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Article

Identifying Challenges and Solutions in Cultural Heritage Adaptive Reuse through the Historic Urban Landscape Approach in Amsterdam

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Abstract: Cultural heritage drives and enables sustainable urban development. The adaptive reuse of cultural heritage creates values while prolonging the lifespan of heritage. Similarly, circular economy creates value while extending the useful life of materials and elements through their reuse. Existing studies on adaptive reuse challenges seldom focus on cultural heritage properties, and they are often identified through the engagement of a limited variety of stakeholders, as compared to the actors normally involved in adaptive reuse. Filling this gap, this paper provides a preliminary baseline of challenges faced by the city of Amsterdam from the perspective of various involved stakeholders, and suggests solutions to address them. The participants represented the public, private, knowledge, and third sectors. The methods used were the following: for data collection, a multidisciplinary workshop using the steps of the Historic Urban Landscape approach as an assessment framework applied to multiple scales on adaptive reuse, and for data analysis, manifest content analysis. The results expanded the range of challenges and solutions reported by previous literature on the adaptive reuse of cultural heritage in content and scale by identifying 61 themes—e.g., knowledge and civic engagement. Tools and stakeholders were also identified. These findings provide a reference for future practice, policymaking, and decision-making, facilitating the adaptive reuse of cultural heritage to capitalize on its potential for sustainable development and circular economy.

Keywords: adaptive reuse; Amsterdam; challenge–solution identification; cultural heritage; historic urban landscape; stakeholder engagement



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1. Introduction

Urban settlements currently face an unprecedented pace of urbanization [1], coupled with the adverse impacts of climate change and resource scarcity [2,3]. To overcome such challenges, these settlements strive for sustainability [2]—in its cultural, social, environmental, and economic dimensions [4]—and circular economy [5,6]. In this context, cultural heritage can act as a driver and enabler of sustainable development [7]: enhancing urban livability, fostering human well-being, and maintaining urban identity [8–13]. Therefore, the conservation of cultural heritage, and built heritage in particular, plays a role in sustainable urban development [14,15].

A strategy to conserve built cultural heritage is adaptive reuse [16], which can enable us to capitalize on this heritage potential for sustainable urban development [17–19]. Adaptive reuse is the process that extends “the building’s [and site’s] physical and social functions by giving the building a new purpose while conserving its historic and cultural significance” [20] (p. 508). This process entails four phases: initiation, planning and design, construction, and operation and maintenance [21,22]. At all stages, a variety of actors is involved, such as architects, engineers, local authorities, owners, developers,

constructors, heritage professionals, and users, among others [23,24]. This variety of actors also represents the wide spectrum of disciplines involved in the adaptive reuse of cultural heritage, e.g., architecture, engineering, and heritage studies [24,25]. In some cases, adaptive reuse can entail limitations and conflicts of interests, e.g., lower energy efficiency compared to new buildings or negative gentrification [24]. Yet, adaptive reuse can contribute to sustainable development, with positive economic, environmental, social, and cultural impacts [20,23,26–28], creating values such as sense of place and new income streams [29,30]. Furthermore, adaptive reuse can contribute to addressing the threats posed to heritage by climate change, e.g., acceleration of degradation. This contribution is twofold: mitigation—such as improving the energy efficiency of heritage—and climate change adaptation by incorporating strategies for anticipatory climate change adaptation, such as promoting maintenance [26,31,32].

Adaptive reuse prolongs the lifespan of a non-renewable resource such as cultural heritage; therefore, it can be regarded as a contributor to the transition of human settlements towards circular economy [5,33]. In fact, circular economy entails production and consumption processes that minimize resource extraction and environmental impact by extending the useful life of materials and elements through reuse [6,25]. Despite this contribution, little attention is given to cultural heritage and the existing urban fabrics in policy and strategy documents for circular cities, nor in the growing body of literature on the circular economy within the built environment [34]. This limitation is being addressed in a timely manner by a European-funded research project: the CLIC project—Circular models Leveraging Investments in Cultural heritage adaptive reuse [35]. This project explores the development and implementation of circular models for the adaptive reuse of cultural heritage [28,36]. Within the CLIC project, this study identifies with a participatory approach the challenges affecting the adaptive reuse of cultural heritage and how to solve them. This manuscript details and contextualizes in the state of the art a brief previous conference paper [37,38].

Even if the research on adaptive reuse is growing, the knowledge available on its challenges and solutions remains limited. Firstly, available research considers adaptive reuse as a product rather than a process, focusing on, e.g., specific phases and aspects of the adaptive reuse lifecycle as the regulatory and technical aspects [17,20,39]. Secondly, several studies have investigated challenges of the built environment, referring to adaptive reuse in general [39,40], or specific values of cultural heritage, e.g., historic [41,42]. Hence, studies on the specific aspects of cultural heritage, such as its significance, multiplicity, and variety of values, are to be furthered [27,43]. Thirdly, previous research jointly focusing on challenges and the adaptive reuse of cultural heritage are either conducted in non-European geographical settings, e.g., East Asia [26], Oceania [20,27], and North America [44], or focused on specific typologies of cultural heritage in Europe, such as industrial buildings [45,46]. Finally, to date, the identification of these challenges considered the views of few stakeholders—mostly owners, developers, and architects [20,47]—although a wide variety of other actors is normally involved in the adaptive reuse of cultural heritage, e.g., investors, heritage professionals, and users [24,48], as flagged by Conejos et al. [20]. Therefore, the current knowledge gap on the challenges for the adaptive reuse of cultural heritage could be reduced by broadening the scope, geographical settings, and variety of stakeholders involved in its production.

This research aims to grow the knowledge on the challenges to the adaptive reuse of cultural heritage, and solutions, by identifying them within a European case study: the city of Amsterdam in the Netherlands. This identification engages a broad range of stakeholders, reflecting the variety of actors and disciplines involved in the adaptive reuse of cultural heritage, while also acknowledging the demand for participation in heritage management [49–51]. This research seeks to answer the following research questions: (i) What are the challenges to the adaptive reuse of cultural heritage according to the stakeholders in the city of Amsterdam? and (ii) how these challenges have been or could be tackled. Since different stakeholders have diverse concerns and priorities, emerging at different

phases of the lifecycle of adaptive reuse, it is hypothesized that engaging a broader range of stakeholders could result in a wider spectrum of challenges hampering heritage reuse. This novel knowledge could facilitate the adaptive reuse of cultural heritage by informing future practices, decision-makers, and policymakers on these challenges and how to tackle them in urban contexts similar to the one considered. Not only does the adaptive reuse of cultural heritage sustain a resource such as heritage over time, but it also contributes to the four tenets of sustainable urban development [24,26,27,33,52]. By facilitating adaptive reuse, therefore, the heritage potential for sustainable urban development and circular economy could be better leveraged [33].

2. Materials and Methods

An overview of the methodological framework applied is illustrated in Figure 1. The methodology is detailed below, and further insights are provided in Appendix A.

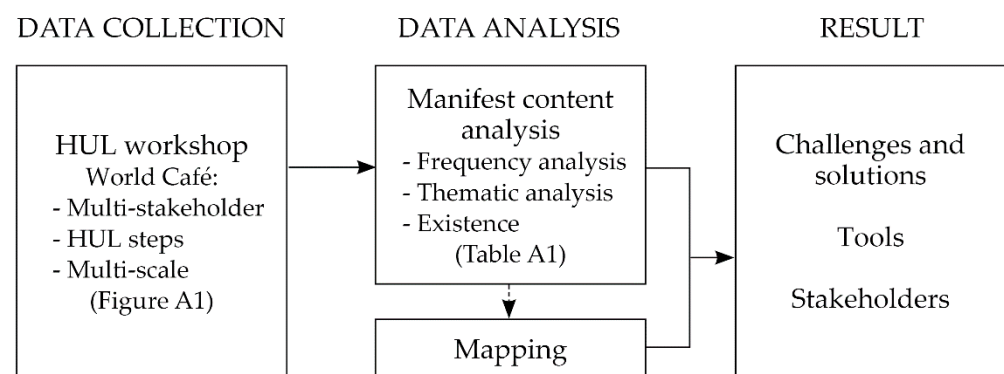


Figure 1. Overview of the methodological framework. Details are also provided in Appendix A.

