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Design of a Support Tool to Improve Accessibility in Heritage Buildings—Application in Case Study for Public Use

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Abstract: The existing literature shows the interest in the study of accessibility within heritage architecture, particularly in the context of repurposing these structures to extend their lifespan. Published examples primarily focus on barrier identification or intervention within specific buildings, without the development of methods that facilitate their widespread application for barrier removal. The proposed methodology entails the division of the building into analytical zones, the identification of existing barriers, the proposal of feasible solutions, and the establishment of various action plans based on the building's priorities. The results reveal a significant percentage of removable architectural barriers within the analysed buildings, all in harmony with the preservation of the heritage. Among the conclusions, it is noteworthy that the method's applicability extends to heritage and non-heritage buildings of varying uses and typologies, showcasing the substantial accessibility potential within heritage architecture.

Keywords: accessibility; person with disabilities; retrofit and refurbishment of existing buildings; building maintenance; health and wellbeing; cultural heritage

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1. Introduction

The requirements imposed by society on both new and refurbished buildings are becoming increasingly demanding. The discovery of new materials and the development of innovative devices enable higher levels of comfort and efficiency, which eventually evolve into legal requirements. In recent years, the focus on architectural rehabilitation has been particularly focused on aspects such as energy efficiency [1–5] and structural stability [6–9]. In relation to the first topic, studies such as the one conducted by D'Adamo et al. [5] demonstrate the cost-effectiveness of integrating renewable energy sources into existing public buildings. Concerning the second topic, researchers such as Unuk et al. [7] focus on exploring novel materials for structural reinforcement in existing buildings, typically necessitated by changes in their intended use. Additionally, some studies, such as Marini et al. [6], encompass both aspects, addressing renewable energy integration and structural reinforcement simultaneously. In these and other cases, the ultimate goal is to extend the lifespan of buildings. This goal aligns with the principles of sustainable finance, encompassing concepts such as the circular economy, aimed at preserving the value of goods and services over time and reducing the consumption of exhaustible natural resources [10]. This is especially pertinent in architectural renovation, considering the significant impact of new construction on natural resource consumption.

While these aspects are present in architectural rehabilitation, their study in heritage buildings is infrequent. As Jiang, Lucchi, and del Curto [11] argue, a detailed study in such cases is essential due to the visual impact or potential loss of historical fabric that an inadequate intervention may entail.

It is precisely from this endeavour to extend the lifespan that the need to provide users with access throughout their lives emerges, welcoming today's increasingly ageing population into this group. Furthermore, based on projections for the year 2050, it is expected that 15% of individuals with disabilities will be part of an approximate population of 6.25 billion people [12]. This poses a challenge that involves ensuring that public spaces are maximally accessible, regardless of the disabilities or specific needs of those who will make use of them.

Attaining this target demands proactive intervention within the built environment, which includes buildings and public spaces, to render them barrier-free and to achieve a state of flexibility and usability that caters equally to the needs of all users [13].

Achieving this requires a comprehensive understanding of the terms in which such actions should be developed. On the one hand, the term "disability" encompasses a wide array of vastly different personal circumstances. The World Health Organisation's International Classification of Functioning, Disability, and Health [14], grounded in a medical perspective, meticulously categorises bodily functions and structures, activities, and participation, as well as environmental factors that play a role in disability. Another classification, practical in its simplicity, is that of the DALCO criteria: Ambulation, Apprehension, Location, and Communication [15], which is geared towards the utilisation of a space or an object. Within the framework of DALCO, the spectrum of disabilities includes those of physical, sensory and cognitive. Moreover, each of these categories further contains an array of distinctly delineated subtypes.

On the other hand, accessibility, as defined in [16], holds the responsibility of ensuring that individuals with disabilities have access to all public spaces, facilitating their participation in societal activities and guaranteeing equal opportunities. Nowadays, the term "accessibility" is intricate. This complexity emerges from the evolution of accessibility models, leading to the present definition established by the International Classification of Functioning, Disability, and Health (ICF) [14,17–19], which has necessarily been broadening to encompass new groups and activities, ultimately evolving into a "universal" concept. According to the UNE 170001-1 standard [15], universal accessibility is the condition that environments, processes, goods, products, and services, as well as objects, instruments, tools, and devices, must meet to be understandable, usable, and functional for all individuals in conditions of safety and comfort, in the most autonomous and natural way possible.

After the literature review has been undertaken, it is possible to verify that, within the concept of accessibility, there are various perspectives, such as barrier-free design, design for all, universal design, and inclusive design [20–25]. Each of these perspectives has subtly different approaches but shares a common objective, which, according to Andrade and Bins Ely [26], is to frame this term comprehensively. This involves understanding the built physical environment not only in terms of material or structural aspects but also in relation to the perception of spaces and their uses. In an attempt to address accessibility holistically, four contexts are identified in the adaptation of public buildings: spatial orientation, communication, mobility, and use. Good spatial awareness empowers users to autonomously make decisions and act safely, which enables them to mitigate or even eradicate limitations on participation or activity constraints faced by individuals with disabilities or limitations by eliminating barriers or incorporating facilitating elements.

The interest in understanding the level of accessibility within these environments is evidenced by the wealth of scientific literature on this subject, which highlights its social relevance and the need for action. These studies encompass urban environments, which play a significant role in enhancing health and quality of life [27–35]. These studies reveal the lack of accessibility in urban public spaces, natural areas, or parks. The main highlighted issues are related to mobility. Jackson [30] asserts that these problems stem from the fact that the design of these spaces was based on disability models that did not advocate for equal opportunities. These works emphasise the need to enhance accessibility in the public environment, a crucial link in the accessibility chain for accessing and using the built environment. Another area of significant interest is acknowledged within the realm of residential architecture, highlighting the research conducted by Attakora-Amaniampong, Goodwin, Wellecke, Burns, Asante or Badreddine [36–41]. The results of these studies show that the majority of people with disabilities live in non-accessible homes, designed without considering their needs, and that they had to be modified [36,37].

Lastly, and being the subject of the present research, recent research that has been conducted in relation to public buildings is highlighted [42–51]. These investigations are approached through various typologies and uses, and are focused on university buildings [10,13,16,26,52–54], educational buildings [55,56], medical centres [57,58], primary care centres [59], or commercial buildings [60,61], as well as sports facilities [62–64]. Buildings designed for library use [65] or for artistic and cultural purposes [66] are less commonly studied.

A prominent group within public buildings comprises heritage buildings. Works such as those by Marín-Nicolás and Sáez-Pérez, Zahari et al., and Naniopoulos and Tsalis [67–76] exemplify this, representing only a few instances.

The legal and social requirements under which heritage buildings were constructed differ from the current standards. However, these buildings remain in use, either preserving their original function or replacing it with another. Consequently, the comfort, efficiency, or accessibility demands imposed on them are, a priori, the same as those expected in a newly constructed building. As a result, the need for intervention in existing buildings to adapt them to accessibility requirements becomes evident. This often entails significant modifications to the building. In the case of historic buildings, such transformation can lead to a conflict of interests with another legal and social demand, that of cultural heritage preservation. This differs from other contexts where the implementation of accessibility measures does not generate such a conflict.

There are different viewpoints regarding whether heritage buildings can or cannot be made accessible. It is common to assert that old buildings were not designed with accessibility in mind, and their adaptation is challenging or even impossible [72,73,77]. Other authors argue that the adaptation of these buildings for individuals with disabilities is feasible to varying degrees [71,75,77,78]. Garcés [79] classified heritage architecture into three major categories, civil, military, and religious, suggesting that only military architecture might be considered inherently inaccessible. Similarly, Monjó [80] proposed that the prevailing stance is to intervene in the building to maximise accessibility without jeopardising the preservation of the monument. In essence, the study of accessibility in heritage presents additional conditions, with the need for preservation being the primary difficulty.

On the other hand, it is common for heritage buildings to have undergone interventions to adapt them to new uses, to enhance their heritage aspects, or for maintenance purposes. However, the incorporation of accessibility is generally not addressed in these actions.

In this line of thought, Zahari and Kusnierz-Krupa [71,81] emphasise the challenge of adapting spaces with unique configurations that must meet the requirements of accessible construction parameters. Additionally, there are those who underscore the significance of preserving the architectural heritage within its cultural, artistic, and historical context. This association aligns the building's history with the optimal conditions for universal use [82]. These two arguments expose the existing conflict between the adaptation of buildings classified as heritage, which necessitates the preservation of their cultural and historical values, and the need for adjustments to facilitate access for users with disabilities. The resolution lies in recognising the inherent incompatibility of these criteria, which mandates the formulation of distinct and tailored proposals that do not fully resolve the ongoing debate. In the majority of the reviewed literature, studies primarily focusing on the detection and identification of barriers and the analysis of the current state stand out. This is achieved through the use of checklists [45] or user surveys [13,16,28,29,51,59,61,71,83–85].

