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## Article

# Using Empathic Design as a Tool for Urban Sustainability in Low-Resource Settings

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**Abstract:** Architectural design plays a crucial role in sustainable city development. In fast-growing cities in developing countries, it can be a challenge to reach sustainable results. In this paper, we propose the use of Empathic Design, borrowed from the human-centered design field, as one means to support the work of architects and other stakeholders in these settings. To investigate aspects in which this method could be helpful, we have synthesized two existing sustainability models and applied them to three examples of affordable housing from different low-resource settings. After analysis of the examples, we propose a model with an equal balance between the four different dimensions of sustainability—environmental, economic, social, and cultural—where the aspects that need inhabitant engagement are highlighted. We argue that, to be able to hold the balance between the diverse dimensions of sustainability, the architect needs to understand in-depth the living conditions of people for whom he or she is designing. This calls for a fine-tuned participatory approach when designing in low-resource settings. It may not always be easy to reach this level of participation, but we propose that it can be achieved when the architecture is created through empathic involvement. The use of Empathic Design methods throughout the design process thus supports the endeavor towards sustainable results.

**Keywords:** affordable housing; sustainability; empathic design; low-resource settings; developing countries; human-centered design; participatory design

## 1. Introduction

Rapid urbanization in developing countries calls for a design approach that enhances sustainable solutions. It is estimated that approximately 66% of the world's population will inhabit urban areas in 2050 [1]. This development increases existing sustainability challenges in cities and might create new ones that we are still unaware of. Urbanisation happens fastest in developing countries where people move to the cities to seek employment and better services. In these regions, the need for affordable housing is particularly acute [2].

In this paper, we propose the use of Empathic Design, borrowed from the human-centered design field, to support the work of architects and other stakeholders aiming for sustainability in these settings. Empathic Design has not been studied in the context of architectural housing design in developing countries before. The origin of Empathic Design suggests a design with open-mindedness, observational skills, and curiosity [3]. This attitude seems right when approaching the urbanisation-related challenges in developing countries.

The objective of this paper is to better understand the interconnectedness between the different dimensions of sustainability and recognize the points in the design process where participatory input

is most urgently needed. To find these points, we have developed a sustainability model through a synthesis of the Quantifying Sustainability in the Aftermath of Natural Disasters (QSAND) and UN Habitat models designed for low-resource settings. The synthesis model is used to examine the architectural design process of three different examples of affordable housing in different parts of the world: Chamazi community in Dar es Salaam, Tanzania [4,5]; the national housing in Kuisebmond, in Walvis Bay, Namibia [6]; and social housing by Elemental Chile in Iquique, Chile [7]. These examples are representative in the context of our research because they all provide housing for less advantaged parts of the society, are situated in developing areas, and are carried out in different ways. The level and type of inhabitant engagement varies in the three projects and thus illustrates where an approach originating in empathy might be needed.

Based on our findings, we provide ideas about how a researcher or practitioner can create an analytical view from the perspective of sustainability of the design process that he or she is studying, planning, or conducting. To deepen the understanding of social and cultural sustainability, we elaborate on ideas and practices of Empathic Design.

## 2. Empathic Design as a Support for Social and Cultural Sustainability

In this section, we utilise the literature on holistic sustainability and inhabitant involvement in low-resource settings, with a final focus on the Empathic Design approach.

There is an urgent need for a holistic sustainable design approach in planning and architecture. Sustainable development has been widely considered to incorporate three dimensions: environmental, economic, and social [8,9]. Typically, the social aspects of sustainability are more difficult both to measure and take into account in practice than environmental and economic aspects, and that might be one reason their meaning has also been widely understated [8,10]. An even more underemphasized issue is cultural sustainability. The discourse on whether cultural sustainability should be included as a separate dimension is complex and still new [11]. Nevertheless, we agree with the view that cultural worldviews and values, traditions, and everyday activities evolve through history and have an impact on the human activities within the natural environment [8], and that is why culture should be considered as an individual dimension of sustainability [2,12].

Attitudes towards environment and use of local resources are strongly shaped by cultural factors. Factors such as sense of place, heritage, and tradition-bound use of space are critically important when striving for sustainable housing solutions locally [13]. Housing offers an insightful perspective on cultural sustainability because housing is a scene for social lifestyles, and the built environment is strongly connected to place and inseparable from the natural surrounding environment [8]. Developments and activities in all dimensions affect each other [14]. Therefore, cultural sustainability needs to be part of the analysis if one wants to get a clear understanding of the sustainability of a particular arrangement, such as affordable housing in developing countries. Consequently, inclusion of the cultural dimension in the analyses of sustainability is not only important from the human perspective, but also from the perspective of the overall sustainability.

Numerous rating systems for evaluating the degree of sustainability of buildings and infrastructures have been proposed. Many of these systems focus mainly on managerial or environmental concerns and on carbon emissions related to construction, all of which are crucial measures of sustainability [15–18]. Nevertheless, we argue for a more holistic approach in which social and cultural dimensions are tightly integrated in the analysis. A need for integration of these aspects into sustainability analyses has been expressed before [14] and in the context of housing [16], but only a few studies have proposed practical tools for the integration of the social and cultural dimensions in developing country contexts [2,17–19]. There is only one tool for the assessment of social performance of buildings, and stakeholder involvement is not part of it [20]. Our experience and analysis show that to integrate the social needs and cultural aspirations of the inhabitants in a developing country context needs stakeholder involvement through a participatory approach.

In social sciences, business, and design studies, participation has been understood as an enduring interaction where diverse actors integrate their knowledge and capabilities to generate novel solutions that they could not imagine or create on their own [21–24]. Today, in developed country settings, a demand for participatory design is widely recognized in the striving for holistic sustainable solutions in city planning, and such methods are often taken for granted in design processes [25]. A participatory process is natural in a democratic society, as in the societies where the methods were developed [26], while in a society built on hierarchical structures, this might cause challenges due to multiple reasons. Ideas of inhabitants' active engagement are still not mainstream in many developing countries. Petrescu (2005) emphasizes that participation is driven by the *desire* of clients, architects, and users [27]. This drive might not exist in situations where the actors have a distance between each other due to the structure of the society, and/or the inhabitants are not used to and might not even be able to imagine that they could have an influence on the development of their surroundings, as is often the case in a low-resource developing country setting. Additionally, the future inhabitants might not be empowered to participate, or they might not have the time and energy to invest in the project [28]. In these cases, a desire for action and involvement is absent.

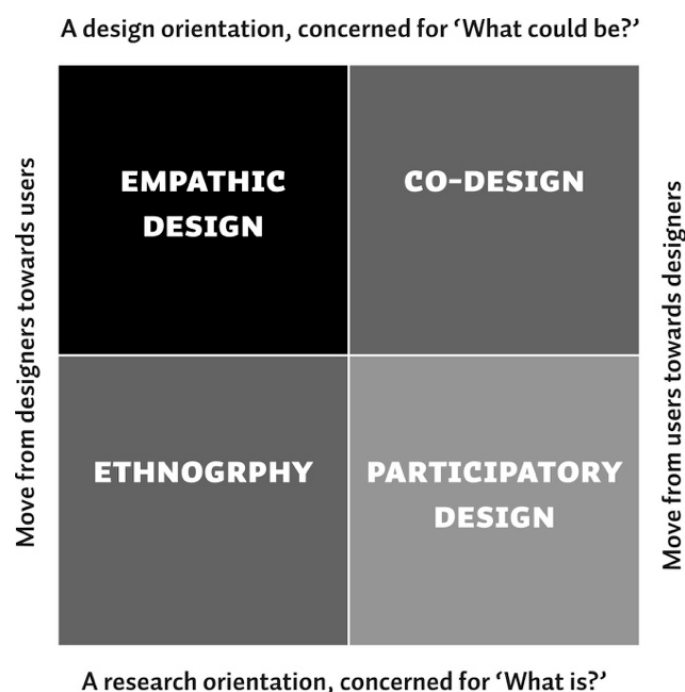
Most of the literature on participatory design relates to projects conducted in Western contexts. Nonetheless, some studies have been carried out in developing country settings. Hussain et al. (2012) suggest that the designer should lead the participatory design activities even if this contradicts the traditional democratic principles of participatory design [28]. Kujala (2010) suggests that the role of the users and the designer needs to be carefully considered [29]. In a case of complex health information systems design in a developing country context, Gregory (2009) emphasizes that the important starting point is to have an intention of mutual learning in challenging settings, then this can further open into reciprocal design [30]. Using classical participatory methods in these societies has also been a subject for critique, as they often do not lead to the desired results [31]. Participatory rural appraisal [32] and participatory action research have been widely used by non-governmental organizations in community development. However, participatory design requires a long-term involvement in a community, which is not always possible in fast urban development in chaotic low-resource settings.