2.1. Data Collection

This research collected primary data through a participatory stakeholder workshop “geared towards (. . .) conducting the research process with those people whose life-world and meaningful actions are under study” [53] (p. 2)—accounting for the participatory approach that cultural heritage now recommends [50]. This workshop was structured by adapting the World Café method [54–56] to have a broad overview of the issue investigated (Appendix A). Although this method was chosen because it is a participatory method to harvest information based on group intelligence, it also incentivizes participation by engaging stakeholders in mutual learning [53–56]. In various research domains, studies have adopted the World Café to collect qualitative data [56], e.g., to identify barriers, opportunities, and design requirements [57–60]. The identification of challenges and solutions took place as rounds of facilitated roundtable discussions (Figure A1). The question discussed within the World Café was about this identification, which was framed by the six steps (henceforth, HUL steps) of the approach implementing the UNESCO 2011 Recommendation on the Historic Urban Landscape (HUL) [61] and a multi-scale perspective.

The workshop used the HUL steps of the HUL approach [61]. These steps are employed in developing conservation and management processes at the local level [62]. Therefore, it was assumed that they could frame the analysis of conservation and management processes, such as the adaptive reuse of cultural heritage. This assumption justified the use of the HUL steps to frame the data collection. In fact, the steps (Table 1) were employed as an assessment framework of the adaptive reuse of cultural heritage to better contextualize the identification of challenges and their solutions in the broader heritage planning process [63], considering the various dimensions composing the urban landscape with an interdisciplinary perspective [64]. With this approach, the interdisciplinary nature of both adaptive reuse [24] and heritage [65] was acknowledged, and the various dimensions of cultural heritage and its context were considered.

Table 1. HUL steps used by the participants as a framework to identify challenges in cultural heritage adaptive reuse and their possible solutions.

Short Name	HUL Step Description ¹
Mapping	Mapping natural, cultural, and human resource
Consensus	Reaching consensus on what values and related attributes to protect
Vulnerability	Assessing the vulnerability of the identified values and related attributes to change and development
Integrate	Integrating values, related attributes, and their vulnerability in the urban development framework
Prioritize or Prioritization	Prioritizing actions for conservation and development
Partnership	Establishing local partnerships and management frameworks for each of the actions

¹ HUL step description adapted from [49–51].

This identification of challenges and solutions also investigated the impacts of measures and practices at multiple scales for the case study analyzed (The 100 Resilient Cities, referenced in [66]). It considered (i) Pakhuis de Zwijger as an example of site scale; (ii) the city of Amsterdam, the Netherlands, as urban scale; and (iii) “elsewhere” for other scales or contexts, e.g., the European level (Figure A1).

The building complex Pakhuis de Zwijger—managed by “Pakhuis de Zwijger Foundation,” a partner of the CLIC project—is a former warehouse of the Amsterdam waterfront, listed as cultural heritage, a target of adaptive reuse, and today a cultural and communal hub [67,68]. The warehouse was built in functionalist style in the 1934 by the architect De Bie Leuvelink Tjeenk and engineer Bakker [69]. When the dock activities ceased in the 70s, the warehouse remained vacant until it was squatted in and used for artistic activities [70]. In 1997, the municipality of Amsterdam assigned the building a cultural function. On that occasion, the foundation Pakhuis de Zwijger was created [71] (p. 124) to group the stakeholders and squatters for the continuation of their activities in a commercial way. The warehouse was in dilapidated conditions, and around 2000, it was threatened with demolition because it laid on the trajectory of a planned bridge [72]. Although Pakhuis was spared from the integral demolition due to the acquired status of national monument, some parts were torn down, allowing the passage of the bridge while further deteriorating its structural soundness. After several unfeasible or unaffordable plans, in 2004, the promoters and future tenants commissioned a reuse plan from the architect André Van Stigt, who involved Stadsherstel, an Amsterdam-based restoration company. A plan adapting the schedule to the building was proposed and the detailed layout was discussed with the future tenants. “Just a few changes (. . .) [were] made to its appearance. (. . .) On the other hand, the interior modifications were numerous and sometimes radical” [69] (pp. 14–15). Currently, the 5000-square-meter building hosts a 350-person auditorium, two smaller halls, studios, offices, and a café-restaurant [70]. The foundation Pakhuis de Zwijger is still the custodian of the former warehouse, and the owner is Stadsherstel [73]. The adaptive reuse of Pakhuis de Zwijger was a bottom-up process entailing strong stakeholder involvement, e.g., future tenants, in the initiation and design phase of the reuse [69]. In addition, this reuse integrated sustainable measures such as photovoltaic panels and embedded good practices of governance and operation models [73]. Furthermore, being operational since 2006, this case allows for reflection upon the whole lifecycle of adaptive reuse, from initiation to operation, instead of limiting the identification of challenges to some phases, as in earlier literature.

Pakhuis de Zwijger personifies the role that heritage and its reuse play in the growth of the city. According to the Municipality of Amsterdam, the goal is “to cherish our historical values, and ensure we maintain an attractive, diverse and sustainable city, in which historic buildings are not only iconic but also economically and socially relevant” [74]. Nevertheless, a “relatively traditional conceptualization of heritage is still more common in heritage

policy in Amsterdam” [75] (p. 115). This is also reflected in the lack of an explicit mention of heritage and its complex set of values in its policy documents on circular economy, even when the city of Amsterdam is one of the pioneers in the transition towards circular economy [76,77] and when adaptive reuse fully aligns with these aspirations [28].

The participants in the HUL workshop represented a broad range of stakeholders encountered in the adaptive reuse of cultural heritage. They were selected for their experience in cultural heritage, adaptive reuse, circular economy, and sustainability-related and (urban) development initiatives and institutions. They were familiar with the adaptive reuse of cultural heritage, the city of Amsterdam, and/or Pakhuis de Zwijger. The participants represented developers, representatives of the Municipality of Amsterdam, researchers, and NGOs, such as the foundation Pakhuis de Zwijger, which invited the participants. In total, 40 participants and 6 facilitators engaged in the roundtable discussion: 17 participants and 6 facilitators from academia and knowledge institutions from the Netherlands and Europe (50%), 10 from the public sector (22%), 7 from the private sector (15%), and 6 from NGOs and the third sector (13%). To avoid confusion, in the following sections, the term “participant(s)” is used to distinguish the stakeholders taking part in the workshop from when stakeholders would be mentioned in their contributions.

2.2. Data Analysis

2.2.1. Definitions

The definitions provided in Table 2 explain the key concepts for the data analysis and result reporting.

Table 2. Definition of key concepts used in the data analysis.

Key Concept	Definition	Reference
Factor	Identified element that affects the adaptive reuse of cultural heritage. Depending on the context, it entails a challenge or a solution. Used to collectively refer to challenges and solutions.	[37]
Challenge	Any factor negatively affecting the adaptive reuse of cultural heritage. It encompasses challenges, barriers, constraints, obstacles, or hurdles hampering the adaptive reuse of cultural heritage.	[78]
Solution	Any factor positively affecting the adaptive reuse of cultural heritage by overcoming a challenge.	-
Statement	Contribution identified neither as a challenge nor as a solution.	-
Theme	Topic shared among contributions identified by content analysis.	[79]

2.2.2. Data Preparation and Content Analysis

The collected data were transcribed in a digital form, cleaned [80], completed, and prepared for the content analysis, as detailed in Appendix A [81]. A manifest analysis of the corpus [82] was performed, employing both deductive and inductive coding (Table A1). For the factors, frequency and thematic synthesis were applied [79]. Coding for existence [81] guided the mapping of tools and stakeholders mentioned in the contributions. While performing the content analysis, the coding consistency was improved by clustering terminology denoting similar concepts, since participants sometimes used synonyms instead.

2.2.3. Mapping

The results of the thematic analysis of the factors were summarized using a graph mapping the challenge–solution relations among themes. This graph also related the themes to the HUL steps used for the data collection. To provide further insights, tools and stakeholders mentioned in the contributions were mapped. Tools were classified according to the tool categories of the HUL approach [51]. Stakeholders were classified using an adaptation of the Penta Helix taxonomy [83,84].

3. Results

3.1. Challenges, Solutions, and Statements

The dataset analyzed includes 353 contributions on factors or statements. This dataset is described in Figure 2 by the distribution of contributions per HUL step, type of contribution, and scale. Although factors and statements were collected per each HUL step, statements prevailed for the step of “integrate.” Most contributions of the participants did not refer to a specific scale ($n = 268$), and only a small number of contributions explicitly referred to the city of Amsterdam, where one specifically addressed the Pakhuis de Zwijger.

