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Taking Up Some Space: How Urban Space Use Supports Material Circularity in Outdoor Public Spaces

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Abstract

Circular urban design is vital for developing the urban environment amidst intense urbanization, resource depletion, and climate change. Recent studies indicate that using urban space effectively is a necessity to promote circularity in the built environment. Yet, so far, discussions on the use of space within the circular economy have hardly shown its value beyond financial terms and enabling the circularity of buildings. To better capture the non-financial benefits and costs, this study uses a plural value perspective by means of a public sector circular business model lens. The model is applied to three cases of urban space use in the city of Amsterdam. In these cases, space is used for temporary storage and handling to facilitate material reuse in urban area maintenance and (re)development projects in outdoor public spaces. Our findings demonstrate that (temporary) use of urban space is a crucial resource to store materials and enable material circularity in outdoor public spaces. The findings show that more permanent use of urban space provides opportunities for value chain collaboration and professionalization of storage and handling, whereas shorter use of urban space can be utilized for temporary storage to orchestrate the reuse of materials locally. The (temporary) use of urban spaces enables reuse, repurpose, refurbish, repair, and/or remanufacture of materials and products applied in outdoor public spaces and can create public, social, environmental, and economic value. The findings guide project stakeholders, urban planners, and policy makers on how to unlock the value-creating potential of (temporary) urban space use to create circular outdoor public spaces.

Keywords

circular economy; public space; reuse; urban planning; urban space; value; value creation

1. Introduction

The circular economy (CE) is considered an alternative to the linear economy. In contrast to the make–take–waste linear economy, CE focuses on narrowing, slowing, closing, and regenerating material loops (Konietzko et al., 2020). Most authors consider CE as a means to sustainable development also at the city scale (Kirchherr et al., 2017). Many European cities are aiming to become so-called "circular cities" (Circle Economy Foundation et al., 2024). A "circular city" requires a transition in adopting CE principles at the city level (Prendeville et al., 2018). Given these developments, awareness and understanding of the city-level transition to a CE has gained increased importance. City-level transitions overarch different industries, sectors, and contexts, with foci ranging from consumer goods to the built environment (Circle Economy Foundation et al., 2024). Cities have different city strategies and policy approaches to facilitate the CE (Bolger & Doyon, 2019; Prendeville et al., 2018).

In circular cities, circular development entails urban development that supports activities and infrastructure that facilitate circular flows, regeneration, and resilience (J. Williams, 2021). Within circular development, the importance of spatial dimensions is recognized (J. Williams, 2023). Additionally, concepts such as urban ecology (McDonnell et al., 2009) and urban metabolism (Amenta, 2026) respond to and explore the material–spatial relationship in the CE. In spatial planning, a more in-depth exploration centers on what role planning can play to create space and infrastructure for circularity (J. Williams, 2020). For instance, in land-use policy, particular attention is given to derelict, vacant, and underused urban land (Amenta, 2026).

Yet, another dimension needs to be considered in cities' circular development: temporary use of urban space. The spatial implications of circular strategies to cities are only rarely addressed (Baumgartner et al., 2024). As space is scarce in cities, temporary occupation (or use) of vacant spaces is a strategy to optimize urban space use for circularity. The temporary use of buildings is a contributing factor to the CE, for example by using these as temporary makerspaces (Kawa et al., 2024). The temporary use of land is also recognized to facilitate circular development. For example, temporary land use to store reused building materials to create real estate with reused materials (Tsui et al., 2024). Though previous studies have looked into the role of (temporary) space use in the context of buildings, this role remains unexplored in the context of *outdoor* public space (OPS). OPSs are spaces that are outdoors and publicly accessible, such as playgrounds, squares, parks, streets, and roads. Materials applied in these spaces are also part of the circular development.

To develop land or urban space use strategies that accommodate circular development, cities need to understand the related value opportunities. Urban space is after all—especially in densely populated cities—in competition with other uses. Meanwhile, land designated to circular activities, even temporary ones, can accomplish social and environmental ambitions and create social and cultural value (Baumgartner et al., 2024). Therefore, this study addresses the following research question: How could different (temporary) urban space uses promote circularity in the outdoor public space and create value?

To answer this question, we analyzed three cases in the city of Amsterdam with a different spatial–temporal interplay of urban space use. The city of Amsterdam is committed to reusing materials in OPSs. It has introduced a principle for the OPS called "reuse, unless" to motivate reuse of materials within replacement and (re)development projects in the OPS (Municipality of Amsterdam, 2023). Data collection took place over the course of the years 2024–2026. For data collection, we conducted workshops, held multiple semi-structured interviews, used internal documentation, and conducted several site visits. The main contribution of this article is an exploration of the value-creating opportunities of different (temporary) uses of urban space for the purpose of reusing materials in OPSs. The article is structured as follows: Section 2 describes the state-of-the-art of value opportunities in space use and material circularity, Section 3 outlines the research methodology, Section 4 presents the case study findings, followed by the discussion in Section 5 and the conclusion and implications for further research in Section 6.

2. State-of-the-Art

In the following sections, we discuss the state-of-the-art on the multi-value perspective on using urban space for circular development. Note that we use "materials" as a category containing both products and objects in the OPS.

2.1. The Value of Space Use in Circular Cities

To facilitate the circulation of different materials in the built environment, spaces are needed to store (and process) and redistribute these materials (Tsui et al., 2024). However, in cities, space is a scarce resource and competes with other uses (Obersteg et al., 2019). For example, in cities, high land prices may be a favorable factor for commercial real estate development (Yalçın & Foxon, 2021), the goals of mixed-use or multi-purpose development (Ferm & Jones, 2016), or urban redevelopment to attract high-value tourism and improve accessibility (Hess & Stevenson-Blythe, 2025). In the context of land allocation for circular activities in cities, Baumgartner et al. (2024) advocate that the academic debate needs to go beyond extracting solely economic benefits from land use. In fact, reutilization of vacant and underutilized land can be a force for driving sustainable urban transformation (Amenta et al., 2022).