The discourse of different approaches in human-centered design is relevant here due to the challenging settings, constraints, and divisions between stakeholders that often exist in low-resource settings discussed above. Within the human-centered design literature, a model has been proposed by Steen (2011) where he defines the different orientations within the field (Figure 1). In relation to this categorization, Empathic Design would be a good solution for user involvement in architectural projects in developing countries, as the leading role would remain with the architect who would lead with empathy, taking the actual needs of the user into account. According to Steen (2011), there must be a clear script on how and to what extent the users are involved in the design process [33]. He maps four different types of human-centered design: Empathic Design, Ethnography, Co-design, and Participatory Design, with respect to their design orientation (What is?/What could be?), as well as the direction of the approach (users to designer/designer to user).

Steen (2011) states that in Participatory Design, the users move closer to the designer, while in Empathic Design the designer moves towards the users. The difference between Empathic Design and Design Ethnography is that Ethnography takes the research orientation of 'What is?' while Empathic Design has an orientation of 'What could be?'. For architectural projects such as the ones studied here, there is a need for more than observation, i.e., a need for the designer to understand the living conditions of people in different cultural and social contexts. The active movement of the architect towards the users with the question 'What could be?' seems relevant in this context [33]. Being responsible for this active movement, the architect can get emotionally involved, whereas, differing from traditional participatory design, the future inhabitant does not necessarily need to be involved as much in the design process when it is done according to Empathic Design principles [34]. This approach can be very helpful in a developing country context, where it is challenging to conduct

deep participation, as the future inhabitants might not be empowered, might not have the time and energy to invest to the project, and might not be used to take part in a design process [28].

The term Empathic Design originates in innovation; for companies to be commercially successful, the products they sell need to meet the needs of the customers [3]. Peculiarly, meeting the needs of users who contribute to business innovation can also support the achievement of social and cultural sustainability in an architectural context. The foundation of Empathic Design is that researchers and designers, and in the case of this study, the architects, are seeking interaction with the end-users or future inhabitants of a housing scheme, trying to empathize with their life experience from a very early stage of the design process. The focus includes individual desires, moods, and emotions of the inhabitants that inspire and guide the project. Recent studies on Empathic Design suggest an emphasis on sensitivity [35]. The sensitivity approach in empathic design enables flexibility and adjustment to the prevailing situation and is crucial in the context of rapid urbanization—the scene for this study. In this situation, the architect as well as the other stakeholders must understand the diverse and transformative living conditions of people in different cultural and social contexts. According to Koskinen (2004), Empathic Design answers exactly these needs [36].



**Figure 1.** Diagram of the differences between approaches in human-centered design, Steen (2011).

### 3. Learning from Existing Sustainability Models and Three Examples of Affordable Housing

In this section, we describe the stages of our study in detail. The method we have used in this paper is a combination of studying existing sustainability assessment models, and with the help of a synthesis model, examining examples of affordable housing. The results of the examination have led to a simple model that shows which aspects of sustainability are related to human interaction in the design process.

The process of creating this model was threefold. Firstly, we evaluated two different sustainability assessment models that were developed for low-resource situations, and we created a synthesis of those (Figure 2). Secondly, we tested this synthesis model on three heterogeneous examples of affordable housing in Namibia, Tanzania, and Chile. All aspects of the synthesis model were examined in each example. The test revealed some lacking aspects that we included in a new version of the model. It also showed that while some aspects mainly belong to one dimension of sustainability, many belong

to several dimensions, and therefore, the dimensions often overlap. Thirdly, this new model was used to examine the sustainability in each of the chosen projects. This examination resulted in a table (Table A1). We let the results of the analyses of the examination inform us on which of the aspects of sustainability require involvement between the architect and the inhabitants during the design process. Our objective is not to develop a new assessment tool, but to investigate what aspects are important, while aiming for sustainable development in low-resource settings and to find out where inhabitant engagement is relevant.



**Figure 2.** A synthesis of two sustainability models for housing in low-resource settings.

### 3.1. The Synthesis of Two Existing Sustainability Models

The first stage of this study was to do a synthesis of two relevant sustainability models as a base for our study: QSAND, that was developed by the Building Research Establishment and the International Federation of Red Cross and Red Crescent Societies for humanitarian construction and Sustainable Housing for Sustainable Cities, A Policy Framework for Developing Countries by UN Habitat [2,17,18]. The reason for choosing these two particular models as a basis for our analysis was that they are both designed for low-resource settings. To include complex assessment models designed for developed country settings would not have been relevant to this study. In the end of this chapter, we are presenting a combined simplified synthesis of the QSAND and UN Habitat models that reveal different aspects to consider within the four dimensions of sustainability in an affordable housing project (Figure 2).

#### 3.1.1. UN Habitat Sustainable Housing for Sustainable Cities

The UN Habitat guide for designing sustainable housing policies and practical actions seeks to promote an integrated policy where environmental, economic, social, and cultural aspects are addressed in housing. This kind of policy, however, is still rare in developing countries [2]. The approach “advocates sustainable housing as socially enhancing and environmentally friendly residential practices integrated into the wider urban/settlement systems” [2], where sustainability and affordability go hand in hand. We find this model particularly interesting, as the emphasis on cultural sustainability is equal to the other dimensions. The approach is an extension of the adequate-shelter-for-all strategy of the Habitat II Agenda 2003 [37].

Despite the New Urban Agenda from Habitat III 2016 [38] that addresses these questions more contemporarily, we find the content of the guide very relevant up to this time. The guide presents a framework which is used for the synthesis model in this paper. Additionally, the guide discusses extensively the different aspects of the framework and reflects upon the relevance for affordable housing of the different dimensions of sustainability. The guide is produced to assist national and local level decision makers, as well as professionals and different stakeholders in the housing sector (Table A2).

#### 3.1.2. QSAND

QSAND was developed by the UK charity Building Research Establishment (BRE) Trust, which provides research and education in the built environment on behalf of the Red Cross. It was done



as a step towards the Red Cross's Strategy 2020 of (1) save lives, protect livelihoods, and strengthen recovery from disasters and crises; (2) enable healthy and safe living; and (3) promote social inclusion and a culture of non-violence and peace. The tool is a further development and adjustment of the standards of Building Research Establishment Environmental Assessment Method (BREEAM), one of the commonly used sustainability certification schemes for the built environment, also developed by BRE Trust.

The intention of QSAND was to support aid agencies and donor organizations striving to recreate a sustainable built environment after natural disasters. QSAND is a self-assessment tool free to be downloaded online and used by individuals who have undergone an online tutorial. The tool is designed to applicate sustainability throughout the reconstruction process and the life cycle of the development. It can also be used to monitor the recovery of the community [18].

The view of sustainability is based on three dimensions: social, environmental, and economic, and the influence of the dimensions on each other [39]. The focus for the social dimension is on participation and community-sensitive design, for the environmental dimension on ecological protection, and for the economical dimension on site selection and spatial planning to help the community to be re-developed in a way that supports the growth of livelihoods. Even if cultural sustainability is not part of this model, it contains aspects that enrich the UN Habitat model, and therefore, we wanted to create a synthesis of the two for our analysis. The tool is divided into two parts, one for pre-assessment and another for core assessment [18]. For our synthesis model, we have used the core assessment only; as our focus is on housing and not on disaster recovery, decisions are not needed to be made in a speedy manner, as in the case of disaster. QSAND is a measurement tool opposed to the Habitat Sustainable Housing for Sustainable Cities, which is a guide for practitioners. Nevertheless, the aspects relevant to our research are similar and comparable (Table A3).

### 3.2. Three Examples of Affordable Housing

In the second phase, the synthesis model (Figure 2) was tested on three examples of affordable housing: Kuisebmond in Namibia, Chamazi in Tanzania, and Quinta Monroy in Chile. The data concerning each example comes from different sources and is not fully comparable. The reason for choosing these examples was that they demonstrate different types of affordable housing in low-resource settings and illustrate the aspects of inhabitant engagement.

