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Temporary Urban Pop-Up Environments – Design Requirements and Sustainable Solutions

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1 ABSTRACT

With more than half of the world's population already living in urban areas, cities are increasingly faced with the challenging and conflicting target of providing a high-quality living environment for its inhabitants whilst at the same time ensuring that the rise in population does not come at the expense of increased land use and loss of green space. Looking at the aspect of space, increasing the density in urban agglomerations is one key approach. However, another way forward is also to consider the aspect of time by assessing which needs can also be catered for by temporary means. In addition to the morphology and structural density of a city, consequently the temporal aspect gains in significance and can ensure that cities become more resilient in times of crisis. Nevertheless, temporary use of space and consequently temporary housing solutions are not yet widely investigated and discussed topics in strategic urban planning.

Based on a highly interdisciplinary research project on PopUp Housing Environments, this paper aims at addressing this knowledge gap by providing investigations on and solutions for the specific design requirements on temporary housing spaces and structures. The goal is to define framework conditions for affordable, flexible, sustainable and reusable concepts, that are easy to construct and swift to implement, in order to fulfil the requirements of environmental, economic and social sustainability. Researchers from the fields of spatial and landscape planning, architecture, building services engineering as well as energy and waste management have been collaborating with social and political sciences as well as humanities in order to develop scenarios and models for sustainable temporary housing environments.

In this paper the process for several scenarios will be presented in terms of their relevance for urban areas and use of space as well as examples of developed housing models, that can serve as an inspiration for architectural, technical and space-saving land-use solutions. The models have been developed with the aim of reducing the impact on land, resource and energy consumption, focusing strongly on de-constructability, reusability and the temporal aspect of the occupied space.

The initial results have been discussed with various stakeholders from the city administration and other related organisations in order to fine-tune the requirements and subsequent scenarios and housing models. The overall aim is to support the methodical development of temporary housing solutions so that these can form an integral part of long-term urban planning strategies.

Keywords: de-constructability, re-usability, pop-up environments, sustainable buildings, temporary buildings

2 REQUIREMENTS FOR TEMPORARY HOUSING

2.1 Urban planning

The urban population is growing with people incessantly moving towards conglomerated and dense areas. Currently already more half the world's people are living in urban areas with a rising tendency with more than 70% of global greenhouse gas emissions (GHG) attributed to those spaces. Life in cities is in large parts responsible for the causes of climate change but cities are also particularly vulnerable to the subsequent effects. Consequently, these densely populated areas must be assessed and optimised from different perspectives, combining geographical, economical and societal characteristics within a holistic and systemic viewpoint. Planning for regenerative and resilient urban systems of production, consumption, transportation and construction is key in reducing the effects of climate change and thus plays and important role in long-term urban planning strategies.

Spatial, infrastructure and construction infrastructure planning however are extensive processes, which follow long-term perspectives and are accompanied by long-term impacts. Urban planning in this context is

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often too slow and does not reflect the dynamics of uncertainties to effectively meet the current needs of society. Thus, in addition to the permanent structures, the temporal aspect can provide a meaningful ratio for cities to quickly respond to unforeseen events. From a construction and architectural perspective, the meaning of temporary can be summed up as being of short and intermediate use and of an interchangeable function. The former refers to the aspect of time, whereas the latter refers to the aspects of function. Both can be applied at the same time or individually within the meaning of temporary in architecture. The architecture for temporary constructions makes use of modularity, flexibility, speed of construction, simplicity of installation, affordability, constrictive reversibility and second-life management. Temporary housing can in an urban context and from an architectural perspective be differentiated into three aspects that include the (1) temporary erection of structures in response to an urgent need (e.g., a disaster), (2) temporary uses and strategies within a city and (3) the actual re-use of temporary structures. Including temporary uses and applications in urban planning strategies can subsequently provide readily accessible measures when they are urgently needed. This however necessitates the understanding, that a specific mind-set in urban planning is a prerequisite for the particular nature of temporary structures. If planned with care, temporary housing can support short-term and urgently needed requirements in a sustainable, flexible and integrative manner and can instigate a constructive impact on the overall urban system.

This paper presents and discusses the process and development of various scenarios and housing models for temporary living conditions with the aim to contribute to a positive discussion in the context of temporary urban housing solutions.