These studies focus on the first step, gathering information about the state of accessibility. However, they do not include the possibility of proposing solutions to these barriers, making it imperative to create a method that incorporates barrier removal.

Focusing on the built environment, one of the main challenges identified in architectural rehabilitation is the specificity of architectural heritage. While in non-heritage construction, the incorporation, removal, or modification of elements poses no significant issue, in architectural heritage, both visual and material preservation are crucial concerns [86,87]. Examples such as the one presented by Tutal [72] demonstrate the feasibility of interventions in historic buildings, yet they remain specific cases, not applicable to a generalised methodology. The review of the existing literature shows the absence of studies that develop a specific methodology for proposing solutions to architectural barriers in heritage buildings.

The analytical tool proposed in this article pursues both methodological and practical goals. Based on all the aforementioned considerations, the aims of this study are the design of a support method for enhancing universal accessibility within built environments intended for public use, tailored to the specific circumstances and attributes of architectural heritage, and to verify the efficacy of this method through its application to a representative group of study cases.

The achievement of these objectives not only serves the needs of individuals with disabilities who frequent these buildings but also extends its advantages to those who encounter challenges in utilising built environments due to various circumstances, including older individuals and parents with baby strollers. Furthermore, these benefits also resonate with the employees and administrators responsible for these buildings.

The article is structured in accordance with the following sections: After the introduction, the "object of study" section presents a group of 45 buildings on which the developed method is applied. The "methodology" section outlines the process followed for the development of the method, which is divided into data collection, exploration of solutions, feasibility analysis, selection of viable solutions for each analysed building, and determination of action steps for each building in the selected group. In the "results" section, the obtained method and the data collected in its application to the group of selected buildings are presented. Finally, the "discussion" section compares the obtained results with the main studies from the literature review conducted in the introduction, and the "conclusion" section highlights the potential of the developed method to support the elimination of architectural barriers and promote equal opportunities and non-discriminatory use of buildings.

2. Object of Study

The group of selected buildings comprises 45 heritage buildings. The geographical context within which this research is framed is limited to the Region of Murcia (Spain). The selection procedure has been conducted among structures officially classified as Assets of Cultural Interest (BIC) in accordance with the current legislation [88]. Assets of Cultural Interest, from an architectural standpoint, refer to "real states [...] of exceptional cultural value". For the selection process, assets within the initial set that were in a state of ruin, unused, or designated for private housing have been excluded. The buildings have been carefully chosen to ensure representativeness in terms of heritage protection levels, building typology, original and current usage, as well as construction age. This comprehensive selection is not only representative of the geographical area under consideration but also mirrors the diversity found throughout the entire national territory. Furthermore, the characteristics of the analysed buildings closely align with those of heritage buildings in other countries in Western Europe [89].

All the buildings included in the selection currently have a public use; hence, their functional requirements are equivalent to those of any other public building. Out of the 45 buildings, 27 are designated for museum or exhibition use, 13 for religious or temple use, 5 for theatre or auditorium use, 5 for library or archive use, and 1 for administrative use. Furthermore, 6 buildings serve dual purposes simultaneously, 16 retain their original functions, 27 have undergone changes in use, and 2 integrate their original function with a new one. Regarding their antiquity, the group of selected buildings encompasses constructions from the 11th to the 20th centuries. The data of the 45 selected buildings are shown in Figure 1.

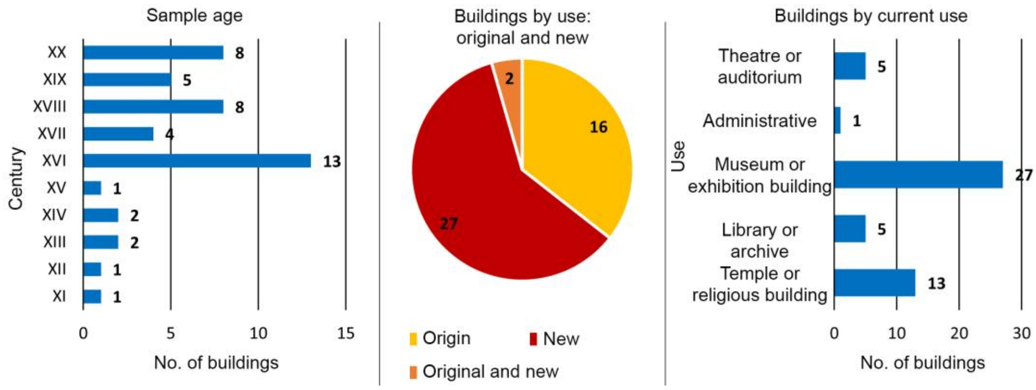

Figure 1. Data from the group of selected buildings. Left: distribution of buildings by age. Centre: proportion of buildings with original use, new use, or a combination of both. Right: distribution of buildings by current use.

Most buildings have been rehabilitated to accommodate their current public use, resulting in varying degrees of intervention; however, these actions have not completely addressed the issue of accessibility. In Figure 2, a selection of the studied buildings is shown.

Figure 2. Examples of public buildings analysed. (**1**): Cayitas Building (Alcantarilla, Murcia, Spain); (**2**): Vico Theatre (Jumilla, Murcia, Spain); (**3**): Aguirre Palace (Cartagena, Murcia, Spain); (**4**): Piñón Building (La Unión, Murcia, Spain); (**5**): Calahorra Tower (Aledo, Murcia, Spain); (**6**): Inmaculada Concepción Church (Cehegín, Murcia, Spain).

3. Materials and Methods

The methodological process developed in this study is structured into six stages: data collection, intervention study, feasibility analysis, selection of viable solutions, expert consultation, and determination of action lines. The first stage provides the necessary information for the work. Stages 2 and 3 encompass the development of a support method aimed at enhancing universal accessibility. Stages 4, 5, and 6 involve the application of the method to a group of 45 buildings with varying use, age, typology, and location in order to assess their functioning. The methodological process is schematically illustrated in Figure 3.

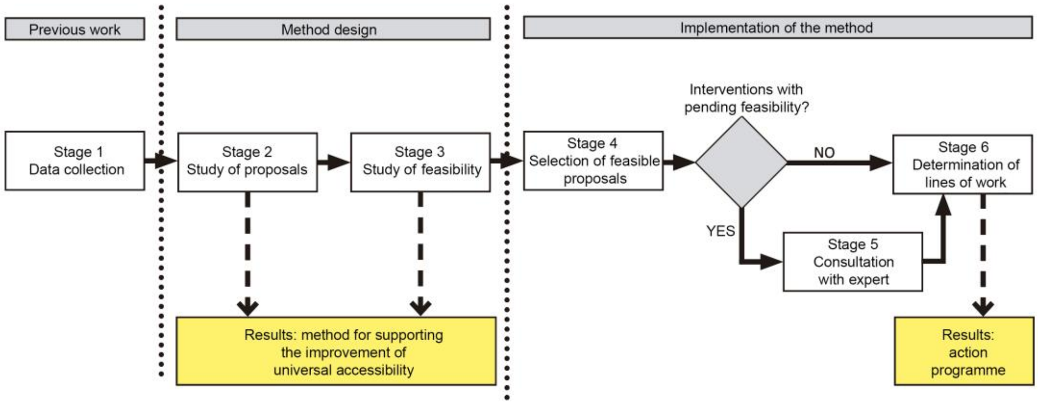

Figure 3. Methodological process of the study.