In the context of each example, data is gathered from different sources. In the case of Kuisebmond, the data consists of (1) several documents from an evaluation currently being done on the national mass housing program by the Namibian architectural firm Nina Maritz Architects [6,40–46]; and (2) through field interviews and observations by one of the authors in 2016 [47]. In the case of Chamazi, the data comes from (1) discussions with the personnel of the NGO Centre for Community Initiatives and an article written by the managing director of the NGO [5,48]; (2) an article about community empowerment in subsistence markets studying the case of Chamazi [4]; and (3) from field observation by one of the authors in 2014 and 2015 [48]. In the case of Quinta Monroy, data comes from (1) a publication written by the architects behind the Quinta Monroy project [7]; (2) a critical scientific article on the case [49]; and (3) internet publications in Arch Daily [50,51], an internet portal, as well as one article in the Guardian [52].

#### 3.2.1. Kuisebmond

The urban growth of Walvis Bay is expected to double by 2030 to an estimated population of 180,000 (from 79,500 in 2014) [45]. In Namibia, there is often an inherited unequal pattern of settlement because of apartheid policies followed by the colonial government [6,42]. In the Kuisebmond area, the government has aimed to respond to the growing need for housing through a mass housing project implemented by the NHE (National Housing Enterprise) and the Build Together program (Figure 3). The NHE is a solely government-owned enterprise that has a mandate to offer housing solutions for national housing needs [46]. However, vulnerable groups such as unemployed and low-income groups

are excluded from access to this government-led housing program. Weak transparency and a slow and unclear decision-making process in this program reduces trust. Transparency in decision-making is considered weak as there have been a limited number of consultations of relevant stakeholders. There also seems to be a lack of good practice evaluation. A decentralized governance model enables local participation at least in theory. Local housing NGO Shack Dwellers Federation of Namibia offers a community network of savings groups and receives annual funding from the government to improve the situation. This is the only form of community participation in the field of affordable housing [47]. In the Kuisebmond project, the end-users were not involved in the process of architectural design [45].



**Figure 3.** Kuisebmond. Photo: Nina Savela.

### 3.2.2. Chamazi

In 2007, the inhabitants of the Kurasini area in Dar es Salaam faced the threat of eviction due to the expansion of the city port. For most of the inhabitants, this meant losing their homes, their neighbors and their livelihoods without compensation, as they were tenants [5]. The government did not provide the tenants that were evicted with any support. The project is an offspring of that failure. The inhabitants were supported by the Tanzanian Federation of the Urban Poor (a sub organization for Slum Dwellers International) and the local NGO Centre for Community Initiatives (CCI) to create a platform for discussion and to make a numeration study on the inhabitants of the area, as no such data existed. This process led to the former inhabitants of Kurasini being able to purchase a plot of land and establish a new community in Chamazi with financial support from Slum Dwellers International [4,5]. This small urban community that is growing incrementally is thus created by the inhabitants themselves (Figure 4).



**Figure 4.** Chamazi. Photo: Helena Sandman.



### 3.2.3. Quinta Monroy

The architects of Elemental Chile were asked to solve the challenge of resettling 100 families who had illegally occupied a site in the center of Iquique for the last 30 years on the same site [50]. The work had to be done within the budget of the Chilean Housing Policy. This equation was solved by a dense urban plan providing half a house to the families with the possibilities for expansion in the future (Figure 5). The project was initiated by a design process aimed at finding a model for housing that would fit into the equation of available land and budget. When the spatial solution was found, the rest of the process was carried out in a participatory manner [7]. The same concept for social housing has been replicated in many projects in Chile. There are different opinions on the success of the project. Alejandro Aravena from Elemental Chile won the Pritzker prize in 2016 for his architecture that reduces inequality [50], but he is accused of inventing a neoliberal method to produce social housing that binds poor people to debts and therefore is vital for the capitalist landscape [49].



Figure 5. Quinta Monroy. Photo: Elemental Chile.

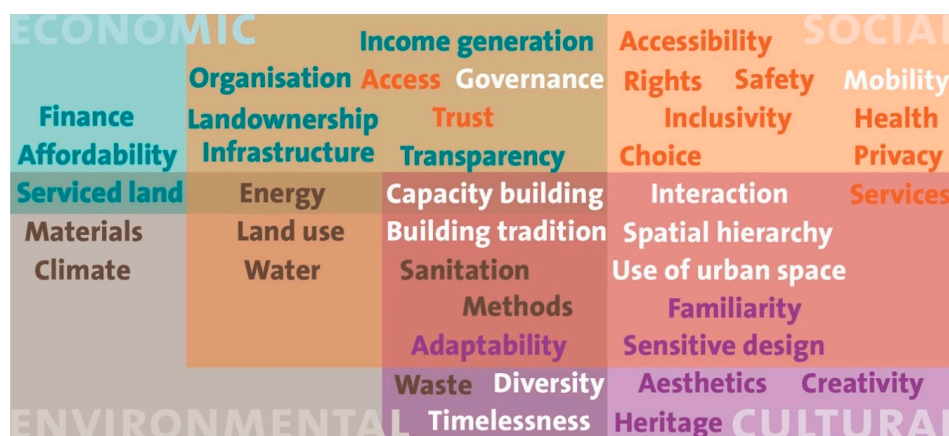
### 3.3. Using the Model to Find Relevant Aspects in the Design Process

Through testing the synthesis of QSAND and UN Habitat sustainability models according to the method explained in the beginning of Section 3 on the three examples of affordable housing using the available data introduced in Section 3.2. It was revealed that many of the sustainability dimensions overlap each other. The division into four different dimensions is not clear, as the borders are blurred, and it is often relevant to look at the aspects from several different perspectives. Therefore, we developed a new model that shows the overlaps. Additionally, we found aspects relevant to the design process that were not part of the original models used for the synthesis. We included these aspects in the new model (text in white) (Figure 6).

None of the models propose a focus on the *governance* of the project process, and in the future, the housing area. This is an aspect that has an influence on the social sustainability of a project. In the three examples, the governance is carried out in different ways. *Mobility* was not mentioned in the examined models. The options for mobility relate to income generation and infrastructure and are therefore connected to the economic, social, and environmental dimensions. Other aspects relating both to cultural, social, and environmental sustainability were *interaction* and *capacity-building*, relating openness and striving for innovative local and frugal solutions. Relating to cultural sustainability according to how it is defined in the UN Habitat model [2], we lacked the aspect of *spatial hierarchy*. This is defined by the movement from public to private space, as this may vary a lot between different cultures and affects the usability of a home and adds to the ability to feel at home. Sensitive design can relate to this, but the definition in the existing models is too tight to involve this aspect. *Use of urban*

*space* was also an important aspect, as this relates to urban culture, and as many of the fast-growing cities in developing countries are positioned in the Global South with a warm climate, outdoor life is important to value and include in the design process. *Diversity* is strived for on all levels, relating to the population in terms of income, culture, and age, as well as to potential activities. For cultural sustainability that has an influence on all the other dimensions, we also missed the aspect of *timelessness*, as a timeless design, not following trends, is durable. We also extrapolate the aspect of *building tradition*, as it covers both methods and materials used that often reflect the requirements of local climate conditions as well as locally available materials and skills.

In the third phase, we used this newly created model to analyze the three examples more extensively than in the first round by looking at each of the aspects in each of the three projects and recording results in an extensive table (Table A3). However, below we present a summary where the main aspects are addressed. For clarity in the text, we have maintained the organization of the aspects according to the principal sustainability dimension for each aspect, even if we are aware of the overlapping as discussed above. The purpose of this study is not to evaluate these projects in detail, but to learn what aspects to be conscious of and how to address these aspects in relation to inhabitant engagement.

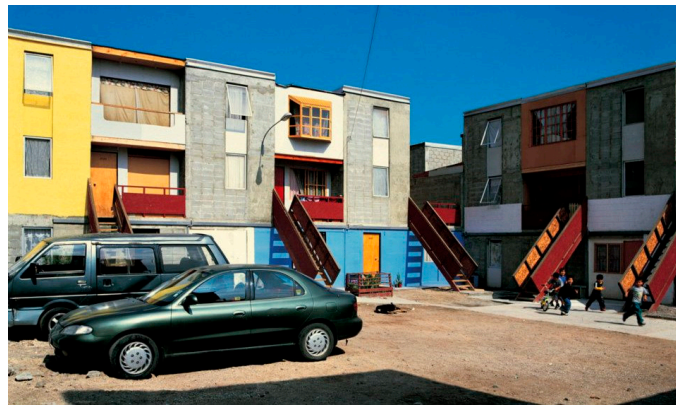


**Figure 6.** Illustration of the different aspects of sustainability regarding affordable housing design in developing countries and how the aspects of sustainability overlap.