2.2 Definition of terminology and outset

Within the framework of the research project "*Urban Pop-Up Housing Environments and Their Potential as Local Innovation Systems*" funded by the Vienna Science and Technology Fund (WWTF), the interdisciplinary research team conceptualised sustainable scenarios and housing models for temporary living environments in the City of Vienna. The aim was to define and assess theoretical solutions within the three aspects of *people* (particular needs for temporary housing, demographic profiles, skills), *housing* (design, energy, waste, material and water) and *area* (location, infrastructure, open space, land-use). The key project aims include the following: (1) The scientific systematisation and development of a database on temporary forms of housing and international examples of implementation; (2) The compilation of adequate land types for temporary forms of housing in Vienna; (3) The development of six interdisciplinary selected scenarios with concretely described housing models for temporary housing in Vienna; (4) The evaluation and assessment of the scenarios and housing models based on a series of technical, ecological, spatial planning and social criteria; (5) Concepts for the use of the housing models as innovation niches and (6) a transfer concept for generalised "urban pop-up concepts" and support for practical implementation. Within the context of this text, the focus is on point 3 above providing a summary of research results on the scenarios and models.

In the following the key terminologies used within the context of the project are outlined. These include the terms *temporary, user groups, scenarios and models*.

Within the context of this paper, the term *temporary* refers to a duration from several weeks up to 5 years. The potential models include structures that are temporarily constructed for residential use and the re-purposing of permanent structures for temporary residential use. Given the fact that also temporary structures must follow the relevant norms and regulations related to the use of land (e.g., following the development plans) as well as the functionality of the buildings (e.g., related to disabled access or fire regulations), the scenarios vary in their degree of how much the actually follow the current legislative framework conditions. This evidently mostly refers to the use of un-occupied or unused land and less so regarding the relevant building regulations as the former allows experimental settings, but the latter is a requirement for health and safety of the occupants.

In order to develop suitable scenarios and models, in a first step the potential *user groups* have been identified. User groups differ in their requirements for temporary housing, but also in their needs and abilities and were thus defined based on the perspective of societal urgency (e.g., exponential increase in housing demand) or individual urgency (e.g., immediate need for shelter). For the City of Vienna, three relevant user groups have been identified. User group A comprises individuals with an urgent, immediate and unexpected need for temporary housing. User group B includes people without an immediate demand,

but with expected urgency and limited alternatives. User group C relates to individuals without an immediate or urgent demand, but nevertheless limited alternatives.

A *scenario* within the project describes an application case for a temporary housing environment within the City of Vienna. The key aspect of each scenario includes the setting of the plot of land or building thus taking into account the availability of adequate areas or vacancies within the city and the user group that would be inhabiting this area, which related to the likelihood of decisive events taking place (e.g., heatwaves, earthquakes or similar disasters that initiate a sudden need for housing). In addition, the expected duration of inhabitation, adequate building equipment and open spaces, properties of the area and neighbourhood, available (technical) infrastructure, and particularities specific to the scenario are defined.

For each scenario, temporary housing units, so called *housing models*, are developed. A model is thus a concretisation and only one of many potential options of a scenario. Each model is defined in detail by its distinct architecture and overall setting thus including descriptions for construction, shape, size, setting, building services, materials as well as water and energy use. The final scenarios and models are subsequently assessed in the detail with a series of indicators that rate their quality related to their social and environmental sustainability.

3 METHODOLOGY

In this section, the overall process, which resulted in the development of the exemplary scenarios and housing models, is presented. The development was carried out in several phases and with different research teams. In addition, the process was supported by external stakeholder groups, that provided in different workshop settings valuable input on the definition and selection of relevant criteria and framework conditions. An external student group from the JASEC (Japan Austria Science Exchange Centre) at the TU Vienna also significantly contributed in the setting of a design studio over two semesters to the project, by developing a series of design ideas for the housing models. Overall, the development spanned a timeframe of over two years and involved a multitude of expertise. In the following the process and the various stages are presented in a summarized and shortened version in order to provide an insight into the *making of* the housing models.

3.1 Process Overview

As shown in Figure 1, the overall development of the final housing models took mainly place in three phases, that was divided into the (1) preparatory phase, the (2) scenario development and the (3) housing model development.

