., Zatta, E., 2021. Reuse of building elements in the architectural practice and the European regulatory context: inconsistencies and possible improvements. J. Clean. Prod. 318, 128413. https://doi.org/10.1016/J.JCLEPRO.2021.128413.

Construction Industry Development Board Malaysia, 2021. Embodied carbon inventory data for construction materials [Online]. Available: www.cidb.gov.my. (Accessed 21 October 2025).

Corotop. Active vapour barrier systems [Online]. Available: https://corotop.com.pl/en/kategoria_produktow/active-vapour-barrier-systems/. (Accessed 22 December 2025).

Dakota Group. Roofing underlayment [Online]. Available: https://www.dakota.eu/en/catalogue/roof/highly-breathable-supported-underlays. (Accessed 22 December 2025).

De, B., Bera, M., Bhattacharjee, D., Ray, B.C., Mukherjee, S., 2024. A comprehensive review on fiber-reinforced polymer composites: raw materials to applications, recycling, and waste management. Prog. Mater. Sci. 146, 101326. https://doi.org/10.1016/J.PMATSCI.2024.101326.

de Graaf, D., Schuitemaker, S., Hamada, K., Fruis, V., 2022. Circular buildings: constructing a sustainable future [Online]. Available: https://circulareconomy.europa.eu/platform/en/knowledge/circular-buildings-constructing-sustainable-future. (Accessed 31 May 2023).

Ding, Z., Wang, X., Zou, P.X.W., 2023. Barriers and countermeasures of construction and demolition waste recycling enterprises under circular economy. J. Clean. Prod. 420, 138235. https://doi.org/10.1016/J.JCLEPRO.2023.138235.

EPD Danmark, 2024. MD-24168-EN [Online]. Available: https://www.epddanmark.dk/media/oegfd13u/md-24168-en.pdf. (Accessed 22 December 2025).

EPD International, 2017. EPD-IES-0000782:003 (S-P-00782) gyproc steel profiles and accessories [Online]. Available: https://www.environdec.com/library/epd782. (Accessed 22 December 2025).

EPD International, 2020. Bitumen sheets for tanking and waterproofing of concrete bridge decks from Nordic Waterproofing AB S-P-01901 [Online]. Available: https://www.environdec.com/library/epd1901. (Accessed 22 December 2025).

EPD International, 2021. EPD-IES-0005046:004 (S-P-05046) WISA spruce plywood, coated [Online]. Available: https://www.environdec.com/library/epd5046. (Accessed 22 December 2025).

EPD International, 2022. EPD-IES-0007203:002 (S-P-07203) Plastic spacers and nearby products for construction purposes [Online]. Available: https://environdec.com/library/epd7203. (Accessed 22 December 2025).

EPD International, 2022. EPD-IES-0005592:003 (S-P-05592) Combiwood painted and natural pine mouldings [Online]. Available: https://www.environdec.com/library/epd5592. (Accessed 22 December 2025).

EPD International, 2023. EPD-IES-0011452:001 (S-P-11452) profiled thermowood [Online]. Available: https://www.environdec.com/library/epd11452. (Accessed 22 December 2025).

EPD International, 2024. EPD-IES-0015715:001 VOTEC Fiberduk/Geotextile (2) [Online]. Available: https://www.environdec.com/library/epd15715. (Accessed 22 December 2025).

EPD International, 2025. EPD-IES-0021252:002 steel nails [Online]. Available: https://environdec.com/library/epd21252. (Accessed 22 December 2025).

EPD-Norway, 2023. Paroc AST L stonewool sandwich panels [Online]. Available: https://www.parocpanels.com/content/dam/paroc/documents/eng/other/environmental-product-declaration-ast-t-ast-l.pdf. (Accessed 22 December 2025).

European Comission, 2020. A new circular economy action plan [Online]. Available: https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf. (Accessed 18 January 2023).

European Environment Agency. Cutting greenhouse gas emissions through circular economy actions in the buildings sector [Online]. Available: https://www.eea.europa.eu/publications/cutting-greenhouse-gas-emissions-through. (Accessed 31 May 2023).

European Environment Agency, 2020. Construction and demolition waste: challenges and opportunities in a circular economy [Online]. Available: https://www.eea.europa.eu/en/analysis/publications/construction-and-demolition-waste-challenges. (Accessed 31 May 2023).