### 3.3.1. Environmental Sustainability

Most of the materials for the Kuisebmond project are imported, which already renders the project not very environmentally friendly, as it raises building costs and influences the affordability of housing. Nevertheless, the wooden parts are biodegradable, and the steel can be reused. The concrete is possible to downcycle for infrastructure, such as road construction. Using concrete as a construction material is not energy efficient. There is apparently little interest in using alternative technologies and local materials in the implementation of the NHEs [45,46]. The Kuisebmond area is not densely planned and will thus add to urban sprawl if the city is growing as fast as predicted [47].

In the Quinta Monroy project, there has been a focus on the design phase to create measurements according to standard material availability, not to cause any unnecessary costs, and to make it easy for inhabitants to build incrementally and make extensions [7] (Figure 7). The main material of the core structure is concrete, which is not a material with a low carbon footprint; however, the economical form of the buildings saves material, and the concrete can have a new lifecycle in road construction [53]. The materials are durable. The materials of the initial construction are not possible to recycle; however, the extensions can be made of reusable or recycled materials. The materials were transported to the site. The row-house model is more efficient than one family houses, but only two floors does not make the habitation very dense [7].



**Figure 7.** In Quinta Monroy, the inhabitants have the freedom to build the extension of their house in any preferred style using their own creativity. Photo: Elemental Chile.

In Chamazi, the walls are made of interlocking bricks of local earth with a minimal addition of cement. The roofs are made of fiber-cement tiles [48]. The materials are durable even if the roof tiles need maintenance. The roof structure is made of wood, which is available in Tanzania. The wood is durable if the roofing stays intact, and it is not exposed to water. The access of termites to the roof structure also must be prohibited. The materials are not recycled but reusable, as the interlocking compressed blocks are stacked without mortar. The quality of the construction is not very high [48]. The materials are energy efficient; however, wood and cement needed to be transported to the site. The houses have only natural ventilation. There are green areas on part of the plot. The sewage and sanitation systems are innovative, and all wastewater is treated on site [48]. Single family one-story houses are not an efficient way of using land and adds to urban sprawl; however, the split of the normative size of a plot makes the site more densely inhabited than regular officially planned areas in Dar es Salaam [4,5].

### 3.3.2. Economic Sustainability

When examining the projects from an economic point of view, the houses in Kuisebmond are too expensive for people with really low income. Additionally, there are significant registration and administrative costs in urban land registration [40,44]. Because of the bureaucratic nature of the process, the houses in the Kuisebmond area are visibly difficult to access, and furthermore, some of the houses are empty and vandalized. The capacity for skills development for the inhabitants in the area is weak. There are no spaces for income-generating activities in the area. Private sector financing is usually limited to the high- and middle-income sector [42]. This creates a missed opportunity in using housing as a tool for integration of different income groups.

In Quinta Monroy, the people who originally lived on the plot and who had access to the national social housing scheme had access to this project; still, we do not know whether everybody had access. The inhabitants had the possibility to choose between elements within their house, within the monetary restrictions [7]. The pricing is according to Chilean social housing standards; besides, instead of receiving a house that is too small, the inhabitants receive half a suitably sized house [7]. People with any income will have the possibility to purchase a house, but they will be bound to a loan, and there is no variety in size, price, or quality in the initial state [7,49]. After the initial purchase, each inhabitant has the option to ameliorate their apartment and make it bigger [7]. The area has been evaluated and the value of the apartments has increased five-fold in ten years [52]. The very organized and long-term participatory design process in this project allowed for a lot of capacity-building. There were learning possibilities for the inhabitants that could potentially be used for income generation, as they were guided by the architects on how to expand their homes [7].

In Chamazi, the sizes of plots were diminished to keep the price of purchase lower [4]. The whole area is built incrementally, for one house to finance the next. The houses were built with the minimal amount of materials and minimum costs. The houses are planned to be as affordable as possible, as the groups were originally tenants. The system for finance is self-organized within the community. The project was done with financial support for the purchase of land. People with any income can purchase a house, but there is no variety in size or quality. The arrangement of credits and incremental construction (one house at a time) made the project possible. There is no information about whether the value of the houses has increased with time, but it is possible, as the methods of construction were the cheapest possible, and the houses were constructed without intermediaries [4,5].

### 3.3.3. Social Sustainability

From the social perspective, the Kuisebmond housing area is an endeavor by the Namibian government to address the housing challenges. However, in reality, the implementation has been challenging, and the actual needs are not completely met. The reality is more diverse than predicted; for instance, some people (mainly men) move from rural areas only to live in the city for periods of time in the year, work, and send money back to their families. Thus, there is a need for a wider range of options, such as subsidized renting and rent-to-buy schemes, to respond to the changing lifestyles. There was no kind of participation involved in the planning of the area. There is potential for social unrest in the Kuisebmond area, as the urban arrangement is monotonous, and walls will probably be constructed around the plots for security. There are no public spaces, parks, or areas for social interaction planned [47].

In Chile, Quinta Monroy is one of several projects carried out according to a housing scheme where the architects influenced the government to make changes in the governmental social housing system for it to accommodate a better structure for social housing [7]. The architects aimed at building capacity for self-organization of the community. The participatory process was also striving to maintain the feeling of neighborhood and belonging among the inhabitants [7].

The Tanzanian project differs from the two others, as in Chamazi, the initiative of the project was taken by the community members, and it was taken forward with the help of an NGO that secured the participation of the inhabitants and meaningfulness of the project for them. TFUP and CCI also built capacity in the community for self-organization [5]. The community participated actively in the whole process of the housing project from the initial stage to realization. The project was totally transparent during the whole process [4]. All people in the original scheme had potential access to the houses; nevertheless, the time span might have made it impossible for some to wait for their turn to receive a house [4]. There is a diversity of inhabitants; however, all belong to a fairly low-income class. Throughout this project, from the perspective of safety, there was trust between the people; most of the inhabitants knew each other from before, as they lived together in Kurasini and created the project together [4].

### 3.3.4. Cultural Sustainability

Looking at the examples from a cultural point of view, the Kuisebmond houses could be anywhere in the world. The building tradition could potentially be adopted from South Africa. However, no cultural identification features are visible, not on the outside of the buildings, nor by investigating the use of space [47].

In Quinta Monroy, the innovation of providing the inhabitants with half of a house instead of a house that was too small was developed by the architects alone, not in collaboration with the end-users [7]. Nevertheless, the outcome of the project had a very strong influence on its inhabitants. The parts of the house that inhabitants have had the opportunity to build and design themselves are truly local and reflect the diversity of colors and personality of both culture and inhabitants. The colorful varieties of the personal extensions make the whole project alive and bound to the Chilean vernacular, while the structure designed by the architects follows a well-planned minimalistic and



timeless aesthetic [50]. Elemental Chile declared the plans for the housing Open Source in 2016 [51]. This is a big and important step in trying to tackle the challenge of rapid urbanization. The question remains about how to anchor the architecture to local climate, local culture, and local use, in different settings, as the plans alone do not solve this challenge.

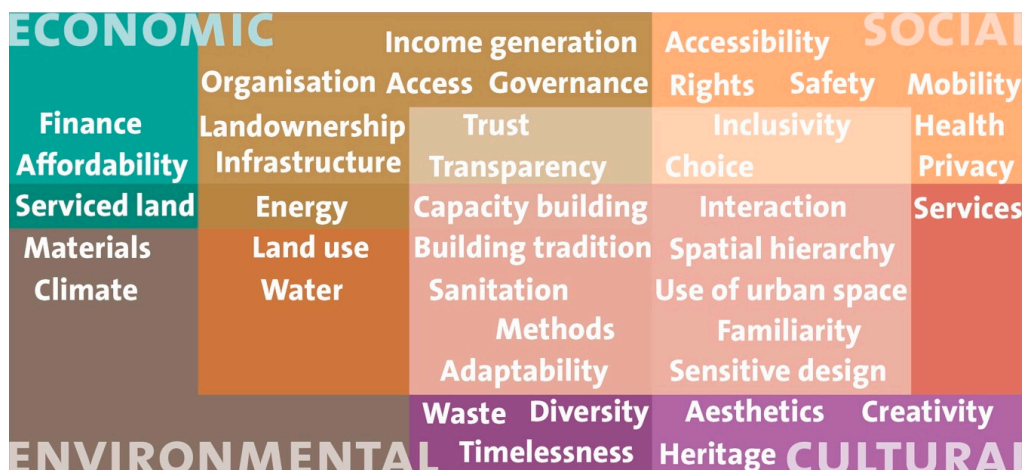
In Chamazi, the area and the houses were designed by a local architect in a conventional manner ordered by community representatives according to the needs of the community [48]. The design followed local suburban norms, except for the sizes of both plots and houses that were smaller [5,48]. The form does not leave space for innovative expansion nor for personal adaption [48]. The organization of the house follows in some respects the traditional way of using space, having a front veranda and the kitchen opening towards the back of the house. Nevertheless, many aspects are forgotten, for instance, the backyard activities, such as laundry, sanitation, and cooking privately in the culture, and this house does not allow for private outdoor activities (Figure 8) [48]. How the houses meet the street has potential to create a traditional street life. Nothing emphasizes locality in the details or decoration. The design of the houses is somewhat timeless and neutral [48].