3.1. Stage 1: Data Collection

Prior to the design and application of the method to support the improvement of accessibility, the necessary data were collected and grouped into the following data blocks:

- List of architectural barriers: Based on the joint study of the DALCO requirements for universal accessibility and state and regional legislation concerning accessibility, a total of 238 architectural barriers have been identified. These barriers encompass all the accessibility requirements outlined in the analysed legislation for public building construction. These barriers are divided across 20 analysis zones [15,67]. These analysis zones result from establishing isolable areas or construction elements within a building for intervention. The distribution of any building can be described using these analysis zones, regardless of whether it is a heritage or contemporary building. Each barrier may have an impact on one or multiple types of disabilities; hence, these data are also stored. In Table 1, the breakdown of barrier distribution across analysis zones is provided.
- Determinants of technical and constructive feasibility: There are conditions within the built environment that can either enable or hinder an intervention, as well as necessitate specific characteristics (available space, load-bearing capacity, etc.). This study encompasses the following aspects:
- Technical feasibility: requirements for the intervention to be executed.
- Heritage feasibility: whether the intervention may impact heritage aspects of the building.
- Economic feasibility: the cost of executing the intervention.
- Affected groups: based on the disparity of terms used and the disabilities considered in the extensive existing literature [28–30,40,50,70,72–74], five major groups of persons with disabilities are delineated: wheelchair users, cane, crutch, or walker users, individuals with visual impairments, individuals with hearing impairments, and individuals with cognitive disabilities.
- Building information: Through a prior accessibility audit, both the existing barriers and the built environment information that could compromise any of the defined feasibilities were documented. Owing to the distinctive nature of heritage structures, the compilation of building documentation encompasses a multifaceted approach, encompassing elements such as a thorough bibliographic investigation, meticulous scrutiny of historical archives, and comprehensive interviews with facility administrators.

Table 1. Analysis zones considered and number of barriers assigned to each one.

Analysis Zone	Code	Barriers
Parking space	AP	7
Access	AC	5
Door	PU	17
Horizontal circulation	CI	12
Flooring	PV	6
Unevenness	DE	6
Information point	PA	8
Staircase	ES	26
Ramp	RA	23
Lift	AS	24
Escalator	EM	8
Moving walkway	TR	7
Step lift platform	PEV	12
Stair lift platform	PEI	6
Auditorium space	EA	10
Furniture	MO	8
Mechanisms	ME	3
Wc	WC	29
Signs	SE	12
Musealisation	MU	9

3.2. Stage 2: Intervention Study

Building upon the list of 238 potential architectural barriers compiled in Stage 1, a range of solutions is established. These solutions involve either the removal of the barrier or the incorporation of a facilitator, ensuring that the barrier does not adversely impact users. In accordance with the guidance provided by English Heritage regarding the UK Equality Act [90], the way to remove an architectural barrier can be framed within one of the following approaches:

1. Remove the feature that constitutes a barrier.
2. Modify the feature that represents a barrier.
3. Provide an alternative to the element that constitutes a barrier.
4. Offer the service in a different manner.

Table 2 displays, by way of example, the proposed actions established for the resolution of a detected barrier.

Table 2. Example of proposed actions established for the resolution of a detected barrier.

	Analysis Zone	Code	Description
Barrier	Door	PU02	Door with insufficient height (<2.00 m).
Proposed actions	Door	PU-I01	Replacement with an accessible door.
	Door	PU-I02	Signposting of alternative route.
	Door	PU-I23	Signage and lintel protection.

3.3. Stage 3: Feasibility Analysis

The potential feasibility of each action is analysed in relation to the known determinants and technical information. Given its relevance, this section focuses on the technical and heritage feasibility.

- Technical feasibility is linked to the technical, material, or physical aspects that determine whether an intervention can be carried out. For example, the presence or absence of sufficient space to construct a ramp that eliminates a step. Each intervention is classified as “assured” whenever it is feasible and its execution does not present any technical or heritage-related issues. Conversely, an intervention is labelled as

"pending" if the feasibility of its execution is not guaranteed, in which case the relevant conditions are specified.
- Heritage feasibility is directed towards the potential adverse impact on the heritage aspects of the building. Each action is classified as "assured" if it is consistently feasible or as "pending" if it could affect the building, both in material and aesthetic terms.

Regarding the aspects of "affected groups" and "economic feasibility", the groups for which the barrier is solved and the estimated cost of its implementation are indicated, respectively, as aspects that will be implemented in Stage 6. Table 3 presents, as an example, the analysis of the heritage and technical feasibility of the actions for the resolution of the barrier outlined in the previous stage.

Table 3. Technical and heritage feasibility of the proposals set out for barrier PU02 (door of insufficient height).

Analysis Zone	Barrier	Proposals	Heritage Feasibility	Technical Feasibility
Door	PU02	PU-I01	Pending	Assured
		PU-I02	Assured	Pending
		PU-I23	Assured	Assured

3.4. Stage 4: Selection of Viable Solutions

Stage 4 is carried out for each of the 45 selected buildings. For each detected barrier within the analysed building, viable solutions are established based on the list of interventions developed in the preceding stage. Among these solutions, the most suitable one is selected from those presenting "assured" technical and heritage feasibility. If there are one or several barriers with "pending" feasibility, the process proceeds to Stage 5. Conversely, if no such barriers are present, advancement to Stage 6 occurs.

In the example posed in the preceding stages (Barrier PU02: insufficient door height clearance), the solution PU-I23 offers assured technical and heritage feasibility. Consequently, at this stage, this solution would be selected.

3.5. Stage 5: Expert Consultation

The presence of barriers with "pending" technical or heritage feasibility selected implies that the method does not guarantee their applicability to the studied building. In such cases, a specialised expert technician is consulted to conduct a specific analysis of each barrier with "pending" feasibility. This technician assesses whether the intervention is ultimately feasible or not for the specific case. If there are multiple viable solutions, the technician would select the most appropriate one based on economic criteria or other relevant factors.

3.6. Stage 6: Determination of Action Lines

Once the technical and heritage feasibility are analysed in Stages 3, 4 and 5, Stage 6 involves the selection of the course of action based on economic, social (beneficiary groups), or functional (interventions by zones to keep the building in use) criteria. The potential action lines include:

- No intervention in the building.
- Complete intervention in the building, removing all barriers.
- Partial intervention in the building, based on criteria such as:
    a. By floors, zones, pavilions, etc.
    b. By beneficiary groups (for instance, removing in a single stage all barriers that affect individuals with visual impairments).
    c. By monetary amount (grouping interventions into stages that adjust to a specific budget).

The solutions selected based on the line of work constitute the action programme, which encompasses the interventions to be executed, timelines or estimated costs, and the accessibility enhancements they entail, among other factors.

4. Results

The results of this study include two aspects: the developed method and its application to the selected buildings.

4.1. Study of Solutions

The starting point of the study is the 238 potential barriers considered according to the regulations for any publicly accessible building. Out of these, 140 pertain to individuals with reduced mobility who use wheelchairs, 146 to individuals with ambulatory mobility limitations, 117 to individuals with visual impairments, 23 to individuals with auditory impairments, and 60 to individuals with cognitive impairments.

In response to the potential barriers, 246 possible solutions have been devised. These solutions facilitate the removal of accessibility barriers. The solutions exclusively address accessibility concerns, without considering other criteria. Their design is carried out using one of the approaches proposed in line with English Heritage [90]: elimination of the feature, alteration of the feature, provision of an alternative, or modification of the service delivery. For each barrier, one or more alternative solutions have been proposed, and some solutions are applicable to more than one barrier. In case there are two or more possible solutions for a barrier, the choice is made at Stage 6. In Table 4, the number of detectable barriers in each analysis zone, the proposed solutions, and their classification according to the aforementioned approaches are shown.

Table 4. Number of detectable barriers in each analysis zone, the proposed solutions, and their classification according to the aforementioned approaches.

Analysis Zone	No. of Possible Barriers	Total Barriers Detected in the Group of Selected Buildings	No. of Total Proposals	No. of Proposals Approach 1	No. of Proposals Approach 2	No. of Proposals Approach 3	No. of Proposals Approach 4
AP	7	7	7	0	6	0	1
AC	5	276	10	4	3	2	1
PU	17	2108	23	4	17	2	0
CI	12	1998	21	5	7	10	0
PV	6	548	10	3	6	1	0
DE	6	314	6	2	4	0	0
PA	8	157	8	3	4	1	0
ES	26	2314	20	3	16	1	0
RA	23	564	13	0	12	1	0
AS	24	217	19	3	15	1	0
EM	8	0	7	1	5	1	0
TR	7	0	8	1	6	1	0
PEV	12	6	9	2	6	1	0
PEI	6	17	7	1	5	1	0
EA	10	654	11	4	7	0	0
MO	8	964	6	0	5	1	0
ME	3	322	3	0	3	0	0
WC	29	517	36	4	32	0	0
SE	12	2118	9	1	6	2	0
MU	9	1211	11	0	11	0	0
Others	0	-	2	0	1	0	1
Total	238	14312	246	41	177	26	3

Out of the 246 proposals, 41 (17%) correspond to the first approach, feature elimination. The majority, 177 proposals (72%), align with the second approach, feature alteration. The third approach (provision of an alternative) encompasses 26 proposals (10%), and 3 proposals (1%) belong to the fourth approach (modification of the service delivery). The order of the approaches is from greater to lesser degree of permanence in barrier removal.

