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User-Environment Interaction: The Usability Model for Universal Design Assessment

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Abstract. Universal Design (UD) aims to provide designed environments that allow users to fully participate in all kinds of activities. Especially, the design of Sport and Leisure buildings should support and encourage the participation of mobility and sensory impaired people in any physical and social activity. Yet, the variety of physical and social users' needs calls for different approaches to investigate, analyze and assess how the environment fulfills users' needs and expectations.

This paper presents a new analytical model that: a) investigates how people with mobility, visual, and hearing impairments interact with specific architectural features; b) links the examined user-environment interaction with the user´s personal assessment of the spatial experience.

The study employs the literature review of the existing analytical models, which are based on the concept of user-environment interaction and framed around empirically deducted basic human needs. These models address the issue of user-environment *fit* by focusing on the identification of environmental barriers. Also, some of these models are too descriptive and cannot inform the practice in creative design processes.

The proposed analytical model, which is built upon the theoretical concepts of *affordances* and *usability,* aims to develop a qualitative evaluation method for identifying environmental facilitators by linking the design of architectural characteristics with the influenced perception of users of the physical and social aspects of the built environment.

The model consists of three groups of elements: (1) users' physical abilities; (2) architectural features and (3) usability criteria. The inter-relations of each element across the groups develop the narrating scenarios that can be investigated from the user's perspective.

This new model does not only advance the understanding of the spatial experiences of persons with mobility and sensory impairments but also offers new insights for exploring UD solutions by identifying the architectural features that enlarge the spectrum of possible user-environment interactions.

Keywords. Universal Design, Person-Environment Fit, Usability, Affordances, New Analytical Model

1. Introduction

While we carry out our daily activities, we always interact with the built environment. Whether it is our home, office, school, supermarket, cinema, or gym, we relate ourselves with physical settings that are designed to be used and functional for physical and social needs. As we experience these spaces, it may happen to encounter difficulties in carrying out some activities. The shelf at the supermarket may be placed too high to reach; the bathroom at the airport may be too small to enter with the suitcase; the stairs to the office may be difficult to climb up. It could happen that some characteristics of the environment do not fit with our physical conditions or with our personal needs. These characteristics are therefore experienced as barriers.

At the same time, spaces can be designed to suggest, support, and facilitate our actions. A glass wall can allow us greater visibility between two rooms; a handrail can support us while we climb the stairs and hangers placed at a reduced height can allow children to hang their coat by themselves. Environmental properties and the design of physical settings play an important role in affecting the way that people perform within a space. Architecture influences and shapes the spatial experience of individuals by hindering or supporting their behaviors and activities.

Furthermore, each person perceives, relates, and experiences the environment differently, due to diverse individual physical and sensory characteristics. A child, an old lady, or a blind person can have a different experience of the same hallway. A child, who experiences the hallway from a lower point of view, might have a reduced visual connection to the surrounding environment. An old lady may probably pay attention to the presence of handrails or seats along the way. A blind person may struggle to find the right way towards the desired destination.

Certainly, most individuals experience and qualify a space according to their visual, kinesthetic, tactile, and auditory abilities. Therefore, when one or more of these abilities is compromised, the individual perception of the space, and, thus, the quality of the experience is also affected. On one hand, the personal physical and sensory characteristics influence our perceptions and interactions with the environment, and on the other hand, the designed features of the environment affect our actions and experiences within it.

For many people with mobility and sensory impairments, participation in sport and leisure activities is often compromised. Because of physical and social barriers that they might experience, persons with these impairments participate less in all forms of sports activities compared to those without impairments [1]. Despite the undoubted importance for people with disabilities to engage in physical activity, most sports and leisure buildings, even if they are considered accessible, do not necessarily influence disabled users´ spatial experiences positively.

Architects usually hypothesize how people are going to use the space and they design solutions that fit with these hypothesized uses and users. However, it could happen that suggested solutions, even if they are architecturally remarkable and comply with legislation, can actually be experienced as not usable by some people, especially when it comes to people with physical or sensory impairments. Instead, architects should find new ways for designing spaces that increase the supportiveness of an environment both physically and socially, especially for disabled people [2].