Through this analysis of the projects, we noticed that several aspects emphasizing cultural and social sustainability require a connection to the people who will use the buildings. The empirical insights of this study have helped us to outline a section of our model where engaging with inhabitants is necessary (Figure 9). Full engagement is not always possible. In the following discussion, we will investigate the possibilities to use an Empathic Design approach to address the aspects that require inhabitant involvement.



**Figure 8.** In Chamazi, there is no designated back yard space, which is one of the most used spaces of a traditional Tanzanian house. The back yard is traditionally used as an extension of the kitchen and an area for hygiene and laundry. Photo: Helena Sandman.





**Figure 9.** The white bubble indicates which of the aspects of sustainability require inhabitant engagement where methods of Empathic Design could be applicable.

#### 4. Discussion: The Potential of Inhabitant Engagement to Reach Social and Cultural Sustainability

In this section, we discuss means to address the aspects illustrated in the model presented in Figure 9 where inhabitant engagement is required. The multiple level challenge of involving inhabitants in the design process might be one of the reasons that social and cultural sustainability is more difficult to define and has therefore tended to receive less attention in traditional sustainability endeavors. Taking into consideration the involvement of the inhabitants might be one strategy to meet the challenges of social and cultural sustainability in the design process of affordable housing in developing countries. To reach these aims, the analysis above shows that architects need to understand the people who will inhabit the houses.

Previous literature on human-centered design and the findings of this study suggest that Empathic Design can support user involvement in architectural projects in developing countries. In Empathic Design, the designer has a leading role but is leading with empathy, taking the actual needs of the user into account. To achieve a sustainable outcome of the different aspects outlined in the model: *trust, transparency, choice, interaction, capacity-building, inclusivity, sanitation, spatial hierarchy, use of urban space, sensitive design, adaptability, familiarity, methods, and building tradition*; methods from Empathic Design can be useful. These methods are often agile, flexible, and do not always require a consistent presence of the designer/architect [36,54,55]. There is an advantage if this connection can be established in the very early phase of a project, as the base for sustainable outcome is laid [53]. In the case of a housing project such as Chamazi, where the inhabitants were in a sensible situation of being evicted, the ability to listen to people's emotions and support an empathic environment, where, for instance, fear can be shared, will have a positive influence for the potential of long-term sustainability. In the Chamazi case, the collaboration with the NGO started already when the notice of eviction was announced, and the community was part of the creation process of the solution of creating a new community for the evicted tenants. This kind of transparency and open collaboration is a foundation for trust, builds capacity, and lets the people involved have a choice. In Empathic Design, there is, for instance, the method of Design Probing, which happens in the early phase of the process, where people involved are asked to fill in or do exercises planned by the designers [54]. The exercises could, in this case, include tasks that reveal living habits, traditions, and wishes and hopes for the future. In the Quinta Monroy project, many participatory workshops took place. This led to a devoted participation in the further development of the area, also after the architects were no longer part of the project. Nevertheless, this kind of workshop-based activity that involves a large number of inhabitants requires a lot of organization and time. The lack of involvement is visible in the Kuisebmond project. This is further

bound to the growing separation and isolation of different income groups in the area. In the ideal situation, the interaction with end-users happens throughout the design process [56].

In the case of Kuisebmond, as there was no participation of local inhabitants, there is also no indication of social or cultural sustainability, nor acceptance [42]. In this case, already, using photography, another technique from Empathic Design, would have been most helpful. In this case, future inhabitants would have been given disposable cameras or used their phones to take pictures of their existing homes and surroundings. Ideas from these environments would have been developed and integrated into the new neighborhood. This would have most probably led to some familiarity and cultural identity recognizable for the inhabitants. Both Chamazi and Quinta Monroy have many aspects that show an emphasis on both social and cultural dimensions of sustainability. As an example from Chamazi, the Tanzanian way of relating to your neighbors is through spending time on the porch of your house talking to passers-by. The housing design in Chamazi allows for this cultural and social tradition to continue. Without engaging in the life of the people, this aspect would not have been known. The plots are not surrounded by a wall, and the porch of the house opens towards the street. This kind of knowledge concerning use of urban space and spatial hierarchy can be shared through different techniques. For instance, story-telling, personal interviews done by the architect or someone else, or the previously mentioned methods of Design Probing or self-photography could reveal these aspects. In the projects investigated for this paper, Design Probing was not used as a method of interaction; nevertheless, the authors have experienced this method as worthwhile in the beginning of the design process. In Quinta Monroy, half of the house is not built. This has resulted in the inhabitants using their creativity while filling up the gaps in the row houses. This form of the design allows for a local continuation of the vernacular architecture and supports cultural sustainability. It also gives space for local building tradition and methods, builds on capacity, and is adaptable for future needs. In this project, a training period on construction was included in the collaboration process between architects and inhabitants.

Empathic Design also requires time, even if the involvement does not need to be on a continuous basis as proper ethnographic studies or long-term participatory planning. This can nevertheless be a challenge in fast-growing urban settings. It is not enough to only observe people's thoughts, motivations, values, or preferences. To get in touch with these observations, there is a need for a more interactive connection. In the endeavor to empathize, all the methods used have the goal of getting a personal input from the participants and a personal experience for the architect. A large portion of the empathic experience depends on the empathic ability, attitude, and motivation of the architect [55]. Using Empathic Design can make the architectural design process empowering for all people involved, both architects and users. However, an Empathic Design process does not guarantee a better design outcome; nevertheless, it has the potential to make a project locally grounded and make the inhabitants feel ownership. We argue that this can have a significant effect on the level of social and cultural sustainability.

## 5. Conclusions

In this article, we have created a synthesis model based on existing sustainability research in the context of housing. The purpose of the synthesis model was to demonstrate areas where previous sustainability studies have focused. We applied the synthesis model into analysis of three examples of different housing solutions from developing countries. Our analysis revealed that the models studied (QSAND and UN Habitat) are appropriate to use for affordable housing in low-resource settings. Nevertheless, there are shortcomings of the synthesis model, especially in terms of social and cultural sustainability and the structure, as many aspects overlap and support several dimensions. Based on our empirical findings, we developed a revised version of the synthesis model. The exercise was carried out to have a tool for revealing aspects that require inhabitant engagement. The model we have presented is not all-encompassing and should be considered as a step towards a more holistic understanding of sustainability.

The findings show that sustainability analyses cannot focus only on the outcomes of design processes, but instead, analyses must include some indicators for what has happened during the process. Similarly, it is important to estimate how well the architect and other stakeholders have managed to create and maintain a connection to each other throughout the design process. We draw on principles of Empathic Design which emphasize the importance of emotional connection between the designer and the inhabitants to understand the social and cultural aspect. Once people are engaged from the very beginning, they feel ownership and can better commit to the aims of the project, which typically leads to more sustainable outcomes in all dimensions of sustainability.

How difficult is it to combine the qualitative and quantitative sides of sustainability? The analytical model that we have developed enables inclusion of the social and cultural dimension into sustainability analyses of housing solutions. Our model also helps architects to consider their role in relation to social and cultural sustainability in practical design projects. Our findings are informative beyond the housing context. We argue that by studying housing solutions in the vulnerable conditions of developing countries, it is possible to better understand the critically important role that social and cultural sustainability plays in all kinds of sustainability analyses. We suggest further research on the creation of a proper measurement tool specifically designed for affordable housing in low-resource settings with inhabitant involvement as a prerequisite.

