Urban pop-up housing environments and their potential as local innovation systems

Description of scenarios and housing models

Deliverable D3

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PREFACE

As part of the interdisciplinary research project "Urban pop-up housing environments and their potential as local innovation systems", six deliverables (D1 – D6) were generated in accordance with the project proposal, which reflect in detail the working process and outputs of the diverse tasks in the working packages. An overview of all deliverables and their key messages is provided in the Executive Summary (Deliverable D0). The individual deliverables were developed chronologically according to the project schedule and progress, and thus, completed at different time points in the project, reflecting the state of knowledge at the respective project status at that time.

Different SCI publications were also generated within the work-packages and based on the deliverables, whereby some contents were deepened and further developed. In some cases, terms and terminology have also been adapted. The contents of the deliverables therefore partly represent “work in progress” at the respective times of completion of the working packages and writing of the deliverables. The contents of the published SCI-papers and the key statements in the executive summary (D0) are to be understood as the most recent and solid outcomes and conclusions.

CONTENT

1 INTRODUCTION

1.1 AIM OF WP3

The project aims to develop a robust inter-disciplinary scientific basis for temporary housing options for diverse scenarios (different user groups and temporally unused urban areas, diverse building densities, etc.) in the Viennese context. WP3 – Scenario selection and pop-up housing model development – represents a cornerstone in this endeavour, encompassing the development of 6 pop-up housing scenarios which have relevance for the city of Vienna and the successive detailed planning and design of these as concrete housing models, including advanced elaboration of the architecture, building infrastructure, applied materials, size and use.

In the context of this project "temporary" refers to a duration spanning from several weeks to 5 years, with temporary housing encompassing structures that are temporarily present for residential use and the repurposing of permanent structures for temporary residential use. The relevance for Vienna includes not only the aspect of what user groups exist or can be expected in the near future in Vienna with a need for or interest in temporary housing (considering both the scope in terms of number of people and the urgency of the plight for the individuals), but also taking into consideration the availability of adequate areas or vacancies within the city and, if applicable, the likelihood of decisive events taking place (such as heatwaves, earthquakes, or sudden increases in numbers of asylum seekers). The project aims to develop not only sustainable temporary housing options but endeavours to offer innovative concepts, which require flexible and experimental settings. Due to this, the developed pop-up housing scenarios vary in their required degrees of freedom ("Freiheitsgrade"), which means to say that there is a range from scenarios which can easily be realized under the given framework conditions in Vienna (e.g., by falling fully within the existing building regulations), to those which are more radical in their approaches and require flexible experimental spaces where new options can be explored.

Six different scenarios for temporary housing in Vienna were developed. These scenarios reflect the different possibilities, options and needs of the city. A concrete model was then defined for each of these scenarios. Table 1 gives an overview of the scenarios and models that emerged from those.

Table 1: Overview of scenarios and pop-up housing models

Name of scenario	Name of pop-up housing model
Beat the Heat	Pallet Shelter
Life sharing to go	InFactory
Gap module	Gapsolutely fitting
Life on track(s)	TinyTainer
Flat-Pack	ShopHoppingBox
DonAutonom	Binnen bleiben

Each pop-up housing scenario was also conceptualized as an experiment for Sustainability Transitions, providing guidance on what a possible implementation project with a focus on exploring sustainable and innovative approaches and solutions could look like.

WP3 draws on the groundwork laid in WP1 (International state of the art research in all disciplines), in which existing temporary housing environments were screened and described and the dimensions of user groups, building and construction and urban spaces were examined. It also draws from the work conducted in WP2 (Case study Vienna), in which the city of Vienna was explored as an empirical study for temporary housing. The theoretical considerations pertaining to and drawn on for WP3 are elaborated in Chapter 1.2.

The following pop-up housing scenarios and models (to be defined in the following Chapter) were developed and are subject of this report:

1.2 THEORETICAL FRAMEWORK AND DEFINITIONS

Before diving into the methods and results of WP3, some definitions and a theoretical background will be provided by this chapter. First, the terms “scenario” and “model” are defined, which both play a fundamental part throughout the entire project. Secondly, the user profiles developed in WP1 are reproduced here to provide reference, seeing as they are referenced in the scenario descriptions. Lastly, the conceptualization of the pop-up housing scenarios as experiments for Sustainability Transitions is based on a selection process of existing experiment concepts which have been developed over the past decades. This chapter will introduce and present an over-view of these concepts, with the methodological approach described in detail in the following Chapter 0.

1.2.1 Definition of terms

Scenario

During this project, the term scenario refers to generally conceivable and plausible ap-plication cases for temporary housing environments in Vienna. They refer to frame conditions in which temporary housing environments might be needed and are suitable for application.

For example: In Vienna, there are vacant building lots that could, in principle, be used for temporary housing and there is a demand for affordable housing for specific user groups. The scenario description would therefore start with a general idea of where the temporary housing environment would be located (vacant lot), and who would be residing there (e.g., students, people with positive asylum status, people affected by homelessness or long-time unemployment). Based on this the scenario is developed further, broadly describing the expected duration of inhabitation, suitable building equipment and open spaces, properties of the area and neighbourhood, available (technical) infrastructure, and particularities specific to the scenario. With these set framework conditions; the scenario already provides a good idea of what the main objectives and what the innovative aspects are.

Temporary (housing) model

Further on, for each scenario concrete (housing) models are developed ("concretization"). Thus, a model is a special occasion case for a scenario. In the models, specific conditions are defined in detail regarding the user group and the number of users, architectural design, selection of ap-plied materials and technologies, etc. (for example: In a specific vacant ground-floor retail space in Vienna, there are five housing units for temporary living, built out of timber).

Models are described to such a level of detail that they could be quite easily used as a basis for implementation (= realization) and that a life cycle modelling and assessment process is made possible (e.g., GWP emissions).

However, it must be mentioned that although the temporary housing models presented in this report already have a very high level of detail, they are still only theoretical in nature. If they were to be implemented, they would have to be recalculated and planned in detail to do justice to the actual conditions.

1.2.2 User groups / user profiles

In WP1 potential user groups for temporary housing were identified. The user groups differ in their ability to meet their needs in a self-organized manner, which has implications regarding the requirements the housing and surrounding area must fulfil. On this basis, three distinct user pro-files were defined, characterized by factors such as access to public transport, urgency from the perspective of the administration (e.g., sudden unexpected increase of housing demand), or urgency from the individual perspective, which can be related to social integration and access to familial or professional networks. The three User Profiles A, B and C were presented in detail in D1. Seeing as a main part of the scenario descriptions within WP3, a summary is presented here again.

User profile A

User Profile A describes individuals with an urgent demand for temporary housing. In this context urgent describes a sudden and unexpected increase of demand with a very limited timeframe for preparation and reaction (within hours or days) (perspective: city), and a pressing lack of instantly available alternative housing solutions (perspective: individual). This consequently entails a need for strong outside organization, as Profile A individuals are severely restricted in their options for finding solutions through self-organization. Outside organization may not only entail the organization of swift housing solutions but may include the organization of medical teams or the provision of psychological care. The mobility of individuals in Profile A can be limited and the lack of alternatives places this group in the particularly precarious situation of lacking freedom of choice in various dimensions. User Profile A is therefore to be considered vulnerable in the sense of being exposed to relying on outside actors. These individuals are experiencing a disruption of their daily routines and find themselves in a state of emergency.

User Profile A is strongly dependent on outside organization to cover their needs and is in no state for self-organization. When accommodating Profile A, it is likely that most needs must be met on-site.

Examples:

- Individuals affected by natural disasters who are temporarily evacuated from their homes or who have lost their homes to destruction or contamination. This group of individuals can be expected to for a large part be culturally well integrated in the area with existing social networks.
- Individuals fleeing from their home countries and either passing through or applying for asylum. An additional characteristic of this user profile is that they are not yet culturally integrated and do not yet possess local social networks (asylum seekers, refugees, migrants).

User profile B

User Profile B describes individuals with low urgency in terms of there being no sudden unforeseen changes in housing demand (perspective: city), but high urgency in terms of there being lacking or unsecured alternatives (perspective: individual). The individuals of User Profile B often lack a supportive social network and find themselves in a phase of not being well integrated into society, or in the worst case even socially excluded. User Profile B is often characterized by acute poverty, which in turn strongly restricts available housing solutions for this profile group and additional degrees of freedom, such as mobility. There is an existing need for outside assistance, particularly regarding the provision of psychological care and support for the re-integration in society, e.g., through means of education or employment.

User Profile B is dependent on outside organization to cover some needs but is able to self-organize others (such as the provision of food), provided there is accessibility.

Examples:

- Individuals affected by (extreme) poverty (e.g., long-time unemployment, sub-group of divorcees)
- Individuals affected by a bad family environment or domestic abuse
- Individuals after release from prison

User profile C

User Profile C describes individuals with low urgency in terms of there being no sudden unforeseen changes in housing demand (perspective: city) and medium urgency in terms of there being existing alternatives (perspective: individual), albeit not to a satisfactory degree in terms of quantity or affordability. Events such as the last financial crisis of 2008 can increase the demand and urgency of User Profile C. The individuals of this user profile are either already well integrated into the area or possess the opportunity and ability to organize and build social networks independently. They can generally be considered to possess high mobility in terms of owning a car, a bicycle, access to public transport, etc. There is no high demand for outside support in the organization of education or employment or medical and psychological support. The individuals of User Profile C possess many degrees of freedom. Their need for temporary housing solutions stems from, for instance, being in education or training or being employed abroad for a foreseeable limited amount of time. This group of individuals can be considered flexible and open to change. Affordable housing options are sought with the temporary nature of stay leading to specific requirements and expectations of this user profile which can be addressed through pop-up housing solutions. Actively contributing to experimenting with pop-up housing may be attractive to this profile group.