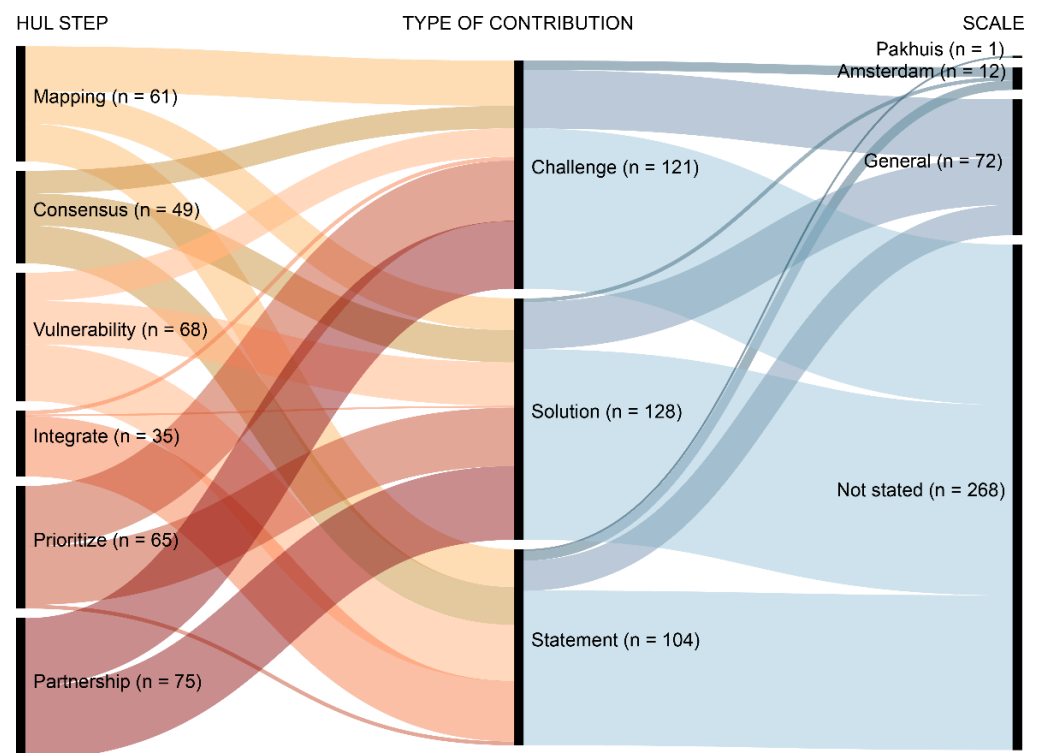


Figure 2. Parallel sets chart describing the dataset of collected contributions based on the HUL steps, the type of contribution, and the scale (created with rawgraphs.io).

3.2. Factors

From the contributions, 61 themes and 250 attributed codes were deduced. About half of the themes entail both challenges and solutions ($n = 29$), whereas 15 themes include contributions reporting only challenges and 17 only solutions. The results of this content analysis are illustrated in Figure 3 as a graph mapping the relationship among the themes—identified by coding the sample—and HUL steps.

While showing that certain themes, e.g., civic engagement, relates to various HUL steps, the graph also highlights the presence of relationships among themes. For example, several solutions suggest tools to solve challenges referring to civic engagement and communication issues. Similarly, opposition challenges could be addressed through strategies relating to “cultural heritage”—by providing evidence on the direct benefits of heritage reuse for the community, and to “approach”—by shifting from a narrative focused on a common past to one focused on a common future. In addition, “continuity” to the process of reuse could be ensured by providing “capacity” in terms of human resources. The graph, therefore, illustrates the presence of cross-relations among themes.

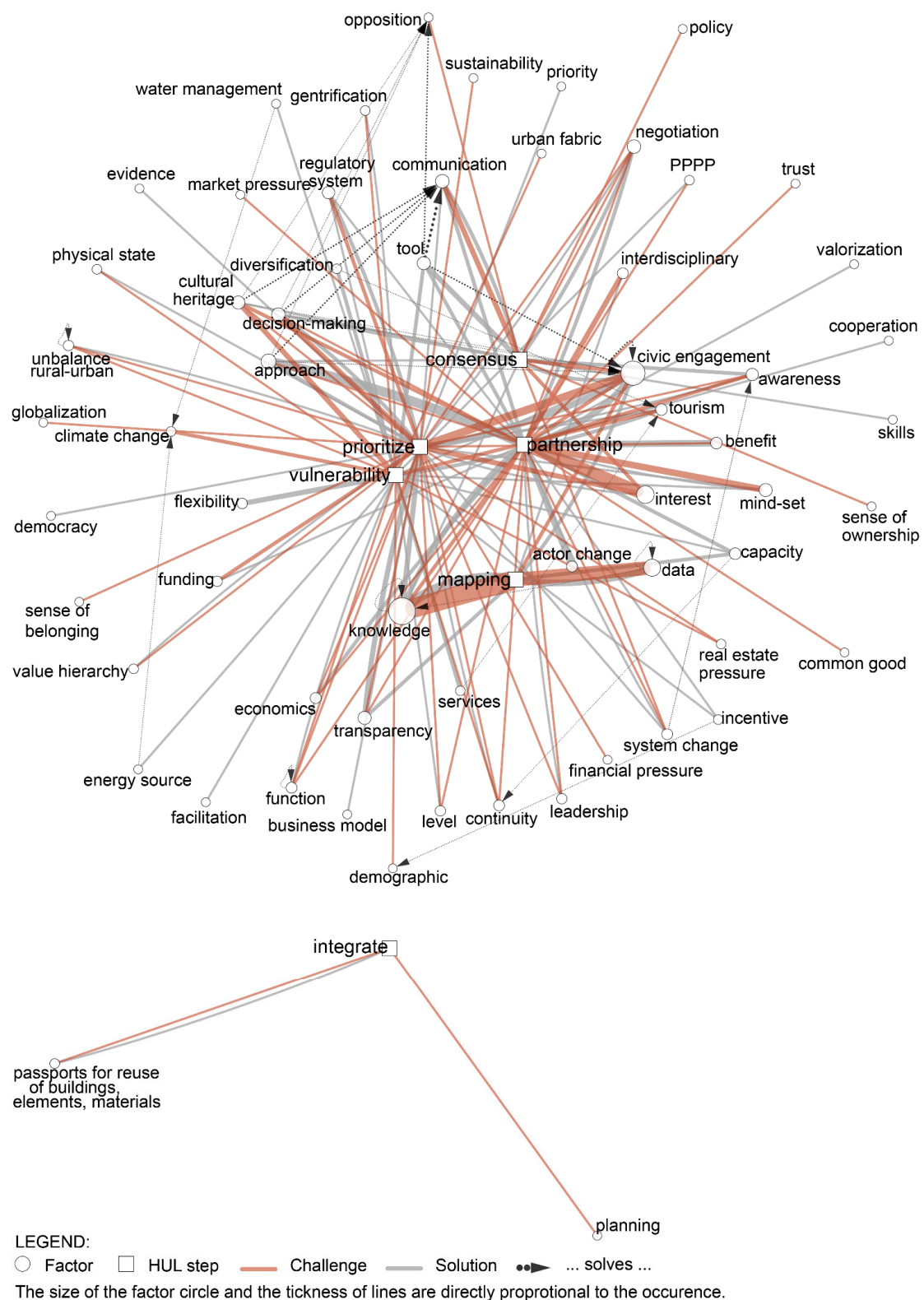


Figure 3. Graph mapping the relation among the themes and HUL steps (67 nodes, 140 edges, and 25 arcs). The graph is two-mode, non-simple, and multi-edge, with loops represented by a prefuse force-directed layout using the occurrence of contributions for each theme as the force. Nodes represent either themes or HUL steps. The edges tie themes and HUL steps and they can represent a challenge or a solution relation. In addition, some themes relate to each other by arcs, i.e., directed edges, connecting the theme of a solution (the arrow origin) with the theme of challenge tackled (the arrow target). Image created using Cytoscape v3.7.2. [85]. Figure S1 allows this graph to be explored using Cytoscape.

This graph counts two components since “integrate” entails themes unshared with any other HUL step (Figure 3). The component composed of most themes and HUL steps includes 17 themes that were mentioned in at least five (2%) contributions (Table 3). These themes are presented in detail in this manuscript. They refer to knowledge, civic engagement, interest, data, approach, communication, negotiation, decision-making, cultural heritage, tools, transparency, mindset, regulatory system, awareness, capacity, benefit, and tourism. To avoid repetition, the factors solely mentioning tools ($n = 7$) are presented in the section “tools,” which maps the tools drawn from all contributions independently from their type.