Future research should explore in more detail how Empathic Design can be useful when addressing the sustainability aspects of design processes. The research carried out in developing country contexts can be very informative in this respect. The idea of stakeholders' active participation is not the standard way of conducting design processes in developing countries, which opens interesting opportunities for studies on co-creation. Based on our findings, we hypothesize that Empathic Design will be a fruitful method when addressing aspects of social and cultural sustainability that need interaction.

**Author Contributions:** H.S. is the main author of the paper. She has a long practical experience of architectural projects in developing countries. She has developed the model for recognizing the aspects of sustainability that require inhabitant engagement and studied Empathic Design. She has also studied the Chilean project by Elemental Chile and visited the Tanzanian Chamazi project and written the parts of the paper about these projects. N.S. has written the parts on the Namibian Kuisebmond project and also collaborated on the parts of the text concerning sustainability. J.L. has contributed to the text about the different dimensions of sustainability, the introduction, conclusions and the overall structure of the paper.

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**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

Table A1. Sustainability examination of three affordable housing projects.

DIMENSIONS [2,18]	Kuisebmond	Chamazi	Quinta Monroy
<b>SOCIAL</b>			
<b>Safety</b> Security, trust in neighbors and authority, feeling at home, connections, urban form and form of structure, materials that are durable, accessibility for fire engines and ambulances, taking into considerations healthy materials and construction methods as well as possibilities to reach health care facilities and pharmacies.	The second least densely inhabited country in the world, smaller risk for hazards. The street structure gives access to fire engines, and the materials and form of the houses are rather fire-proof, except the roof structure. Urban arrangement, no units of houses, monotonous urban planning, potentially walls will be constructed for security.	The community is small and have been organized since the beginning. There is a trust between the people. The area is accessible for fire engines and ambulances. Wood is used in the construction of the roofs, which is not fire safe, but otherwise the materials are safe. The courtyards are not walled, but the windows have bars.	The participatory process was striving to create a feeling of belonging among the inhabitants to create safety. The houses are only two floors high and the regular streetscape allows fire engines to pass easily. The materials are fire safe.
<b>Access, Accessibility, and Inclusivity</b> for all societal levels, ethnical groups, and people with physical disabilities, shared responsibilities, and shared opportunities.	Connected to the access of housing. Vulnerable groups such as unemployed and low-income groups are excluded from the process. Constructed in one floor, but no ramps.	All people in the original scheme had potential access to the houses, but the time span might have made it impossible for some to wait. Constructed in one floor, but no ramps.	The people the area originally was meant for had access to the social housing scheme. The organization among future neighbors allowed them to share responsibilities and opportunities [7]. Stairs, no ramps.
<b>Interaction and Participation</b> , sense of community, trust in neighbors, form supporting social interaction, connections to neighbors, meaningfulness of the interventions done and decisions taken, feeling of ownership, ownership, learning possibilities.	Weak transparency and slow and unclear decision-making process reduces trust.	The initiative of the project was taken by the community members and it was taken forward through a local NGO that secured the participation of the inhabitants and meaningfulness of the project for them [5].	The inhabitants were informed of the details, restrictions and constraints during the whole process [7]. The focus was on information and choice within restricted frames [7]. There were learning possibilities for the inhabitants.
<b>Transparency</b> Trust in system and authorities, information management practices, open access of design.	Transparency in decision-making considered weak as there have been a limited amount of consultations of relevant stakeholders. No good practice evaluation. This reduces trust.	The project was totally transparent during the whole process [4].	The project was transparent during the whole process and focused particularly on keeping the inhabitants informed of the budget and steps taken [7]. The drawings are shared as open source by the architects and can be used by anybody [51].
<b>Empowerment and Capacity-Building</b> Public participation, capacity for self-organization, societal collaboration, community structure.	Shack Dwellers Federation of Namibia offers a community network of savings groups and receives annual funding from the government. Decentralized governance model enables some local participation.	The help of the NGO Center for Community Initiatives and the Federation of the Urban Poor (part of Slum Dwellers International) has helped the community to self-organization [5].	The architects aimed at building capacity for self-organization of the community [7].
<b>Services</b> Areal planning: schools, public services, health care, shops, access to public transport.	Community services available in the area.	The area is not very big and there is a nearby community with schools and shops. Nevertheless, a small market place, an area for agriculture, a community hall, and a bus station was planned into the area.	The area includes only housing, but the inhabitants has the possibility to have income-generating activities in the ground floor.
<b>Governance</b>	The government addresses the housing challenges in its policies and programs. However, in reality the implementation of these policies has been challenging.	The government did not provide the tenants that were evicted with any support. The project is an offspring of that failure. The project is self-organized and governed with the help of NGOs [5].	Initiated by a group of architects based on the social housing scheme of Chile. The architects influenced the government to make changes in the scheme for it to accommodate a better structure for social housing. The project was planned accordingly. [7]

Table A1. Cont.

DIMENSIONS [2,18]	Kuisebmond	Chamaz	Quinta Monroy
<b>CULTURAL</b>			
<b>Cultural Heritage</b> Tangible and intangible, history of place, history of people and activities, capacity-building in a sustainable direction regarding energy use recycling, communal living, place maintenance etc.	Some move from rural areas only to live in the city for some periods of time in the year, work and send money back to their families in urban areas (mainly men). Thus, there is a need for a wider range of options, such as subsidized renting, rent-to-buy schemes to respond to the changing lifestyles.	The community members had a say in the planning of the houses and the houses were done by a local architect [5]. There is a basic form that follows a bit the traditional way of using space, but many aspects are forgotten. There were no structures on the area before.	The people were staying where they lived before. The houses were constructed in the same area [50]. Even if the actual living area changed, the nearby surroundings stayed familiar.
<b>Adaptability and Choice</b> Possibilities to make personal choices, incremental construction possibilities: if the family grows, the home can grow, if the income grows the home can be updated accordingly.	There is not much space for extensions around the houses.	The area and the houses were designed by a local architect ordered by representatives of the community according to their needs. The design is conventional, except that the houses were made smaller than the common house type. The form does not allow extension nor personal adaption. The area is built incrementally, for one house to finance the next [5].	The whole scheme has a strong innovation of providing the inhabitants with half a house instead of a too small house [7]. The form leaves space for optional extension of the house. The inhabitants also had the possibility to choose between elements within their house, within the monetary restrictions.
<b>Diversity and Inclusiveness</b> , mixed use: income, age groups, ethnic, prevention of segregation.	Age groups: pensions provided by the government, inherited unequal pattern of settlement as a result of apartheid policies followed by the colonial government [20,34].	Anybody within the community had accessibility to the project. There is a diversity of inhabitants, but all are of a fairly low-income class [5].	As it was a certain group that was moved to the area, they were of a rather similar income level, but a diverse age structure [7].
<b>Vernacular building tradition</b> Local forms, resilient techniques, promoting local knowledge, energy efficiency, sustainable resource use.	Building tradition adopted from South Africa.	The form does partly follow local vernacular principles.	The part designed by the architects is contemporary and minimalistic, whereas the potential for extensions leave room for vernacular features.
<b>Spatial Hierarchy</b> Local use of space and structure, steps from public to private, assisting transition from other forms of housing to more dense options.	Strong urban-rural link (caused by historical factors such as apartheid, food security and employment). Patriarchal society where especially unmarried women are facing insecure tenure.	The traditional way of using space in Swahili culture does not fit very well into the Chamazi planning.	The apartments are designed in a basic manner and the house is in two floors. This does not seem to follow traditional use of space, but the literature does not reveal specific answers to this question.
<b>Use of Urban Space</b> Tradition of use of outdoor private or shared space.	No courtyards or public spaces. Monotonous structure of the city scape.	How the houses meet the street has a potential to create a traditional street life. There are also elements such as the market place, that might, when the area is fully populated, have an urban life according to the cultural habits.	This project covered only housing. The buildings are placed in rows, there has not been paid particularly attention to use of urban space.
<b>Cultural and Religious Activities</b> Spaces reserved for religious activities, traditions, and events.	Available and affordable public transportation is important to maintain strong urban-rural linkage between families. Churches or community halls?	There is a plan for a community hall, but no other spaces for cultural or religious activities.	There is nothing that supports cultural or religious activities.
<b>Symbolism, Colors and Decoration</b> Local attachment, dignity.	Natural stones used for decoration?	Nothing emphasizes locality in the details.	The parts that inhabitants have had the possibility to build themselves, 1/2 house are truly local and reflects the color diversity and personality of both culture and inhabitants.
<b>Creative Activities</b> Promoting and arranging space for affordable sports and cultural activities, activity areas for children.	Some but are they accessible to all?	There are no areas designated for these kinds of activities in the plan.	The focus is on the housing and these things are not visibly considered.