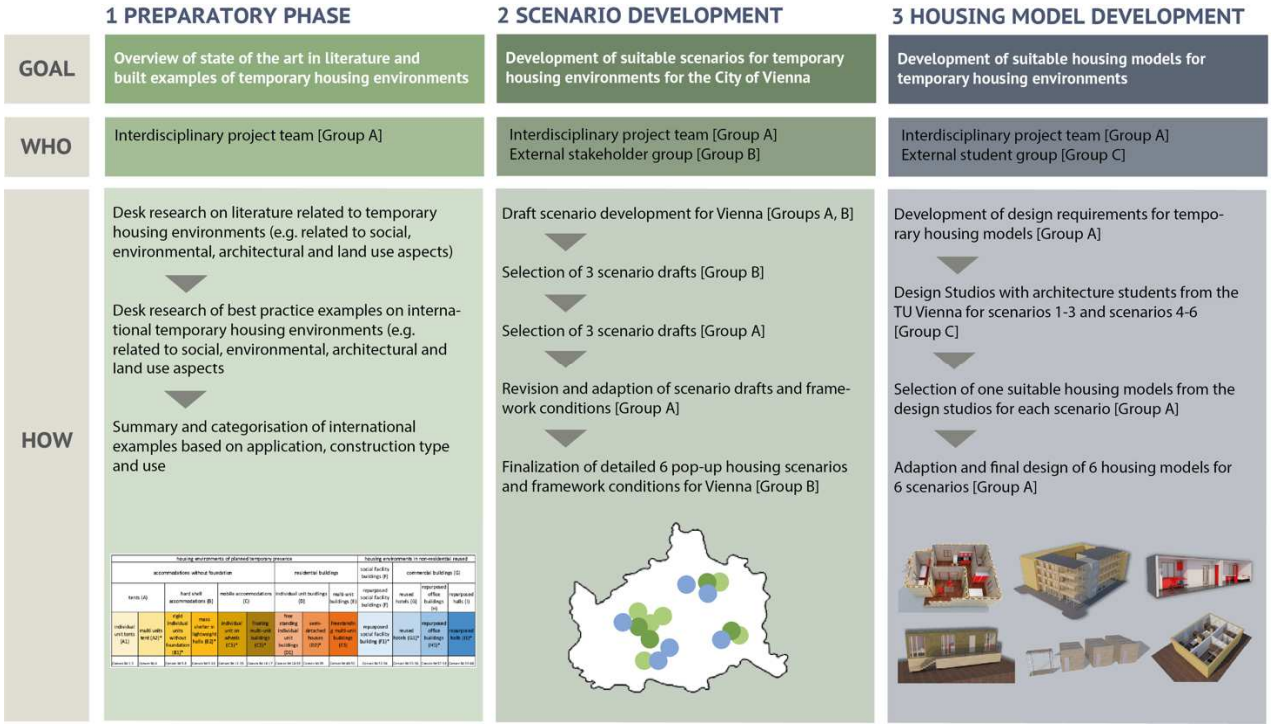

Fig. 1: Development of temporary pop-up environments; simplified process.

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For each phase a series of tasks supportted the goal of the process. In these phases, the project research team (group A) was supported by external stakeholder groups (group B) and a student design team from the architectural faculty of the TU Vienna.

3.2 Development phases

The initial preparatory phase mainly consisted in the basic research tasks with the goal to provide an overview of the state of the art on temporary housing environments. This entailed not only the collection of relevant literature related to the social, environmental, architectural and land use aspects within the topic, but also on the analysis of implemented examples related to temporary housing. The tasks resulted in a summary and categorisation of international examples based on application, construction type and use. This phase was carried out by the project research team in an interdisciplinary approach, with each research group providing the relevant state of the art and example analysis within their field of expertise and subsequently combining the results in an integrated manner.

In a second step, the scenario development, the main goal was to develop suitable scenarios for temporary housing environments for the City of Vienna. As outlined above, the scenarios not only relate to the actual building, but more importantly to the application cases, thus focusing on the availability of suitable land or buildings and the uses for the different potential options. The individual scenarios reflect the various possibilities, options and needs of the city. This phase started with the draft scenario development for Vienna, carried out by the project team with support of the stakeholder groups and was followed by scenario drafts from the research team as well as the stakeholders. The following task was to further develop the scenario drafts, revise and improve them and select the most suitable scenarios for the project. In the final tasks the selected scenarios were adapted and summarized in order to arrive at six different scenario settings. This phase was carried out by the project research team with the support of stakeholder groups in workshop settings in order to provide an external view on the framework conditions for the scenarios and on the selection of suitable scenarios for the Vienna case.