Table 3. Overview of the 17 most mentioned themes.

Theme	Number of Contributions	Definition		Example of Factor - for Challenges, + for Solutions
Knowledge	28	Understanding of and information about cultural heritage and adaptive reuse, and their context	-	Lack of knowledge
			+	Knowledge acquisition
Civic Engagement	24	Adoption and implementation of participation processes of all sorts of stakeholders	-	Lack of time and resources for participation
			+	Use of ICT platforms to involve citizens
Interest	14	Concern for the process of adaptive reuse resulting from the willingness of participation or benefits/advantages foreseen or derived from this process	-	Conflicting interest among actors
			+	Ensuring equity of roles among stakeholders
Data	13	Element collected to be used to inform a decision or a reasoning	-	Data lacking structure, comparability, and interoperability
			+	Interoperable and user-friendly platforms of open data
Decision-Making	8	Process of making decisions	-	Top-down decision-making
			+	Balancing top-down and bottom-up decision-making
Approach	10	Ways adopted to deal with and carry out the adaptive reuse of cultural heritage	-	Competition within a sector
			+	A future-oriented approach emphasizing the common future instead of the common past
Negotiation	8	Processes aiming at reaching some sort of consensus among parties	-	Lack of mediation
			+	External mediator/broker
Communication	8	Exchange of information among actors	-	Jargon, e.g., understanding “cultural heritage”
			+	Definitions and lay language
Cultural Heritage	7	Recognition or management of cultural heritage	-	Heritage not being a priority
			+	Providing evidence of the usefulness of cultural heritage
Mindset	7	Demands for a shift in mindset	-	Risk-adverse mentality, fearing the unknown
			+	Promoting flexibility by changing mentality through the third sector
Transparency	7	Clarity and access to information	-	The mismatch between the expectation and the outcome
			+	Enhancing transparency of processes and decision-making
Tools	7	Mention of a tool	+	Business improvement districts for partnerships

Table 3. Cont.

Theme	Number of Contributions	Definition		Example of Factor - for Challenges, + for Solutions
Awareness	6	Realization of a fact and concern about a situation	- +	Lack of awareness within the community ICT playing games to raise awareness
Regulatory System	6	Policy, frameworks, legislation, and regulations	- +	“Manipulation of the legal framework for the protection of heritage” Regulation to allow experimentation in solutions/processes
Benefit	5	Foreseeing and proving benefits derivable from the adaptive reuse of cultural heritage	- +	Lack of ability to foresee distribution of impacts Providing evidence of the potential benefits
Capacity	5	Capacity-building	+	Building capacity to create “heritage brokers”
Tourism	5	The system related to people visiting places	- +	Reuse of cultural heritage as a touristic attraction provokes a loss of uses intended for locals Conceiving of solutions working all year long and for both tourists and locals

Knowledge encompasses factors relating to the understanding of and information about cultural heritage and adaptive reuse, and their context. Challenges referring to knowledge primarily mention the lack of knowledge, and secondarily the access to knowledge. Consequently, the solutions predominately refer to knowledge production and dissemination in terms of tools and needed information. The majority of challenges under this theme are experienced concerning “mapping.” A challenge for the adaptive reuse of cultural heritage is identified in the lack of knowledge about both tangible and intangible attributes. At the tangible level, the absence of maps of vacant buildings is problematic for the city of Amsterdam and in general. At the intangible level, the lack of knowledge on “(. . .) values, perceptions, opinions,” and on social issues is challenging. An example of such social issues is the needs of some age groups, such as children. In addition, challenges relate to confidentiality and access to knowledge, the knowledge gap between civic society and experts, and the time-consuming practice of acquiring information. Furthermore, the adaptive reuse of cultural heritage is negatively affected by the lack of knowledge on opportunities and possible solutions to create partnerships for such processes. Over half of the proposed solutions relate to knowledge acquisitions, e.g., by “mapping knowledge of society” and building a knowledge base via roundtables, focus groups, perception data collections, and ICT tools. Knowledge production and dissemination could also be achieved by building/sharing knowledge on “good practices” and “interdependences,” as well as on best practices for prioritization and how this is done in other countries.

Civic engagement relates to the adoption and implementation of participation processes of all sort of stakeholders [51] concerned with the adaptive reuse of cultural heritage. This theme is the only one transversal to all HUL steps except for “integrate.” The challenges about civic engagement address a variety of aspects of participation in the adaptive reuse of cultural heritage. These challenges span from civic engagement being considered a barrier to development projects to the lack of time and resources for participation. The adaptive reuse of cultural heritage faces a challenge in politicians’ lack of acknowledging the value of these engagement practices. An additional barrier is encountered in identifying

and including stakeholders. Similarly, for the city of Amsterdam, a problem is the limited representativeness of the citizens willing to take part in the reuse of cultural heritage. The participating citizens are “only well-educated (. . .),” resulting in a “(. . .) low real engagement.” A further challenge is the lack of interaction between cultural heritage and “citizens,” which is also associated with their lack of involvement in mapping. Solutions mainly relate to providing tools and support for civic engagement. For instance, providing an ICT platform could enable citizen involvement in mapping. Analogously, digital platforms “(. . .) facilitate cooperation and empower the civil society.” Along with these digital tools, other solutions are based on participatory budgets dedicated to creating partnerships for heritage practices, “storytelling perceptive methods,” and participatory governance to reach consensus on actions and to prioritize for the adaptive reuse of cultural heritage.

Interest entails the concern for the process of adaptive reuse resulting in the willingness of participation, as well as the benefit or advantage foreseen or derived from this process. These factors are mainly associated with challenges as either lack of interest or conflicting and prevailing interests among actors. For example, these challenges are represented by clashing interests between the investors and the community/users, by diverging interest among actors, and by the “prevailing of external agendas.” Concerning the lack of interest, this affects some “(. . .) sectors of society,” limiting the creation of partnerships for the adaptive reuse of cultural heritage.

Data, per two-third challenges, focuses solely on “mapping.” These challenges address predominantly the management of collected data. For instance, challenges are data interoperability, organization, and lack of structure. In addition, the lack of comparability among datasets prevents their use and reuse. Further challenges encompass the fragmentation of data, e.g., maps, among owners or responsible people and the expense of “time and effort” demanded to merge such data. This has been identified as occurring at the local, national, and European level. Regarding data collection, the only challenge is presented by the attempt to perform such data collection using an integrated approach. Solutions mainly address the data management challenges by providing a framework for data acquisition and management, such as the adoption of a European standard for interoperability, and the use of open data platforms.

Approach means the ways adopted in dealing with and carrying on the adaptive reuse of cultural heritage. These factors are primarily solutions advocating for a change in strategies and perspectives towards a more collective and collaborative approach. The competitive attitude within a sector, the only challenge, hampers the creation of partnerships. Conversely, solutions entail sharing infrastructures, resources, and potential risks through partnerships. It is also suggested to favor placemaking, to provide guidelines for changing approaches, and to adopt a business model perspective also considering long-term investments and related returns. Moreover, a strategy to build consensus could adopt a future-oriented approach advocating for “a common future instead of a common past.” Other solutions propose the presentation of “(. . .) heritage as an opportunity” and the promotion of self-management, -organization, and -government.

Decision-making, evenly addressed as challenges and solutions, mainly relates to “prioritization.” This theme is mainly mentioned as top-down decision-making hampering the adaptive reuse of cultural heritage. Yet, other decision-making-related challenges are the municipalities prioritizing new developments over heritage reuse and decision-makers opting for simplified solutions to implementing sustainability instead of considering its complexity. To solve some of these challenges, a suggested strategy is to balance top-down and bottom-up decision-making and attempt to reach consensus also by performing multi-criteria decision analysis.

Negotiation broadly relates to processes aimed at reaching some sort of consensus among parties. Hence, this theme partially intertwines with decision-making and interest-related factors. Negotiation factors are slightly more associated with solutions, rather than challenges. The challenges refer to the lack of mediation for consensus and prioritization, as well as the lack of ways to reach agreements upon the allocation of limited resources

in partnerships. Conversely, solutions propose involving mediators. These mediators are alternatively presented as brokers creating connections and as facilitators of the dialogue among stakeholders. For example, the “conservation specialists (. . .)” could act as “(. . .) mediators or brokers for the investors.”