Each proposed solution is technically defined, encompassing its requirements, approximate cost, and the groups for which it resolves the barrier. As a premise, it has been established that no intervention should lead to the creation of a new barrier for another group. Each proposal can address one or multiple barriers. Figure 4 serves as an illustrative example of a proposed solution sheet.

PU-I01	**Replacement by accessible door**
Replacement of existing door with another one with the following conditions: – Width ≥ 0.80m wide and height ≥ 2m, with a single door (or total opening for automatic door). – Chromatically contrasted with the wall. – Diameter of manoeuvre ≥ 1.20m on both sides, outside the door sweeping area. – Operators separated from the door ≥ 40 mm, usable with one hand and non-rotating or automatic, contrasted with the door and located at a height of 0.80–1.20 m and ≥ 0.30 m from the corner. – Necessary opening force ≤ 25N (65N if fire resistant). – If automatic, closing time ≥ 5 s, remains open in case of failure and its sensor detects walking sticks and assistance dogs. – If it is swinging, it has transparent or translucent parts at a height of 0.70–1.50m. – If it is sliding, distance between door and corner ≥ 20 cm. – If it has latch, it is ergonomic (lever, pin or pressure, but no turning) and can be unlocked from the outside. – If it is made of glass, it has contrasting strip between 0.85–1.10 m and 1.50–1.70 m or the distance between mullions ≤ 60 cm.	
Estimated budget: 250.23€/unit.	

Figure 4. Example of a proposal and information on its characteristics.

4.2. Feasibility Analysis

The 246 proposed solutions have been examined based on their technical and heritage feasibility. Each intervention falls into one of the following four scenarios, depending on the combination of the previous cases:

- The intervention possesses both guaranteed technical and heritage feasibility.
- The intervention secures heritage feasibility but lacks assured technical feasibility.
- The intervention guarantees technical feasibility, while heritage feasibility is uncertain.
- The intervention lacks assured technical and heritage feasibility.

Solutions found within the first scenario allow their selection in any situation, whereas those positioned within the remaining scenarios require the study of the specific case by a competent technician. Interventions are prioritised for each barrier in accordance with the aforementioned sequence, ensuring that the primary option for each barrier is consistently a technically and heritage viable intervention. The count of proposed interventions situated within each state, across analysis zones, is shown in Table 5. Figure 5 depicts the overall count of proposed interventions within each scenario, differentiating between "assured" and "pending" feasibility. Pending feasibility actions, categorised by reason (technical, heritage, or both) are itemed in Table 6.

Table 5. Interventions proposed by analysis zone and distribution according to their feasibility.

Analysis Zone	Number of Possible Barriers	Number of Total Proposals	Number of Total Proposals with Assured Feasibility	Number of Total Proposals with Pending Feasibility
AP	7	7	6	1
AC	5	10	6	4
PU	17	23	10	13
CI	12	21	8	13
PV	6	10	5	5
DE	6	6	2	4
PA	8	8	4	4
ES	26	20	5	15
RA	23	13	3	10
AS	24	19	13	6
EM	8	7	3	4
TR	7	8	3	5
PEV	12	9	5	4
PEI	6	7	3	4
EA	10	11	6	5
MO	8	6	4	2
ME	3	3	1	2
WC	29	36	28	8
SE	12	9	7	2
MU	9	11	6	5
Others	0	2	1	1
Total	238	246	129	117

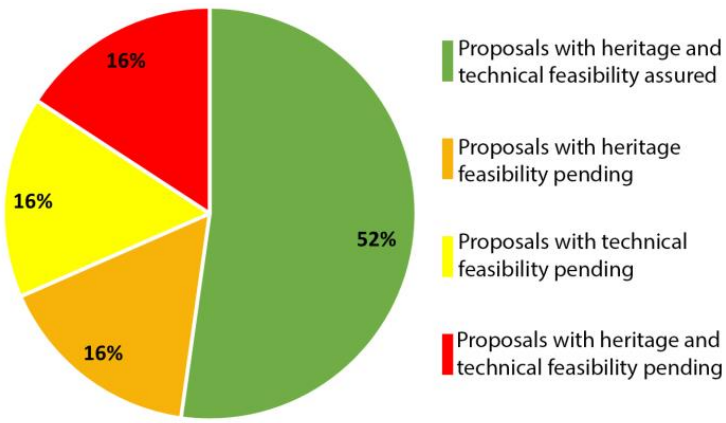

Figure 5. Percentage of interventions proposed in each of the cases and their distribution between assured and pending feasibility.

Technical and heritage feasibility are guaranteed in 52% of cases, while the remaining 48% lack guaranteed technical and/or heritage feasibility. Across the different analysis zones, a significant proportion exhibits percentages ranging from 40% to 60% of interventions that maintain consistent feasibility. Domains that deviate from this range by default include doors (35%), unevenness (33%), stairs (25%), ramps (23%), moving walkways (38%), and mechanisms (33%). In the cases of doors, stairs, and ramps, a significant proportion of barriers present heritage-related constraints, while for moving walkways, potential technical challenges emerge. As for unevenness and mechanisms, the low percentage is attributed to the limited number of proposed actions, resulting in inconclusive data.

Table 6. Proposed interventions with pending feasibility distributed by reason.

Analysis Zone	No. of Total Proposals with Pending Feasibility	Distribution of Proposals with Pending Feasibility by Reason		
		Heritage Feasibility	Technical Feasibility	Both
AP	7	0	1	0
AC	10	0	4	0
PU	23	9	1	3
CI	21	3	2	8
PV	10	1	4	0
DE	6	2	1	1
PA	8	0	4	0
ES	20	2	5	8
RA	13	2	5	3
AS	19	3	1	2
EM	7	4	0	0
TR	8	4	0	1
PEV	9	3	0	1
PEI	7	3	0	1
EA	11	4	0	1
MO	6	0	0	2
ME	3	0	1	1
WC	36	5	0	3
SE	9	0	1	1
MU	11	0	3	2
Others	2	0	0	1
Total	246	45	33	39

Regarding the impacted groups for each solution, each proposal eliminates barriers for the affected groups therein. Given this parallelism, the groups with the highest count of proposed interventions align with those encountering a higher number of architectural barriers. These groups are individuals with reduced mobility, including cane (169) and wheelchair users (171), followed by individuals with visual impairments (133). This stands in contrast to the measures proposed for individuals with cognitive (85) or auditory disabilities (34). Figure 6 depicts the total potential barriers and proposed solutions, categorised by the group for which a barrier is removed.

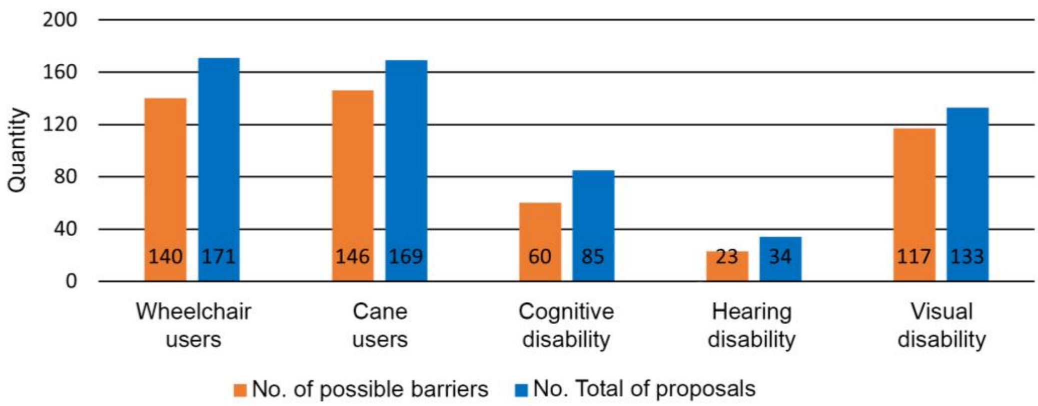

Figure 6. Number of possible and proposed barriers by groups of people with disabilities.

4.3. Selection of Viable Solutions

The intervention support tool has been applied to the 45 selected buildings. The analysis results are summarised in Table 7. All the buildings display a percentage of removable barriers exceeding 75%.

Table 7. Existing, removable, and non-removable barriers per building analysed.