During the last key phase, the exemplary housing models for temporary housing environments have been developed. Following the initial task of the definition of the design requirements, a collaboration with the TU Vienna resulted in two design studios with architecture students that focused on the architectural development of various temporary housing models for the different use cases. The studio was part of a series of courses offered by JASEC at the TU Vienna, which focuses on disaster mitigation and security in buildings. During both one winter and summer term, three model types have each been developed for three scenarios, resulting in a multitude of different designs for the six scenarios and framework conditions. The students approached the design tasks with creative solutions that all followed the concept of sustainability in a temporary urban setting. Depending on the semester, they could each chose from three different scenarios for their architecture project.

Architectural quality	**Constructional quality**	**Sustainability quality**	**Urban planning quality**	**Social quality**
General design concept	Logistical aspects (transport)	Resource-efficiency	Urban district integration	Potential for social interaction
Flexibility of space	Ease of construction / deconstruction	Potential for renewable energy	Urban accessibility	Flexibility of uses (in the building)
Accessibility	Storage	Type of materials	Neighbourhood concept	Number of users
Types and size of living units	Logistical requirements for construction	Potential for reuse	Quality of external spaces	Area per person (private units)
Aesthetics	Type of foundation	Potential for recyclability	Mix of private / semi-private, public spaces	Area per person (total area)

Table 1: Housing model development; basis for selection of designs for housing models

Based on the student's designs, the research team subsequently selected the most appropriate and relevant solutions following an assessment of various criteria related to architectural quality, constructional quality, sustainability quality, urban planning quality and social quality as outlined in Table 1. The objective of this

process step was to arrive at a limited number of design solutions that could be further developed by the research team. The aim of the selection process was to choose the most appropriate design ideas for each of the six scenarios to merge, adapt and develop this further into the six final temporary housing models. The selection and adaptation processes have been carried out by the research team.

4 RESULTS

The final housing models provide a theoretical approach to the defined framework conditions and specific requirements of user needs for temporary housing within strictly hypothetical urban settings of the city of Vienna. The models are theoretical and exemplary and provide only one each of many suitable and relevant solutions. They must therefore be seen in the context of a highly theoretical approach and do not represent actual designs for buildings projects. They should convey what type of approaches and solutions could be feasible, if sustainability in temporary housing is at the core of the design development. In the following the potential temporary housing models are briefly presented to provide an overview of the development of the research project for pop-up housing environments. The housing models are one of a range of outcomes of the research project and should visualise the potential for temporal construction in an urban setting.

The first scenario “Gap module” as shown in Figure 2 shows a setting for temporarily vacant building lots within urban areas with a high density. Short-term shelter can be provided in these vacant lots, at times when the area is already emptied of previous buildings but not yet ready for new construction. These plots are considered to have a usable ground floor area of around 1000m^2 so that multi-storey structures could be erected on site. The idea is that the systems are made of highly modular, prefabricated units that are grouped together over several storeys. They can subsequently be constructed and de-constructed within a very short timeframe (i.e., less than two months on site) and with little disruption to the plot. The focus is on easily accessible plots within a densely populated area and an extremely well-established infrastructure, but to use these plots for a limited time only and with a high re-use capability of the modular elements.

Fig. 2: Example 1 temporary housing model for scenario “Gap module”.