2.2. The Value of Material Circularity in OPSs

In circular cities, buildings are considered material stocks, being part of the so-called "urban mine." Hence, buildings can supply our future secondary resources (Amenta, 2026). Within the OPS, this translates, for example, into the reuse of obsolete materials in OPSs (Horton, 2012). With an existing building stock in place, circularity emphasizes prolonging the use of materials during replacement or redevelopment. This involves the circular strategies of reuse, refurbishment, repair, and remanufacturing (Potting et al., 2017). These circular strategies are also referred to as "slowing the material loop" (Konietzko et al., 2020).

The CE is expected to contribute to achieving economic prosperity, social equity, and environmental quality (Kirchherr et al., 2017). Achieving the CE as part of policy goals is considered a public value (Van den Berghe et al., 2020). The European Union has the target to become a full circular economy by 2050 (European Commission, 2020). *Public value* is a disputed concept within academic literature. To interpret public value creation, the interpretation of Faulkner and Kaufman (2018) is helpful; they deconstructed public value into four key dimensions: creating trust and legitimacy, achieving societal outcomes, delivering service quality, and increasing resource efficiency.

2.3. Conceptualization of Spatial–Temporal Interplay

Based on the above-mentioned literature about the built environment, urban space, circular cities, and expected value in a CE, we come to a theoretical conceptualization of the spatial–temporal interplay concerning circularity in OPSs. Since material reuse in buildings requires intermediate storage space (Tsui et al., 2024), a similar rationale is logical for OPSs. Furthermore, we expect environmental, economic, social, and public value creation in the context of circularity in OPSs. This theoretical understanding is displayed in Figure 1.

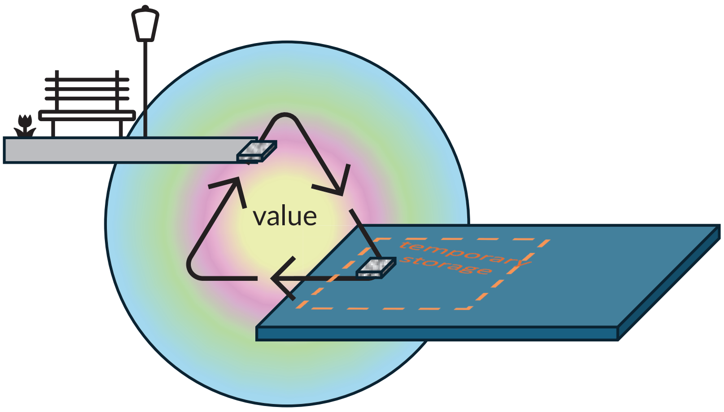

Figure 1. Visualization of spatial–temporal interplay: *Urban space use* contributes to *multiple value creation* through facilitating the *reuse of materials* in the OPS. The circle represents the city boundaries, and the four colors denote the generation of value across four distinct domains: social, environmental, economic, and public value. Example: concrete tile used for pavement.

3. Methodology

3.1. Case Study Approach

We used a case study approach to gain insight into how (semi-)temporal space use can accelerate the circulation of materials in the urban space. A case study approach is well-suited when little perspective and empirical support on the phenomenon is available (Eisenhardt, 1989). Specifically, when no prior theory is available, case study research is a useful approach to gain insight and offer new perspectives (Eisenhardt, 1989). We analyzed three cases within the Municipality of Amsterdam, using a public sector circular business model (PSCBM) framework (see Section 3.2). We followed the sequence of steps displayed in Figure 2.

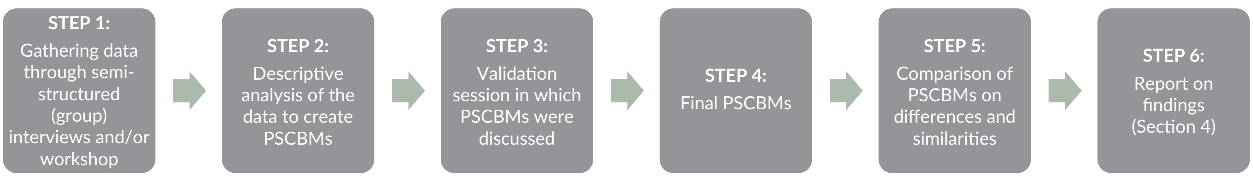

Figure 2. Research design.

3.2. Framework Used to Analyze Value

The PSCBM framework used in this study captures value generation from circular strategies from a public sector perspective, including a focus on sustainable value and public value creation. The framework is the result of a study conducted by two authors of this article in 2023, resulting in an internal report for the municipality. This report was commissioned by the Municipality of Amsterdam to design a business model for the reuse of materials within the city. In the Netherlands, OPSs are owned and managed by municipalities; hence, the interest in reusing materials within OPSs. For the previous study, we conducted a sequence of workshops inspired by Jonker and Faber's (2020) business model template (BMT). The workshops were conducted with practitioners from the Municipality of Amsterdam and resulted in a final public sector business model framework to be used by the municipality to explore the value of circular strategies in the OPS. We used this PSCBM framework for this study as well, containing the building blocks and questions displayed in Table 1.

Table 1. PSCBM building blocks.