In particular, the design of sport and leisure buildings should offer spaces that enable and support people to carry out desired activities with satisfaction regardless of their physical or sensory abilities. The design of a built environment that is more responsive to users' needs can help to improve their experiences and thus also increase their active participation in the activities. The main challenge is to better understand how people with mobility and sensory impairments perceive and interact with the built environment and how these interactions positively influence their experience of doing sport and other leisure activities.

Building regulations and guidelines that suggest good practice are often based on objective spatial evaluations, which are limited to quantitative and measurable variables and do not include the complexity and contextuality of the individual-environment interaction. The use of such objective methods, which sometimes do not engage the user directly, makes it difficult to determine how and to what degree space could enhance individuals' activities. Existing analytical models analyze the analysis of the complex user-environment interaction but predominantly focus on identifying environmental barriers. Also, some of these models are too descriptive and cannot inform the practice in creative design processes.

In contrast, the new analytical model presented in this paper tackles individual-environment interplay by focusing on the architectural characteristics that support users with mobility and sensory impairments. The proposed model unfolds individual-environment relations as well as engages with users to assess their personal perception of the experienced interactions with the built environment. Through a comprehensive and qualitative investigation of real spatial experiences, the model aims to identify how architectural features (such as materiality, dimension, organization, lighting, and acoustics) have an influence on supporting users' activities and on their positive experience of space. By collecting detailed and qualitative descriptions of different spatial experiences, it can be possible to inform architects about the influence that architectural characteristics have on users' activities and, thus, about how to design more easily usable and inclusive sport and leisure buildings.

This new model is framed around the theoretical concepts of *affordances* and *usability*. In this paper, affordances are considered here as all the opportunities for actions offered in the form of functional environmental characteristics for the user to perceive and interact with space to perform an action. While usability is defined as the personal assessment of the built environment and the extent to which these architectural features accommodate users' needs and expectations of acting in the space. By linking user-affordances interaction with influenced aspects of usability, it makes it possible to identify not only the barriers but also the facilitators that the environment can offer to users with different mobility and sensory abilities for fulfilling their needs.

In what follows, the paper introduces the user-environment interaction and discusses the importance of investigating the interplays that occur between individual and environmental factors within the UD perspective. Subsequently, existing models for the analysis of user-environment are presented and discussed, articulating the pros and cons of these models in applying to design practice. Finally, a new model, which is built on the concepts of affordance and usability, is suggested to better evaluate, from the first-person perspective, the spatial experiences of disabled people in sport and leisure buildings, and to identify the architectural features that can contribute to improving users' satisfaction.

2. The Role of the Environment in the User-Environment Interplay

Within UD approach, a built environment is accessible when it is usable by any person with any temporary or permanent impairment [3]. When the demand for performing activities in the environment exceeds the abilities of the person, the environment, which is not responsive to the individual's needs, is experienced as a barrier [4]. The interaction between a person with impairments and environmental barriers results in a condition of disability and thus in reduced participation in society [5].

This definition explains disability not as a consequence of a disease but as the result of individual and environmental factors that interact with each other [6] influencing the spatial experience and the participation in any physical or social activity. In this perspective, the match or mismatch between the individual and the environmental characteristics respectively eliminates or creates a situation of disability. The extent to which the environment hinders or enables user activities reflects the degree of disability experienced by the user. Figuratively speaking, disability can be represented as a gap between individual and environmental factors (Figure 1) [7, 8], where the size of the gap is inversely proportional to the extent to which the environmental factors can match with individual factors.

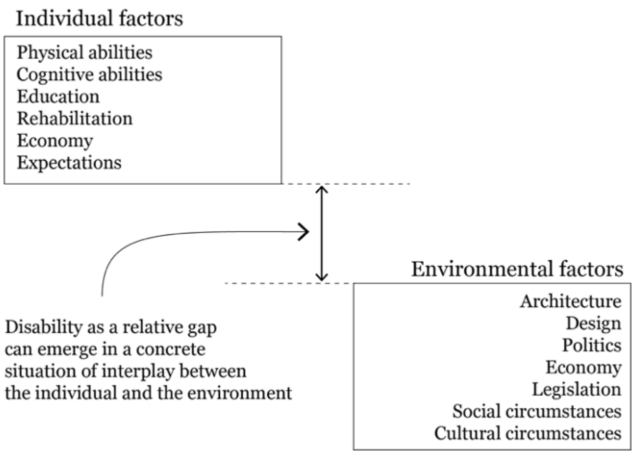

Figure 1. Gap model of disability [8], redrawn by the authors

In recent decades, architects and designers have become more aware of the importance of reducing this gap by designing environments according to their actual uses and users' characteristics. In particular, the attention to the design of accessible environments for disabled people has given rise to various approaches that aim to eliminate the so-called architectural barriers. Within these different approaches, UD promotes design solutions and products responsive to users' variety and complexity [9]. In particular, UD does not focus only on creating accessible environments for people with disabilities, but it aims to create physical and social inclusion for the entire population, recognizing diversity as an added value to be considered and included in the design process.