Examples:

- Students
- Employees requiring (regular) short-term accommodation (seasonal workers, construction workers, expats, ...)

Table 2 gives an overview of the three User Profiles presented in this chapter.

Table 2: Comparison of User Profiles regarding urgency (perspectives city and individual) and ability to self-organize needs

	Profile A	Profile B	Profile C
Urgency (perspective city)	x	-	-
Urgency (perspective individual)	x	x	-
Ability to self-organise needs	-	-/x	x
Examples	individuals affected by natural disasters	individuals affected by homelessness	students

1.2.3 Experimentation for sustainability transitions

[The content of this chapter is taken directly and abbreviated from the paper: The Learning City: Temporary Housing Projects as Urban Niches for Sustainability Experiments by Gloria Rose, Mirjam Stocker, Michael Ornetzeder, Sustainability 2022, 14(9), 5198; https://doi.org/10.3390/su14095198.]

More sustainable ways to satisfy human needs and wants to require not only technical or social innovations but necessitate societal transitions to bring about change in socio-technical systems (Geels 2002, Markard et al. 2012). Socio-technical systems are complex entities involving inter-actions between companies, consumers, rules and regulations, technologies, and infrastructures (Köhler et al. 2018). The past years have shown an increased interest in approaches concerning transitions, focusing not only on the optimization of technologies, but regarding the transformation of entire systems of production and consumption. In this context, concepts surrounding niches as spaces where fledgling technologies and ideas can develop and grow in experimental settings have gained relevance (Smith and Raven 2012, Raven et al. 2015, Raven et al. 2008). Within these niches, more radical solutions and ideas can be explored, with the bounded nature of the niches limiting risks and the niches providing protected spaces, free from market (and other) pressures. Existing concepts of socio-technical experimentation in the field of Sustainability Transitions were identified by Sengers et al. (2019) in the course of an extensive literature re-view.

Sustainability transitions

The past decades have produced a growing body of literature in the field of Sustainability Transitions, which addresses the transformation of current systems to more sustainable socio-technical systems (Geels 2011, 2013; Geels and Schot 2007; Kemp et al. 1998; Raven et al. 2010). Markard et al. (2012: 956) describe Sustainability Transitions as "long-term, multi-dimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption." A core com-ponent of Sustainability Transitions is the utilization of socio-technical experimentation as means for technological, social and institutional learning, which is essential for fundamental and long-term changes (Sengers et al. 2019). In contrast to technical experiments, which focus solely on the technical dimension, socio-technical experiments include the dimensions of user practices and institutional structures and involve real-world actors and real-life contexts (Sengers et al. 2019; Markard et al. 2012). The concept of "innovation" is understood in this context as referring not only to radical new technologies based primarily on research and development (R&D), but as including the dimension of social innovations and less formalized activities. Constructive technology assessment (CTA) can be considered as the source of many of these ideas, the CTA approach aiming to open up the process and decision-making of technology development to users, citizens and policymakers, in order to enable social learning to take place. Strategic niche management (SNM) is a specific approach stemming from CTA, which endeavours to facilitate interactive social learning surrounding new innovations within protected spaces (Schot and Geels 2008; Schreuer, Ornetzeder and Rohracher 2010). This core notion of establishing niches to benefit social learning and facilitate Sustainability Transitions has given birth to a wide variety of concepts regarding how experiments towards increased sustainability can take shape.

Experimentation

Against the backdrop of radical transformations, the concept of experimentation is given particular importance. Experiments for Sustainability Transitions must explicitly be distinguished from techno-productive pilot or demonstration experiments. Within this type of pilot experiments the scope of experimentation is small and focused on adjusting and optimizing project design for larger scale endeavours, with feasibility and cost often taking the centre stage (Huguenin and Jeannerat 2017: 629). Experimentation in the context of Sustainability Transitions, or what Huguenin and Jeannerat referred to as pilot and demonstration experiments with an emphasis on the societal dimension, must be regarded as efforts to bring about fundamental and radical change in socio-technical systems and as an attempt to explore as of yet unrealized opportunities. This requires fresh perspectives, new alternatives and problem framings, and novel ways of interpreting observations, all of which make up higher-order learning (Schot and Geels 2008: 541, Grin and van de Graaf 1996). An important characteristic of these experimental approaches, as described by Gross (2016), is that they use failure as a basis for learning, resulting in the seemingly paradox situation of failed experiments simultaneously being successful. Gross also notes that more recently experimentation has become more closely tied to learning in policymaking and governance (p. 618). As Sengers et al. (2019) have described within their systematic literature review, the notions of experimentation found in the Sustainability Transitions literature are manifold, operating according to different logics and serving different, albeit sometimes similar or related, overarching goals. This multiplicity of conceptualizations and approaches must be recognized as a strength, as complex sustainability challenges demand actions comprising a wide variety of perspectives and methods and addressing different levels (see also Ansell and Bartenberger 2016). When planning an experimental process in practice, it is crucial that the main objective and existing contextual factors inform the choice of experiment design, in order to allow for the potential of achieving long-term effects.

Higher order learning

A central role in all experiment conceptualizations is taken by learning processes. As Quist and Tukker describe: “To achieve sustainable innovation, people from numerous disciplines must work together to challenge existing paradigms with new, innovative approaches to governance, education, and product-service system provision, all of which are designed to help us develop societal systems that are equitable and sustainable.” (2013: 168). Mutual learning and collaboration are essential for sustainable innovation, with the importance of second-order learning being emphasized throughout literature on transitions towards sustainability (Schot and Geels 2008: 541, Brown and Vergragt 2008, Grin and van de Graaf 1996). First-order learning describes the learning taking place based on the insights gained from the experiment outcomes, without questioning the governing variables. Second-order learning, on the other hand, takes place when actors question the reigning values, frames, and paradigms (Quist and Tukker 2013). Different experiment types use slightly different methods to stimulate and support higher-order learning. In Bounded Socio-Technical experiments (see detailed description below), for instance, experiments include visioning exercises which serve to identify and articulate common goals among involved stakeholders and back casting exercises, which translate future visions into sets of actions and strategies (Vergragt and Brown 2007). Transition experiments (see detailed description below), on the other hand, are based on deepening, broadening and scaling up, whereby deepening describes learning from the transition experiment within a specific context, broadening de-scribes the repetition of the experiment in different contexts and linking to different functions, and scaling up refers to embedding the experiment in dominant ways of thinking, doing or organizing (van den Bosch 2010: 63-72). Most experiments for Sustainability Transitions involve some form of co-creation or co-production with users, which denotes an active involvement in various stages of designing or producing a product or service. Voorberg et al. (2013: 11) distinguish between three different degrees of citizen involvement, these being co-implementation, co-design, and co-initiating. While the terms “co-creation” and “co-production” are related and often used inter-changeably, a systematic literature review by Voorberg et al. (2013: 12) could find that co-production typically refers to co-implementation activities, while co-creation often refers to co-designing activities, though this differentiation is not consistently made.

Typology of experiments for sustainability transitions

The overview of experiment types we developed within the project is based on a systematic literature review presented by Sengers et al. (2019), which consists of the five concepts “niche experiment", "bounded-socio-technical experiment", "grassroots experiment", "transition experiment" and "sustainability experiment". The review serves as a helpful guide in navigating the various concepts and their origins. Sengers et al. mention Urban Living Labs (ULLs) as an emerging conceptualization on urban experimentation, but it was not expanded upon in detail due to the concept being new and not yet prominently visible within the literature. We have included ULLs in our overview, finding that there are enough distinguishing characteristics to be featured next to the other concepts. Another difference between the choice of concepts featured in the typology of Sengers et al. and our own is that we have chosen not to include sustainability experiments as a separate experiment type for our context. This choice was made because sustainability experiments share many core features with other experiment concepts and remain relatively vague in their design. The characteristics of this experiment type did not allow for a clear enough distinction from the other concepts for our purposes. In general, within the literature surrounding these experiment concepts, one can find many descriptions which give the distinct impression of being all-encompassing. This is evidence of the laudable ambitions these concepts embody. This aspiration of the different concepts to "do it all" creates a certain vagueness, which blurs the lines between them and makes it difficult to recognize the appropriate contexts for the different concepts. Our aim was to examine the distinct differences between these concepts and discover their respective strengths and weaknesses in order to produce a typology that can serve practitioners in their decision-making. We therefore developed a typology based on ideal types, which may differ from descriptions in other sources. These ideal types are mainly characterized by their starting points or drivers, the main objectives being pursued, the scope (e.g., if the learning process is geared towards gaining insights regarding the technical or social innovation itself or if it can also address overarching institutional structures or broader forms of living and cooperation), the involved actors and their roles and agency within the experiment and the degree of control from the implementation team.