Context	Building block	Content	Questions
Define value	Circular strategy (& Project description)	Description of the circular strategy (and the project)	What are the circular strategy/strategies you applied? Optional: What is the project context?
	Motive & Context	Description of the reasons, challenges, and requirements for executing the circular strategy	What are the reasons to implement the circular strategy? What are the challenges? What are the relevant requirements?
	The dream	Description of the common dream that is worked towards when implementing this circular strategy	What are the opportunities to apply the circular strategy/strategies? What is the dream regarding the circular strategy/strategies (i.e., one day…)?
	Value proposition (for each stakeholder, separately)	Description of the value proposition for each stakeholder	Who are the stakeholders and what are their tasks, pains, and gains, and how does the circular strategy contribute?
Deliver value	Core activities, parties involved, and resources required	Description of all activities, actors, and resources (incl. artifacts) required	What activities are required within the project and the municipal organization?
	Risks and risk mitigation	Description of risks and possible measures to mitigate them (and who is responsible for mitigating these)	What risks (and for whom) are present, and how are these mitigated?
	(Internal) test	Description of conditions for success and factors that influence feasibility	What are the conditions for success and factors influencing the feasibility of implementing the circular strategy/strategies?

Table 1. (Cont.) PSCBM building blocks.

Context	Building block	Content	Questions
Generated value	Value created	Description of benefits and costs that relate to the value domains: public, social, environmental/circular, and financial	What are the public, social, financial, and environmental/circular value created (i.e., in each value domain, costs and benefits are discussed)?
	Impact measured	Description of indicators that measure the impact	What public, environmental, financial, societal, and material/circularity impact needs to be measured to indicate the impact (i.e., track progress) and who is responsible for doing so?

3.3. Case Selection

Purposive sampling was used as a strategy to select cases and interviewees. Purposive sampling is a sampling strategy to retrieve a sample of a particular process or phenomenon (Robinson, 2014). The aim was to select cases with different temporal uses of urban space that enable circularity in OPSs. We focused our search for cases on the city of Amsterdam, since the Municipality of Amsterdam set a goal to become a CE by 2050. This includes the built environment, where they focus on reusing materials in the OPS (Municipality of Amsterdam, 2023, p. 54). The Municipality of Amsterdam is concerned with scheduling and managing replacement/redevelopment projects in OPSs. Due to their "reuse, unless" policy, they focus on reusing materials when executing these tasks. We selected three cases with different spatial–temporal use of space to understand their value creation potential, ranging from short-term to long-term use.

3.4. Case Descriptions

The three selected cases are all oriented around the storage function for urban space use (see Figure 3 and Table 2). The first case is the City-Scale Storage (CSS) and focuses on material storage within the city—including materials and products to be reused, refurbished, repaired, or remanufactured—enabled by long-term use of space to store materials. The storage involved two plots: one for mainly playground equipment (Amsterdam-Southeast) and one for mainly pavers and some street furniture and lampposts (Amsterdam Sloterdijk) near the City's Daily Maintenance department. Storage managers within this department are responsible for managing the storage space. This urban space use is regarded as semi-permanent, because in 2024 the storage managers lost part of the storage space to alternative uses. Meanwhile, storage managers are seeking opportunities to expand their storage capacity to unused municipal-owned space that has been reserved for the asset management of bankrupt companies. Since 2015, materials have been reused, but due to budget issues, these operations have been scaled down. Since 2022, a budget has been made available for managing the reuse of materials.

The second case, Neighborhood-Scale Storage (NSS), is urban space use in the transformation area Buiksloterham (Amsterdam North). In June 2024, a temporary materials storage capacity was created on a plot of land that was prepared for real estate development. However, due to a delay in the real estate development, the plot is being used for storage until construction begins in 2 to 4 years. Predominantly pavers and concrete tiles are stored in this location. A contractor made the plot operational for storage capacity by creating a sand bed of ± 90 cm, followed by a layer of gravel of ± 30–40 cm. Also, three rows of concrete slabs were installed to create a road to provide sufficient space for transport vehicles. Finally, the site is surrounded by construction fences with a gate equipped with a lock code. In 2024, a project leader part of the area development in Buiksloterham (Amsterdam-North) managed the storage space. Materials for

Figure 3. The three cases of urban space use: (a) PSS: concrete tiles 850 m from project site; (b) PSS: concrete tiles near flat building; (c) NSS: concrete tiles and curbs, and baked pavers (front view); (d) NSS: concrete tiles and curbs, and baked pavers (back view); (e) CSS: concrete tiles; (f) CSS: bicycle racks; (g) CSS: bollards; (h) CSS: lampposts.

Table 2. Overview of cases.

Case	Scale	Duration of use	Budget source	Use of	Governed by	Place	Timespan of occupation	Area
CSS	City (material collection for projects in the city; repairs and replacements during use)	Long-term Temporary use of space for material storage	Municipal budget	Site near Daily Maintenance department + external site	Daily Maintenance department	Amsterdam Sloterdijk, near highway	No destined timespan	± 12,000 m^2
NSS	Neighborhood (transformation area)	Medium-term Temporary use of vacant space for material storage because of a postponed real-estate development	Land Development budget	Postponed real-estate development	Project leader	Buiksloterham, Amsterdam-North	Destined for ± 2–4 years	2,222 m^2
PSS	Project (maintenance project of an urban area)	Short-term Temporary use of a parking space for material storage	Project budget	Part of a public parking place	Contractor	Amsterdam-North	Destined for ± 8 weeks	± 200 m^2 (parking space 850 m away from the project) ± 50 m^2 (space on project)

reuse are sourced from urban area maintenance or (re)development projects within the city and are destined to be applied in OPSs within the Buiksloterham transformation area. A project leader from Buiksloterham is in charge of the storage, spending time on a regular basis sourcing material and managing material transport and storage.

The third case, Project-Scale Storage (PSS), is urban space use within and near a project site. It concerned a maintenance project of sidewalks in front of two flats (total: 1,338 m^2) in an urban area in Amsterdam-North in which concrete tiles were reused. For this purpose, proximity storage was required, only for the duration of execution. A small municipal parking place was made available for storage capacity, 850 m away from the project. During execution, a small part of green space was occupied near one of the flats. The occupation of the space was short, and non-permanent in nature. The project was executed from October to December 2025.