According to UD, the built environment is considered indispensable and significant for the independence and the wellbeing of people. Furthermore, it is considered as the means for facilitating people's participation in society [10]. For this reason, the built environment should be designed with the aim of not only supporting persons but also accommodating bodily complexity and different forms of physical and sensory impairments [11].

Architectural characteristics contribute to support or hinder participation by offering or not offering users with different abilities the opportunities to act upon. By accommodating different user's characteristics and needs, specific architectural features offer users with certain abilities the possibility to perform and thus to improve their personal perception of building's usability. When environmental characteristics match with individual's characteristics, users' needs are satisfied, and the environment can be considered usable for performing the desired activities.

The goal is to design "universally usable" [12] environments, which consider a wider range of abilities and increase the possible matches between the individuals and the given environment. But how is it possible to address and investigate the match between the person and the environment? How is it possible to evaluate the extent to which an environment accommodates bodily complexity and individuals' needs? How is it possible to identify the architectural features in sport and leisure buildings which are considered to be the most important by persons with mobility and sensory impairments to better perceive, use and enjoy the environment?

3. State of Art – the Existing Analytical Models

There are several models that evaluate the built environment based on UD approach. These have the purpose to assess how the environment influences users' performance and participation. The sub-sections below present and discuss three dominant analytical models 1) the Person-Environment-Occupation model, 2) the Housing Enabler model, and 3) the User-Built Environment model.

3.1. The Person-Environment-Occupation Model

The Person-Environment-Occupation model describes the relationship between the person, the occupation, and the environment for further unfolding environment-behavior theories and supporting practical guidelines in occupational therapy [13]. The model is based on three elements: 1) the *person*, 2) the *environment*, and 3) the *occupation*.

The *person* is defined as a dynamic being, characterized by qualities and skills, which influence the way the person interacts with the environment. The *environment*, or rather the context in which the person behaves, is also dynamic and characterized by variable aspects that affect the performance of the person. And finally, the *occupation*, which could be any activity performed by the person for fulfilling his or her needs. The *occupational performance* represents the intersection between the *person*, the *environment,* and the *occupation* in spatial and temporal conditions that characterize the performance as a complex and dynamic phenomenon.

The model describes the fit between these three elements as their intersection, where a small intersection corresponds to reduced occupational performance and, inversely, a bigger intersection corresponds to a wider occupational performance and therefore wider participation (Figure 2).

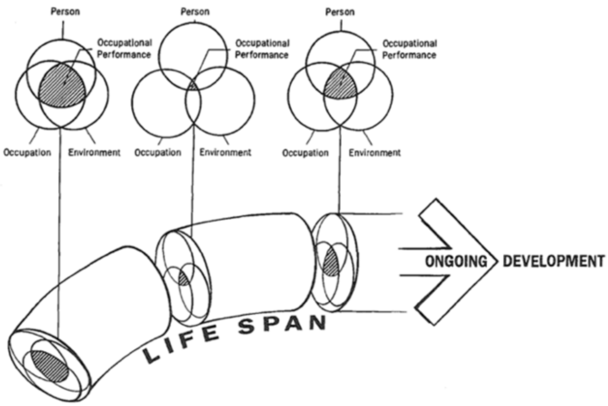

Figure 2. Occupational performance based on person, environment, and occupation fit [13]

This model acknowledges the complexity and the dynamism of the person-environment interplay. It recognizes the changes caused by different personal circumstances and contexts, and therefore requires continuous monitoring to better determine the possible interventions in the built environment [13]. The Person-Environment-Occupation model clearly expresses the condition of disability by representing it as a mismatch of the three main components.