Type of Usage	Building (Ref. No.)	Existing Barriers	Removable Barriers (%)	Non-Removable Barriers (%)
Theatre or auditorium	15	626	88	12
	23	911	99	1
	26	722	92	8
	37	1406	89	11
	44	249	94	6
Administrative	42	284	96	4
Museum or exhibition building	2	397	89	11
	6	132	93	7
	7	150	93	7
	8	244	91	9
	9	157	87	13
	10	153	93	7
	11	278	95	5
	12	256	95	5
	13	177	89	11
	14	336	86	14
	15	626	88	12
	19	360	84	16
	21	94	90	10
	22	243	85	15
	24	202	89	11
	25	312	91	9
	27	85	85	15
	29	266	78	22
	31	307	99	1
	32	254	93	7
	34	540	98	2
	35	196	92	8
	36	471	89	11
	38	414	97	3
	40	456	86	14
	42	284	96	4
	43	90	100	0
Library or archive	4	144	94	6
	9	157	87	13
	20	211	99	1
	31	307	99	1
	39	157	89	11
Temple or religious building	1	220	93	7
	3	205	82	18
	5	311	86	14
	16	512	97	3
	17	178	96	4
	18	245	91	9
	28	287	92	8
	30	266	88	12
	33	362	98	2
	36	471	89	11
	40	456	86	14
	41	90	94	6
	45	388	86	14

After analysing the feasibility of barrier removal based on the considered group, the results are depicted in Table 8. Noticeable values of removable barriers exceeding 75% are observed across nearly all buildings for all groups. Among these, the group of individuals with auditory disabilities stands out, with all analysed buildings exhibiting a 100% percentage of removable barriers. On the other end, groups with lower percentages include those with physical disabilities, including both wheelchair and cane users. These groups display several instances of removable barriers below 80% and exhibit the lowest average when compared to other groups. The average has been calculated by dividing the sum of the values by the number of values.

Table 8. Removable barriers by the building analysed and group considered.

Building (Ref. No.)	Removable Barriers (%)				
	Wheelchair Users	Cane Users	Visual Disability	Hearing Disability	Cognitive Disability
1	91	90	94	100	98
2	82	80	93	100	89
3	77	76	87	100	89
4	85	91	99	100	98
5	81	82	100	100	92
6	87	91	96	100	91
7	93	88	95	100	95
8	93	89	91	100	100
9	89	82	86	100	91
10	90	93	98	100	97
11	97	92	94	100	96
12	94	89	95	100	90
13	88	86	91	100	98
14	82	76	88	100	95
15	86	84	94	100	96
16	96	96	98	100	99
17	96	94	96	100	100
18	79	88	95	100	97
19	85	77	88	100	91
20	99	99	97	100	100
21	87	83	89	100	88
22	76	80	91	100	94
23	86	91	95	100	98
24	99	88	89	100	96
25	94	89	94	100	97
26	86	87	95	100	95
27	93	76	80	100	74
28	89	90	95	100	99
29	88	73	83	100	80
30	80	87	93	100	91
31	98	99	100	100	100
32	90	87	95	100	95
33	96	96	50	100	99
34	93	96	99	100	100
35	85	88	98	100	100
36	87	78	90	100	98
37	89	85	89	100	90
38	95	95	98	100	100
39	92	84	87	100	90
40	82	85	89	100	96
41	98	91	93	100	97
42	91	92	98	100	99
43	100	100	100	100	100
44	90	85	95	100	98
45	99	100	98	100	100
Average	90	88	92	100	95

When evaluated by analysis zone, those with the highest percentage of non-removable barriers in the examined group of buildings are stairs (468 barriers, 3% of the total), circulation areas (455 barriers, 3% of the total), doors (171 barriers, 1% of the total), ramps (44 barriers, less than 1% of the total), unevenness (30 barriers, less than 1% of the total), auditorium spaces (23 barriers, less than 1% of the total), museumisation areas (20 barriers, less than 1% of the total), and WCs (12 barriers, less than 1% of the total). The remaining areas exhibit a number of barriers for which a viable solution could not be proposed, each comprising less than 10.

4.4. Determination of Work Lines: Case Study Resolution

As an illustrative example, potential courses of action for Building No. 43 from the selected group of buildings are presented. This compact single-floor building features an entrance with varying elevation levels and a layout comprising multiple interconnected spaces. The building is designated for museum use and includes restroom facilities. It is a building within the selected group for which the complete removal of barriers is feasible. The proposed criterion for a work line based on partial interventions is that it benefits specific user groups.

The work lines considered for the building in question are set out below. Each line encompasses one or multiple intervention stages. These stages detail the quantity and percentage of barriers eliminated and remaining at the conclusion of each stage. Additionally, they provide the estimated budget for the material execution of the stage and the remaining budget to conclude subsequent stages. The barriers eradicated for each analysed user group are also itemised.

- Work Line A: No intervention is conducted on the building.
- Work Line B: Complete intervention in the building. One stage (Table 9).
- Work Line C: Partial intervention based on the criteria of benefiting user groups. Two stages (Tables 10 and 11).

Table 9. Summary of work line B.

Stage I		
Element	**Amount**	**% Total**
Barriers removed	90	100.00
Barriers non-removed	0	0.00
Estimated budget	18,184 €	100.00
Estimated remaining budget	0 €	0.00
Analysis by groups		
Barriers removed for wheelchair users	48	100.00
Barriers removed for cane users	44	100.00
Barriers removed for visual disability	62	100.00
Barriers removed for hearing disability	5	100.00
Barriers removed for cognitive disability	35	100.00

Table 10. Summary of Stage 1 of work line C.

Stage I—Physical Disability		
Element	**Amount**	**% Total**
Barriers removed	54	60.00
Barriers non-removed	36	40.00
Estimated budget	6514 €	35.85
Estimated remaining budget	11,670 €	64.15
Analysis by groups		
Barriers removed for wheelchair users	48	100.00
Barriers removed for cane users	44	100.00
Barriers removed for visual disability	32	51.61
Barriers removed for hearing disability	1	20.00
Barriers removed for cognitive disability	13	37.14

Table 11. Summary of Stage 2 of work line C.

Stage II—Other Disabilities		
Element	**Amount**	**% Total**
Barriers removed	36	40.00
Barriers non-removed	0	0.00
Estimated budget	11,670 €	64.15
Estimated remaining budget	0 €	0.00
Analysis by groups		
Barriers removed for wheelchair users	0	0.00
Barriers removed for cane users	0	0.00
Barriers removed for visual disability	30	48.39
Barriers removed for hearing disability	4	80.00
Barriers removed for cognitive disability	22	62.86

From these proposed work lines, the building's management is tasked with selecting the line to be implemented.

5. Discussion

Following the methodology developed, the objectives set for the study have been successfully addressed while at the same time contributing to filling the gaps identified in the literature review. Most of the analysed studies focus on the current state of buildings [16,28,29,37–40,48,70,74], and those that propose interventions mainly concentrate on individual buildings [72] or a few specific environments [30], but from a particular perspective. In contrast, the proposed methodology complements these analyses and, building upon them, provides support for interventions aimed at removing barriers in any public building.

Moreover, while the consulted references centre on specific types of usage, whether public [13,16,26–35,52–66] or private [36–41], this method encompasses the realm of any public space, allowing its application to built environments with diverse functions, as verified through the undertaken experience.

The division of the studied building has demonstrated significant utility in applying the method to a particular case. The conceptual fragmentation of the building into segments that facilitate analysis is a common approach in accessibility studies [75,77]. However, in this study, this division not only aids in identifying barriers but also adjusts to structural elements (stairs, ramps, doors, etc.) or spatial units (auditorium space, circulation space, hygiene core) that allow for isolated interventions. This feature correlates with the ultimate goal of the developed method: the effective removal of architectural barriers from the building.

As stated, the notion that heritage buildings are not accessible is widely held [72,73,77,79,80]. This perception may be rooted in the fact that most analyses are confined to the current state of buildings. Conversely, the feasibility study of barrier removal within the encompassed group of selected buildings demonstrates a high level of barrier removal across all buildings, with values exceeding 80% in all cases and reaching 100% barrier removal for specific groups in several instances. Based on this, it can be asserted that heritage buildings are potentially accessible, unlike what findings from other investigations suggest [79,80].

This perception of difficulty or impossibility in adapting heritage buildings to the needs of individuals with diverse disabilities is connected to the need for heritage preservation. In response, the proposed tool is based on an analysis of the compatibility of each intervention with the building. This approach also facilitates the potential export of the methodology to non-heritage buildings without hindrance, unlike methodologies that do not consider heritage aspects, which may struggle to undergo the reverse transition with the same ease.