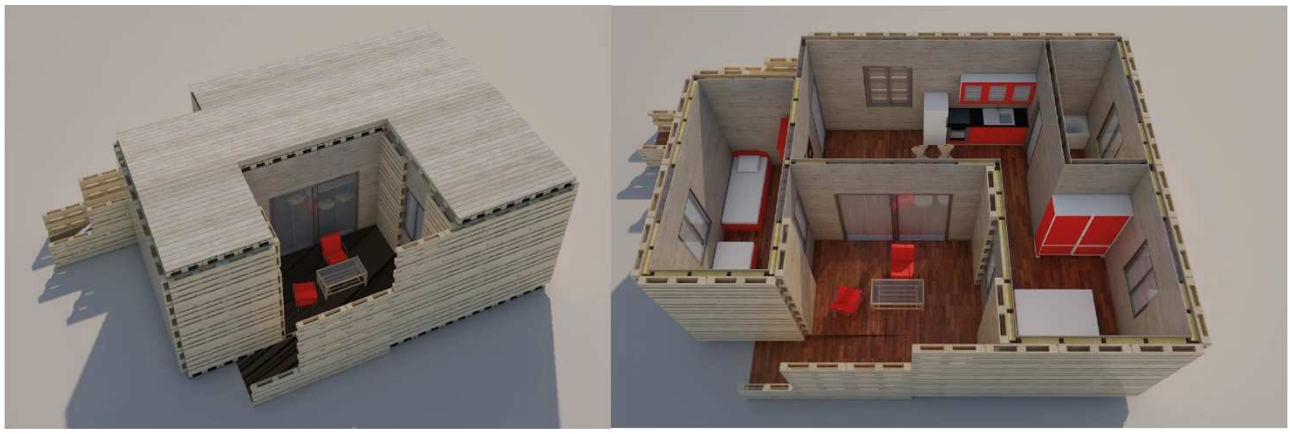

Fig. 3: Example 2 temporary housing model for scenario “Beat the heat”.

In a second setting “Beat the heat”, as shown in Figure 3, the urban heat island effect has been considered in the development of the scenario. The theoretical approach was, that during heat waves, vulnerable groups

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should be given the possibility to move from their potentially overheating homes into cooler and subsequent more appropriate environments. This addresses the growing concern that certain urban groups that live in buildings prone to summer overheating could be exposed to an increased health risk. Thus, in this scenario, temporary housing accommodation is provided for the duration of extremely hot summers. In a vacant area, that is preferably heavily shaded by trees and greenery. In this setting the reusable and storable light-weight housing pellet units could provide shelter in a cooler and more suitable environment.

In the third potential scenario named “Life sharing to go” unused industrial or open space office buildings have been chosen as suitable environments. The benefit of adapting existing structures lies in the overall reduced impact on resource and energy use for the construction of the units. The re-purposing of these existing structures has the objective to provide a flexible and open-space area that can house temporary, lightweight, prefabricated and modular units in existing spaces and subsequently reduce the requirements on raw materials since the main structures are already there. The units are designed as easily moveable modules for fast and easy mantling and dismantling, allowing flexibility of space in a series of private and semi-private areas as shown in Figure 4.

Fig. 4: Example 3 temporary housing model for scenario “Life sharing to go”.

Fig. 5: Example 4 temporary housing model for scenario “DonAutonom”.

A less stable and more flexible approach was considered in the scenario “DonAutonom” as this would involve the inhabitation of a redesigned and reused old cargo ship on the Danube. The ideas for the housing models involve common areas on a lower deck and three upper container decks with living units. On top of the containers a series of terraces and plant areas are foreseen in order to provide green and open spaces on an otherwise steel designed object as shown in Figure 5. The experimental setting is considered to be self-sufficient in terms of water and waste by using rain- and river water and the conversion of biogenic waste into biogas.

In another moving scenario called “Life on tracks” temporary housing solutions could be swiftly deployed when needed by using adapted old waggons on the existing rail infrastructure. This scenario has been specifically developed with user group C in mind, i.e., people without an imminent or urgent demand, but limited alternatives. This could include individuals participating on a voluntary basis and not currently affected by existential threats, for example members of NGOs (non-governmental organisations) or similar.

The highly flexible scenario can through its high mobility serve as a disaster risk management and resilience measure. The potential housing solutions as shown in Figure 6 shows a highly adaptable interior which makes use of the logic of container architecture. Similar to the previous model, the aspect of safety and connection to the existing infrastructure (urban networks, water, waste) must be specifically considered.

Following the logic of the scenario as outlined previously in Figure 4, the scenario "Shop-Hopping Box" makes use of existing structures and addressed high vacancy rates for ground-floor retail spaces. The small-scale stores could be adapted for families or other co-habituating groups. The scenario is foreseen as a simple approach as no construction works or severe adaptations would have to take place. In the potential housing model as shown in Figure 7 the retail space is provided with new modular room divisions to create separate entities for kitchens, bath- or bedroom areas. The units are designed for swift and easy assembly and disassembly and provide high flexibility regarding placement and arrangement within potential vacant stores.