European Extruded Polystyrene Insulation Board Association. Where is XPS insulation used? | Exiba: the European XPS Association [Online]. Available: https://exiba.org/xps-insulation/where-is-xps-insulation-used/. (Accessed 19 December 2025).

European Manufacturers of Expanded Polystyrene. About EPS - eumeps corporate - the voice of the European EPS industry [Online]. Available: https://eumeps.eu/about-eps-sie. (Accessed 19 December 2025).

European Plastic Pipes & Fittings Association. Plastic Pipes offer a major contribution to your living comfort [Online]. Available: https://www.teppfa.eu/applications/above-ground/. (Accessed 18 December 2025).

European Resilient Flooring Manufacturers' Institute. Home - european resilient flooring manufacturers' Institute [Online]. Available: https://erfmi.com/#products. (Accessed 19 December 2025).

Eurovent. Vapor barriers [Online]. Available: https://eurovent.de/en/oferta/vapor-barriers. (Accessed 22 December 2025).

Eurovent. Facade [Online]. Available: https://eurovent.de/en/oferta/facade. (Accessed 22 December 2025).

Exolon Group. Case studies in polycarbonate roofing sheets [Online]. Available: https://www.exolongroup.com/en/255/Roofing.htm. (Accessed 22 December 2025).

Farjana, S.H., Mungombe, T.M., Gamage, H.M.K., Rajwani, A.S., Tokede, O., Ashraf, M., 2023. Circulating the E-Waste recovery from the construction and demolition industries: a review. Sustainability 15 (16). https://doi.org/10.3390/SU151612435.

Fråne, A., Henrik, Johansson, Bergkund, R., Kellner, M., Moyes, J., 2021. Plast i byggsektorn – en kartläggning av biobaserade och återvunna alternativ (Plastics in the construction sector- A survey of bio-based and recycled alternatives) [Online]. Available: https://www.naturvardsverket.se/publikationer/8800/Plast-i-byggsektorn/. (Accessed 19 October 2022).

Forever Plast S.p.A.. Amazzonia - HDPE flooring system [Online]. Available: https://www.foreverplast.it/en/amazzonia-hdpe-flooring-system/. (Accessed 22 December 2025).

Fråne, A., et al., 2022. Kartläggning av plastflöden i Sverige 2020- Med avseende på råvara, produkter och avfall (mapping of plastic flows in Sweden 2020- with regard to raw materials, products and waste) [Online]. Available: https://www.naturvardsverket.se/publikationer/7000/978-91-620-7038-0/. (Accessed 11 July 2022).

Fufa, S.M., Brown, M.K., Hauge, Å.L., Johnsen, S.Å., Fjellheim, K., 2023. User perspectives on reuse of construction products in Norway: results of a national survey. J. Clean. Prod. 408, 137067. https://doi.org/10.1016/J.JCLEPRO.2023.137067.

García, C., Caro, J., Gallo, G., Tonini, F., 2024. Techno-Economic and Environmental Assessment of Construction and Demolition Waste Management in the European Union Status Quo and Prospective Potential. https://doi.org/10.2760/721895.

Gardner, J., 2020. State of play for collected and sorted plastic waste from construction [Online]. Available: https://ec.europa.eu/docsroom/documents/43694. (Accessed 31 May 2023).

Gerflor. Sports flooring and accessories [Online]. Available: https://www.gerflorme.com/category/sports-flooring-and-accessories. (Accessed 22 December 2025).

Gerhardsson, H., Lindholm, C.L., Andersson, J., Kronberg, A., Wennesjö, M., Shadram, F., 2020. Transitioning the Swedish building sector toward reuse and circularity. IOP Conf. Ser. Earth Environ. Sci. 588 (4). https://doi.org/10.1088/1755-1315/588/4/042036.

Ghafoor, S., Shooshtarian, S., Udawatta, N., Gurmu, A., Karunasena, G., Maqsood, T., 2024. Cost factors affecting the utilisation of secondary materials in the construction sector: a systematic literature review. Resour. Conserv. Recycl. Adv. 23, 200230. https://doi.org/10.1016/J.RCRADV.2024.200230.