Table A1. Cont.

DIMENSIONS [2,18]	Kuisebmond	Chamazi	Quinta Monroy
<b>Aesthetics and Timelessness</b> Neutral design, not to be outdated within a short time-frame. An aim towards beauty.	The design of the houses is somewhat timeless, but not bound to the local culture or traditions.	The design of the houses is somewhat timeless and neutral and parts of them are bound to local vernacular.	The designed part of the architecture follows a simple and well-planned aesthetics while the colorful varieties of the personal extensions makes it alive and bound to culture [50].
<b>ENVIRONMENTAL</b>			
<b>Material Efficiency</b>	Materials as basic as Portland cement, steel and construction timber are not locally available and are imported from neighboring countries. This raises building costs and affect the affordability of housing. Banks are reluctant to finance houses using alternative material as they are not considered durable. Small number of suppliers and regulations create barriers.	The houses were built with the minimal amount of materials and the minimum costs.	There has been a focus in the design phase to create measurements according to standard material, not to cause any spare costs and to make it easy for inhabitants to build incrementally and make extensions [7].
<b>Low Carbon Footprint</b> Low greenhouse emissions in all parts of the design and during the whole life cycle of the material.	Concrete is not a material with low carbon footprint, nor is steel.	Compressed cement and earth blocks and fiber-cement roof tiles have a rather low carbon footprint.	Concrete is not a material with low carbon footprint, but the economical form of the buildings saves material [53].
<b>Life Length</b> Use of durable materials.	Materials are fairly durable, if there are no termites that destroy the timber and if the steel is rust proof and thick enough.	The materials are durable. The roof tiles need maintenance.	The materials are durable.
<b>Reusability of Materials</b> Use of materials that are bio degradable or that can be recycled if the buildings are turned down.	The wooden parts are biodegradable, and the steel can be reused. The concrete is not possible to reuse.	The materials are reusable, as the interlocking compressed blocks are done without mortar.	The materials of the initial construction are not reusable, but as the extensions can be made of anything, that material can be reusable.
<b>Use of Recycled Materials</b> Use of materials that are recycled or upcycled.	No recycled materials are used as they are not considered durable [42]. Lack of technology to use local material [6].	No recycled materials are used.	In the extensions recycled materials can be used [7].
<b>Locally Available Materials</b> Transport avoided during the construction phase.	Materials imported from neighboring countries. This raises building costs and affect the affordability of housing.	The bricks are made of local earth with an addition of cement. Wood and cement needed to be transported to site.	The materials were transported to site.
<b>Resilience</b> Durable construction according to potential natural disasters, e.g., earthquakes, floods or storms, adaptability, and incremental construction possibilities.	The city of Walvis Bay does not have a policy paper or an action plan for climate change. mitigation. No any specific criteria concerning the thermal environment. There are no considerations of potential flooding.	The construction is not done in a very durable way.	The calculations are made with potential earthquakes in mind [7].
<b>Energy Efficiency</b> Efficiency in all different stages, construction, and use, e.g., possibilities for energy savings and use of materials and solutions that support cooling or heating, integrating housing to sustainable energy systems.	Using concrete as a construction material is not energy efficient. Apartments tend to overheat during summer time and are extremely cold during winter time.	The materials are rather energy efficient, and the houses have natural ventilation only.	Using concrete is not energy efficient [53].

Table A1. Cont.

DIMENSIONS [2,18]	Kuisebmond	Chamazi	Quinta Monroy
<b>Innovative Solutions</b> for housing-related infrastructure e.g., rainwater harvesting, sewage systems with natural water purification solutions, solar energy, ventilation based on gravity, toilet solutions etc.	Challenges in solar energy provision (sand storms affect to the maintenance of solar panels). There is very little interest in using alternative technologies and local materials in the implementation of the National Housing Enterprise's activities or the Build Together program.	The sewage system is innovative.	The innovation of providing half a house is brilliant. The house is also measured to fit to common building material sizes, so that the extensions would be as easy and economical to construct as possible [50].
<b>Land Use</b> Efficiency of the use of land, density, green areas, protection of bio-diversity.	Inherited unequal pattern of settlement as a result of apartheid policies followed by the colonial government. One floor. Green areas available (availability of water). The area is not densely planned, will add to urban sprawl if the city is growing as fast as predicted.	One family houses are never that an efficient way of using land, adds to urban sprawl, but the split of the normative size of plot makes the site more densely inhabited than regular officially planned areas in Dar es Salaam. There are green areas on part of the plot.	The row-house model is more efficient than one family houses, but only two floors does not make the habitation very dense.
<b>Urban Mobility</b> Urban sprawl, citizen's need for transport, promoting low-carbon infrastructure.	In some areas public transportation (bus service) is provided by a private actor (uranium mines). In most cases people use taxis, which are an expensive form of transportation to some and affects to the increase of carbon emissions. Road conditions are generally good.	The area is not close to the city center and as the inhabitants were moved from the port area that was very central, there is commuting. There are buses, not very far from the area.	The buildings are placed in central Iquique.
<b>Waste Management</b> Promoting recycling and proper management of hazardous waste.	Some activities concerning recycling and proper management of hazardous waste but this is not always consistent. There is a need for awareness raising activities.	There was no particular attention paid to waste management in the design.	Literature does not reveal answers to this question, but the area is central and follows probably the prevailing waste management system of the city.
<b>Sanitation</b> Preventing hazardous and polluting materials, introducing ecological sanitation systems.	The local authority provides a sewage system network but has sometimes been proved to be insufficient.	There is a natural ecological water cleaning system for the area.	The area is within the existing urban structure and is probably connected to the existing city system.
<b>ECONOMIC</b>			
<b>Affordability</b> Balanced housing markets, system for finance, mixed buying, and tenure options.	Houses are mainly offered for a certain income group (unbalanced housing markets).	The houses are planned to be as cheap as possible. The sizes of plots were diminished, to keep the price of purchase lower. There is no tenure option but there is a self-organized system for finance. Done with financial support for the purchase of land [4].	The pricing is according to Chilean social housing standards, but instead of getting a too small house the inhabitants get half a bigger house [7].
<b>Economic Inclusiveness</b> Mixed income options, and inhabitants.	Houses are mainly offered for a certain income group.	People with any income will have the possibility to purchase a house, but there is no variety in size or quality.	People with any income will have the possibility to purchase a house but will most probably be bound to a loan. There is no variety in size or quality in the initial state. Inhabitants have the possibility to ameliorate their apartment and make it bigger [49].
<b>Capacity-Building</b> Job creation & skills development during the whole process, planning, construction, and maintenance.	Capacity for skills development is weak. BT project offers some form of participation in construction work. Private sector financing is usually limited to the high and middle-income sector [42].	The community participated actively in the whole process of the housing project from the initial stage to realization. There was a lot of capacity-building included.	The long-term and thorough participatory design for this project allowed a lot of capacity-building. The aim was also for the community to get organized during the process, for the future maintenance of the housing area [7].

Table A1. Cont.

DIMENSIONS [2,18]	Kuisebmond	Chamaz	Quinta Monroy
<b>Income-Generating Activities</b> Spaces for income-generating activities mixed with housing and possibilities domestic economic activities and enterprise.	No spaces for income-generating activities in the housing areas.	A market place was planned as part of the area.	It is only a housing area, but the inhabitants have the choice to have economic activities in the ground floor facing the streets.
<b>Socio-economic Organizing</b> Accessibility for anybody, arrangements for credit, lobbying activity.	Expensive for people with really low income. Empty houses are vandalized. Potential buyers register to the NHE and are placed on their waiting list. They are contacted when a suitable house is available [42].	This project was done by a particular group of people that were the tenants in a community that was evicted. The arrangement of credits and incremental construction (one house at a time) made the project possible [4].	Accessible for the people who have access to social housing. In Chile the system seems to be rather organized.
<b>Investment Possibilities</b> Increased value with time.	No private sector participation in the process of low-income housing. Missed opportunity in using housing as a tool for integration of different income groups [42].	It is possible that the value of the houses has increased, as the methods of construction were the cheapest possible and the houses were constructed without middlemen.	It has been evaluated that the value has increased five-fold in ten years [52].
<b>Landownership</b> Clear form and clear information, trust.	Significant administrative costs in urban land registration. There are transaction costs and risks involved to some [40].	The land was originally purchased with aid from Slum Dwellers international but is now owned by the inhabitants [4].	The families had occupied the land for 30 years. Land is owned by the state owned Programa Chile Barrio [7].