Communication entails the exchange of information among actors. These factors are slightly more associated with solutions than challenges. The challenges relate to a lack of common ground among actors: Jargon is the main communication challenge. These jargon issues are twofold: Some concepts, such as cultural heritage, are not understood by some actors and other concepts are understood differently, e.g., “value.” An additional challenge is posed by different communication systems such as languages. Solutions tackle the jargon issue, but also enhance the communication among actors and create narratives. Overcoming the communication challenges entails providing definitions and using plain language. For example, jargon can be avoided by formulating questions such as “what’s the most important thing for you in the city?”. Other solutions aim at enhancing the communication between decision-makers and the community by means of media coverage and creating new narratives.

Cultural heritage regards factors, mainly challenges, regarding the recognition of cultural heritage and its management. For example, cultural heritage is absent among the “(. . .) pressing issues.” Other challenges are the recognition of informal heritage and the existence of “heritage restrictions (. . .).” An additional challenge is a little differentiation among cultural heritage sites, which makes it difficult to decide which to conserve. However, cultural heritage is included in a solution that proposes providing evidence of the usefulness of cultural heritage as a resource and an asset.

Mindset demands a shift in mentality. The related factors are prevalently concerned with the creation of partnerships. On the one hand, the challenges are conflict-prone mindset, risk aversion, and skepticism. On the other hand, it is stated that the entrepreneurs’ mindset hinders the creation of partnerships for the adaptive reuse of cultural heritage. Hence, there is a need for “heritage entrepreneurs.” In other words, there is a lack of entrepreneurs understanding the characteristics of cultural heritage. Other solutions propose the development of a “theory of «complementary»,” of a mindset refusing corruption and lack of transparency and flexibility brought on by the third sector.

Transparency refers to ensuring and enhancing clarity and access to information during the adaptive reuse of cultural heritage. This theme largely entails solutions linked to “prioritization.” Particularly, challenges lay both in the mismatch between expectations and what is performed as engagement and in the lack of clarity about who makes decisions. Transparency and its enhancement are solutions per se and build trust among actors.

Awareness, as the realization of a fact and concern about a situation, and in particular the lack thereof, was recognized as a challenge for the city of Amsterdam and in general. For example, this lack of awareness concerns both cooperation and investment opportunities. Raising awareness is a solution devised to reach consensus by also involving “community experts.” In the city of Amsterdam, awareness is lacking among the “community” hurdling the prioritization, which can be addressed by raising it through ICT and playing games.

Regulatory systems, including “legislative and regulatory measures” [51], are mostly associated with solutions. However, challenges are present. In the city of Amsterdam, a need to reduce conflicting rules has been identified. General challenges entail the “vulnerabilities and manipulation of legal frameworks for the protection of heritage” and the impunity related to “prioritization” without further clarification. This barrier is solvable by providing preventive rules. Other solutions associated with legal frameworks are regulations that allow experimentation with “partnership” and multilevel regulations and legislation to address challenges.

Benefit entails the foreseen and the proving of benefits derivable from the adaptive reuse of cultural heritage. A challenge lays in the inability to foresee the distribution of benefits and impacts of reuse. Conversely, solutions for the creation of partnerships are

based on providing stakeholders with both the understanding of potential benefits and evidence of effective benefits derived by the adaptive reuse of cultural heritage.

Capacity-building is a solution to work with communities and archives and needs to be increased with professionals dealing with “vulnerabilities.” Capacity-building is suggested for creating new professions, such as the “broker” active in the context of cultural heritage and its adaptive reuse.

Tourism is slightly more associated with solutions. Yet, within the city of Amsterdam, tourism is a challenge due to the vulnerability of the urban fabric to its impacts. In general, tourism is also associated with challenges such as seasonality and depriving the locals of uses dedicated to them by reusing cultural heritage as a tourist attraction. Therefore, to overcome these challenges, solutions need to be conceived as inclusive solutions that work all year long for both tourists and locals.

Additional themes were also identified (Figure 3 and Table A2). Being less mentioned, these themes generally entail factors less detailed than the ones already presented. These factors range from the definition of the function to be attributed to cultural heritage by its adaptive reuse to the lack of or the need to foster interdisciplinary approaches. Other examples entail costs, funding, and alternative currencies, such as tokens using blockchain to share the renewable energy produced at Ceuvel in Amsterdam [86]. Additional factors address gentrification, public–private–people partnerships, and the need for system changes, e.g., heritage authorities assuming a proactive role during the planning phase. Furthermore, the adaptive reuse of cultural heritage is negatively affected by the lack of continuity at the political level. This challenge is the result of either political instability or a mismatch between the duration of political mandates and the timeframe to implement actions. This mismatch could be solvable by involving actors unrelated to political cycles in adaptive reuse.

3.3. Tools

Analyzing the contributions, 43 tools were identified. These tools were clustered based on the four tool categories introduced by the 2011 UNESCO Recommendation on the Historic Urban Landscape [51] (Table A1) and cross-referenced with the type of contribution mentioning them (Figure 4).

Firstly, slightly more than a third of the mentioned tools are regulatory ones. Both the knowledge and planning tools and the financial ones represent a fourth, and the remaining sixth refers to civic engagement tools. The tools belonging to multiple categories are roundtable, focus groups, and interviews; ICT platforms and tools; and participatory reformed policies. Secondly, 55% of these tools were associated with solutions, 10% with challenges, and the remaining with statements. Yet, material passports and regulations for materials were mentioned both in challenges and solutions. Thirdly, only the civic engagement tools are transversal to all HUL steps. Finally, concerning the city of Amsterdam, the tools reported as solutions are alternative currencies—specifically cryptocurrencies—and serious games, role-playing, and observation.

Among the tools associated with solutions, some tackle a specific challenge. Roundtables and focus groups allow the lacking knowledge of communities’ experiences to be mapped. As for ICT platforms, they solve the lack of citizens’ involvement in mapping and problems with the interoperability of data when associated with open data. Furthermore, a strategy using interviews, multi-criteria decision analysis, serious games, role-playing, and observation could address that (i) “cultural heritage” is not a term in the public domain, (ii) concepts such as value and benefit being differently understood by individuals, (iii) the public debate swinging because of public protests, (iv) and that politicians “are not convinced of the values of community engagement.” Turning to incentives, such tools were suggested to advert gentrification-induced person displacement.