Fig. 6: Example 5 temporary housing model for scenario "Life on tracks".

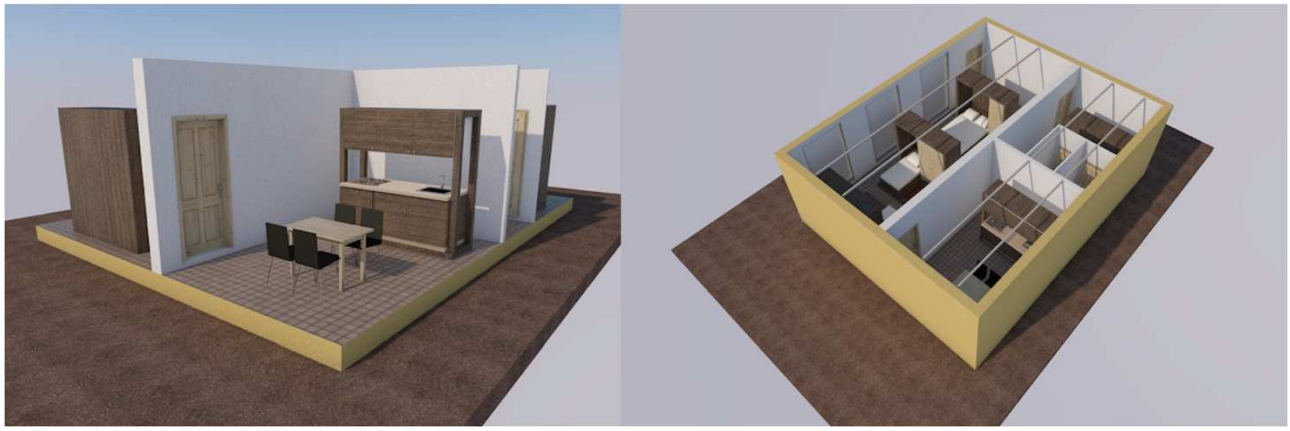

Fig. 7: Example 6 temporary housing model for scenario "Shop hopping box".

In a subsequent step, all models have been analysed based on a series of over 50 environmental, technical and social indicators in order to simulate and assess the overall suitability and sustainability of the models. From an architectural perspective, aspects such as material (e.g., durability, embodied energy) and structure (e.g., constructability and de-constructability) as well as internal comfort parameters (e.g., daylight quality, ventilation, thermal comfort) have been specifically addressed. The potential ideas for the housing models are then discussed and reviewed by an external stakeholder group to critically assess the theoretical suitability for the application case of Vienna and to evaluate if and how temporary housing can form an integral part of future planning activities related to strategic development plans and to strategic risk and disaster mitigation aspects.

5 CONCLUSION

The developed scenarios and models show examples from a multitude of options for temporary housing for the City of Vienna. The theoretical scenarios housing models should serve as an inspiration for solutions that include sustainability aspects as an inherent outset for choices in terms of urban areas, use of space and

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architecture. All models have in common, that they are designed with a strong focus on the reduction of the impact on land, resources and energy by accounting for de-constructability, reusability and temporality.

The process has shown that there is a multitude of influencing factors that limit or allow the development and subsequent implementation of temporary housing within the urban environment of the City of Vienna. The scenarios and models have been created within an open and experimental setting, but with the current framework conditions regarding land use, design development and constructability in mind.

Even though the initial results have been discussed with relevant stakeholders from the city administration and other related organisations to fine-tune the requirements, the overall aim is to support the methodical development of temporary housing solutions in order to form an integral part of long-term urban planning strategies. In a next step it should be analysed how the project results could be used for the city as such. On a strategic level (i.e., relating the aspects of spatial planning and development) the project results could be integrated into the strategic development plans so that temporary uses can form an inherent part of planning processes for urban developments. Other aspects, such as cost constraints, conversion into permanent settings and societal aspects such as end of tenure and subsequent housing for the occupants should be further explored. On an experimental level a concrete implementation could support a detailed analysis regarding construction, optimisation in operation, dismantlability and storage as well as after-use concepts and recycling.

One of the goals of this research work is to contribute with an in-depth evaluation of potential solutions to a critical discussion on temporary housing environments.

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