When reference not indicated the data for Walvis bay originates in observations [47], likewise for Chamazi [48] and for Quinta Monroy the authors' interpretation of secondary data.

Table A2. UN Habitat A multi-scale framework for sustainable housing policies.

	MACRO (National)	MESO (Region, City)	MICRO (Neighbourhood, Household)
<b>Environmental dimension</b>	<ul style="list-style-type: none"> <li>Housing to support climate mitigation and adaptation efforts.</li> <li>Mainstreaming green housing practices and innovations.</li> <li>Ensuring energy and resource efficiency in the building industry.</li> <li>Integrating national housing and energy systems.</li> </ul>	<ul style="list-style-type: none"> <li>Achieving good location and density for residential areas and access to infrastructure.</li> <li>Serviced land in environmentally safe locations and green areas.</li> <li>Protection of ecosystems and biodiversity.</li> <li>Promoting sustainable and low-carbon urban infrastructure, public transport and non-motorised mobility, energy systems.</li> <li>Waste management and recycling.</li> </ul>	<ul style="list-style-type: none"> <li>Ensuring energy efficiency, micro/generation, water and resource efficiency.</li> <li>Green design, using sustainable local construction and materials.</li> <li>Sanitation, preventing hazardous and polluting materials.</li> <li>Affordable use of resources.</li> <li>Improving resilience and adaptation of homes.</li> </ul>
<b>Social dimension</b>	<ul style="list-style-type: none"> <li>Fulfilling the right to adequate housing and promoting the right to the city.</li> <li>Ensuring affordable, decent and suitable homes for all, including disadvantaged groups.</li> <li>Developing social housing provision.</li> <li>Promoting choice and security of tenure.</li> </ul>	<ul style="list-style-type: none"> <li>Promoting integrated communities and ensuring trust in communities. Providing community facilities, preventing segregation and displacement.</li> <li>Regenerating and reintegrating 'neglected' areas into regional, urban fabric.</li> <li>Ensuring infrastructural integration of housing into wider areas.</li> <li>Upgrading inadequate housing and slum areas.</li> </ul>	<ul style="list-style-type: none"> <li>Empowering people and ensuring public participation. Ensuring health, safety, well-being in residences. Creating a sense of community.</li> <li>'sense of place', and identity.</li> <li>Meeting specific needs and wants in housing (including those related to gender, age and health).</li> <li>Providing access to infrastructure and public spaces.</li> </ul>

Table A2. Cont.

	MACRO (National)	MESO (Region, City)	MICRO (Neighbourhood, Household)
<b>Cultural dimension</b>	<ul style="list-style-type: none"> <li>Promoting links between housing and knowledge-based and cultural economies.</li> <li>Promoting traditional, indigenous and local knowledge (including of relevance to sustainable resource use, energy efficiency and resilient building techniques).</li> <li>Protecting cultural heritage.</li> </ul>	<ul style="list-style-type: none"> <li>Promoting urban creativity, culture, aesthetics, diversity.</li> <li>Shaping values, tradition, norms and behaviours (e.g., in relation to energy use, recycling, communal living and place maintenance).</li> <li>Protecting housing heritage and familiarity of city (e.g., preventing unnecessary social replacement/gentrification or complete redevelopment).</li> </ul>	<ul style="list-style-type: none"> <li>Culturally responsive settlements and house planning and design.</li> <li>Improving aesthetics, diversity and cultural sophistication of the built environment and residence.</li> <li>Helping community creativity (i.e., via amenities; affordable sporting, cultural and entertainment facilities).</li> <li>Assisting people's transition from rural and slums areas to decent housing or multifamily housing.</li> </ul>
<b>Economic dimension</b>	<ul style="list-style-type: none"> <li>Institutional capacities for sustainable housing markets and housing development.</li> <li>Articulating housing productivity within national economic systems.</li> <li>Improving housing supply and effective demand, stabilising housing markets.</li> <li>Improving housing finance options.</li> <li>Promoting innovations in housing.</li> <li>Stimulating necessary technological developments for sustainable housing.</li> </ul>	<ul style="list-style-type: none"> <li>Managing economic activities and growth by strengthening housing provision and housing markets.</li> <li>Provision of necessary infrastructure and basic services to housing.</li> <li>Providing serviced land for housing.</li> <li>Strengthening entrepreneurship of communities, local building industry and enterprise.</li> <li>Promoting local and traditional building materials and techniques.</li> <li>Promoting regional and urban regeneration.</li> </ul>	<ul style="list-style-type: none"> <li>Ensuring housing affordability for different social groups. Providing adequate residences.</li> <li>To raise labour productivity; ensuring housing is integrated with employment.</li> <li>Supporting domestic economic activities and enterprise.</li> <li>Promoting petty landlordism and self-help housing.</li> <li>Housing management and maintenance.</li> <li>Strengthening resilience and future-proofing of homes.</li> </ul>

[2] UN Habitat Sustainable Housing for Sustainable Cities 2012, p. 8.

Table A3. QSAND CAT Core Assessment Tool, Relevance of Issues.

Category	Title	AIM
<b>Shelter and Community</b>	<b>Community Sensitive Design</b>	To promote integration of community-sensitive shelter and settlement layout design features which support inclusivity and accessibility for community members.
	<b>Privacy</b>	To recognize and encourage shelter and settlement design measures that respect and promote privacy within the disaster-affected community and where possible eliminates the risk of privacy invasion.
	<b>Internal Environment</b>	To ensure that the internal environments of individual shelters and community facilities are healthy and comfortable for the occupants.
	<b>Construction Approach</b>	To recognize and encourage the selection and application of construction methods that are environmentally sound and appropriate to the location and needs of the community.
<b>Settlement</b>	<b>Site Selection</b>	To ensure that the site selected for development or redevelopment is suitable for the affected community and other relevant parties, enabling long term sustainable development.
	<b>Security of Tenure</b>	To recognize and support: <ul style="list-style-type: none"> <li>– Diverse tenure arrangements relating to housing, land and property.</li> <li>– Transparency, accountability and communication with the affected community in regard to tenure issues.</li> <li>– The promotion of security of tenure in all shelter responses.</li> </ul>
	<b>Spatial Planning</b>	To ensure that a settlements layout, amenities, other designated land uses and infrastructure sustainably support social, cultural and economic activities, providing the necessary basis for the community to develop and grow.

Table A3. Cont.

Category	Title	AIM
	Infrastructure	To recognize and encourage provision of infrastructure systems that are well planned, resource efficient, environmentally friendly, secure, culturally sensitive and economically viable.
Materials and Waste	Material Properties/Specification	To encourage the use of construction materials of an appropriate quality and which consider climate, culture, durability, local supply and environmental impact.
	Material Sourcing	To encourage and promote procurement of construction materials based on quality, environmental, social and economic considerations.
	Post disaster Waste Management	To promote the sustainable management of post disaster waste, by ensuring efficient use, removal and disposal.
	Construction Waste Management	To promote the sustainable management of waste generated on site during the construction process, by encouraging the efficient use, removal and where necessary disposal of waste.
	Operational Waste Management	To promote sustainable operational solid waste management throughout the disaster-affected community by proper and effective waste management, solid waste reduction and community education.
Energy	Energy Demand & Supply	To establish and optimize the energy demands of the community ensuring that these can be sustainably met in the future through the specification of reliable, affordable and sustainable energy supplies that meet needs of the community.
	Energy Consumption	To ensure that energy is consumed by the affected community in an efficient and sustainable way.
Water and Sanitation	Water Demand & Supply	To ensure that the water demand of the affected community is optimised and met for all needs, through a sustainable and secure water supply.
	Water Quality	To ensure that potable water is palatable, of sufficient quality to be consumed and ensures that communities health is not compromised by water resources.
	Sanitation	To ensure that adequate sanitation solutions, facilities and infrastructure are available for beneficiaries and the importance of hygiene is promoted.
Natural Environment	Human Relationship to Ecosystem Services	To develop, implement and effectively communicate a locally appropriate Action Plan which will identify existing ecosystem services and facilitate effective management of human activity in the natural.
	Ecological Protection	To protect the ecological value of the site during the resettlement phase and support on-going ecological protection over the life of the development.
	Ecological Restoration and Rehabilitation	To encourage the restoration, rehabilitation and enhancement of the ecological value of the site during settlement or re-settlement.

[18] QSAND 2014, Assessment and Scoring Tool.

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