Gherman, I.E., et al., 2023. Circularity outlines in the construction and demolition waste management: a literature review. Recycling 8 (5), 69. https://doi.org/10.3390/recycling8050069.

Giorgi, S., Lavagna, M., Wang, K., Osmani, M., Liu, G., Campioli, A., 2022. Drivers and barriers towards circular economy in the building sector: stakeholder interviews and analysis of five European countries policies and practices. J. Clean. Prod. 336 (Feb). https://doi.org/10.1016/J.JCLEPRO.2022.130395.

Guerra, B.C., Leite, F., 2021. Circular economy in the construction industry: an overview of United States stakeholders' awareness, major challenges, and enablers. Resour. Conserv. Recycl. 170 (Jul). https://doi.org/10.1016/J.RESCONREC.2021.105617.

GuttaWerke. PVC corrugated sheets [Online]. Available: https://www.gutta.com/product/pvc-corrugated-sheets/. (Accessed 22 December 2025).

Häkkinen, T., Kuittinen, M., Vares, S., 2019. Plastics in building- A study of Finnish blocks of flats and daycare centers [Online]. Available: https://ym.fi/documents/1410903/122689634/Plastics+in+buildings.+A+study+of+Finnish+blocks+of+flats+and+daycare+centres.pdf/9bf6e496-fd8f-1a84-f12a-b19fbcbc906e/Plastics+in+buildings.+A+study+of+Finnish+blocks+of+flats+and+daycare+centres.pdf?t=1687434923078. (Accessed 6 May 2023).

Hernandez, G., et al., 2023. Quantifying and managing plastic waste generated from building construction in Auckland, New Zealand. Waste Manag. Res. 41 (1), 205–213. https://doi.org/10.1177/0734242X221105425.

Høibye, L., Sand, H., 2018. Circular Economy in the Nordic Construction Sector. Nordic Council of Ministers. https://doi.org/10.6027/TN2018-517.

Ignatyev, I.A., Thielemans, W., Vander Beke, B., 2014. Recycling of polymers: a review. ChemSusChem 7 (6), 1579–1593. https://doi.org/10.1002/CSSC.201300898.

Institut Bauen und Umwelt e.V. (IBU), 2015. NUOVA FAR S.r.l.-laboratory taps-fittings for water, pure water, burning gases, and technical gases at every purity level up to 6.0 [Online]. Available: https://ibudata.lca-data.com/resource/sources/6b92da54-d44c-4f01-af79-7beb7e1d0889/Laboratory_taps_from_Nuova_Far.pdf?version=00.01.000. (Accessed 22 December 2025).

Janson, U., Richter, J.L., Milios, L., Johansson, D., 2022. Towards a Circular Building Industry. https://doi.org/10.1007/978-3-030-68074-9_148-1.

Jansson, A., Boss, A., Lundberg, L., 2019. Återvinning av plast från bygg-och rivningsprocesser (recycling of plastics from construction and demolition processes) [Online]. Available: https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1416046&dswid=-5356. (Accessed 27 July 2023).

Jansson, A., Boss, A., Ekici, S., Lindkvist, L., 2021. REPIPE demo – insamling, sortering och återvinning av rör i stor skala (REPIPE demo – large scale collection, sorting and recycling of pipes) [Online]. Available: https://resource-sip.se/projekt/repipe-demo-insamling-sortering-och-atervinning-av-ror-i-stor-skala/. (Accessed 29 October 2025).

Jayarathna, C., et al., 2025. Role of training in changing designers' attitudes and behaviour in optimal use of products with recycled content in the construction sector: a systematic literature review. Resour. Conserv. Recycl. Adv. 25, 200248. https://doi.org/10.1016/J.RCRADV.2025.200248.

Jónsdóttir, H., Björkman, M.B., Industriteknik, C., Boss, A., Lindqvist, K., 2023. Ett cirkulärt system för emballageplast från byggindustrin steg 2 - CirEm steg 2 (A circular system for packaging plastic from the construction industry stage 2) [Online]. Available: https://ri.diva-portal.org/smash/record.jsf?pid=diva2%3A1813135&dswid=1030. (Accessed 30 August 2024).

King, S., Locock, K.E.S., 2022. A circular economy framework for plastics: a semi-systematic review. J. Clean. Prod. 364, 132503. https://doi.org/10.1016/J.JCLEPRO.2022.132503.