Niche experiments

The concept of niche experiments aims to introduce the social dimension to technological development. It was born from Strategic Niche Management (SNM), an approach developed in the 1990s within the fields of Constructive Technology Assessment (CTA), Science and Technology Studies (STS) and evolutionary economics to manage the transition of new sustainability-oriented technologies from labs to real-world application (Sengers et al. 2019). SNM was de-scribed by Kemp et al. (1998: 189) as "stimulating learning about problems, needs and possibilities of a technology, building actor networks, alignment of different interests to a goal, altering the expectations of different actors and fostering institutional adaptation". Hoogma et al. (2002) further developed the SNM approach, emphasizing this marriage between the technical and the social which can be found in all technical systems (p.3-4), defining real-life experiments as the means to deliberately manage the niche formation process (p.181).

A niche is understood as a protected space where radical innovations can be developed and mature and where learning processes can take place (for more on this process and the multilevel perspective, see Geels (2002), Schot and Geels (2008)). The starting point for a niche experiment is, as mentioned, the development of a sustainability-oriented technological innovation or service, with its objective being the successful introduction of the same. It follows that the scope of the experiment is limited to the advancement of knowledge surrounding the technological or service innovation itself, with there being limited possibility to examine options regarding wider institutional or cultural innovations (for instance, a niche experiment about electric vehicles would regard the viability of the technology through the involvement of various actors, but would not provide a setting where the invited actors could reimagine mobility itself, through the redesign of infrastructure and land use or making use of telecommunication technologies to reduce the need for transportation).

While user needs are examined and user preferences can be questioned (Hoogma et al., 2002: 5) participants do not grow beyond this role of "user" and the experiment does not move beyond the focus on the technological or service innovation. Niche experiments closely follow a project-logic in the sense of there being a high level of control over the conditions and the duration typically spanning between two and five years. They involve multiple actors, such as public authorities, industry, research institutions and civil society, whereby civil society often takes the role of users who are monitored throughout the experiment. The importance of "outsider" and entrepreneur engagement is emphasized, referring to actors who do not count among the traditional actors of the technology or service being examined, in order to reduce the likelihood of vested interests in existing systems hampering innovative new ideas and developments (Hoogma et al., 2002: 193-194).

This element of actors and roles is closely related to learning processes, which can be considered as fundamental for these experiments. The idea is to move beyond first-order learning and achieve second-order learning taking place to increase the chances of success. Kemp et al. (1998) point out the importance of the articulation of expectations and visions between actors and the building of networks to ensure that learning processes can take place on multiple dimensions.

Niche experiments are embedded in the real-world insofar that a technology or service is made available at a specific location for a specific amount of time, while profiting from its status as a niche which can provide protections from market pressures, such as through financial aids.

A strength of niche experiments lies in its ambition to exploit windows of opportunity at the local level. Its focus on technology and service development allows specific problems and needs to be addressed, gaining insight on usability and conditions of a variety of specific options, which can, in turn, be used to inform decision-making processes, making it a helpful governance tool. Hoogma et al. (2002) describe SNM as "a way to improve the functioning of the variation selection process by increasing the variety of technology options upon which the selection process operates." (p. 200).

Regarding the weaknesses, niche experiments have suffered from a lacking input attributed to them taking place as isolated events and being too small in scale, whereby the importance of "negative learning" or failures is regarded as important for learning processes (Hoogma et al., 2002: 195). What niche experiments cannot do, and were indeed not designed to do, is to call into question wider practices, systems, or paradigms.

Urban living labs

The term “living laboratory” was first used by Bajgier et al. (1991) with the concept of the urban Living Lab (ULL) subsequently being developed further by William J. Mitchell (2004). The European Union adopted ULLs as a central tool for open innovation in 2006, allowing the concept to gain traction in many fields tackling complex problems, such as sustainable energy or health care.

The starting point for ULLs is the development of technologies or services, with a key characteristic being the endeavour to integrate this process of development into real-world systems in urban settings. This serves to, among other things, better align solutions with the specific market conditions through a co-production approach, whereby information and communication technologies (ICTs) usually play a central role. This integration into the “real-life” goes together with the involvement of all actors throughout the trial process phases, whereby the stakeholders are made up of the ULL owners, the ULL stakeholders in charge of organization and implementation, the ULL users who test the innovations and the ULL customers who are expected to benefit from the results. The actors taking on these roles are typically made up of a mix of public authorities (initiators, promoters, coordinators), firms (providers of technologies, products and services), research organizations (coordinators) and citizens (users).

The process phases are cyclical in the ULL approach and are made up of planning, implementation, evaluation and acting phases (Nesterova and Quak, 2016, Nesti, 2018). ULLs are small-scale projects at local levels, spanning from six months to two years, or in some cases beyond (Veeckman et al., 2013). At the core of open innovation and co-production lies the idea that solutions (new technologies, products, or services) are not only to be validated and refined with participants, but also designed and prototyped (co-design and co-creation) with them to promote a knowledge exchange between all actors (for a detailed analysis of co-production in ULLs, see Nesti (2018). This process allows for higher-order learning to take place. The focus on the development of technologies and services, however, frames the projects in a way that does not allow for involved actors and participants to question and examine wider contexts or alternatives outside of the regarded system. The control over the conditions of these types of experiments is high.

ULLs allow for possibilities of circumventing red tape and provide a space where failures can take place and serve as learning experiences. As a method for open innovation, ULLs bear the potential of flexible problem-solving fit to meet the complex sustainability challenges of urban life. In practice, however, this flexibility is rarely provided, with traditional project management struggling with the open structures needed for co-production processes to function, which lie at the heart of ULLs (Nesti, 2018). Some projects which encounter this issue fly under the banner of ULL but would be considered niche experiments according to our typology when the involvement of citizens is reduced to the role of users to be monitored. If co-production is successfully implemented, a great strength of ULLs can be realized, namely the generation of innovative ideas suit-ed for a specific local context.

As Nesti points out in her 2015 publication, the mortality rate of Living Labs is very high. This is interpreted as a natural progression within a “Hype cycle”, but also due to the high organizational costs and the lack of public funding, which represents the main source of funding for ULLs (Nesti 2015). Another challenge surrounding the co-production process involves the involvement of stakeholders and users. Any process reliant on participation must face questions regarding representativeness and ongoing commitment of participants to stay involved and engaged through-out the entire process (Nesti, 2018: 321). ULLs are not designed to question wider practices, systems, or paradigms.

Bounded socio-technical experiments

The theoretical foundation for bounded socio-technical experiments (BSTEs) is anchored in social learning theory (Sengers et al. 2019). The objective of BSTEs is to solve larger societal problems related to unsustainable technologies, services, and modes of living; they are therefore strongly driven by sustainability agendas. It is, however, not the primary objective of BSTEs to implement new technologies, services, and systems in society, but to achieve higher-order learning regarding sustainability, preferences, acceptance and system barriers and transitions (Vergragt and Brown, 2004: 22).

Vergragt and Brown (2004) propose that participatory visioning and back casting exercises should be conducted before BSTEs, defining desirable sustainable futures, and translating them into concrete steps to achieve this future vision, serving as a starting point for the BSTE. The sustainability focus is placed within this visioning process and can address societal or environ-mental problems. For social learning to take place, the actors within BSTEs must be diverse, with participants being made up of technical experts, educational and research institutions, governments, businesses and NGOs (Vergragt and Brown, 2004).

In their publication from 2007, Vergragt and Brown describe a BSTE project as being “[…] a project exhibiting several characteristics: an attempt to introduce new technology or service on a scale bounded in space and time; a collective endeavour, carried out by a coalition of diverse ac-tors, including business, government, technical experts, educational and research institutions, NGOs and others; a cognitive process in that at least some of the participants explicitly recognize the effort to be an experiment, in which learning by doing, trying out new strategies and new technological solutions and continuous course correction, are standard features.” (2007: 1110). The dimension of time is measured in years (typically around 5 years) and the dimension of space can be described in terms of geography (a community) or the number of participants, which is usually held small (Brown and Vergragt, 2008).

Vergragt and Brown (2004: 9) list higher-order learning as an indication that a BSTE has been successful, along with a new configuration of technology or service becoming a commercial success or ideas having been diffused beyond the project boundaries (Sengers et al., 2019, Vergragt and Brown, 2004). What makes BSTEs unique is the possibility to not only question the functionality of a solution but to radically call into question entire structures and frameworks and consider alternatives which fundamentally differ from anything existing in practice. Brown and Vergragt (2008) have presented a conceptual framework for monitoring higher learning processes taking place for individuals, communities, and societies at large in BSTEs.

Since BSTEs require higher-order learning on various scales, the effort and resources required can be assumed to be quite high, with a high demand for discussion and exchange between the participating actors. Successful BSTEs can indeed contribute to higher-order learning and con-tribute to sustainability visions, but in order to achieve this there are certain requirements: “the presence of a clear focus and boundaries for the project […]; intense and sustained interactions of several professionals with a commitment to the process and the goals of the project; a sense of urgency (rooted in the time and financial pressures); agreement among the participants about the vision for the project and its social mission, and about the process; agreement among them about the core social values, and overlap among the participants’ interpretive frameworks.” (Brown and Vergragt, 2008: 126). These basic requirements, which can be found for most multi-disciplinary endeavours, highlight the challenges these experiments face.