This model considers the environment broadly by including cultural, socio-economic, institutional, physical, and social contexts [13] for identifying and operate on disabling mechanisms. This comprehensive approach provides occupational therapists with important information about the individual in relation to the environment and therefore allows them to intervene in the environment for the improvement of a specific context related to that individual.

However, the environment component is not specified through a description of the architectural features that characterized it. This makes it impossible to directly link specific aspects of architecture with an increased or reduced occupational performance. Without having the possibility to identify the most relevant architectural features, it is then not possible to inform architects about the most influencing characteristics to work with for improving occupational performance.

3.2. The Housing Enabler Model

The Housing Enabler model [14, 15, 16] is a tool for a more objective assessment of physical barriers and housing accessibility. The tool helps to identify accessibility problems in housing and to evaluate their degree of influence on user's performance by following three main steps: 1) the assessment of the functional limitations of the individual (Figure 3a), 2) the assessment of physical environmental barriers belonging to the four main areas – outdoor environment, entrances, indoor environment and communication (Figure 3b), and 3) the calculation of the accessibility score through the combination of the individual functional limitations and the physical environmental barriers (Figure 3c). The main aim of this model is to develop an instrument for identifying, assessing, and scoring causes of individual's disabilities in home physical settings.

Unlike the previously presented Person-Environment-Occupation model, the Housing Enabler model has a time-limited approach and directly indicates the environmental aspects correlated with the accessibility of persons with functional limitations [15]. The Housing Enabler is a powerful and effective tool for the identification and subsequent improvement of the architectural barriers experienced by persons with different functional limitations. Furthermore, the possibility of assessing the degree of influence that the identified barriers have on users makes it possible to prioritize any improvement. Although it is a good model for the analysis of the relationship between the functional capacities of the individual and the environmental aspects, this model does not allow to identify the features that facilitate user's performance. Also, the model is difficult to apply to other environments than the home.

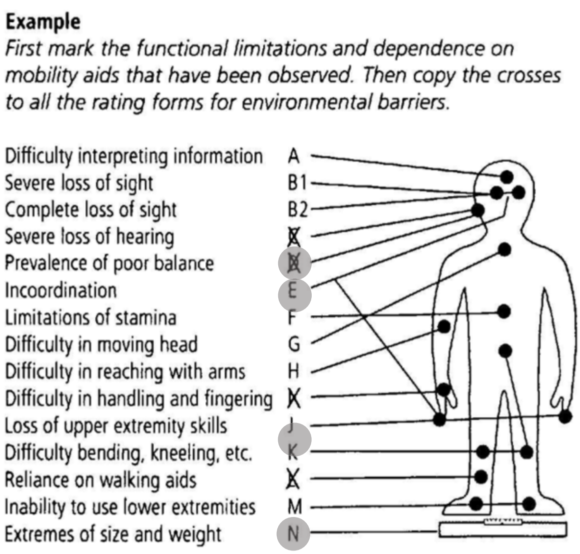

Figure 3a. The Housing Enabler assessment tool – step 1 [15]

Mark the observed environmental barriers with a cross.

A. Outdoor Environment	A	B1	B2	X	X	E	F	G	H	X	J	K	X	M	N
General															
1. Narrow paths (less than 1.3m)					3	3							3	3	1
X Irregular walking surface (includes irregular joins, sloping sections, etc.)		2	3		1	1		3					3	3	
3. Unstable walking surface (loose gravel, sand, clay, etc.)		2	3		3	3	2						3	4	

Figure 3b. The Housing Enabler assessment tool – step 2 [15]

Then put a circle around the points (1-4) in the squares at the intersections of functional limitations and environmental barriers.
The total of the points is a measure of the degree of accessibility problems.

A. Outdoor Environment	A	B1	B2	X	~~D~~	E	F	G	H	X	J	K	X	M	N
General															
1. Narrow paths (less than 1.3m)					3	3							3	3	1
X. Irregular walking surface (includes irregular joins, sloping sections, etc.)		2	3		1	1		3					3	3	
3. Unstable walking surface (loose gravel, sand, clay, etc.)		2	3		3	3	2						3	4	

Note. The figure shows only a minor part of the extensive Enabler instrument.