Expanding the scope to the built environment, authors such as Jackson [30] have indicated that the lack of accessibility in urban environments is due to their construction under disability models that did not consider people with disabilities as users with the same rights as others. However, the feasibility of ensuring accessibility in much older heritage environments, to a significant extent, raises the possibility of adapting urban environments built with more recent models. Another aspect of the developed method is its comprehensive nature. The existing literature often examines accessibility for specific groups, with a greater focus on those with physical disabilities [29,40,47,49,67,70] or visual impairments [40,48,49,78]. In the conducted study, it has been demonstrated how a single barrier affects groups of individuals with different disabilities and, at the same time, a single proposed solution can eliminate an architectural barrier for multiple groups. Hence, a thorough analysis encompassing all disabilities is advantageous. In this regard, some studies are presented [30,71,73].

Additionally, authors such as Kwame and Bamfo [13] argue that competent authorities should ensure accessibility in the built environment. While this assertion holds true, the development of analysis methodologies that contribute to this goal is of paramount importance. Both authorities and building managers need tools to effectively undertake this task. In this context, methodologies such as those discussed in the existing literature are helpful in identifying issues, but it is essential to incorporate studies such as the one presented in this article that encompass the entire barrier removal process.

6. Conclusions

Equal access to and use of the built environment is a universally recognised right for all users. Interventions in any building to ensure equal accessibility for all users have the primary aim of enabling utilisation, whether by maintaining its current use or by substituting it with a new one. In both cases, this factor contributes to the building's functionality and thus enhances its lifespan. Consequently, improving accessibility is vital for the preservation of built heritage, as is structural or energy-related rehabilitation.

The conclusions of this study can be categorised into three main ones. In relation to the existing literature:

- There is a significant interest in the study of accessibility in the built environment, as it corresponds to the context in which people carry out their activities. However, this analysis often tends to focus only on the current state of accessibility.
- Most built environments present significant accessibility challenges, both in urban spaces and in public or private buildings. This results in a loss of participation capacity for people with disabilities.
- The idea that heritage buildings are inherently inaccessible or that built environments are inaccessible because they were designed without considering people with disabilities is widely held, impeding efforts to remove barriers.

About the proposed tool:

- The development of this method fills a gap identified in the literature review on the study of heritage accessibility, specifically the analysis of potential building accessibility. Building upon the examination of the existing state, this proposal presents the potential to comprehend not only a potential accessibility state but also the essential actions for eliminating architectural barriers. The proposal also details the different disabilities for which the barrier is removed. Furthermore, it ensures that the intervention is compatible with the heritage aspects of the building, which must be preserved.
- The use of this intervention support tool makes it possible to speed up decision-making, both at a technical level, with the proposed solutions, and at an administrative level, through the selection of the different lines of action that can be generated. The systematisation of the analysis makes it possible to move from a case-by-case study to the formulation of master plans covering several buildings. The only actions that require a specific study are those that need to be confirmed by an expert.

In relation to the social implications and potential avenues for future research:

- The development of this tool enables authorities and managers to work on space adaptation. Efforts must continue in areas such as the cost of interventions and execution times, which are relevant considerations within the framework of sustainable economics.
- The similarities between heritage and non-heritage buildings, as well as the needs of people with disabilities in other locations, allow for the systematic application of such studies in other areas. This will result in a larger and more comprehensive database that contributes to the identification of potential configurations of different barriers or new solutions. Thanks to the modular nature of the tool, it can incorporate this knowledge to enhance its functionality. The design based on isolable elements (segmentation of buildings into analysis zones and the establishment of distinct barriers and solutions for each) allows for updates through the following possibilities:
    a. Incorporation of new analysis zones for application in different physical environments, such as urban or natural settings.
    b. Incorporation of new possible barriers in an existing analysis zone due to the emergence of new regulatory requirements.
    c. Incorporation of new potential solutions due to the development of novel technical solutions or materials.

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References

1. Ahmed, A.; Mateo-Garcia, M.; Arewa, A.; Caratella, K. Integrated Performance Optimization of Higher Education Buildings Using Low-Energy Renovation Process and User Engagement. *Energies* **2021**, *14*, 1475. [CrossRef]
2. Antonov, Y.I.; Heiselberg, P.K.; Pomianowski, M.Z. Novel Methodology toward Nearly Zero Energy Building (NZEB) Renovation: Cost-Effective Balance Approach as a Pre-Step to Cost-Optimal Life Cycle Cost Assessment. *Appl. Sci.* **2021**, *11*, 4141. [CrossRef]
3. Suman, N.; Marinic, M.; Kuhta, M. A Methodological Framework for Sustainable Office Building Renovation Using Green Building Rating Systems and Cost-Benefit Analysis. *Sustainability* **2020**, *12*, 6156. [CrossRef]
4. Mao, Z.H. Study on Comprehensive Evaluation on Green-targetedEnergy-saving Renovation Design for Existing Buildings. *IOP Conf. Ser. Earth Environ. Sci.* **2019**, *330*, 022009. [CrossRef]
5. D'Adamo, I.; Falcone, P.M.; Gastaldi, M.; Morone, P. The economic viability of photovoltaic systems in public buildings: Evidence from Italy. *Energy* **2020**, *207*, 118316. [CrossRef]
6. Marini, A.; Passoni, C.; Belleri, A.; Feroldi, F.; Preti, M.; Metelli, G.; Riva, P.; Guiriani, E.; Plizzari, G. Combining seismic retrofit with energy refurbishment for the sustainable renovation of RC buildings: A proof of concept. *Eur. J. Environ. Civ. Eng.* **2022**, *26*, 2475–2495. [CrossRef]
7. Unuk, Z.; Lukic, I.; Leskovar, V.Z.; Premrov, M. Renovation of timber floors with structural glass: Structural and environmental performance. *J. Build. Eng.* **2021**, *38*, 102149. [CrossRef]
8. Van der Geer, J.; Hanraads, J.A.J.; Lupton, R.A. Structural renovation of residential building in Zagreb after the 22 March 2020 earthquake. *Gradevinar* **2010**, *73*, 633–648. [CrossRef]