Transition experiments

The formulation of the transition management concept is credited to Rotmans, Kemp, Geels, Ver-bong and Molendijk (Rotmans et al. 2000). It uses “a visionary, cyclical process of agenda building, learning, instrumenting and experimenting” (Rotmans, 2005: 4) to steer towards more sustainable developments. Transition experiments are an element of this management concept, first described by Rotmans (2005: 50) as “practical experiments with a high level of risk (in terms of failure) that can make a potentially large contribution to a transition process”. Van den Bosch (2010) further elaborated the concept, emphasizing an important distinction between transition experiments and experiments in Strategic Niche Management. This distinction is found in the starting point of the experiments, with SNMs starting with a technological innovation, while transition experiments have societal challenges as a starting point for experimentation. It follows that the sustainability focus of transition experiments revolves mainly around sustainable ways to meet societal needs, which relate to subjects such as housing, healthcare, agriculture, or mobility for instance. The fact that societal challenges serve as a starting point, in turn, impacts the extent of what participants of the experiment can call into question, with transition experiments allowing for institutional and cultural innovations in addition to technological innovations with the potential of questioning existing systems, infrastructures, practices or paradigms.

Another fundamental characteristic of transition experiments that sets them apart is identified by van den Bosch as being regarded as part of a broader governance approach, with an objective of developing and managing a “portfolio of transition experiments that is connected to a long-term sustainability vision” (Van den Bosch, 2010: 50). Transition experiments are therefore always to be considered as elements of a larger transition management, which follows a learning-by-doing and doing-by-learning approach (Loorbach, 2007: 281-282).

Loorbach and Rotmans (2010: 237-238) conceptualize a “transition arena”, which describes a specific network of frontrunners and diverse actors as a central element of transition experiments where co-production takes place. The participation of civil society is not essential for transition experiments, the case examples presented in Loorbach and Rotmans (2010) describing well-defined networks made up of actors such as public authority actors, experts and practitioners, consultants, industry, transition researchers and NGOs. Regarding the real-world setting, Rotmans (2005: 51) defines the experimental spaces quite clearly, stating: "Experimental spaces are delimited environments which form a geographical, administrative or functional unit (system). Within these spaces we can identify test laboratories (sub-systems) where practical experiments take place". While the experiments themselves are small in scale, they are, as said before, meant to form a portfolio of experiments all serving to transition towards a broader sustainability vision organized within a transition management process. Transition management itself allows only for a limited amount of control, as it is subject to much unpredictability (Loorbach, 2007: 282), often being characterized as being "chaotic" due to unexpected developments. This must be recognized as an inherent and necessary characteristic of transition processes, which must be guided in a "flexible but determined way" (Loorbach and Rotmans, 2010: 244).

Regarding strengths, Loorbach (2007) describes transition management as "provid[ing] a way of thinking about governance that is concrete enough for implementation but simultaneously allows enough room for reflection, adaptation and learning" (p. 281) going on to state that it "is also a way of thinking in which limitations to control are not seen as barriers but as starting point for exploring possibilities that lack of control can offer." (p. 282). Ultimately, Loorbach also recognizes transition experiments as having the ability to have long-term impact on societal systems development due to the ability to redirect governance processes and reframe societal perspectives (p. 282). On the other hand, Rotmans (2005) describes transition experiments as being very time-consuming and costly, with the further development of successful experiments being gaged as taking between 5 and 10 years. In addition, there is a tendency for transition experiments to fail, due to their nature as projects dedicated to deep learning processes.

Grassroot experiments

Grassroots activities towards sustainability are community-based as opposed to market-based and have been taking place for several decades, for instance within Agenda 21 programs which launched in the 1990s (Evans and Theobald, 2003). Seyfang and Smith (2007: 585) define grass-roots innovations as "networks of activists and organisations generating novel bottom-up solu-tions for sustainable development; solutions that respond to the local situation and the interests and values of the communities involved". It is emphasized that these activities take place in civil society arenas. Citizens and civil society actors are therefore the drivers of grassroots experiments, placing a focus on social innovations and greener technologies. They represent an alternative to science and industry-based innovation, relying on resources such as grant funding, voluntary input and mutual exchange, whereby forms of organization can differ substantially (Seyfang et al., 2014: 24-25, Seyfang and Smith, 2007: 591).

The starting points for grassroots experiments are values, social need and ideology, making them dependent on a strong commitment of activists and involved communities. Views therefore also differ on what constitutes a “successful” grassroots innovation, seeing as the objectives can differ greatly. While some grassroots movements may wish to grow and disseminate, others may opt to aid other initiatives to grow while maintaining their own limited size, or not nurture any ambition for growth at all with a focus placed on local issues. Generally, grassroots attempt to ad-dress social and environmental needs to provide flexible and localized services (Seyfang and Smith, 2007: 591). While most grassroots activities are a response to articulated problems and needs, there can be overarching political goals (Ornetzeder and Rohracher, 2013).

Grassroots experiments have many elements which define them as unique, relating to the traits of being organized as bottom-up and being citizen-driven. This affords grassroots experiments certain advantages, such as being able to tap into specific local knowledge that users hold, which is crucial for problem definition and solving (Von Hippel, 1998). The strength of grassroots experiments lies in their function as a source of innovative diversity. They are also open and flexible enough to allow for different social, ethical, and cultural rules to be observed, which can lead to new incentives outside of what can be done within the mainstream economy.

Difficulties grassroots activities can face are largely related to the resources and skills needed to keep the activities going. Funding is a fundamental challenge for most grassroots innovations, affecting the ability to remain viable as prospects for institutionalization and diffusion of ideas into society are closely linked (Seyfang and Haxeltine, 2012). The local focus of most grassroots also causes difficulties when attempting to scale them up and the often-radical values they are built on can clash with already established commercial or policy interests (Seyfang et al., 2014: 25, Seyfang and Smith, 2007: 596).

Comparison of concepts

The concepts presented above share many core attributes. For instance, all these five experiment types address complex problems with high uncertainty and revolve around learning pro-cesses involving a mix of actors. They are also each embedded in real-world settings. Regarding the innovation focus, most of the concepts deal with either ecologically sustainable development (e.g., niche experiments), socially sustainable development (e.g., transition experiments), or a combination of both (e.g., BSTEs and grassroots experiments). But there are also some striking differences, resulting in unique types with different potentials. Table 3 shows an overview of the typology of experimentation for Sustainability Transitions as understood within this project, aiding in a comparison between the types.

As can be seen in Table 3, niche experiments focus on new products or services as parts of new systems of production and consumption and are mainly driven by industry. They aim to include user needs and preferences to optimize the introduction of a sustainability-oriented technology or service, placing an emphasis on engaging outsiders of the traditional system. The strong focus on the development of a new technology or service with the potential of creating revenue is also found in ULLs, which show many other similarities to niche experiments, such as the high degree of control. The main difference between niche experiments and ULLs according to this typology are found in the stronger participatory nature of ULLs, which place an emphasis on co-production approaches, incorporating a multitude of stakeholders not only to test and vali-date, but also to actively create and prototype.

The third concept in Table 3 differs from the previous two in multiple respects. BSTEs aim to support the development of radically different sustainable ways of living, whereby learning on several levels is an important element. The concept encourages participants to radically question the solutions offered, a possibility not found in niche experiments or ULLs. The social dimension takes up a prominent role in BSTEs, a similarity shared with transition experiments and grass-roots experiments, whereby BSTEs are typically still tied strongly to new technologies or ser-vices in contrast to the other two concepts. This is related to the starting point of BSTEs being the development of sustainability-oriented technologies or services in connection with sustainability visions, whereby transition experiments and grassroots experiments typically start from a specific societal challenge.

Transition experiments are driven by normatively defined sustainable futures and not by techno-logical innovation, providing the freedom to call existing systems into question and pursue institutional or cultural innovation. Co-production processes play a central role, with the flexibility of transition experiments leading to high unpredictability. While grassroots experiments share a similar driver, also being propelled by a desire to seek solutions for local problems, there is a core difference to all other types concerning the roles actors may take.

Grassroots experiments are bottom-up processes with there being no central innovation actor. The experiment typically starts with tangible problems being taken up by local initiatives. This is the source of both the main strengths and weaknesses of this experiment type: the bottom-up process allows for an incredible range of innovative diversity, which in turn allows alternative pathways to be explored, even if they run opposed to existing dominating solutions or policies. In turn, however, this often results in lacking support over the long-term, with the required re-sources to keep the experiment running becoming difficult to secure.

This chapter has detailed existing concepts of experimentation in length, to establish their weaknesses, strengths, and fundamental differences. These make them suitable for different contexts addressing different objectives. In this report, the developed scenarios for temporary housing are matched with these experimentation concepts based on the findings of this chapter as summarized within Table 3.