Figure 3c. The Housing Enabler assessment tool – step 3 [15]

3.3. The Users-Built Environments Model

The Users-Built Environments model [17] aims to map, document, and resolve conflicts between users and built environments by relating permanent, temporary, and situational limitations of the user with environmental features during the performance of observed activities. The model is framed around two main components: 1) the *user* and 2) the *environment*. In this model, the *user* is defined based on lists of possible impairments and activities, while the component of the *environment* is subdivided into lists of aspects and elements belonging to the physical setting (Figure 4).

This model offers a framework for describing user-environment conflicts by connecting the variables influence each other. The model is detailed and the lists that specified the components are used as building blocks for the description of real situations of interaction.

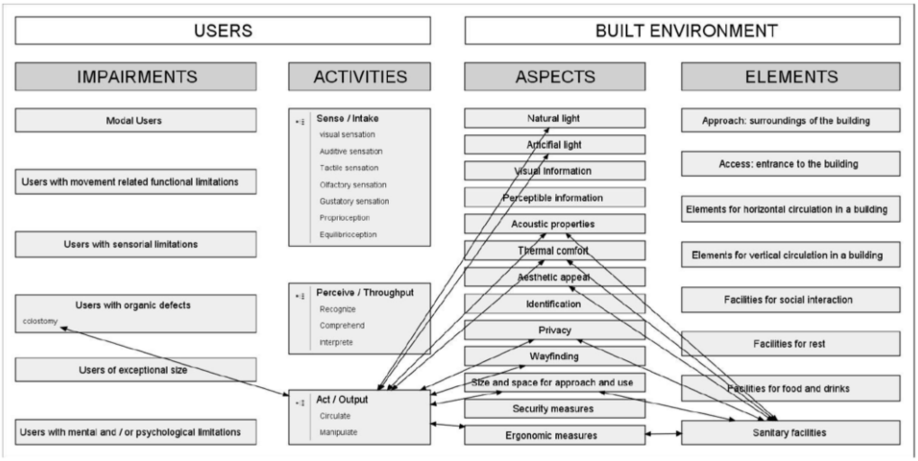

Figure 4. Users-Built Environment Model [17]

The interactions between the variables are mapped by the researcher to show some key circumstances, called *patterns*, that affect a person's activity in a specific environment. The collected patterns are important information for designers to eventually intervene and solve the identified conflicts.

Although this model is very useful for improving the knowledge of the dynamics happening between the individual and the environment, it aims at identifying the disabling mechanisms, and not the enabling ones, which the proposed model intends to investigate. Furthermore, even if the Users-Built Environment model allows to connect all the variables that participate in the user-environment relation, it does not make it possible to assess the spatial experience with a user-centered perspective.

The possibility to understand which kind of positive influence environmental characteristics have on different bodily performances and preferences would only improve the knowledge on how to enhance the user's spatial experience.

4. Theoretical Bases for the Usability Analytical Model

The new analytical model also aims to investigate the influences of the built environment on user performance and participation. However, unlike the existing models presented above, the new one focuses on identifying the features that contribute to improving the fit between the offered spaces and the users with mobility and sensory impairments.

This proposed new model is built upon the concepts of affordances and usability. As the opposite concept of architectural barriers, affordances are here considered as the functional features the environment offers to users as facilitators for preventing disabling mechanisms. To evaluate these functional features, usability is introduced as the personal assessment of the extent to which affordances accommodate bodily diversity and complexity.

4.1. Affordances

Architecture initiates, directs, and organizes behavior and movement. A building is not an end in itself; it frames, articulates, structures, gives significance, relates, separates and unites, facilitates, and prohibits [18].

In the user-environment interaction, what makes certain behaviors most likely or just possible are in fact the characteristics of the environment, which suggest, allow, and affect the way the user acts into space.

In 1977, in his article *The theory of affordances*, James Jerome Gibson introduced and defined affordances as the qualities of an object or an environment that suggest and allow an individual to perform an action. The term affordances refers to all the environmental features that offer users with certain skills the opportunity to act within that environment [19, 20].

Affordances further strengthen the definition of spatial experience as an interplay between the user and the environment. While we experience a space, the functional properties of the space are perceived by our bodies, and directly identified as opportunities offered for our purposive actions [21]. Within this interactionist view [19], the degree of freedom of action is determined by reciprocal limitations either in the user or in the environment. For example, a window located at 1,20 meters from the floor offers the possibility to look out only to people with a point of view higher than this height. Reciprocal characteristics, in addition to determining the possibility of looking out, also influence the experience itself, making it more or less pleasant for the person who performs the action.