9. Takahashi, N.; Katakai, Y.; Aoki, T. Optimal structural restoration of historic building in Japan considering lifecycle seismic loss analysis. *Jpn. Archit. Rev.* **2020**, *3*, 284–297. [CrossRef]
10. Iannuzzi, A.P.; Labini, S.S.; D'Apolito, E. Sustainability and the circular economy. In *Sustainable Finance and the Global Health Crisis*, 1st ed.; Falcone, P.M., Sica, E., Eds.; Routledge: London, UK, 2023; Volume 2, pp. 67–87.
11. Jiang, K.; Lucchi, E.; Del Curto, D. Adaptive reuse and energy transition of built heritage and historic gardens: The sustainable conservation of Casa Jelinek in Trieste (Italy). *Sustain. Cities Soc.* **2023**, *97*, 104767. [CrossRef]
12. Accessibility and Disability Inclusion in Urban Development. Available online: https://www.un.org/disabilities/documents/2015/accessibility-urbandevelopment.pdf (accessed on 7 July 2020).
13. Kwame Ansah, S.; Bamfo-Agyei, E. Adequacy of disabled facilities in university buildings: The case of University of Cape Coast-Ghana. *Int. J. Dev. Sustain.* **2014**, *3*, 726–736.
14. Clasificación Internacional del Funcionamiento, de la Discapacidad y de la Salud. Available online: https://apps.who.int/iris/bitstream/handle/10665/43360/9241545445_spa.pdf (accessed on 25 January 2020).
15. *UNE 170001-1*; Accesibilidad Universal. Criterios Generales de Diseño. AENOR: Madrid, Spain, 2007.
16. Velasco Machado, L.; R´ebula de Oliveira, U. Analysis of failures in the accessibility of university buildings. *J. Build. Eng.* **2021**, *33*, 101654. [CrossRef]
17. Retief, M.; Letšosa, R. Models of disability: A brief overview. *HTS Theol. Stud.* **2018**, *74*, a4738. [CrossRef]
18. Zajadacz, A. Evolution of models of disability as a basis for further policy changes in accessible tourism. *J. Tour. Futures* **2015**, *1*, 189–202. [CrossRef]
19. Velarde, V. Los modelos de la discapacidad: Un recorrido histórico. *Rev. Empresa Humanismo* **2012**, *15*, 115–136. [CrossRef]
20. Xiang, Z.R.; Zhi, J.Y.; Dong, S.Y.; Li, R.; He, S.J. The impacts of ergonomics/human factors of wheelchair/user combinations on effective barrier-free environments design: A case study of the Chinese universal rail coach layout. *Int. J. Ind. Ergon.* **2018**, *67*, 229–241. [CrossRef]
21. Borowczyk, J. Architectural Accessibility of Historic Legacy: The Social Aspect and Design Prospects. *IOP Conf. Ser. Mater. Sci. Eng.* **2017**, *245*, 052087. [CrossRef]
22. Clarkson, P.J.; Coleman, R.P. History of inclusive design in the UK. *Appl. Ergon.* **2015**, *46*, 235–247. [CrossRef]
23. Persson, H.; Åhman, H.; Yngling, A.A.; Gulliksen, J. Universal design, inclusive design, accessible design, design for all: Different concepts—One goal? On the concept of accessibility— historical, methodological and philosophical aspects. *Univers. Access Inf. Soc.* **2015**, *14*, 505–526. [CrossRef]
24. About EIDD. 2008. Available online: https://web.archive.org/web/20130810002235/http://www.designforalleurope.org:80/About-EIDD (accessed on 14 February 2023).
25. The Principles of Universal Design. 1997. Available online: https://projects.ncsu.edu/design/cud/about_ud/udprinciplestext.htm (accessed on 1 May 2023).
26. Andrade, I.; Bins Ely, V.H. Assessment method of accessibility conditions: How to make public buildings accessible? *Work* **2012**, *41*, 3774–3780. [CrossRef]
27. Wojtyszyn, B. Urban Solutions in the Universal Planning of Residential Spaces for the Elderly and the Disabled. *Civ. Environ. Eng. Rep.* **2022**, *32*, 72–95. [CrossRef]
28. Wazani, I.A.; Mohamad, D.; Jaafar, M. Accessibility for persons with disabilities in built environment of urban area: Case study of George Town, Penang. *Plan. Malays.* **2021**, *19*, 53–65. [CrossRef]
29. Du, X.; Zhang, X.; Wang, H.; Zhi, X.; Huang, J. Assessing Green Space Potential Accessibility through Urban Artificial Building Data in Nanjing, China. *Sustainability* **2020**, *12*, 9935. [CrossRef]
30. Jackson, M.A. Accessing the Neighbourhood: Built Environment Performance for People with Disability. *AMPS Archit. Media Politics Soc.* **2019**, *16*, 1–26. [CrossRef]
31. Perry, M.A.; Devan, H.; Fitzgerald, H.J.; Han, K.; Liu, L.; Rouse, J. Accessibility and usability of parks and playgrounds. *Disabil. Health J.* **2018**, *11*, 221–229. [CrossRef]
32. Setola, N.; Marzi, L.; Torricelli, M.C. Accessibility indicator for a trails network in a Nature Park as part of the environmental assessment framework. *Environ. Impact Assess. Rev.* **2018**, *69*, 1–15. [CrossRef]
33. Fan, P.; Xu, L.; Yue, W.; Chen, J. Accessibility of public urban green space in an urban periphery: The case of Shanghai. *Landsc. Urban Plan.* **2017**, *165*, 177–192. [CrossRef]
34. Xiao, Y.; Wang, Z.; Tang, L.Z. An assessment of urban park access in Shanghai—Implications for the social equity in urban China. *Landsc. Urban Plan.* **2017**, *157*, 383–393. [CrossRef]
35. Emin Baris, M.; Uslu, A. Accessibility for the disabled people to the built environment in Ankara, Turkey. *Afr. J. Estate Prop. Manag.* **2009**, *4*, 801–814.
36. Attakora-Amaniampong, E.; Miller, A.W.; Tengan, C. All-inclusiveness and disability end-user satisfaction in student housing nexus: Cognitive dissonance perspective. *Hous. Care Support* **2022**, *25*, 107–121. [CrossRef]
37. Goodwin, I.; Davis, E.; Winkler, D.; Douglas, J.; Wellecke, C.; D'Cruz, K.; Mulherin, P.; Liddicoat, S. Making homes more accessible for people with mobility impairment: A lived experience perspective. *Aust. J. Soc. Issues* **2022**, *57*, 956–969. [CrossRef]
38. Wellecke, C.; D'Cruz, K.; Winkler, D.; Douglas, J.; Goodwin, I.; Davis, E.; Mulherin, P. Accessible design features and home modifications to improve physical housing accessibility: A mixed-methods survey of occupational therapists. *Disabil. Health J.* **2022**, *15*, 101281. [CrossRef] [PubMed]

39. Burns, S.P.; Mendonca, R.; Pickens, N.D.; Smith, R.O. America's housing affordability crisis: Perpetuating disparities among people with disability. *Disabil. Soc.* **2021**, *36*, 1719–1724. [CrossRef] [PubMed]
40. Asante, L.A.; Sasu, A.; Gavu, E.K. Physical Access for Persons with Disability in Rented Compound Houses in Kumasi: Evidence From Selected Neighbourhoods in the Metropolis. *Dev. Ctry. Stud.* **2016**, *6*, 60–75. [CrossRef]
41. Badreddine, A. Accessibility of Wheelchair Users to Residential Units under the National Building Code. Master's Thesis, Degree-Granting University at Concordia University, Montreal, QC, Canada, 2013.
42. Carlsson, G.; Slaug, B.; Schmidt, S.M.; Norin, L.; Ronchi, E.; Gefenaite, G. A scoping review of public building accessibility. *Disabil. Health J.* **2022**, *15*, 101227. [CrossRef] [PubMed]
43. Duman, U.; Uzunoğlu, K. The Importance of Universal Design for the Disabled in Public Buildings: A Public Building in Northern Cyprus as a Case Study. *Civ. Eng. Archit.* **2021**, *9*, 690–707. [CrossRef]
44. Setiawan, Y.A.; Prasetia, I.; Rusdi, H.A. Study of Development Disabilities Friendly Building. *Am. J. Eng. Res.* **2021**, *10*, 28–32.
45. Ibrahim Badawy, U.; Qasem Jawabrah, M.; Jaeada, A. Adaptation of Accessibility for People with Disabilities in Private and Public Buildings using Appropriate Design Checklist. *Int. J. Mod. Trends Sci. Technol.* **2020**, *6*, 125–137. [CrossRef]
46. Shapiro, D.; Pate, J.R.; Cottingham, M. A Multi-Institutional Review of College Campus Adapted Intramural Sports Programming for College Students with and without a Disability. *Recreat. Sports J.* **2020**, *44*, 109–125. [CrossRef]
47. Basha, R. Disability and the Built Environment: Analytical Study of Public Buildings in Prishtina. *Int. J. Contemp. Archit.* **2018**, *5*, 17–27. [CrossRef]
48. Nischith, K.R.; Bhargava, M.; Akshaya, K.M. Physical accessibility audit of primary health centers for people with disabilities: An on-site assessment from Dakshina Kannada district in Southern India. *J. Fam. Med. Prim. Care* **2018**, *7*, 1300–1303. [CrossRef]
49. De Medeiros, T.M.; Costa, K.N.d.F.M.; Da Costa, T.F.; Martins, K.P.; Dantas, T.R.d.A. Acessibilidade de pessoas com deficiência visual nos serviços de saúde. *Rev. Enferm.* **2017**, *25*, e11424. [CrossRef]
50. Lau, W.K.; Ho, D.C.W.; Yau, Y. Assessing the disability inclusiveness of university buildings in Hong Kong. *Int. J. Strateg. Prop. Manag.* **2016**, *20*, 184–197. [CrossRef]
51. Keerthirathna, W.A.D.; Karunasena, G.; Rodrigo, V.A.K. Disability Access in Public Buildings. In Proceedings of the International Research Conference on Sustainability in Built Environment; 2010; pp. 94–104. Available online: https://www.researchgate.net/publication/324496984_Disability_Access_in_Public_Buildings (accessed on 27 September 2023).
52. Stetieh, H. An evaluation of the school of engineering buildings at the university of Jordan with regard to accessibility. *Sustain. Cities Soc.* **2018**, *42*, 240–251. [CrossRef]
53. Acioly, A.; Oliveira, M.; Freitas, V. Analysis of accessibility for buildings of a graduation school—An experiment in ergonomics training curriculum. *Work* **2012**, *41*, 4124–4129. [CrossRef] [PubMed]
54. Jamaludin, M.; Abdul Kadir, S. Accessibility in Buildings of Tourist Attraction: A case studies comparison. *Procedia Soc. Behav. Sci.* **2012**, *35*, 97–104. [CrossRef]
55. Wibawa, B.A.; Widiastuti, K. Evaluation of Accessibility with Wheelchairs Approach for Educational Buildings. In Proceedings of the 2nd International Conference on Education and Social Science Research (ICESRE 2019), Semarang, Indonesia, 19 October 2019. [CrossRef]
56. Tudzi, E.; Bugri, J.; Ak, D. Human rights of students with disabilities in Ghana: Accessibility of the university built environment. *Nordic J. Hum. Rights* **2017**, *35*, 275–294. [CrossRef]
57. Clemente, K.A.P.; Silva, S.V.; Vieira, G.I.; Bortoli, M.C.; Toma, T.S.; Ramos, V.D.; Brito, C.M.M. Barriers to the access of people with disabilities to health services: A scoping review. *Rev. Saúde Pública* **2022**, *56*, 64. [CrossRef]
58. Furtado de Lacerda Araújo, Y.; Silva Coura, A.; Satiro Xavier de França, I.; Queiroga Souto, T.; Araújo Rocha, M.; Chaves da Silva, J. Accessibility to basic health units for people with physical disabilities. *Cogitare Enferm.* **2022**, *27*, e75651. [CrossRef]
59. Groenewegen, P.; Kroneman, M.; Spreeuwenberg, P. Physical accessibility of primary care facilities for people with disabilities: A crosssectional survey in 31 countries. *BMC Health Serv. Res.* **2021**, *21*, 107. [CrossRef]
60. Ketema, E.; Deribe, E. Accessibility of Commercial Buildings for Persons with Physical Difficulties in Addis Ababa. *Landsc. Archit. Reg. Plan.* **2022**, *7*, 34–42. [CrossRef]
61. Ezanee Hashim, A.; Aida Samikon, S.; Ismail, F.; Kamarudin, H. PWDs Accessibility Audit: Commercial complexes, Klang Valley, Malaysia. *Asian J. Environ. Behav. Stud.* **2018**, *3*, 177–186. [CrossRef]
62. Slaug, B.; Jonsson, O.; Carlsson, G. Public entrance accessibility: Psychometric approach to the development of a new assessment. *Disabil. Health J.* **2019**, *12*, 473–480. [CrossRef] [PubMed]
63. Calder, A.M.; Mulligan, H. Measurement properties of instruments that assess inclusive access to fitness and recreational sports centers: A systematic review. *Disabil. Health J.* **2014**, *7*, 26–35. [CrossRef] [PubMed]
64. Rimmer, J.H.; Riley, B.; Wang, E.; Rauworth, A. Development and validation of AIMFREE: Accessibility instruments measuring fitness and recreation environments. *Disabil. Rehabil.* **2004**, *26*, 1087–1095. [CrossRef] [PubMed]
65. Accessibility in Libraries: A Land Scape Review. Available online: https://www.ala.org/tools/sites/ala.org.tools/files/content/220928-ppo-ltc-access-landscape-review.pdf (accessed on 7 June 2023).
66. Building Access: A Good Practice Guide for Arts and Cultural Organisations. Available online: https://www.artscouncil.org.uk/sites/default/files/download-file/Building_access_guide_260319_0.pdf (accessed on 7 June 2023).
67. Marín-Nicolás, J.; Sáez-Pérez, M.P. An Evaluation Tool for Physical Accessibility of Cultural Heritage Buildings. *Sustainability* **2022**, *14*, 15251. [CrossRef]