Table 3: Typology of experimentation for Sustainability Transitions and their defining characteristics

Core Character-istics	Niche experiments	Urban Living Labs	Bounded Socio-Technical experiments	Transition experiments	Grassroots experiments
Starting point	Development of sustainability-oriented technology or service	Development of innovative technology or service	Development of sustainability-oriented technology or service and sustainability visions	Societal challenge	Societal challenge, ideology
Main objectives	Successful introduction of sustainability-oriented technology or service	Successful and efficient introduction of innovative technology or service for sustainable and smart cities	Higher-order-learning on sustainability and transitions Development of a socially embedded new configuration of technology or service and new forms of living	Contribution to a long-term sustainability vision Development of new forms of living Realizing a transition	Meeting social and environmental needs through flexible, localized services
Scope	Advancing knowledge surrounding a technology or service including user needs and preferences	Advancing knowledge surrounding a technology or service including user needs and preferences	Advancing knowledge surrounding a technology or service or new forms of living and cooperation with the potential of questioning existing systems, infrastructures, practices, or paradigms	Advancing new forms of living and cooperation with the potential of questioning existing systems, infrastructures, practices, or paradigms	Advancing new forms of living and cooperation with the potential of questioning existing systems, infrastructures, practices, or paradigms
Learning processes	Articulating & aligning expectations Building actor networks	Co-production (user-engagement, multi-stakeholder participation) Multi-method approaches	Monitoring of learning processes Co-production	Transition arenas (network of frontrunners & diverse actors) Co-production	Capacity-building through learning-by-doing Bottom-up Needs-oriented

Actors	Government, industry, research institutions, civil society (as users) Outsiders of the traditional system and entrepreneurs	Government, industry, research institutions, civil society Role of civil society as users and co-creators	Government, industry, research institutions, civil society (as co-creators)	Government, industry, research institutions, NGOs Involvement of actors who are engaged with the societal challenge driving the experiment	Civil society and NGOs as initiators, coordinators, and participants
Degree of control	High	High	Limited	Limited	Low
Strengths	Governance tool addressing specific problems with a variety of options Exploiting windows of opportunity at the local level	Flexible problem-solving and innovative solutions through co-production for specific local contexts Exploiting windows of opportunity at the local level	Breaking down wider sustainability goals to specific local problems which are addressed with flexible problem-solving and development of sustainability-oriented technologies or services Room to question wider contexts such as existing systems, infrastructures, practices, or paradigms	Flexible governance with room for reflection, adaptation, and learning Reframing societal perspectives Long-term impact on societal systems development	Innovative diversity and alternative pathways
Weak-nesses	Isolated events at small scales (low impact) No questioning of wider practices, systems, or paradigms	High organizational costs (time, money) Lacking ongoing commitment of participants No questioning of wider practices, systems, or paradigms	High organizational costs (time, money) Lacking ongoing commitment of participants	Time-consuming and costly Tendency towards failure	Securing resources to maintain activities

1.3 METHODOLOGICAL APPROACH

Following the groundwork laid in WP1 (International state of the art research in all disciplines) and WP2 (Case study Vienna), the objective of WP3 is the development and selection of 6 pop-up housing scenarios and the detail planning and design of respective pop-up housing models, which are evaluated in a later phase of the project (WP4) with an interdisciplinary assessment system, that is developed in parallel to the scenarios and pop-up housing models. Furthermore, for each pop-up housing model a niche experimentation model is selected.

In this section, the approaches and methods used in WP3 „Scenario selection and pop-up housing model development" are described in detail.

1.3.1 Developing pop-up housing scenarios and pop-up housing models

The development of pop-up housing scenarios and pop-up housing models was a multi-stage process that took almost 2 years. This chapter provides an overview of the process, the groups of people involved in the development, and the feedback loops undertaken to achieve a wide range of pop-up housing scenarios and models that consider many points of view and an interdisciplinary approach.

For better comprehensibility, the development process is also presented as a process flow. (The graphic of the whole process flow is presented in the Annex).

Figure 1, Figure 2, Figure 3 and Figure 4 reflect the different phases – from the first scenario idea to the detailed elaboration of the developed models – and show in total the whole process. In the interplay, there were phases in which mainly internal project team members made decisions and phases in which external stakeholders were deliberately involved in the process to involve new perspectives and to widen the process to a transdisciplinary approach.

The phases for the development of pop-up housing scenarios and pop-up housing models are:

- Phase 1: Preparatory Phase
- Phase 2: Scenario development
- Phase 3: Model development
- Phase 4: Detail planning and Finetuning

Phase 1: Preparatory phase

The research and elaboration of WP1 and WP2 can be seen as a preparatory phase for scenario and pop-up housing model development, in which on the one hand the state of knowledge regarding temporary housing was researched, and on the other hand, the situation and framework conditions for temporary housing in Vienna were investigated. More details can be found in the respective reports and deliverables of WP1 and WP2. The findings in this phase were generated mainly through desk research, supplemented with some site visits to interesting examples of temporary housing, and were an important preliminary work for the scenario development.

At this point, the importance and composition of the interdisciplinary project team should be high-lighted once again, as this is also reflected in the results and in the topics and focal points that gained greater importance. The interdisciplinary project team consists of a total of 23 people and represents the disciplines of social science, architecture, landscape planning, spatial planning, waste management, resource management and closed-loop processes, water and wastewater management, energy engineering, risk and technology assessment, and modelling.

Phase 2: Scenario development

The scenario development phase can be roughly divided into two stages, on the one hand, a transdisciplinary stakeholder work to develop rough scenario drafts and on the other hand a revision and selection process (see Figure 2).

Launch of the scenario development process with a transdisciplinary stakeholder workshop

The process of scenario development was launched with a stakeholder workshop in February 2019 (Workshop WS1).

The stakeholder workshop was an important starting point and an opportunity for necessary, transdisciplinary exchange, since the preparatory research was largely anchored as desk re-search and in theory, so the findings were to be discussed with a group of stakeholders from practical fields regarding temporary housing, regarding accommodation and care of persons be-longing to one of the user profiles, regarding urban planning and housing, etc. This was the first of several feedback loops that were implemented in the process of scenario and model development, which on the one hand represented a "reality check" for the research findings, and on the other hand, also opened new perspectives for further process steps. The stakeholder workshop took place at BOKU University with 11 external participants, that had professional backgrounds in social work, city councils, architecture, urban planning, etc.

The goal of the stakeholder workshop was to assess relevant framework conditions for Vienna and "building blocks" as a basis for temporary housing scenario drafts. Different scenario ideas were developed in three small groups (of 3-4 persons each) with participants from different professional and disciplinary backgrounds and moderated by internal project team members (PIs). One important guiding principle for developing ideas and suggestions for pop-up housing scenarios was the relevance for Vienna – derived from the professional backgrounds of the participants.

To better structure the ideas and compare them later, different scenario “building blocks” were elaborated in a template (see Figure 1), which was also used in a similar form to characterize and collect real examples of temporary housing (see WP1). The template consists of the following “building blocks”:

- User / target group and social aspects
- Duration of temporary living
- Building facilities and open space
- Characteristics of areas and zones
- (Technical) infrastructure connection
- Characteristics of the neighbourhoods
- Special features / particularities of scenario draft

The stakeholder workshop yielded 5 preliminary scenario drafts with which the scenario development process was continued.

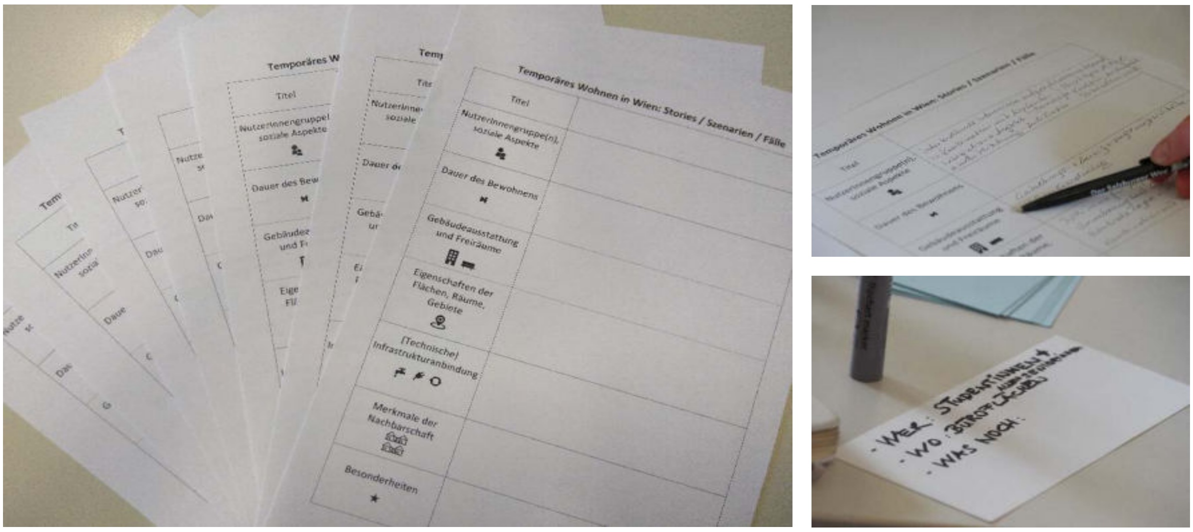


Figure 1: Stakeholder Workshop 1: Developing temporary housing scenarios with "building block" templates

<u>Scenario revision and selection process</u>

In April 2019, an internal 2-day project retreat took place with the following objectives:

1. Development of further scenario drafts
2. Revisions and improvements of the scenario drafts
3. Selection of pop-up housing scenarios for the project