From the introduction of Gibson´s concept to the present, the existing literature presents a vast nuance of attempts to better define what constitutes an affordance [22]. The existing definitions qualify affordances as a relational [23, 24, 21], dispositional [25, 26] and performative concept [27, 28]. In fact, affordances can be seen very much as qualities pertaining to and given by the environment, which, however, must be observed with reference to an individual acting in the same environment.

In this study, the concept of affordances is represented as the intersection between individual and architectural features, where the positive match between users' needs and environmental offers results in the ability of the user to carry on the desired physical or social activity (Figure 5). This representation, compared to the gap model of disability (Figure 1), helps to look at affordances as the opportunity to further investigate and elaborate on how it would be possible to reduce conditions of disability through a design that better relates with the end-users.

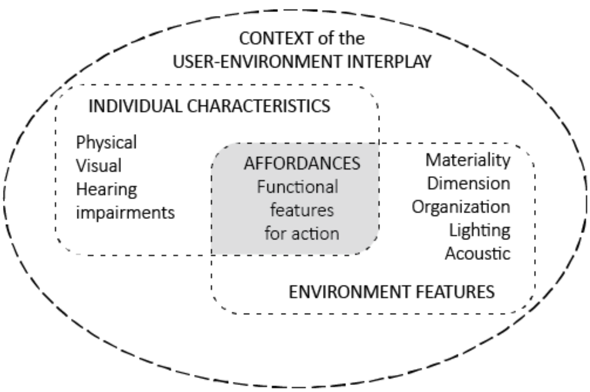

Figure 5. Affordances in the user-environment interplay

Affordances have a strict relation with users and with their physical and cognitive abilities to perceive and make use of the support offered by the environment. Features that are functional to an activity for a user may not be functional in the same way for another user with different characteristics. Tactile numbers on the changing room's lockers allow blind users to touch and easily identify their locker. This characteristic, while results important for users with visual impairments is not even perceived by other users, such as wheelchair users who are more concerned about how high the lockers are located. In this case, the physical characteristics of the lockers, such as their materiality and organization in the space, become opportunities for actions when bodily perceived and experienced by the individual with certain characteristics, skills, and expectations. For this reason, environmental features are experienced, and therefore must be also evaluated, with respect to the functional meaning given by the person who is experiencing them [29].

Regarding the environmental side of this mutual responsiveness, the existing literature suggests that designers have the great opportunity to facilitate positive user-environment interplays by being aware of how relevant features could invite and support users' physical and social activities in different contexts [30, 31, 32, 33, 34]. For example, the presence of a ramp in the pool allows wheelchair users to enter the water. Although this action would also be possible with the use of lifters, the ramp makes the experience of entering the water physically easier, both for users and staff, as well as it offers more dignified access to the pool. In fact, affordances, in addition to making action possible for a certain user, can help to facilitate the activity, by reducing the physical and mental effort of the person experiencing the space. Most importantly, affordances contribute to make users feel less disabled and more comfortable in participating in the activities.

Affordances represent the integration in spatial settings of what architects imagine are the physical and social interactions of users within the built environment. In this perspective, it is important to consider real users' relevant interactions and expectations, so to able architects to know and translate them into actual opportunities of action.

The following section discusses how the concept of usability can help to evaluate affordances as a litmus test to assess if and how architectural features enhance positive interactions between the environment and the user.

4.2. Usability

In De Architectura, Vitruvius included the concept of *utilitas* among the three principles of architecture: *firmitas, utilitas* and *venustas*. The principle of *utilitas* highlights the importance of architecture to respond to users' needs and underlines the duty of architects to design environments that can actually be used for the intended purpose. UD recognizes the importance of usability and integrates the concept of accessibility with the need for an environment to be not only accessible but also usable, to the greatest extent possible, by as many people as possible [35]. The necessity is then to evaluate this extent, by looking at the quality of interactions between the environment and users and how architectural features support and enhance activities.