3.5. Data Collection, Analysis, and Validation

The data collected include transcripts, meeting notes, observations, photographs collected from field work, internal documents, and completed PSCBM templates. If business model components could not be deduced directly from the data (e.g. in interviews), a deductive coding strategy was applied to analyze the data, using pre-set codes to create an overview of the PSCBMs in the three cases. We applied an initial code scheme based on the building blocks (e.g., Dream, Risk, Value) and content (e.g., Mitigation Measures, Reasons, Success Conditions) to compile useful information in the data. We let codes arise when necessary to provide a full overview of the value dimensions (e.g., Consumers, End Destinations).

We used the coding scheme to conduct a descriptive analysis with the goal of providing an overview of the PSCBMs of the three cases. Once results were organized and documented according to the PSCBM structure, a follow-up meeting was scheduled to discuss and validate the interim findings with participants (see Figure 2). The final PSCBMs included the feedback provided in these validation sessions. Table 3 displays the meetings held and their respective dates. In the event of uncertainty, clarification was sought through emails or mobile phone communication with participants. All participants signed a consent form conforming to European GDPR regulations.

Table 3. Overview of data collection.

Purpose	Case	Actors	Type	Duration (approximately)	Date Session
Initial	PSS	Project leader, client, asset advisor, innovation manager, contractor	Workshop	3 h	4 June 2024
Validation	PSS	Project leader, client, asset advisor, supplier, innovation manager, contractor	Interview	1 h	21 November 2024
Validation	PSS	Contractor, supervisor, construction manager, project leader	Workshop	2.5 h	25 February 2026
Initial	NSS	Storage manager (and project leader; SM-3)	Interview	4 h*	18 July 2024

Table 3. (Cont.) Overview of data collection.

Purpose	Case	Actors	Type	Duration (approximately)	Date Session
Validation	NSS	Storage manager (SM-3)	Interview	30 min*	28 November 2024
Initial	CSS	Two storage managers (SM-1, SM-2)	Interview	4 h*	17 September 2024
Validation	CSS	Two storage managers (SM-1, SM-2)	Interview	2 h*	13 November 2025

Note: * These interviews were recorded; quotes used in this article stem from these interviews.

4. Findings

First, we provide an overview of the circular strategies identified in the cases, then we provide results in the PSCBM structure: Define Value, Deliver Value, and Generated Value.

4.1. Circular Strategies in the Different Cases

Table 4 shows an overview of circular strategies found in the cases. The circular strategies are: reuse (at the initial project site), reuse (in another project site), repurpose, refurbishment, repair, and remanufacturing.

Table 4. Overview of circular strategies found in the three cases, per material type.

Material	Reuse	Repurpose	Refurbishment	Repair	Remanufacturing	CSS	NSS	PSS
Concrete pavers	X	X (for temporary roads, e.g., in construction works)				X		
Clay baked pavers	X					X	X	
Cobble stones	X					X		
Concrete paving tiles (30 × 30 cm)	X					X	X	X
Concrete curbs	X					X	X	X
Bicycle staples and racks	X					X		
Benches	X		X			X		
Bins*	X		X	X		X		
Gullies	X					X		
Sport & playing equipment	X		X			X		
Poles	X					X		
Planters	X					X		
Gullies	X					X		

Table 4. (Cont.) Overview of circular strategies found in the three cases, per material type.

Material	Reuse	Repurpose	Refurbishment	Repair	Remanufacturing	CSS	NSS	PSS
Traffic sign bollards	X					X		
Traffic signs					X	X		
Tree protectors			X			X		
Traffic light bollards			X			X		
Lampposts			X			X		
Luminaires			X			X		

Note: * This also included refurbishment and repair at the original manufacturer, enabling circularity outside the city of Amsterdam.

4.2. Defining Value

The motivation to start with material storage for reuse at the CSS was to prevent the "leakage" of materials to contractors, who would then resell or apply them elsewhere. Also, the City's agenda includes emphasis on carbon footprint reduction of scope 3 emissions, which involves reducing the impact of material use within the city (Municipality of Amsterdam, 2024). Lastly, some reused (and new) materials are stored because the City's Daily Maintenance department has the obligation to conduct ad-hoc replacements during the asset use and maintenance phase.

In NSS, the main motivation to create storage was to contribute to the local ambition to design OPSs in the Buiksloterham transformation area with 80% circular materials. Local storage of reused materials ensures a steady supply for projects within Buiksloterham. Though there was some space reserved for Buiksloterham at the CSS, this was considered too far away to maintain a good overview of the incoming and outgoing material flows collected for Buiksloterham. In addition, the CSS storage capacity was reached rather quickly. The primary challenge is to ensure that all materials are removed from the storage space, prior to the commencement of the real estate development.

For PSS, the motivation to reuse concrete tiles and curbs is the recent municipal policy "reuse, unless," which stimulates the reuse of materials when technically feasible (Municipality of Amsterdam, 2023). Occupying a parking space 850 meters from the project was intended to mitigate potential local nuisances, given the significant parking demand. However, during execution, some parking spaces and grass near one of the flats could be used for local storage. All stakeholders' value propositions to reuse materials in the urban space are summarized in Table 5.

Table 5. Collected value propositions for the three cases.