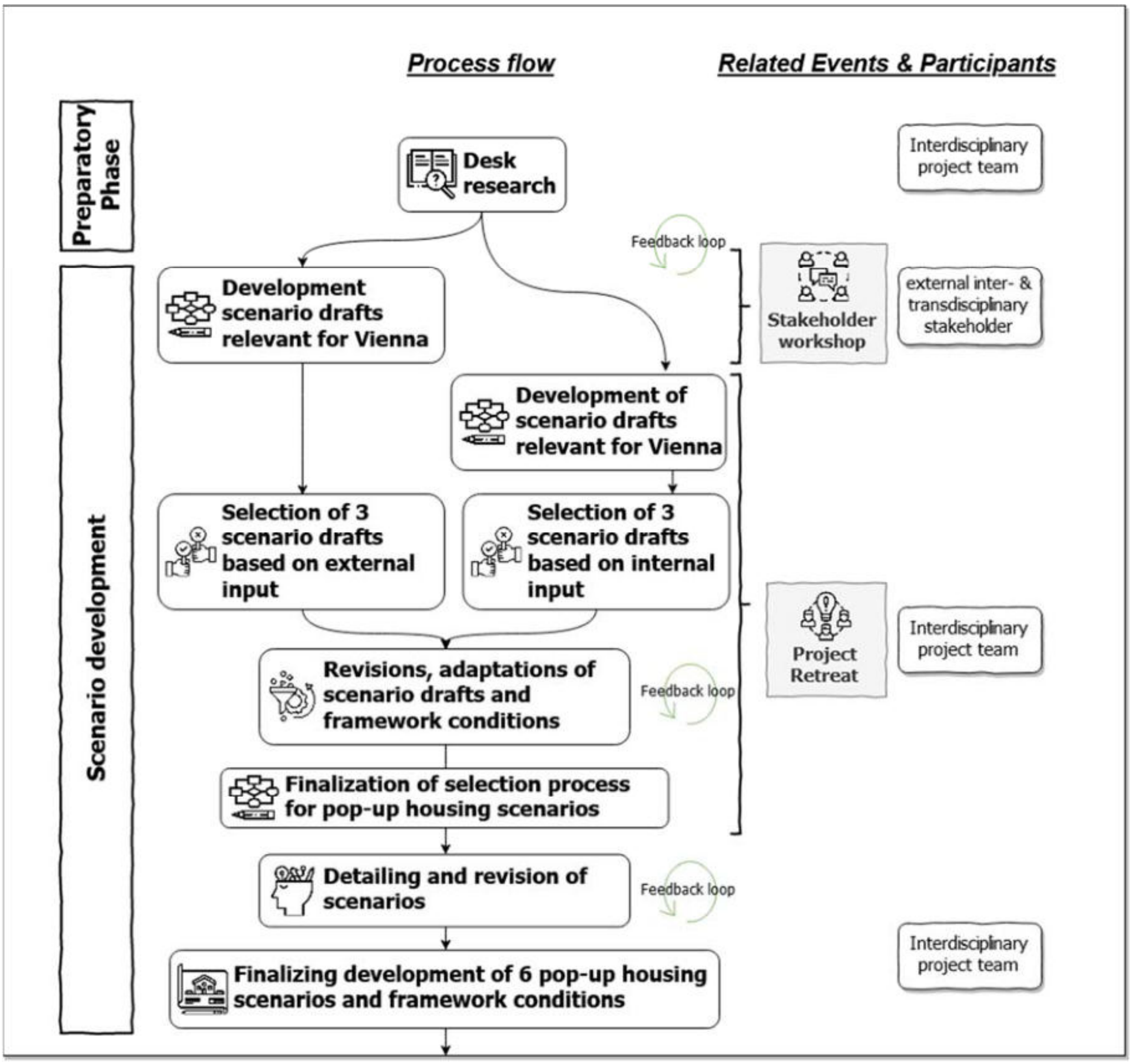


Figure 2: Process flow of scenario and model development I: Preparatory phase and scenario development[1]

First, the project group was divided into interdisciplinary small groups (3-4 persons): The task at hand was to develop either additional scenario drafts and framework conditions in a similar manner as the participants of the stakeholder workshop did (using the template of scenario building blocks) or to build on scenario drafts of the stakeholder workshop and revise and refine those initial ideas. To develop a diverse range of scenario drafts, some guiding criteria for this task had to be taken into consideration:

- Scenario drafts must be relevant for the City of Vienna
- Scenario drafts must follow an internal logic and be consistent
- Scenario drafts should consider different framework conditions (e.g., various building and area types, …)
- Scenario drafts must include some new or innovative aspects

[1] This chart was created by Zeilinger using resources from diagrammeditor.de and Flaticon.com. The icons were designed by Eucalyp, Surang, freepik, icongeek26, phatplus, bqlqn,dDara, geotatah, prettycons, golubev, umtimatearm, flat_icons and pixelmeetup.

- A minimum of 3 scenario drafts must be developed and should consider some auxiliary conditions:
    a. At least one scenario draft should include the adaption or refurbishment of an existing building, at least one scenario draft should include new constructions.
    b. Three degrees of freedom ("Freiheitsgrade") regarding the use of land and application of building codes ("Bauordnung") were defined (see below). The scenario drafts should consider those degrees of freedom.

It was an objective of the scenario development to generate creative and innovative new ideas, without having to take the existing legal and planning constraints (e.g., regarding building codes) too literally in a first step. To facilitate this out-of-the-box thinking, three degrees of freedom for scenario drafts were predefined.

Table 4: Degrees of freedom to be considered in the development of temporary housing scenario drafts

Degree of Freedom	Name	Restrictions	Explanation
1	Total restriction	Use of land and area / restricted Building code / restricted	- Only areas are to be used for temporary housing where it is allowed by the current zoning plan. No areas are allowed to be rededicated as new building land. Therefore, green spaces are not suitable to build temporary houses. - Temporary buildings must fully fulfil the current building code.
2	No vacancy ("kein Leerstand")	Use of land and area / restricted Building code / open	- Only areas are to be used for temporary housing where it is allowed by the current zoning plan. No areas are allowed to be rededicated as new building land. Therefore, green spaces are not suitable to build temporary houses. - Restrictions regarding the current building code can be (partly) omitted by temporary housing projects.
3	Laissez-faire	Use of land and area/ open Building code / open	- All areas (including green spaces and others currently not permitted for residential buildings) can be used for temporary housing. - Restrictions regarding the current building code can be (partly) omitted by temporary housing projects.

The different scenario ideas were first presented, discussed, adapted and analysed within the project team. This represents a second important feedback loop, as it opened the floor for all present project team members to raise their concerns, questions, suggestions and was intended for improving and streamlining the scenario drafts. Later, the revised versions of the scenario drafts were put up on posters in a "gallery" so that the individual project team members could look through the different proposals, compare them and form their opinions.

As a final step, the scenario proposals were voted on, with a maximum of 5 points being awarded per person, whereby it was optional whether the points were distributed evenly, or all placed on one scenario draft. The selection was done in 2 rounds, the first 3 scenario drafts based on ex-ternal input were selected (drafts that were developed in the stakeholder workshop) and in the second round, further 3 scenario drafts based on internal input were selected. The selection pro-cess took place in an open setting; within a certain time limit all project members were to distribute their sticky points on the posters of their favoured proposals. Strategic voting was partly made possible by these rules. Another drawback that must be mentioned is the fact that not the entire project team was present at the retreat, and only those people present were able to participate in the selection process and cast their votes. The drafts with the most points were finally selected as one of six pop-up housing scenarios for this research project.

After the selection took place at the project retreat, the scenarios were further revised and improved. Especially the project members who could not participate in the selection process were familiarised with the selected scenarios and their expert opinions were considered. For several scenarios, there were also valid objections from individual disciplines or individuals, so that this further feedback round was important to be able to make improvements to the scenarios in an interdisciplinary exchange or to learn from each other in discussions and to get to know the different viewpoints and rationales of the various disciplines. Only the selection of the 6 (basic) scenarios made at the retreat was not open for discussion and not changed, but the inner logic of each scenario was improved.

Table 5 gives an overview of the 6 selected pop-up housing scenarios. More details on all scenarios and corresponding pop-up housing models can be found in the following chapters.

Table 5: Results of scenario selection process

Scenario	User Profile	Trigger, Framework	New construction or adaption of existing buildings	Degree of freedom
Beat the Heat	A, B, C	For a state of emergency in heat waves, seasonal, abruptly, and short-termed	New building construction	2
Life sharing to go*	A, B, C (heterogeneous user group)	Appropriation of vacant buildings	Use of existing, vacant industrial building (industrial halls) and newly constructed living modules	2
Gap Module*	A (refugees), C	Temporary use of brownfield / vacant lot	Vacant lot – new building construction	1 (-2)
Life on track(s)	A, C	(semi-)mobile	new construction and / or appropriation of existing objects	3
Flat-Pack*	C (voluntary mobile persons)	Appropriation of vacant ground floor retail / commercial space	Use of existing, vacant part of a building (ground floor) and newly constructed living modules	1 (-2)
DonAutonom	C (voluntary mobile persons)	Mobile, short-term work stays	Appropriation of existing objects (and newly constructed parts)	3
* Based on drafts created at stakeholder workshop (Feb 2019)				

Phase 3: Model development

The next phase was the development of pop-up housing models. It can be divided into two stages: first, a collaboration with students partaking in a Design studio of the TU Vienna (TU Wien) and second, model revision and finetuning (see Figure 3).

Collaboration with TU Vienna

Beginning in winter term 2019/20, a cooperation with the TU Vienna (TU Wien) was established. In the course for architecture students, "POP-UP SHELTER - Design Studio", by JASEC at the Vienna University of Technology, the selected pop-up housing scenarios for Vienna were elaborated into concrete model design drafts (Technische Universität Wien, 2019). In a Design Studio course, students must design their visions of a building model, demonstrate and develop their skills in this respect.