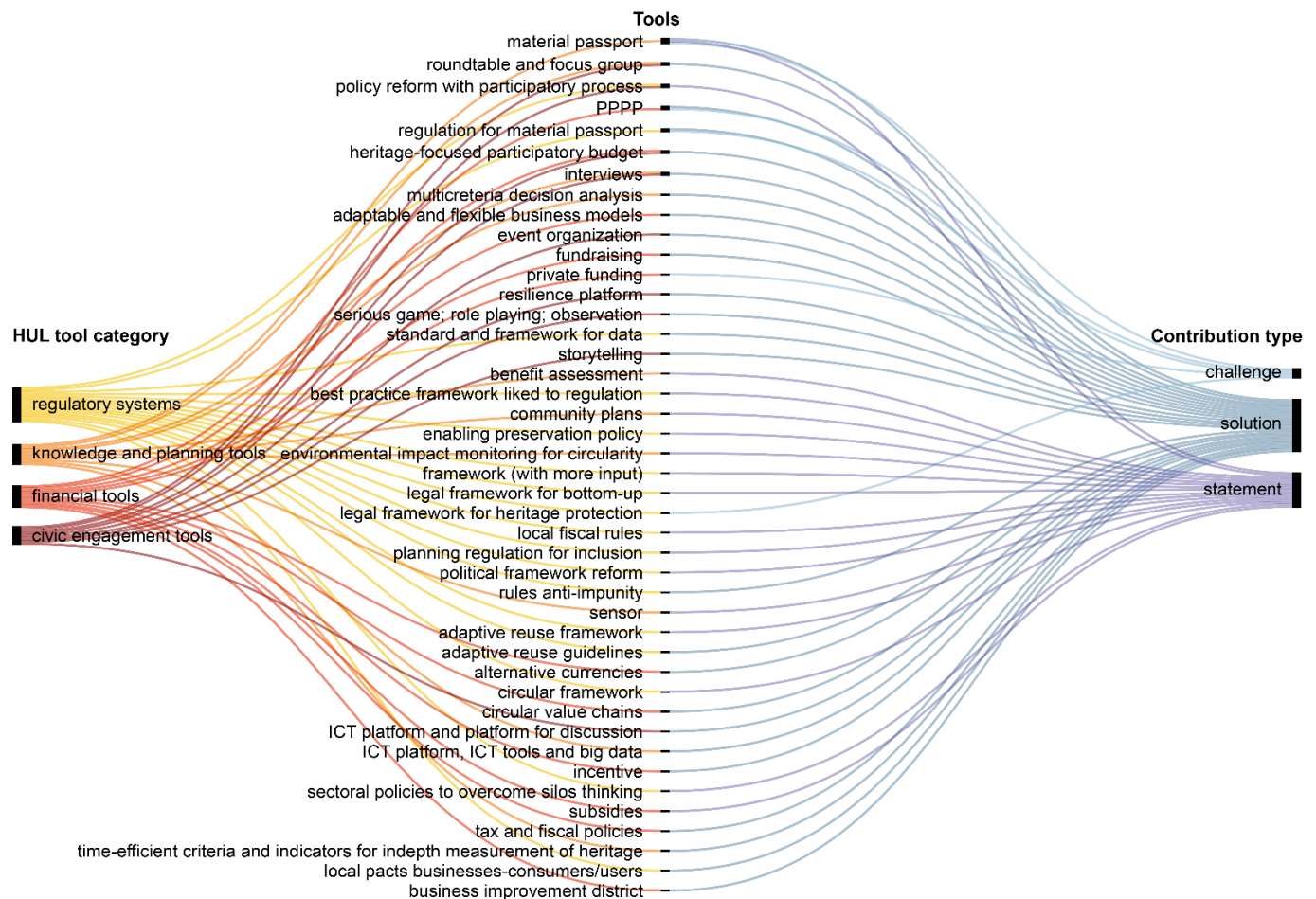


Figure 4. Parallel sets chart illustrating the tools identified in participants' contributions per HUL tool category and type of contribution (created with rawgraphs.io).

3.4. Stakeholders

Several stakeholders were mentioned in the contributions. They were classified based on an adapted Penta Helix taxonomy (Table A1) [83,84], as illustrated in Figure 5.

Concerning the public sector, these actors are associated with challenges in the case of politicians doubting the value of civic engagement, governments lacking the sense of responsibility to act for the adaptive reuse of cultural heritage, and a "municipality prioritizing new development over heritage." These stakeholders are associated with solutions as governments with a facilitating role and heritage authorities playing a "more proactive role" in planning the adaptive reuse of cultural heritage.

Among the private-sector stakeholders, a challenge is partnering with entrepreneurs when dealing with heritage reuse. Such a challenge is solvable by a new entrepreneurial figure: the "heritage entrepreneur" who is aware of heritage specificity, value, and potential. In addition, private actors encompass social housing corporations mentioned in a statement about gentrification. Solutions relating to private actors foresee collaboration with "young entrepreneurs," the use of local pacts "between businesses and consumers/users," and the involvement of professionals to decouple the implementation of adaptive reuse from the timeframe of political mandates. Particularly, these professionals would ensure continuity despite a possible change in the governing party.

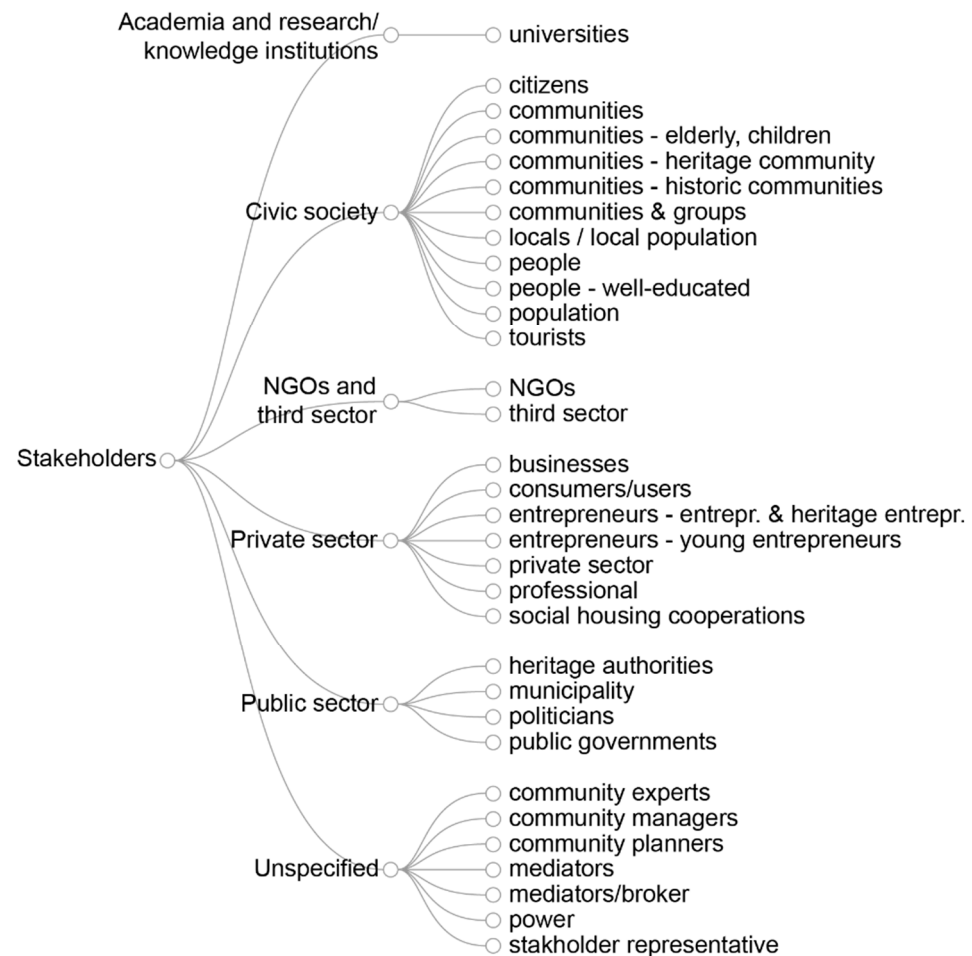


Figure 5. Dendrogram reporting the stakeholders identified in participants' contributions classified based on the Penta Helix taxonomy (created with rawgraphs.io).

As for civic society, overall, the challenges entail the lack of involvement of these stakeholders, their lack of awareness about cultural heritage, or the limited representativeness of participating stakeholders. A further challenge is the lack of knowledge of these stakeholders and their needs. In addition, a statement highlights the risk that tourists could potentially be the only beneficiary of the adaptive reuse of cultural heritage. Solutions mention the same actors listed for the challenges. The knowledge sector refers to universities as a solution advocating for collaboration with such institutions within the process of the adaptive reuse of cultural heritage.

NGOs could participate in the adaptive reuse of cultural heritage, ensuring the continuity of such processes over time. Furthermore, NGOs are presented as mediators between "public government and citizens" to reach consensus. As for the third sector, it appears in solutions as an introducer of a change of mentality and adaptability of plans. Finally, some stakeholders were not classified because they were identified by their role without further specification. These stakeholders, associated with solutions or statements, are the "community planner," the "community manager" to be involved in planning, the "external mediator broker," the "community expert," and the "representatives of stakeholders."

4. Discussion and Conclusions

This research set out to provide a broad overview of challenges and to identify solutions to address them. Tools and stakeholders mentioned were also mapped. This overview contributes to starting to build a baseline for the adaptive reuse of cultural heritage, which could later be of reference to the formulation of relevant policies and strategies and inform

the design and implementation of adaptive reuse. Evidence of the challenges and possible solutions is provided.

4.1. Factors

This research reports on the 17 most broadly identified themes and the related factors expanding the spectrum of challenges proposed by the literature (Table 3). The factors presented go beyond the concerns about design, technical aspects, and compliance with legal requirements [20,39,87]. Even “regulatory systems” expand on the challenges related to legal requirements. For instance, the manipulation of the legal framework was identified as a challenge, whereas in literature the emphasis is on compliance with regulations, such as fire safety [20]. However, the present study also identified some of the challenges commonly reported in the literature, although they were less frequently mentioned and/or more generally formulated.

This difference in findings is likely related to the broadened variety of stakeholders and the methodology, set according to the study aim: a multi-scale identification as broad as possible of challenges and solutions to the adaptive reuse of cultural heritage. The framework of the investigation, i.e., HUL steps, might have induced participants to focus less on design and technical aspects by adopting an integrated and holistic perspective. Therefore, other aspects of adaptive reuse were revealed, e.g., civic engagement, negotiation, and tourism.