Kingspan. Insulation boards [Online]. Available: https://www.kingspan.com/ie/en/products/insulation-boards/. (Accessed 22 December 2025).

Kiwa, 2023. EPD-Dr. Schutz-279-EN [Online]. Available: https://www.kiwa.com/globalassets/germany/veroffentlichte-epds/2023/01-0323/epd-dr.-schutz-279-en.pdf/. (Accessed 22 December 2025).

Kiwa, 2024. PARAWEB geostrips for reinforced soil retaining walls and bridge abutments [Online]. Available: https://www.kiwa.com/globalassets/germany/veroffentlichte-epds/2024/3105024/epd-kiwa-ee-000374-en.pdf/. (Accessed 22 December 2025).

Knoth, K., Fufa, S.M., Seilskjær, E., 2022. Barriers, success factors, and perspectives for the reuse of construction products in Norway. J. Clean. Prod. 337, 130494. https://doi.org/10.1016/J.JCLEPRO.2022.130494.

Kozminska, U., 2019. Circular design: reused materials and the future reuse of building elements in architecture. Process, challenges and case studies. IOP Conf. Ser. Earth Environ. Sci. 225 (1). https://doi.org/10.1088/1755-1315/225/1/012033.

Lazarevic, D., Buclet, N., Brandt, N., 2010. The influence of the waste hierarchy in shaping European waste management: the case of plastic waste. Reg. Dev. Dialog. 31 (2), 124–148 [Online]. Available: http://www.diva-portal.org. (Accessed 1 November 2025).

Liu, J., Wu, P., Jiang, Y., Wang, X., 2021. Explore potential barriers of applying circular economy in construction and demolition waste recycling. J. Clean. Prod. 326, 129400. https://doi.org/10.1016/J.JCLEPRO.2021.129400.

Luciani, V., Serranti, S., Bonifazi, G., Di Maio, F., Rem, P., 2013. Quality control in the recycling stream of PVC from window frames by hyperspectral imaging. Opt. Sens. 8774, 87741N. https://doi.org/10.1117/12.2014755, 2013.

Luciano, A., Cutaia, L., Altamura, P., Penalvo, E., 2022. Critical issues hindering a widespread construction and demolition waste (CDW) recycling practice in EU countries and actions to undertake: the stakeholder's perspective. Sustain. Chem. Pharm. 29, 100745. https://doi.org/10.1016/J.SCP.2022.100745.

Ma, M., Tam, V.W.Y., Le, K.N., Li, W., 2020. Challenges in current construction and demolition waste recycling: a China study. Waste Manag. 118, 610–625. https://doi.org/10.1016/J.WASMAN.2020.09.030.

Mhatre, P., Gedam, V.V., Unnikrishnan, S., Raut, R.D., 2023. Circular economy adoption barriers in built environment- a case of emerging economy. J. Clean. Prod. 392 (Mar). https://doi.org/10.1016/J.JCLEPRO.2023.136201.

Ming, H.Y., Rashid, Z.Z.A., Adnan, H., 2021. Significant barriers influencing green design application among the contractors in construction industry. Int. J. Sustain. Const. Eng. Technol. 12 (1), 221–227. https://doi.org/10.30880/IJSCET.2021.12.01.022.

Mohamed, G., Brown, A., 2023. Towards a circular economy: a review of the current challenges and potential for recycling construction waste materials in New Zealand. In: 2023 Conference Papers Conference Papers [Online]. Available: https://archscience.org/paper/towards-a-circular-economy-a-review-of-the-current-challenges-and-potential-for-recycling-construction-waste-materials-in-new-zealand/. (Accessed 10 September 2025).

Munaro, M.R., Tavares, S.F., 2023. A review on barriers, drivers, and stakeholders towards the circular economy: the construction sector perspective. Clean. Responsib. Consum. 8. https://doi.org/10.1016/J.CLRC.2023.100107.

Munaro, M.R., Freitas, M.D.C.D., Tavares, S.F., Bragança, L., 2021. Circular business models: current state and framework to achieve sustainable buildings. J. Construct. Eng. Manag. 147 (12), 04021164. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002184.

NSF International, 2023. FlowResin flowfresh urethane cement flooring system [Online]. Available: https://info.nsf.org/Certified/Sustain/ProdCert/EPD10998.pdf. (Accessed 22 December 2025).