The cooperation was initiated through the professional network of one of the project members. JASEC (Japan Austria Science Exchange Centre) coordinates the scientific cooperation between all faculties of Vienna University of Technology and Japanese partner institutions (JASEC 2019a). Disaster mitigation and security in buildings are focus areas of their research and education program. This made it possible to establish a connection to the topic of temporary buildings in a broader sense, even though there was no focus on Japan in our model development and selection.

To achieve this task, the students were provided with a short description of each scenario and relevant framework conditions that had to be considered in the design proposals. The students worked either in pairs or alone. This yielded two to four design proposals per scenario. In the winter semester of 2019/20 students worked on the scenarios Gap module, Beat the Heat and Life sharing to go. In the summer semester of 2020, the collaboration with TU Wien was renewed and a new group of students worked on the remaining scenarios Life on track(s), Flat-Pack and DonAutonom.

This cooperation was advantageous in several respects: the JASEC course instructors had clearly defined tasks and frameworks for their students to work on, the students were not just designing for the sake of practicing but knew that the results would be appreciated and further processed in a research project, and for the project team there was the opportunity to receive a selection of design proposals from architecture students straight away. Even though there were no conflicting objectives or motivations for all parties to participate in this cooperation, it must be noted that the learning and training character of the Design studio was of course the focus for the course instructors and students, and some adaptations and assumptions to the pop-up housing scenarios were made by the course instructors or the students themselves to better fit the framework of a Design studio. This was not always completely in the spirit of the scenarios as they were originally conceived or of the research project and in the following processes, this was partly aligned again to the focus of the research project.

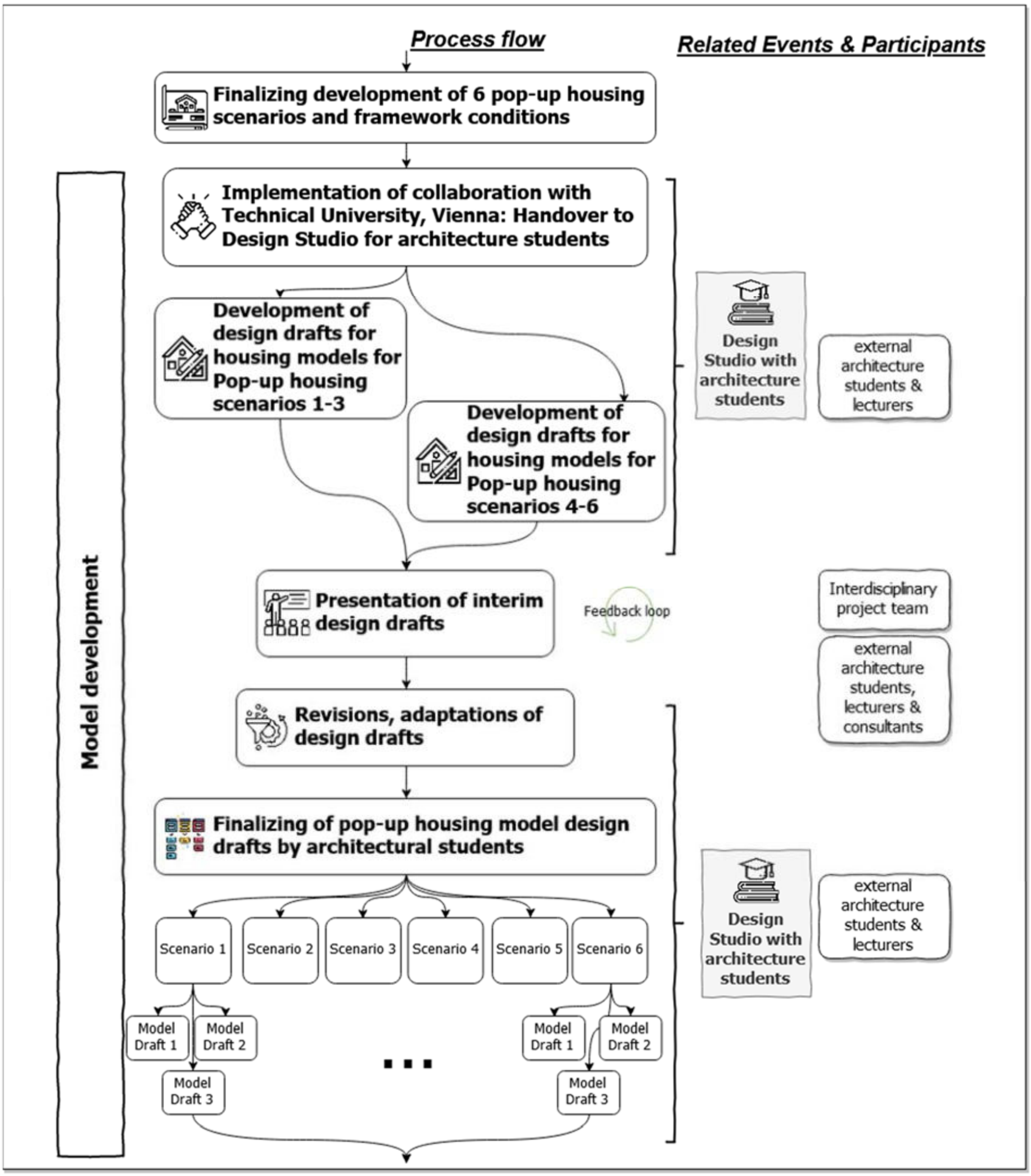


Figure 3: Process flow of scenario and model development II: Model development[2]

An interesting opportunity for exchange and feedback with the architecture students arose in public presentations of the interim and results of the students' work which was open to project members, consultants for the Design studio, the interested public and students. The first presentation for the first three scenarios took place in December 2019 in a classroom event and the second presentation for the remaining scenarios took place in June 2020 in a virtual event due to Covid restrictions. These events allowed the project team to gain initial insights

[2] This chart was created by Zeilinger using re-sources from diagrammeditor.de and Flaticon.com. The icons were designed by Eucalyp, Surang, freepik, icongeek26, phatplus, bqlqn,dDara, geotatah, prettycons, golubev, umtimateearm, flat_icons and pixelmeetup.

into the design drafts and contribute impulses or aspects that could or should be considered in the de-sign. The students could receive feedback that was still to be integrated into the designs in a subsequent revision step. Also, at the presentation of the results strengths, weaknesses and overall rationale and implications of the model design drafts were discussed. It is considered as a good opportunity for inter- and transdisciplinary exchange and included new aspects that had not been considered yet.

The result of the students was handed over the project team and further revisions and adaptations of the model design drafts, and the final selection process took place within the inter-disciplinary project team.

Model revision and selection process

The architecture students provided two to four model design drafts for each scenario. This revealed a wide variety of implementation ideas and approaches, but ultimately a single model de-sign had to be selected for each scenario. The selected design was then elaborated in more de-tail including all disciplines (e.g., estimation of quantities of building materials, number of users per living unit, grid connection, etc.). The project-internal selection process for pop-up housing models started with a presentation of all design proposals and a discussion within the interdisciplinary project team. The revision and selection process are shown in Figure 4.

For better comparability and thus as a basis for decision-making, the design drafts were analysed and presented in a standardized form using five categories, namely architectural quality, constructional quality, sustainability quality, urban planning quality and social quality (see Table 6).

Table 6: Overview of categories for model draft assessment

Architectural Quality	Constructional quality	Sustainability quality	Urban planning quality	Social quality
General 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 dimensions of living unit [m²]	Logistical requirement 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 (regarding pop-up environment)

This process step showed how complete and well-thought-out the individual design proposals by the student groups had already been. Where no information was provided in the design proposal, the respective subcategories were left blank, or information was added if it was not explicitly stat-ed but was clear from the documents and drafts (e.g., type of water supply, etc.).