Furthermore, this difference in themes might also reflect the evolution in the understanding of both cultural heritage [88,89] and adaptive reuse as well as the change in urban and heritage management approaches [90]. For instance, the potential of cultural heritage for sustainable development and circular economy is increasingly being acknowledged [50,91–93]. Similarly, the different thematic emphasis revealed by this research could be explained by the change in discourse in domains such as heritage and sustainable urban development [90,94]. For example, factors referring to civic engagement present increased discussion and articulation probably due to the rising interest in participatory practices in heritage management [95]. Additionally, a growing interest in the practicing of adaptive reuse might have triggered measures and spread coping strategies that made both design and technical aspects and legal requirements less regarded as challenges. Likely, these aspects were also mentioned to a limited extent because of the participants’ background: Few architects were presented, and no engineers joined the workshop. Finally, the practice of cultural heritage adaptive reuse embeds the changes occurring in the built environment, such as “new participatory design principles, new models for (public) investment, and new societal needs” [24] (p. 110), a dynamism that is reflected in the emergence of new challenges and solutions for adaptive reuse.

Moreover, reflecting the integrated, holistic, and multi-scale approach incorporated in the methodology, the results reveal the complexity of the adaptive reuse of cultural heritage and its interconnection with the urban ecosystem where it occurs. Therefore, this approach shifted the framework used to investigate adaptive reuse by expanding the focus from the building or site to also considering the urban scale. An example of such an interconnection and shift is the theme of tourism. In general, tourism can be a source of revenue to financially sustain the operative phase of reuse [26,96]. Nevertheless, the reuse of cultural heritage solely as a tourist attraction can deprive the locals of uses dedicated to them and could negatively impact urban livability. Furthermore, the city of Amsterdam is a popular touristic destination that is (perceived to be) facing over-tourism and where the negative impacts of tourism can outweigh the positive impacts [97–99], in pre-COVID-19 pandemic conditions when the study was performed. For instance, participants identified tourism as a threat to the urban fabric of the city and, therefore, its cultural heritage. Besides, a general challenge for the adaptive reuse of cultural heritage is posed by the seasonality of tourism [100]. Such an articulated problem could be addressed by proposing a program of adaptive reuse that considers both the tourists and locals, and that works all year long.

Hence, some challenges identified are not specific to the adaptive reuse of cultural heritage, but rather are common to heritage reuse and other phenomena such as tourism.

4.2. Tools

By listing the tools mentioned in the contributions, this study offers a toolkit to address some of the challenges encountered in the adaptive reuse of cultural heritage and highlights which tools are associated with challenges. Although some of these tools were already reported in the literature, in the present study, they sometimes appeared for different purposes. For example, to adverse negative gentrification induced by adaptive reuse, incentives schemes were identified to retain the population related to the cultural heritage, whereas they were mentioned as a driver for adaptive reuse in previous studies [87].

4.3. Stakeholders

An overview of stakeholders is provided. The civic society was identified with several different terms, e.g., “citizen,” “residents,” and “locals.” However, the analysis failed to reveal the difference between them. The results also suggest that NGOs and the third sector are gaining a role in the adaptive reuse of cultural heritage, as mediators or providers of continuity to this process. Yet, they were absent among the actors previously identified among the decision-makers for the adaptive reuse of cultural heritage [48]. In addition, the findings suggested that stakeholders are changing their roles: Local governments are becoming facilitators rather than decision-makers [48]. This facilitation role could be symptomatic, reflecting the strong (inter)national promotion and dissemination of participatory and bottom-up practices in heritage management [50,51,101].

Furthermore, the stakeholders mentioned in the contributions are varied and partially differ from the ones involved in the literature to identify challenges for adaptive reuse, suggesting that broadening up the variety of these identifiers better reflects the variety of actors involved in the adaptive reuse of cultural heritage. Specifically, the literature prevalently considered the perspective of architects and project managers [20,87,102] as well as owners [40,102,103], and to a lesser extent developers [27,103], local authorities [103,104], building managers [27], heritage consultants, inhabitants, or bankers, financial institutions, and investors [103]. Conversely, in the contributions analyzed, architects, project managers, developers, owners, and building managers were seldom referenced. Yet, these actors might be the ones generically indicated or mentioned by their role—for instance, the “professionals” who could decouple the implementation of adaptive reuse from the timeframe of political mandates. Possibly, the difference in stakeholders could also be explained by the shift from solely consider the building to also include a multi-scale approach in the roundtable discussion.

4.4. Limitations and Outlook

Almost 75% of the contributions lack an explicit indication of a scale likely because participants implicitly assumed it to be the city of Amsterdam and the adaptive reuse of cultural heritage in this context, i.e., the focus of the data collection. Yet, performing the manifest content analysis, this lack of indication drove us to assimilate these contributions to general ones. In this regard, future research could confirm the applicability of these factors to the urban or site scale, or both. Despite this limitation, this research offers some evidence of the challenges and possible solutions for heritage reuse in the city of Amsterdam. Besides, the general factor might apply to a wider context. For the case-specific factor, they are likely to be transferable to similar local contexts. Additional analyses should further detail and advance the understanding of such factors and their relationship with their context, the wider context—such as other regions—and transferability. Similarly, additional case study analysis is needed that considers more examples of adaptive reuse within the city of Amsterdam, and stakeholders to refine the overview provided in this research.

The solutions reported in the study were derived from the analysis of the participants' contributions during the HUL workshop. Therefore, these solutions have either already

been applied in other adaptive reuse practices, drawn from other domains, or proposed by the participants. To develop a full picture, future studies, such as case studies, will be needed to investigate these solutions, and their feasibility, applicability, and generalizability.

This study starts to create a baseline that needs to be further developed. The structure of the workshop allowed for a contextual validation of the results by the participants. However, repeating the study and engaging a higher number of stakeholders would allow the present results to be refined and their contextualization to the city of Amsterdam to be fostered. Particularly, some participants in the workshop were citizens representing other categories of stakeholders, hence, it is likely that the civic society perspective had limited representation. Because of this limitation and based on the results about civic engagement, future research is advised to investigate factors involving a broader representation of civic society. Furthermore, a bias might be present, despite the presence of facilitators in the roundtable discussion, due to the sample of participants, their personal bias and needs, and discussions sometimes steered by anchoring themes addressed at length by more vocal participants.

The present findings offer an overview of factor variety without attempting to explain these factors in depth. Some contributions were also ambiguous or statements. Furthermore, although enriching the factor identification, the participants' multidisciplinary and variety of background might have introduced uncertainty in the use of jargon and lay language. To account for these terminology and linguistic issues, (i) a peer debriefing of the explicit content analysis was conducted (Table A1), with the main author acting as a coder and a co-author as peer reviewer [105]; (ii) terms that were afferent to the same phenomenon or domain were clustered when developing the themes; and (iii) the participants' wording was often used in reporting the results to stay close to the content of the contributions [82]. Future research is advised to (i) deepen the understanding of the identified factors, unpacking and differentiating where the present study clustered; (ii) verify if the statements refer to challenges or solutions; and (iii) compare the present findings with the results of other European projects investigating the adaptive reuse of cultural heritage.

Concerning the tools and stakeholders revealed in the contributions, future research is needed since this study solely related them to challenges and solutions. Further investigation could explore the inclusion of these tools in the HUL toolkit, contributing to its localization in the city of Amsterdam—the context in which they were identified. Additional research could also elucidate the differences in stakeholders mentioned in the contributions and the one commonly involved in literature to identify challenges.

4.5. Conclusive Remarks

These findings have key implications for future practice, decision-making, and policy-making. Firstly, this investigation informs on the current state of the art of challenges both to future decision-making and policymaking related to the adaptive reuse of cultural heritage. Secondly, this research raises awareness of the challenges through an evidence-based empirical approach. Finally, besides knowledge and evidence, this study offers advocates and practitioners a set of solutions and tools that can address or be further developed to overcome such challenges. Therefore, the findings favor a transition towards a proactive approach in developing the adaptive reuse of cultural heritage. This facilitation could foster its diffusion, thus prolonging the lifespan of cultural heritage, integrating climate change adaptation, and raising awareness about adaptive reuse and its role in circular cities and sustainable urban environments. On the one hand, this diffusion could result in the inclusion of heritage and its reuse in visions of circular cities. On the other hand, this diffusion would contribute to the transition of human settlements towards circular economy and sustainable development, enhancing the livability of urban environments under the strain of climate change, urbanization, and related challenges.