Nusa, F.N.M., et al., 2023. The challenges of green supply chain management (GSCM) system implementation in civil construction project. IOP Conf. Ser. Earth Environ. Sci. 1151 (1). https://doi.org/10.1088/1755-1315/1151/1/012011.

OECD, 2020. Improving resource efficiency and the circularity of economies for a greener world [Online]. Available: https://www.oecd.org/en/publications/improving-resource-efficiency-and-the-circularity-of-economies-for-a-greener-world_1b38a38f-en.html. (Accessed 21 October 2025).

OECD, 2024. Policy Scenarios for Eliminating Plastic Pollution by 2040. OECD. https://doi.org/10.1787/76400890-EN.

Oluleye, B.I., Chan, D.W.M., Olawumi, T.O., Saka, A.B., 2023. Assessment of symmetries and asymmetries on barriers to circular economy adoption in the construction industry towards zero waste: a survey of international experts. Build. Environ. 228, 109885. https://doi.org/10.1016/J.BUILDENV.2022.109885.

O'neill, M., Booth, S., Lamb, J., 2018. Using nvivoTM for literature reviews: the eight step pedagogy (N7+1). Qual. Rep. 23 (13), 24–39. https://doi.org/10.46743/2160-3715/2018.3030.

Page, M.J., et al., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 372 (Mar). https://doi.org/10.1136/BMJ.N71.

Plastic Pipe and Fittings Association. Uses of plastic pipes [Online]. Available: https://www.ppfahome.org/page/Uses. (Accessed 18 December 2025).

Plastics Europe, 2024. The circular economy for Plastics-A European analysis [Online]. Available: https://plasticseurope.org/knowledge-hub/the-circular-economy-for-plastics-a-european-analysis-2024/. (Accessed 20 August 2024).

Plastics Pipe Institute. Building & construction division home [Online]. Available: https://plasticpipe.org/BuildingConstruction. (Accessed 18 December 2025).

Potting, J., Hekkert, M., Worrell, E., Hanemaaijer, A., 2017. Circular economy: measuring innovation in the product chain [Online]. Available: https://www.pbl.nl/uploads/default/downloads/pbl-2016-circular-economy-measuring-innovation-in-product-chains-2544.pdf. (Accessed 23 March 2023).

Prysmian Group. Construction & infrastructures - Product centre [Online]. Available: https://www.prysmian.com/en/product-centre/construction-and-infrastructures. (Accessed 22 December 2025).

PU Europe. Product and market – PU Europe [Online]. Available: https://www.pu-europe.eu/product-and-market/. (Accessed 19 December 2025).

Rakhshan, K., Morel, J.C., Alaka, H., Charef, R., 2020. Components reuse in the building sector – a systematic review. Waste Manag. Res. 38 (4), 347–370. https://doi.org/10.1177/0734242X20910463.

Santos, G., Esmizadeh, E., Riahinezhad, M., 2023. Recycling construction, renovation, and demolition plastic waste: review of the status quo, challenges and opportunities. J. Polym. Environ. 1–31. https://doi.org/10.1007/S10924-023-02982-Z/TABLES/10.

Schneider Electric Netherlands. Merten system design (brand Merten) [Online]. Available: https://www.se.com/nl/en/product-range/63620-merten-system-design-brand-merten/?N=brand%3Dse%26country-code%3DNL%26language-code%3Den%26node-id%3D%26subnode-id%3D12366828928#products. (Accessed 22 December 2025).

Shooshtarian, S., Maqsood, T., Caldera, S., Ryley, T., 2022. Transformation towards a circular economy in the Australian construction and demolition waste management system. Sustain. Prod. Consum. 30, 89–106. https://doi.org/10.1016/J.SPC.2021.11.032.

Shooshtarian, S., Caldera, S., Maqsood, T., Ryley, T., Wong, P.S.P., Zaman, A., 2022. Analysis of factors influencing the creation and stimulation of the Australian market for recycled construction and demolition waste products. Sustain. Prod. Consum. 34, 163–176. https://doi.org/10.1016/J.SPC.2022.09.005.