Stakeholder	Value proposition for reusing materials	PSS	NSS	CSS
Municipality (City Council)	Circular policy "reuse, unless" is effectuated, and a contribution to circularity goals and carbon impact reduction goals	X	X	X
Citizens	Maintaining urban identity, fast replacements, fast updates to new needs during use (during use phase), and/or sustainability	X	X	X
Project leader (planning & execution)	Meeting municipal ambitions, project within budget and time, availability of reused materials	X	X	X
Landscape designer	Availability of reused materials to create a circular urban design	*	X	X
Storage managers	Storage provides the opportunity to match demand and supply		X	X
City's Asset Management department	Material meets technical requirements for another term of use, no procurement costs, no unnecessary material use	X	X	X
City's Daily Maintenance department	Fast repairs or replacements with similar (worn-out) materials, maintaining visual appeal in the streetscape			X
Public schools or allotments	Low-budget reused materials/products (e.g., playground equipment, bins, and benches)			X
Local area manager	Fulfilment of locals' needs for the OPS during the asset use and maintenance phase through replacements or accommodation of new needs			X
Contractor (external)	Fulfilment of client's (Municipality) needs and wants, and a positive assessment in a CO_2 certificate audit	X		
Carpenter (external)	Refurbishment of benches by people who are distanced from the labor market			X

Note: * No urban designer was involved in the maintenance project.

4.3. Value Delivery

If we compare the management of the different urban space occupations/uses in the cases, we observe differences in terms of value delivery in three themes: storage management, sustaining demand and supply, and pilots and collaborations.

4.3.1. Storage Management

For the CSS and NSS, similar activities are required, but the type and quantity of materials and amount of storage space vary (Table 2). The difference is that materials in the CSS are available for urban area maintenance or (re)development projects within the city, whereas at NSS materials are only destined for projects within the Buiksloterham transformation area. At the CSS and NSS, storage managers are responsible for the management of material delivery and transport. In the NSS, this is a part-time task executed by a project leader, whereas this is a full-time task at the CSS. At the PSS, a contractor takes care of storage management and transportation. It hardly occurs that projects can take over each other's materials immediately, so intermediate storage is needed. In the case of CSS, storage management remains a challenging job because of limited storage capacity. It occurs that materials of sufficient quality to be reused are rejected because storage capacity is reached. Creating storage space at more local levels, like NSS and PSS, is useful to reduce demand for storage space at the CSS and offer the opportunity to store materials locally, saving transportation miles.

4.3.2. Sustaining Material Demand and Supply

Materials arrive at CSS due to the "reuse, unless" policy that stimulates reuse in urban area maintenance and (re)development projects, but also via the informal network of storage managers. Storage managers or material specialists visit projects to approve or reject materials for reuse by visual inspection and expert judgement. An internal digital marketplace—only accessible within the Municipality—is used to showcase available material supply at the CSS. At the PSS, a considerable risk was the disapproval of reused materials from the City's Asset Management department. Effective communication with this department is pivotal. Moreover, in order to sustain the demand for reused materials, landscape architects or project leaders should select materials from the CSS—or within the Buiksloterham area from the NSS—and/or from within their urban area maintenance or (re)development projects (e.g., PSS) and incorporate reused materials into their urban designs.

4.3.3. Pilots and Collaborations

Since 2022 at CSS, the storage managers have invested in professionalizing activities and exploring opportunities to further increase the reuse of materials by piloting collaborations. These collaborations can be both with internal parties (like the social return labor force within the Municipality) as well as seeking collaborations with external parties. Internally, they had a small crew refurbishing fixtures and repairing bins, before returning these into the city. Externally, a long-lasting collaboration exists between an industrial coating company and a street furniture supplier to repair and refurbish lampposts. They also piloted a collaboration with a traffic sign supplier to remanufacture traffic signs by replacing no longer valid reflective stickers. They also partner up with a contractor that sorts, packages, and stores baked and concrete pavers. Lastly, they collaborate with a carpenter who repairs benches together with people distant from the labor market. In the NSS case, for pavers that cannot be processed by the contractor, like concrete tiles, other contractors are paid to sort, collect, and transport these products to the NSS. At the PSS, the contractor that is responsible for the execution of the project takes care of all activities for reuse: managing storage and handling. The project was also used to test a nano coating as a protective measure for concrete tiles to maintain longevity and patina.

4.4. Generated Value

From the data we collected, we distinguished four different domains of value creation: public, environmental, economic, and social value. Table 6 provides an overview of the value created in the different cases through the circular strategies applied (see Table 4). We observed that value creation was provided by the materials reused and the activities executed.

Table 6. List of values created from the circular strategies applied in the different cases.

Stakeholder	Value Domain	Case CSS	NSS	PSS	Value	Benefits	Costs
Local citizens	Public	X	X		(Unique) aesthetics	Nice outlook (e.g., vintage outlook of pavers)	
Local citizens	Public	X	X	X	Satisfaction	Citizens' acceptance	Citizens' disapproval
Municipality	Public	X	X	X	Responsibility	Municipal goals achievement, good image	Deterioration of municipal image
Local citizens	Public	X			Historical/cultural meaning	Maintaining city identity	
Municipality	Public	X			Functionality	Increased material quality (e.g., strength increase in case of concrete tiles)	
Municipality	Public	X	X	X	Budget efficiency	Avoided costs of purchasing new material	Costs related to activities* to reuse, repair, refurbish, or remanufacture
Municipality	Public	X			Budget efficiency	Efficient use of municipal trucks for transport of reused materials/products	
Local citizens	Public	X			A safe, functional, and responsive OPS due to having stored reusable material for repairs/replacements	(Immediate) available material supply (i.e., you avoid delays from new material supply)	

Table 6. (Cont.) List of values created from the circular strategies applied in the different cases.

		Case					
Stakeholder	Value Domain	CSS	NSS	PSS	Value	Benefits	Costs
Society/Nature	Environmental	X	X	X	Resource efficiency and impact avoidance	Material and carbon footprint reduction because virgin material use is avoided	Material and carbon footprint of activities* to reuse, repair, refurbish, or remanufacture
Municipality	Economic	X	X	X	Material value retention	Functional lifespan** extension through reuse, repair, refurbishment, or remanufacture	
Workers	Social	X		X	Reintegrated labor	Learning, reintegration	
Local citizens	Social	X			Social Cohesion***	Sense of collaborative ownership	
Value chain actors	Social	X	X	X	Collaboration	Collaborative efforts to make success stories	
Value chain actors	Social	X	X	X	Knowledge assimilation	Learning by doing (otherwise, in case of inaction, missing out on opportunities to learn)	

Notes: * Activities that involve, for example, transport, cleaning, coating (PSS), storage creation (NSS), operation & management (CSS, NSS); ** functional life span = time that material is in use before reaching technical life span; *** this was the case for reuse of planters—because the Municipality had contracted an external party for planter maintenance, planters that are reused are maintained by locals.