68. Mastrogiuseppe, M.; Span, S.; Bortolotti, E. Improving accessibility to cultural heritage for people with Intellectual Disabilities: A tool for observing the obstacles and facilitators for the access to knowledge. *Alter* **2021**, *15*, 113–123. [CrossRef]
69. Marín-Nicolás, J.; Sáez-Pérez, M.P. Accesibilidad al patrimonio arquitectónico. Una herramienta para fomentar el turismo accessible. In *IV Congreso Internacional de Tecnología y Turismo para la Diversidad. Libro de Comunicaciones TTD 2021*; Fundacion ONCE: Madrid, Spain, 2021; pp. 191–202.
70. Lynch, S.; Proverbs, D.G. How adaption of historic listed buildings affords access. *Int. J. Build. Pathol. Adapt.* **2020**, *38*, 76–86. [CrossRef]
71. Zahari, N.F.; Che-Ani, A.I.; Abdul Rashid, R.B.; Mohd Tahir, M.A.; Amat, S. Factors contribute in development of the assessment framework for wheelchair accessibility in National Heritage Buildings in Malaysia. *Int. J. Build. Pathol. Adapt.* **2020**, *38*, 311–328. [CrossRef]
72. Tutal, O. Universal access in historic environment and accessibility of the Haci Hasan Mosque in Eskisehir. *Int. J. Archit. Plan.* **2018**, *6*, 126–141. [CrossRef]
73. Vardia, S.; Khare, R.; Khare, A. Universal Access in Heritage Site: A Case Study on Jantar Mantar, Jaipur, India. *Study Health Technol. Inform.* **2018**, *256*, 67–77.
74. Zahari, N.F.; Harun, S.F.; Ahmad, N.A.; Zawawi, Z.A.; Salim, N.A.A. Comparative Analysis of Disabled Accessibility Needs of Heritage Building in Perak. *MATEC Web Conf.* **2016**, *66*, 00110. [CrossRef]
75. Naniopoulos, A.; Tsalis, P. A methodology for facing the accessibility of monuments developed and realised in Thessaloniki, Greece. *J. Tour. Futures* **2015**, *1*, 240–253. [CrossRef]
76. Parrot, C. *A 19kh-Access to Historic Buildings for the Disabled*; Heritage Conservation and Recreation Service Publication: Washington, DC, USA, 1980.
77. Biere, R.; Egusquiza Ortega, A. Herramienta para el diagnóstico de la accesibilidad en entornos de patrimonio histórico, en base a escaneado láser y realidad virtual: ACC3DE 1.0. *ACE Archit. City Environ.* **2010**, *5*, 61–90. [CrossRef]
78. Andrade, P.S.; Martins, L.B. Tactile reality: The perception of space in the cultural heritage for people with visual impairments. *Procedia Manuf.* **2015**, *3*, 6013–6019. [CrossRef]
79. Garcés, M. Accesibility and Heritage Monuments and Standard Compliance. *ReCoPar* **2010**, *7*, 11–21. Available online: http://polired.upm.es/index.php/recopar/article/view/2216 (accessed on 10 July 2020).
80. Monjo, J. Accessibility in the Historic Heritage. *ReCoPaR* **2010**, *7*, 2–10. Available online: http://polired.upm.es/index.php/recopar/article/view/2215 (accessed on 10 July 2020).
81. Kusnierz-Krupa, D. Historical buildings and the issue of their accessibility for the disabled. *IOP Conf. Ser. Mater. Sci. Eng.* **2019**, *603*, 052007. [CrossRef]
82. Brasil, C.; Costa, A.; Castanon, J. Abandonment and accessibility in a railway historic buildings. *Work* **2012**, *41*, 5431–5433. [CrossRef]
83. Physical Accessibility Making UN Premises & Facilities Accessible through the Business Operations Strategy (BOS) 2.0. Available online: https://unsdg.un.org/sites/default/files/2021-04/Physical%20Accessibility-BOS-Disability%20Inclusion-Practice%20Note-20210303.pdf (accessed on 16 August 2023).
84. Yarfi, C.; Ashigbi, E.Y.K.; Nakua, E.K. Wheelchair accessibility to public buildings in the Kumasi metropolis, Ghana. *Afr. J. Disabil.* **2017**, *6*, a341. [CrossRef]
85. Bayat Bodaghi, N.; Zainab, A.N. Accessibility and facilities for the disabled in public and university library buildings in Iran. *Inf. Dev.* **2012**, *29*, 241–250. [CrossRef]
86. Carta del Restauro de Roma. Available online: https://www.portaenrere.cat/wp-content/uploads/2017/08/1932_Carta_Restauro_Roma.pdf (accessed on 13 January 2020).
87. Carta de Atenas. Available online: https://en.unesco.org/sites/default/files/guatemala_carta_de_atenas_1931_spa_orof.pdf (accessed on 7 June 2023).
88. Carta de Venecia. Available online: https://www.icomos.org/images/DOCUMENTS/Charters/venice_sp.pdf (accessed on 13 January 2020).
89. Ley 4/2007, de 16 de marzo, de Patrimonio Cultural de la Comunidad Autónoma de la Región de Murcia. Available online: https://www.boe.es/buscar/pdf/2008/BOE-A-2008-12526-consolidado.pdf (accessed on 7 June 2023).
90. Sawyer, A. *Easy Access to Historic Buildings*, 2nd ed.; English Heritage: London, UK, 2015.