Sigrid Nordby, A., 2019. Barriers and opportunities to reuse of building materials in the Norwegian construction sector. IOP Conf. Ser. Earth Environ. Sci. 225 (1), 12061. https://doi.org/10.1088/1755-1315/225/1/012061.

Snyder, H., 2019. Literature review as a research methodology: an overview and guidelines. J. Bus. Res. 104, 333–339. https://doi.org/10.1016/J.JBUSRES.2019.07.039.

Souder, J., et al., 2024. Modelling Plastic Product Flows and Recycling in the EU. Joint Research Center. https://doi.org/10.2760/69492.

Tarkett. Homogeneous commercial vinyl flooring solutions [Online]. Available: https://www.tarkett-me.com/en_ME/category-emea_C01001-homogeneous-vinyl. (Accessed 22 December 2025).

Tarkett. Non PVC vinyl flooring [Online]. Available: https://www.tarkett-me.com/en_ME/category-emea_C01003-non-pvc. (Accessed 22 December 2025).

Tirado, R., Aublet, A., Laurenceau, S., Habert, G., 2022. Challenges and opportunities for circular economy promotion in the building sector. Sustainability 14 (3). https://doi.org/10.3390/SU14031569.

Tyvek, 2024. Product portfolio [Online]. Available: https://www.dupont.co.uk/content/dam/dupont/amer/us/en/performance-building-solutions/public/documents/en/Product_Portfolio_Pocket_booklet_EN.pdf. (Accessed 22 December 2025).

United Nations Environment Programme, 2023. Building materials and the climate: constructing a new future. United Nations Environ. Program. [Online]. Available: https://wedocs.unep.org/xmlui/handle/20.500.11822/43293. (Accessed 21 December 2024).

United Nations Environment Programme, 2024. Global resources outlook 2024: bend the trend – pathways to a liveable planet as resource use spikes [Online]. Available: https://www.unep.org/resources/Global-Resource-Outlook-2024. (Accessed 27 February 2025).

United Nations Environment Programme, 2024. Global Status Report for Buildings and Construction: Beyond Foundations: Mainstreaming Sustainable Solutions to Cut Emissions from the Buildings Sector. https://doi.org/10.59117/20.500.11822/45095.

Uponor, 2020. Uponor PEX piping systems [Online]. Available: https://brandportal.uponor.com/m/29e028a95acb8e77/original/TI-PEX-piping-systems-EN-1118689-v1.pdf. (Accessed 16 January 2023).

van Stijn, A., Wouterszoon Jansen, B., Gruis, V., van Bortel, G.A., 2023. Towards implementation of circular building components: a longitudinal study on the stakeholder choices in the development of 8 circular building components. J. Clean. Prod. 420, 138287. https://doi.org/10.1016/J.JCLEPRO.2023.138287.

Véliz, K., Walters, J., Busco, C., Vargas, M., 2022. Modeling barriers to a circular economy for construction demolition waste in the Aysén Region of Chile. SSRN Electron. J. https://doi.org/10.2139/ssrn.4244940.

VinylPlus, 2025. PVC to deliver sustainable housing and construction in Europe [Online]. Available: https://www.vinylplus.eu/wp-content/uploads/2025/12/vinylplus_affordable_housing_position_paper_2.pdf. (Accessed 22 December 2025).

Wuni, I.Y., 2022. Mapping the barriers to circular economy adoption in the construction industry: a systematic review, Pareto analysis, and mitigation strategy map. Build. Environ. 223 (Sep). https://doi.org/10.1016/J.BUILDENV.2022.109453.

Zaman, A., Caceres Ruiz, A.M., Shooshtarian, S., Ryley, T., Caldera, S., Maqsood, T., 2023. Development of the circular economy design guidelines for the Australian built environment sector. Sustainability 15 (3). https://doi.org/10.3390/SU15032500.

Zhao, J.R., Zheng, R., Tang, J., Sun, H.J., Wang, J., 2022. A mini-review on building insulation materials from perspective of plastic pollution: current issues and natural fibres as a possible solution. J. Hazard. Mater. 438, 129449. https://doi.org/10.1016/J.JHAZMAT.2022.129449.

Zheng, J., Suh, S., 2019. Strategies to reduce the global carbon footprint of plastics. Nat. Clim. Change 9 (5), 374–378. https://doi.org/10.1038/s41558-019-0459-z, 2019 9:5.