4.4.1. Economic, Environmental, and Social Value

Economic value is created by prolonging the functional lifespan: Keeping materials in use for as long as possible avoids procurement costs of new material. Environmental value is created because of the high embodied environmental impact of the materials. Most materials or products are made of aluminum, clay, steel (i.e., energy-intensive production), natural stone (i.e., mining operations), or concrete (i.e., cement and sand use). Reuse saves environmental impact by eliminating new primary material demand. Social value is created through the employment of people distanced from the labor market for refurbishment activities (e.g., street bench refurbishment by a third party). On the CSS, storage managers perceived this as unlocked potential. As SM-1 explained, small tasks like cleaning and painting lanterns, cleaning and repairing benches, but also refurbishing bicycle racks and planters could be done by people distant from the labor market. At the PSS, the contractor was bound by the stipulation to allocate only 2% of the commission to social return labor. Another form of social value creation is knowledge assimilation from learning by doing. Lastly, undertaking efforts to reuse materials contributed to a feeling of success (i.e., contributing to the municipal circularity goals) and frugality (i.e., not being wasteful). Regarding aesthetics, reused materials provided in some situations the opportunity to maintain the existing urban area patina (e.g., avoiding a patchwork pattern by replacing broken tiles with old tiles). Meanwhile, the historical and cultural meaning of antique lampposts was preserved through refurbishment. Lastly, social cohesion was created through citizens maintaining reused bins, benches, or planters. As SM-1 (CCS) explained, "In the neighborhood plan, it is discussed that the local residents will maintain the [reused] planters and they really like that."

4.4.2. Public Value

We found in all cases the contribution to local municipal circularity and environmental impact reduction goals, creating public value in terms of responsibility. Reuse is in line with current local policy and is considered an opportunity to act responsibly. In addition, reuse holds the potential to maintain urban identity and quickly restore and reshape the OPS to fulfil local citizen needs. As SM-1 (CSS) stated, "If you need to order something new…that could take up to a month to deliver, but if we have something in stock that can be reused…that is available…we can resolve it immediately." The aesthetics of reused materials are regarded as context-dependent and also dependent on one's perspective. In all cases, it was suggested that there are most likely citizens who prefer new materials over reused materials. But, there are also cases in which citizens prefer to reuse materials instead. As SM-1 (CSS) illustrates, "We had a little project and we didn't have enough pavers to reuse. A piece was added with new materials. Residents complained about it; they wanted pavers to be reused." Also, SM-3 (NSS) explained, "We also have some residents here in the neighborhood who find sustainability very important. And then also appreciate it very much if you will also work very sustainably in the public space."

Budget efficiency, as part of improvements in resource efficiency, involves monetary costs and benefits. Materials in the urban space are not necessarily always used until their technical lifespan is reached. Overall, though the exact costs spent on activities required to reuse are not exactly known, reuse saves money by avoiding procuring new materials, and is particularly noteworthy for high-priced products (i.e., outdoor sport equipment, playground equipment, or baked pavers). Besides, on the CSS, the transport of reused materials contributes to the use of otherwise un(der)used transport vehicles. For the PSS and NSS, reuse decreases transport distances, as both storage spaces are locally organized. It remains undetermined whether reuse requires increased maintenance, such as the need for more frequent road maintenance, when compared to the application of new materials. This is illustrated by SM-1: "Because a new street is guaranteed for 30 years. So if you say, I'll use the [concrete] tiles [in sidewalks] for 20 years, then the management costs will be higher, of course, in case you have to replace earlier."

For the CSS, costs are covered internally within the Municipality; receiving projects do not pay for the materials. Like SM-1 (CSS) explained about the stored bench for reuse:

> We take it [the bench] to the [destination] place and tune it there and we make a distribution slip. It [the bench] comes from this storage [the CSS], for a zero value price. It has already been paid for once and it will also go out for zero. There is no revenue model to it.

Costs for creating and managing the NSS are covered by previously reserved budget in the land surfacing account. The land of the NSS is still owned by the Municipality. The Municipality will transfer this land to a project developer as soon as the plans are final and there is a prospect of realization. Nothing is paid for the use of the land during the occupation. The PSS is covered in the maintenance project budget.

4.4.3. Tracing Impact

Though many forms of impact can potentially be measured and calculated, only a few impact indicators are used in the cases to track progress. Indicators are predominantly tracking environmental and circularity goals. At the PSS, the project manager is obliged to indicate the amount of materials reused to calculate the total environmental impact of the project via a material emission tool developed by the City's Asset Management department. The tool calculates the percentage of circularity within the project and the environmental benefits using product environmental cost indicators. In addition, the contractor has its own KPIs for progress on reuse, collaboration, and staying within budget. Within the NSS, collected materials are tracked in an Excel spreadsheet. The storage managers of the CSS have a system to bill incoming and outgoing reused materials.

5. Discussion

Our findings indicate that the (temporary) use of urban space plays a crucial role in enabling reuse in OPSs, being a temporary storage space for reclaimed materials. Hence, intermediate storage is needed for using reused materials in buildings (Tsui et al., 2021), but also for reusing materials in OPSs. The cases show exemplary spatial–temporal interplays in which the ability to reuse materials is made possible by intermediate storage, which also results in economic, social, environmental, and public value creation. As a contribution to the academic debate, this research puts forward the argument that urban space use contributes to multiple value creation (public, social, economic, and environmental) by providing temporary storage for materials that can be reused, repurposed, refurbished, repaired, or remanufactured to be applied in OPSs.