The 7 principles of UD (eg 1. Equitable use, 2. Flexibility in use, 3. Simple and intuitive use, 4. Perceptible information, 5. Tolerance for error, 6. Low physical effort, 7. Dimensions and space for approach and use) aim at evaluating the usability of existing environments and products, and intend to guide for the implementation of UD concepts in design practice [36]. However, when these principles are applied in architecture, they are difficult to translate into design guidelines. Also, they do not include the valuable individual interpretation of the spatial, sensory, and social quality experienced by the user acting in the space [8, 36, 37, 38].

The concept of usability evaluates the extent to which the environment is usable by people and how well the characteristics of the environment match with a broad spectrum of physical and social needs. It describes how and to what extent the design of the environment enables operations, performance, and well-being from the user's perspective [39, 40]. Usability evaluates more than building's functionality and accessibility [41] by including a more comprehensive analysis of the supportiveness of the built environment in relation to individuals and their actions. It integrates the component of personal assessment to qualitatively evaluate the influence of the environment on individual functional, sensory and cognitive experiences [42]

Researchers in the design field have proposed different sets of usability criteria with the aim to place value on the less tangible human needs associated with buildings [43], like personal satisfaction and the accomplishment of social needs. Usability criteria are used for understanding and evaluating users' experience and for this reason, they should reflect the wide spectrum of users' needs when behaving in the environment. Some proposed criteria derive from the UD principles [36], some others from the study of basic human needs [44], or simply from empirical deductions guided by professional experience or the requirements of a specific building [45]. What all these sets of criteria have in common is the will to evaluate human-environment relation based on users' perspective and to address users' functioning and personal satisfaction instead of users' disability and activities restriction.

For this study, a set of criteria have been suggested on the basis of the needs expressed by the users during the initial interviews made in the two investigated sport and leisure buildings.

5. The Usability Model for Universal Design Assessment

The aim of the proposed analytical method is to offer a structured way to address and analyze the complex interactions that occur while people with mobility, visual and hearing impairments perform activities within the investigated facilities. This analysis points to evaluate specific architectural characteristics in relation to the users' impairments and their personal assessment of usability.

By linking user-environment interactions with the influenced aspects of usability it is possible to advance the understanding about which architectural features are the most functional to users so to positively influence their active participation and how these features affect the usability of the building in terms of perception, cognition, physical fit, comfort, and social relevance.

The model is structured in two main components: 1) *user's physical characteristics* which include the investigated users' physical and sensory impairments, and 2) *architectural features*, that lists a set of features related to the designed environment (i.e., materiality, dimension, organization, lighting and acoustic (Figure 6).

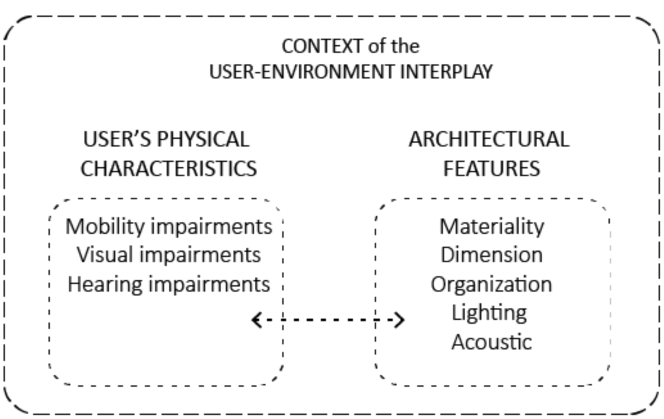

Figure 6. The Usability Model for UD assessment in Sport and Leisure Buildings

The first step is to identify, through interviews and deep observations, with which architectural features the users interact the most while they carry out the observed contextual activity. For example, when entering into the building for the first time, the materiality of the pavement, which leads the blind user towards the main entrance is considered crucial for him/her for finding the way towards the entrance.

The second step, which is also carried out through interviews and direct questions to the user, is to ask about the personal assessment of how, for example, the different materiality of the pavement supports the action and affects the usability. To allow users to express their opinion on usability, the model suggests a list of criteria related to physical and social needs, which have been deductively identified from the analysis of initial interviews. Using the same example, the materiality of the pavement supports the action of entering by improving the user's spatial cognition (Figure 7).

This model can be used for investigating all the activities that happen from the moment the user gets into the building to the moment the user gets out.