Supplementary Materials: The following is available online at <https://www.mdpi.com/article/10.3390/su13105547/s1>, Figure S1: Graph mapping the relationships among the themes and HUL steps.

This file allows the graph depicted in Figure 3 to be explored using Cytoscape. Cytoscape is available at <https://cytoscape.org/download.html> (accessed on 11 May 2021).

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Appendix A.

The data collection was carried out in an HUL workshop—a workshop following the approach implementing the UNESCO 2011 Recommendation on the Historic Urban Landscape [51]—held in 2018 in the city of Amsterdam, the Netherlands. The HUL approach supports the integration of “policies and practices of conservation of the built environment into the wider goals of urban development in respect of the inherited values and traditions of different cultural contexts” [106]. This approach is holistic since it considers the various dimensions composing the landscape, and it is integrated because of its interdisciplinary perspective [64].

Appendix A.1. Data Collection

The HUL workshop was articulated in two parts: preparation and discussion (Figure A1). During the preparation, the participants in the workshop shared knowledge of the city of Amsterdam, Pakhuis de Zwijger, and current trends and initiatives regarding heritage, circular economy, sustainability, and adaptive reuse practices in the city.

The identification of challenges and solutions took place as six rounds of the facilitated roundtable discussion. During each round, participants grouped in multi-disciplinary teams identified challenges and solutions focusing on one of the HUL steps. Particularly, each roundtable discussion entailed an individual reflection, collective discussion, and a collective summary with validation of the contributions (Figure A1). The qualitative data collected include written notes on these contributions. This study solely analyzes the dataset including the contributions validated by consensus by the participants during the collective summary of the roundtable discussion (Figure A1). These contributions were agreed upon among participants and visible to all team members when written down by the facilitators.

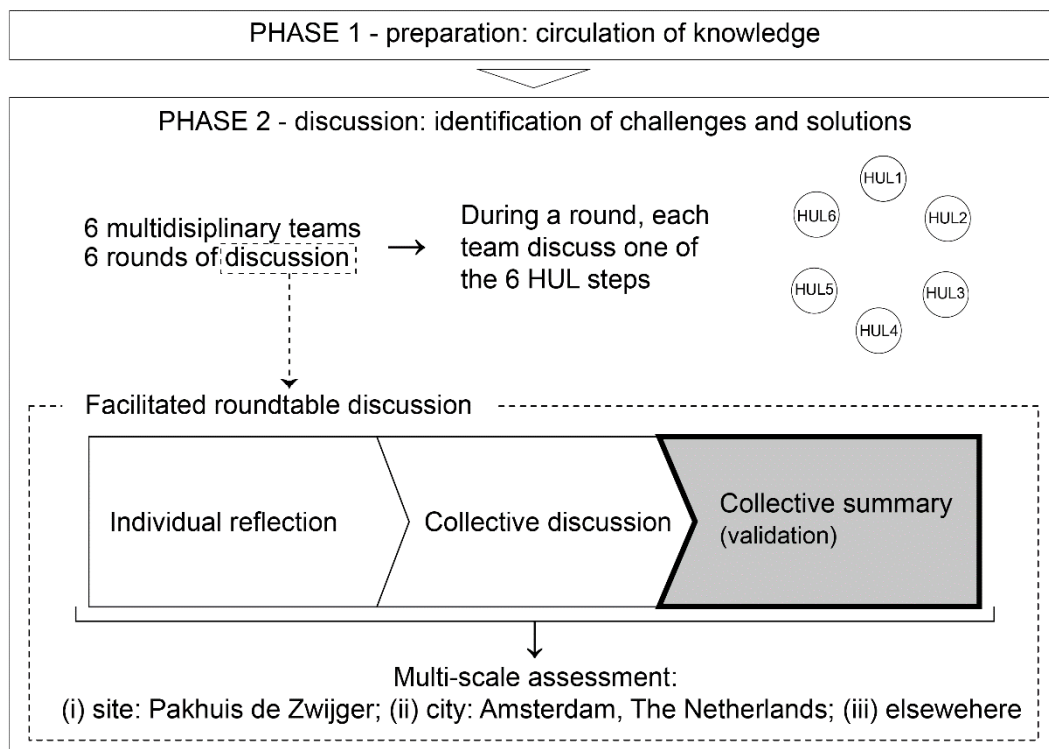


Figure A1. Scheme of the structure of the workshop and one round of roundtable discussion. The grey background highlights the data analyzed and reported in the present study.

Appendix A.2. Data Analysis

Appendix A.2.1. Data Preparation and Cleaning

The collected data were transcribed in a digital form, cleaned [80], and prepared for the content analysis. For instance, typos were removed, and spellings were homogenized. Furthermore, some contributions lacked information about either the scale or the type of contribution. This lacking information was completed when retrievable from unambiguously corresponding notes from the individual reflection and the collective discussion (Figure A1). Otherwise, this information was indicated as “not stated” in the transcription.

Appendix A.2.2. Coding

The content analysis was performed in two stages: Firstly, the participants categorized the contributions during the workshop by type of contribution, scale, and HUL steps. Secondly, the researcher analyzed the data during the desk work (Table A1).

Table A1. Content analysis: coding process and analysis techniques.

Time of Coding	Coders	Type of Coding	Variable Coded	Number of Codes	Type of Analysis	Sample of Contributions Coded
Workshop	Workshop structure	Deductive	HUL step	6 ¹		Individual reflection, collective discussion, collective summary
			Scale	3 ²		Individual reflection, collective discussion, collective summary
	Participants	Deductive	Type of contribution	2 ³		Individual reflection, collective discussion, collective summary

Table A1. Cont.

Time of Coding	Coders	Type of Coding	Variable Coded	Number of Codes	Type of Analysis	Sample of Contributions Coded
Desk work	Authors (1 coder, 1 peer reviewer ⁴)	Deductive	Scale	4 ²	Frequency [79]	Collective summary
			Type of contribution	3 ⁵	Frequency [79]	Collective summary
		Inductive	Factor	6 ⁷	Frequency and thematic synthesis [79]. Complexity mapping [107]	Collective summary indicated as challenges or solutions
		Deductive	Tool	4 ⁶	Existence [81]	Collective summary explicitly indicating a tool independently from the type of contribution
			Stakeholder	6 ⁷	Existence [81]	Collective summary explicitly indicating a stakeholder independently from the type of contribution

¹ Deductive codes: mapping, consensus, vulnerability, integrate, prioritize, partnership [61]. ² Deductive codes: Pakhuis de Zwijger, Amsterdam, elsewhere. ³ Deductive codes: challenge, solution. ⁴ To increase the validity of the content analysis, the main author acted as a coder and a co-author as peer reviewer [82,105,108]. ⁵ Added code “not stated” to the one used during the workshop. This code is used for contributions missing an indication for the variable and that were not completed based on participants’ contributions in Post-it and notepad notes. During the desk work, code labels used in the workshop were reviewed to align them with the content of the contributions. Thus, the label “elsewhere” was changed to “general” to better reflect the use the participants made of it. ⁶ Deductive codes: civic engagement tools, knowledge and planning tools, regulatory systems, financial tools [51]. ⁷ Deductive codes: public sector, private sector, civic society, knowledge sector, NGOs, and third sector [83,84].

Appendix B.

The complete overview of the results of the frequency and thematic synthesis for the factors are illustrated in Table A2.

Table A2. Overview of the frequency and thematic synthesis for the factors in alphabetical order.

Themes	Number of Contributions
actor change	4
approach	10
awareness	6
benefit	5
business model	1
capacity	5
civic engagement	24
climate change	2
common good	1
communication	8
continuity	4
cooperation	1
cultural heritage	7
data	13
decision-making	8
democracy	1
demographic	1
diversification	2
economics	4
energy source	1
evidence	1
facilitation	1
financial pressure	1
flexibility	3
function	4
funding	3
gentrification	2
globalization	1

Table A2. Cont.

Themes	Number of Contributions
incentive	2
interdisciplinary	4
interest	14
knowledge	28
leadership	3
level	3
market pressure	1
mentality	7
negotiation	8
passports for reuse of buildings, elements, materials	2
physical state	2
planning	1
policy	1
PPPP	2
priority	1
opposition	1
real estate pressure	2
regulatory system	6
sense of belonging	1
sense of ownership	1
services	2
skills	1
sustainability	1
system change	4
tool	7
tourism	5
transparency	7
trust	1
unbalance rural-urban	3
urban fabric	1
valorization	1
value hierarchy	2
water management	1
actor change	4

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