5.1. Temporary Space Use to Recirculate Materials

Amenta et al. (2022) found that the reuse of abandoned and underutilized urban spaces can drive sustainable urban transformation. Our findings indicate that (temporary) space use contributes to sustainable urban transformation in OPSs. Space use in close proximity to urban area maintenance or (re)development projects (e.g., PSS, NSS) facilitates reuse locally and reduces transport miles. A more permanent, large central storage space (e.g., CSS) provides the city with an opportunity to collect materials to be reused/refurbished/repaired/remanufactured across the city and professionalize the storage management and organization, for example by tracking the in- and outflow of materials and exploring collaborations. It also provides an opportunity to maintain reused material stock for (ad-hoc) replacements and repairs, and to collect a diverse range of materials and products, including unique pieces.

Based on the empirical findings of this study, Figure 4 visualizes the spatial–temporal interplays within the city in comparison to Figure 1.

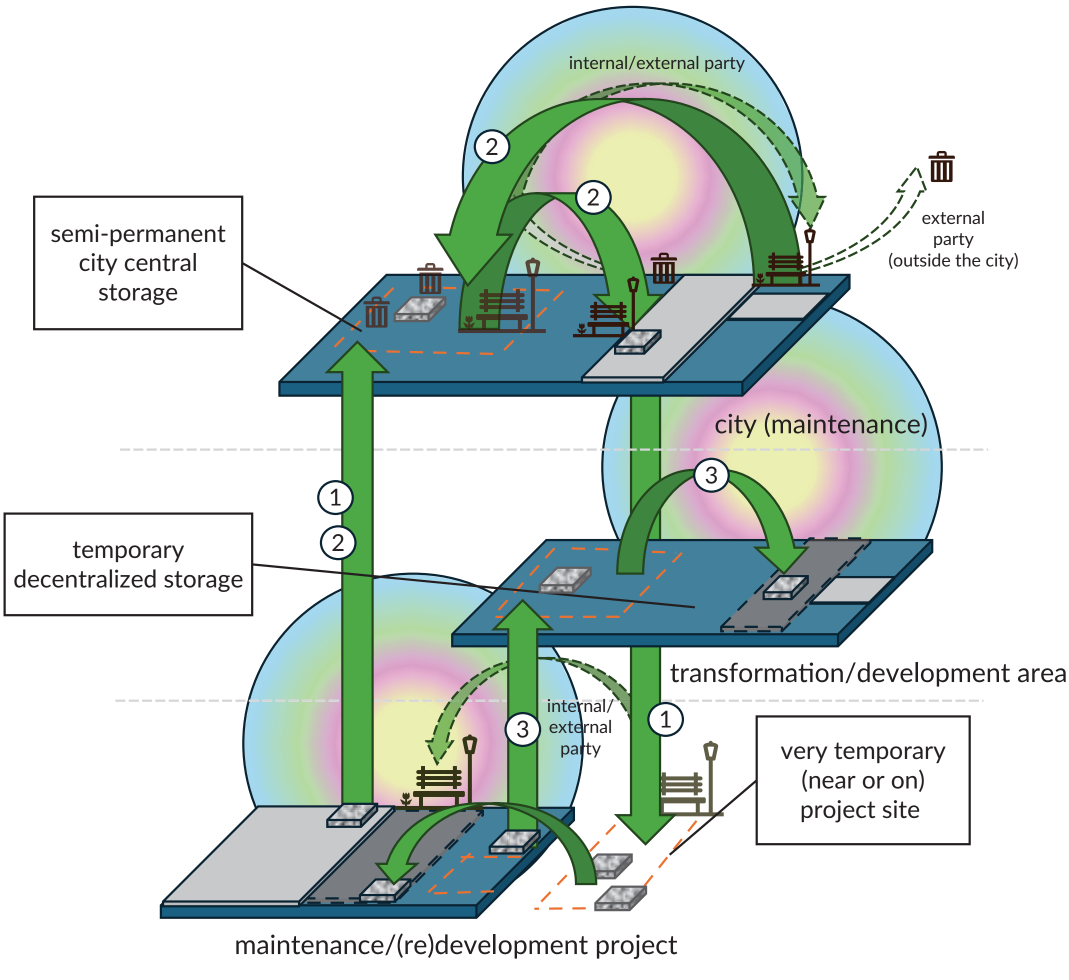

Figure 4. Overview of the spatial–temporal interplay of the different urban space uses that facilitate temporary storage for reuse based on the empirical findings: (1) material exchange between projects and central city storage for maintenance or to projects; (2) material exchange from projects to the central city storage to fulfil maintenance & replacements; (3) material exchange between projects within the city and projects within a transformation area. All enable value creation in the four domains: social, environmental, economic, and public value.

Studying Brussels as a case, Baumgartner et al. (2024) observed that local governments did not show willingness to take land off the market to facilitate circular activities. However, their study entails a more permanent occupation of land, whereas in our study we indicate the potential for temporary use of land in a transformation area (as a result of a postponed development) to store reused materials (e.g., NSS). Hence, our findings indicate that temporary use of land can also facilitate circular activities.

Furthermore, our findings show that all urban space uses contribute to public, social, environmental, and economic value creation. Congruent with previous studies in the built environment, public value is created through achievement of CE goals (Van den Berghe et al., 2020) and maintaining historical and aesthetic value (I. D. Williams et al., 2025). In academic literature, a linkage already exists between the preservation of urban identity and adaptive reuse of cultural heritage buildings (Foster & Saleh, 2021) and urban space design (Tzortzi & Saxena, 2024). Besides, circular use of products creates social, environmental, and economic benefits (Vulsteke et al., 2024), likewise in the application of circular strategies in the built environment (Ho et al., 2024). Also, Lundgren et al. (2024) report that the adaptive reuse of a building saved embodied energy and carbon through the reuse (i.e., keeping intact) of the concrete structure and bricks. In the OPS, reuse of materials saves embodied energy and carbon likewise.