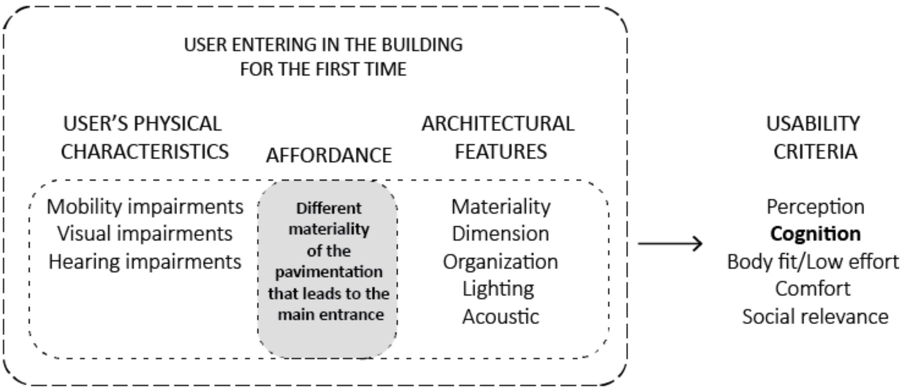

Figure 7. Example of experience investigation

This model connects and displays the interactions between the user and the architectural affordances to the aspects of usability which these affordances have the greatest influence on. Also, the personal judgment on usability is decisive for attributing a positive connotation to the experience. This makes it possible to determine whether the characteristics of architecture, which the user has interacted with, have been experienced as facilitators in their activities.

The information obtained with this analysis has both theoretical and practical implications. On the one hand, the collected information contributes to advance and define the knowledge about the interactions of users with physical and sensory impairments with the built environment. In fact, further information is acquired about how users with different abilities perceive the environment and how they can be supported and invited to physical activity and participation. On the other hand, the collected insights of personal experiences can offer designers the opportunity to experiment and design with architecture properties creatively, being aware of the influences that they may have on users and their participation.

The investigation of different lived experiences, which are qualitatively assessed by users with impairments themselves, offers the opportunity for designers to better understand the functional requirements linked to individual necessities and preferences.

6. Discussion

The proposed analytical model aims to identify the environmental characteristics that support and enable users' physical and social activities. To do this, it collects information on subjective and contextual experiences and links them with the architectural features with which users interact most. It then provides information on how the identified characteristics positively influence the experiences of users with mobility or sensory impairments.

- The Usability Model, unlike other existing ones, offers the possibility to understand how the environment can be supportive rather than just identifying possible barriers. In a UD perspective, architects' main challenge should be, in addition to not designing barriers, also to design spaces that support activities by improving usability and therefore the experiences of individuals. A paradigm shift that encourages addressing spatial experiences of users with mobility and sensory impairments not as a problem-solving process, but as the possibility of experimenting with new solutions that meet the real needs of users and that encourage participation in daily activities and social life.
- The model intends to offer an approach to qualitatively analyze the architectural features that mostly influence the individual perception of building's usability in contextual and dynamic situations. It is acknowledged that physical and social scenarios in real settings, because of their complexity and the variability of the factors involved, are always different and thus impossible to repeat with the same dynamics. However, this approach can offer a rich and comprehensive collection of personal experiences, which brings valuable insights to architects on how to improve architecture so to positively influence users' activities and participation.
- The model can provide architects with knowledge about user's experiences and how these can be positively influenced by architecture. The next important step for the actual use of this model in architectural practice is the synthesis and the representation of this information into a resource that can be used by designers. This knowledge would give architects further awareness about the influences of different design solutions on users' spatial experience.

7. Conclusion

The environment is a crucial and influencing factor in disabling and enabling mechanisms. By better knowing which and how architectural features are able to accommodate, support, and fulfill personal needs, it can be possible to design more supportive and enhancing environments which prevent the experience of disabling mechanisms by users with mobility or sensory impairments.

The presented Usability Model tackles the complex interactions between built environment and persons with mobility, visual and hearing impairments. First, it investigates the interactions that users have with architectural features based on their impairments and their needs. Then, it analyzes how, and under which circumstances architectural features – like materiality, dimension, organization, acoustic and lighting – are affordances for the investigated interaction and thus positively influence the user's personal perception of building usability.

By knowing the relation between impairments, architectural features and usability criteria, architects can increase their abilities to design architectural features that improve the usability for users with different abilities. This will lead to the design of more inclusive built environments, which consider, accomplish, and add value to the wide variety of individuals' needs.

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