Regarding aesthetics, perceptions can differ among citizens. Though some examples of reuse specifically show the appreciation (or even request) of locals for reused materials because pavers nicely match the aesthetics of the existing urban area patina, some examples show objections to reuse. This is in line with Horton (2012), who argues that the interpretation of reused materials in their context can be perceived differently and can suffer from "discrimination against waste."

5.2. Limitations

5.2.1. Appraising Value Creation

During our assessment of value creation, we found a mere account of what participants perceived as benefits and costs according to their practice and knowledge. Value in relation to sustainability is dependent on the stakeholder's perspective and is context- and time-dependent (Neesham et al., 2023). Also, others in the public value debate have acknowledged the importance of human perception in what they regard as valuable to society (Meynhardt, 2019; Talbot, 2011). This valuation is partly embedded in societal and municipal targets, strategies, and policies, but also in what public officials regard as valuable based on their preferences, tasks, and responsibilities. This is also the case for citizens who can(not) appreciate sustainability (n)or aesthetics. Some citizens may dislike the aesthetics of reuse, while others prefer it over new. In urban area maintenance and (re)design projects, multiple stakeholders are involved who all have certain preferences in design, execution, use, and maintenance. However, some value creation is more objective, like maintaining urban identity, environmental impact reduction, primary material use, and financial costs. What is considered of value involves, for some categories, subjectiveness and limits the immediate generalizability of the listed created value (Table 6) to other contexts, as in other contexts other things may be of value. Hence, Table 6 rather prompts the direction of value generation abilities of urban space use to reuse materials within the OPS, and is not an exhaustive account. It is a mere account of what is considered of value in the research context.

5.2.2. Further Research Recommendations

To understand the value of the use of (temporary) available public space to facilitate the circulation of materials in the OPS, we used a PSCBM framework. This framework has been useful for the purpose. However, we understand that value cannot be separated from the beneficiary. Further research could put more emphasis on what value is created for whom. Lastly, in the public value domain, value is related to ambitions, targets, strategies, and policies, which are captured in internal (and sometimes external) documents. Also, internal and external actors across the value chain have their own needs and preferences based on their strategies and plans (e.g., company strategy of a contractor or asset maintenance plan). For further research, we encourage assessing value according to these documents as well. In light of our insights, assessing value creation comes with a context-based validity and approach.

6. Conclusion

This study aimed to explore the value of using urban space for reuse within the OPSs. We applied a PSCBM framework to understand the value defined, delivered, and created. We analyzed three cases with different spatial–temporal interplays of urban space use to enable the reuse, repurpose, refurbish, repair, and remanufacture of materials in OPSs. All these spatial–temporal interplays contributed to public, social, environmental, and economic value creation.

We aimed to answer the research question: How could different (temporary) urban space uses promote circularity in the outdoor public space and create value? In summary, short-term occupation of urban space in close proximity to urban area maintenance/(re)development projects can help store materials that are to be reused in projects, creating value predominantly through reducing transport distance, and limiting the need to occupy central storage space. Medium-term occupation of urban space near a transformation area to temporarily store materials to be reused creates value through securing material availability for local projects and meeting the local circular ambitions of the area. However, long storage times hinder efficient management due to limiting material throughput. Long-term occupation of urban space to circulate materials within the city creates value through location centrality and large storage capacity. The location is internally known and provides opportunities to professionalize the organization and to set up longer-term collaborations with other parties to implement circular strategies for various materials/products.

The findings of this study lead to several implications for the academic debate. First, we underscore the claim of Verga and Khan (2022) that space is a key urban resource that can enable circular activities within the city. We add to this debate more specifics on how space is used in cities to circulate materials to create circular OPSs. Particularly in densely populated areas, the use of urban space for circularity purposes poses significant challenges and prompts critical questions regarding the optimal allocation of urban space. For this reason, we aimed to establish an understanding of the value opportunities of urban space uses with different spatial–temporal interplays. Second, we stress the value opportunity of using temporary vacant spaces in transformation areas. Given the nature of urban development, in which occasionally developments are being postponed, this results in the availability of temporary vacant urban spaces. These temporarily available vacant urban spaces present the opportunity to serve as storage spaces to temporarily store materials to be reused in OPSs. This temporal use of urban space underscores the importance of "circulation of space" to optimize space use to facilitate the circulation of materials within cities (Pekdemir et al., 2025). Lastly, more permanent occupation of space for central storage can contribute to circularity in OPSs, which requires, following J. Williams (2020), a more prominent role for spatial planning to facilitate circular activities.

This study has implications for practice beyond the case study context. First, spatial planners can use our findings to more structurally organize their activities to work towards a circular built environment, using the urban space (temporarily) and including circular ambitions into their spatial strategies. Second, project leaders concerned with urban area maintenance/(re)development projects are encouraged to explore any opportunities of using (vacant) urban space to temporarily store materials in their projects. Ultimately, (temporal) urban space use has value opportunities to enable a sustainable urban transition towards a circular city and create circular OPSs.

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Conflict of Interests

The authors declare no conflict of interests. In this article, editorial decisions were undertaken by Chiara Mazzarella (TU Delft).

Data Availability

The findings of this study are based on projects and activities conducted within the Municipality of Amsterdam. No separate dataset has been published.

LLMs Disclosure

The authors declare that AI-based language tools (ChatGPT and DeepL Write) were occasionally used for language assistance to improve sentence structure only. The content, analysis, and conclusions were developed entirely by the authors.

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