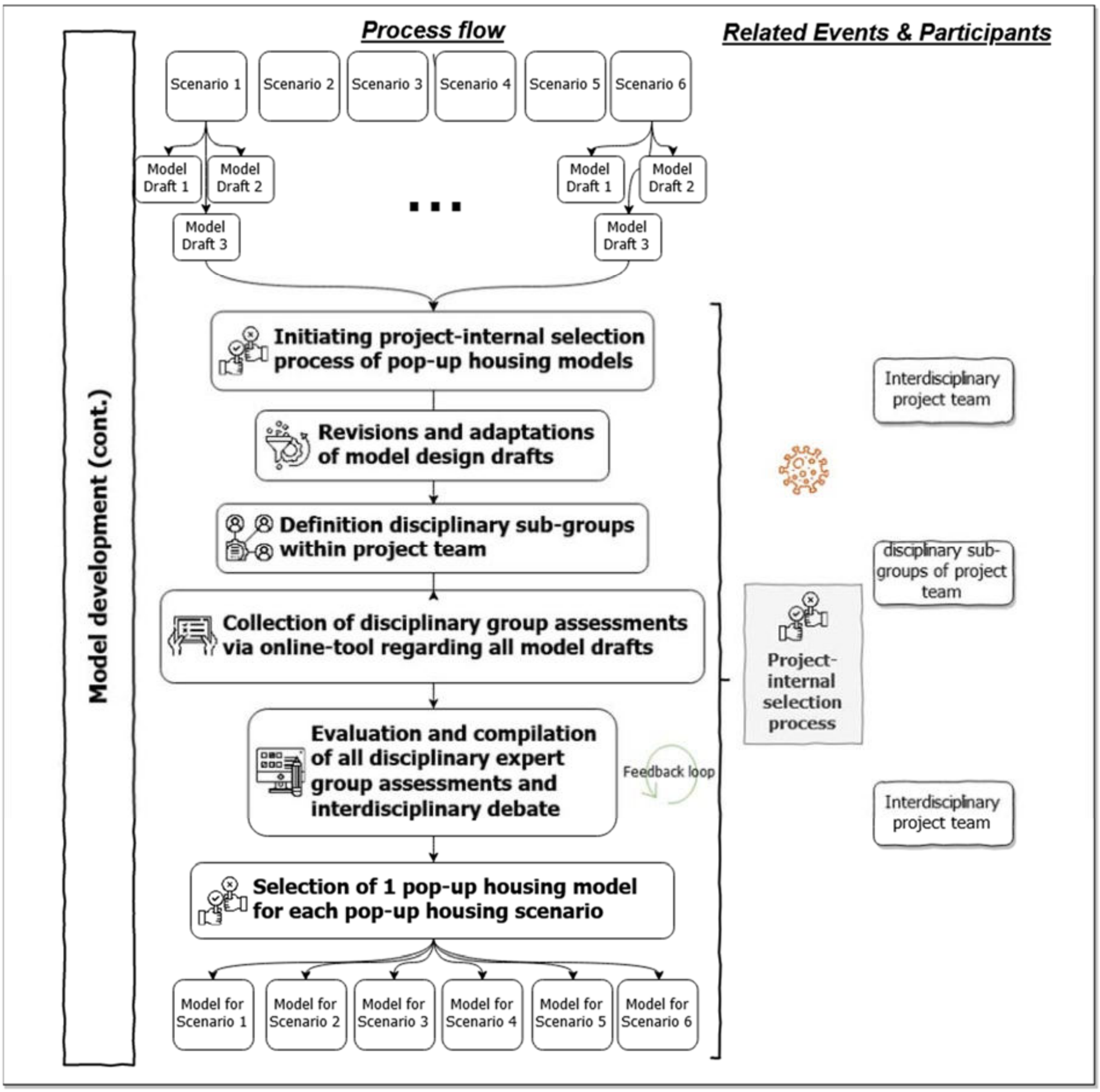


Figure 4: Process flow of scenario and model development III: Model development (cont.)[3]

After these preparations, the project team members' assessments of the design proposals and their favourites model draft for each scenario were collected. In view of the emerging Covid-19 pandemic, and because of the experiences from the first selection and voting process at the project retreat (especially “limited access to voting” – as only those who were present could participate in the selection of the pop-up housing scenarios), a digital selection process for the pop-up housing models was implemented, whereby the time period for the selection was a few weeks.

The online selection process was also designed to facilitate an in-depth discussion within the different disciplines represented in the project team. All project team members were allocated

[3] This chart was created by Zeilinger using resources from diagrammeditor.de and Flaticon.com. The icons were designed by Eucalyp, Surang, freepik, icongeek26, phatplus, bqlqn,dDara, geotatah, prettycons, golubev, umtimatearm, flat_icons and pixelmeetup.

to a disciplinary sub-group that best represents their professional background. The online assessment and selection process had to be undertaken after finding a consensus within the disciplinary group. This enabled in-depth disciplinary analysis and debate regarding the respective model design drafts. Seven disciplinary sub-groups were established, ranging from two to maximum 4 persons (see Table 7: Overview of disciplinary groups for selection of pop-up housing models).

Table 7: Overview of disciplinary groups for selection of pop-up housing models

Discipline	Number of representatives within the project team
Architecture	2
Energy engineering	3
Landscape planning	3
Resource and waste management	3
Social science and risk assessment	3
Spatial planning	4
Water management and closed-loop design	2

For the online assessment a short questionnaire was implemented using google-forms and com-prises seven questions (partly multiple-choice, partly open questions) and the option for submit-ting further comments:

1. Name of disciplinary sub-group
2. How would you assess the model design draft [No. 1-4] regarding its architectural, constructional, sustainability, urban planning, and social quality? (1= low quality, 5= high quality)
3. How would you rank the suggested model design drafts? (First choice to last choice)
4. Which of the suggested model design drafts should we choose as the basis for the pop-up housing model for scenario [1-6]?
5. What do you like most regarding your selected design draft?
6. What do you like least regarding your selected design draft? Where is room for improvements?
7. Is there an aspect of another model design draft that should be integrated (if possible) into the design draft you have chosen?

As an example: For the pop-up housing scenario Gap module, there were four model design drafts provided by the architecture students (see Figure 5).

Divergent Enclosures[4]

Where the wild poles grow[5]

Pop-up Shelter[6]

Gapsolutely Fitting[7]

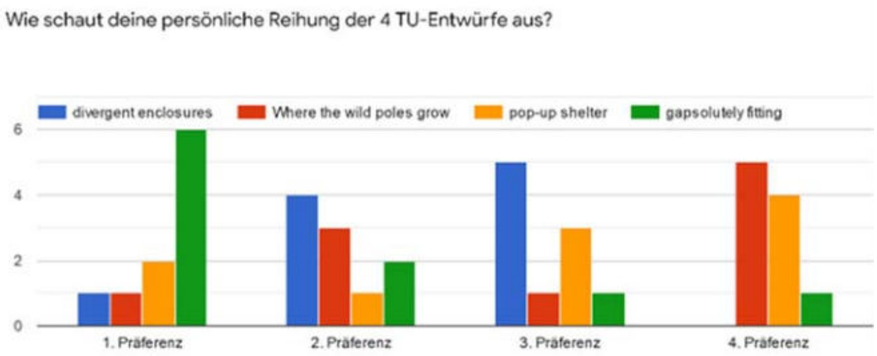
Figure 5: Exemplary designs by students for scenario Gap module

The results of the assessment process were compiled for all disciplinary subgroups and the most important arguments of the different disciplines were summarized. In the case of the exemplary scenario “Gap Module”, the design proposal “Gapsolutely fitting” was ranked highest amongst the model design drafts (see Figure 6, colour of design draft “Gapsolutely fitting” is green).

The next step was an interdisciplinary debate where the results of the assessment process were presented, analysed, and discussed. Particular attention was given to situations, when one disciplinary group had assessed a design proposal completely opposite to most of the other subgroups, as it could indicate shortcomings regarding this respective discipline, that the others had not been aware of. With verbal negotiations to include or remove certain aspects of a specific design draft, there was an attempt to yield the best (interdisciplinary) ideas from the wide range of details given in the design proposals. Finally, one of the model design drafts was chosen as a pop-up housing model for a given scenario, or a composite design was

[4] Design by Huber & Oldland, Design Studio Pop-up Shelter, JASEC, TU Wien, WS 2019
[5] Design by Richter, Design Studio Pop-up Shel-ter, JASEC, TU Wien, WS 2019
[6] Design by Calvo & Zugmayer, Design Studio Pop-up Shelter, JASEC, TU Wien, WS 2019
[7] Design by Friedwagner & Prömers, Design Studio Pop-up Shelter, JASEC, TU Wien, WS 2019

envisaged if the assessment results were too close, or all the design proposals needed major revisions to fit the interdisciplinary research project objectives.



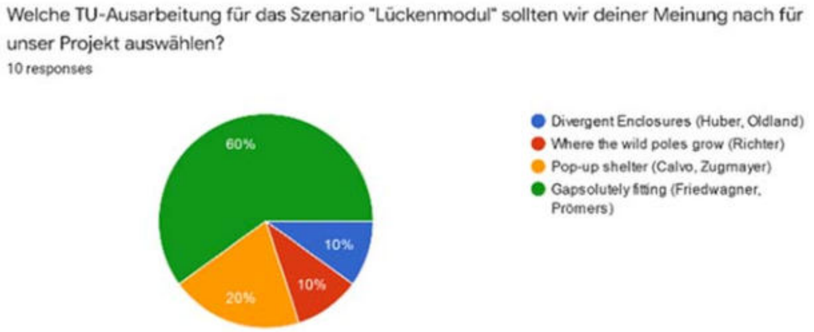


Figure 6: Exemplary display of voting results regarding model design drafts by students for scenario Gap module within the model selection process

Table 1 at the beginning of this report shows the pop-up housing models that were selected based on the model design drafts. InFactory and Shop Hopping Box are a composite of suggested model design drafts by the students and major revisions by the project team members.

Phase 4: Detail planning and finetuning

Following an iterative decision-making process, six pop-up housing models for six different pop-up housing scenarios were finally chosen, based on design proposals from architecture students who participated in JASEC's Design studios. By their disciplinary nature, the design proposals focused primarily on aesthetics and architectural design. To allow a subsequent com-prehensive and interdisciplinary modelling (which is the focus of WP4), the pop-up housing models must be described in much more details that are relevant for the involved disciplines.

As mentioned in the beginning of this chapter, the last step of the pop-up housing model selection process was an in-depth interdisciplinary discussion within the project group, that highlighted necessary adaptions, revisions, combinations, and suggestions for the model design. The models were described in detail from the many different disciplinary perspectives and finetuned. These alterations were considered in the first of several interdisciplinary revision and adaptation loops (see Figure 7).

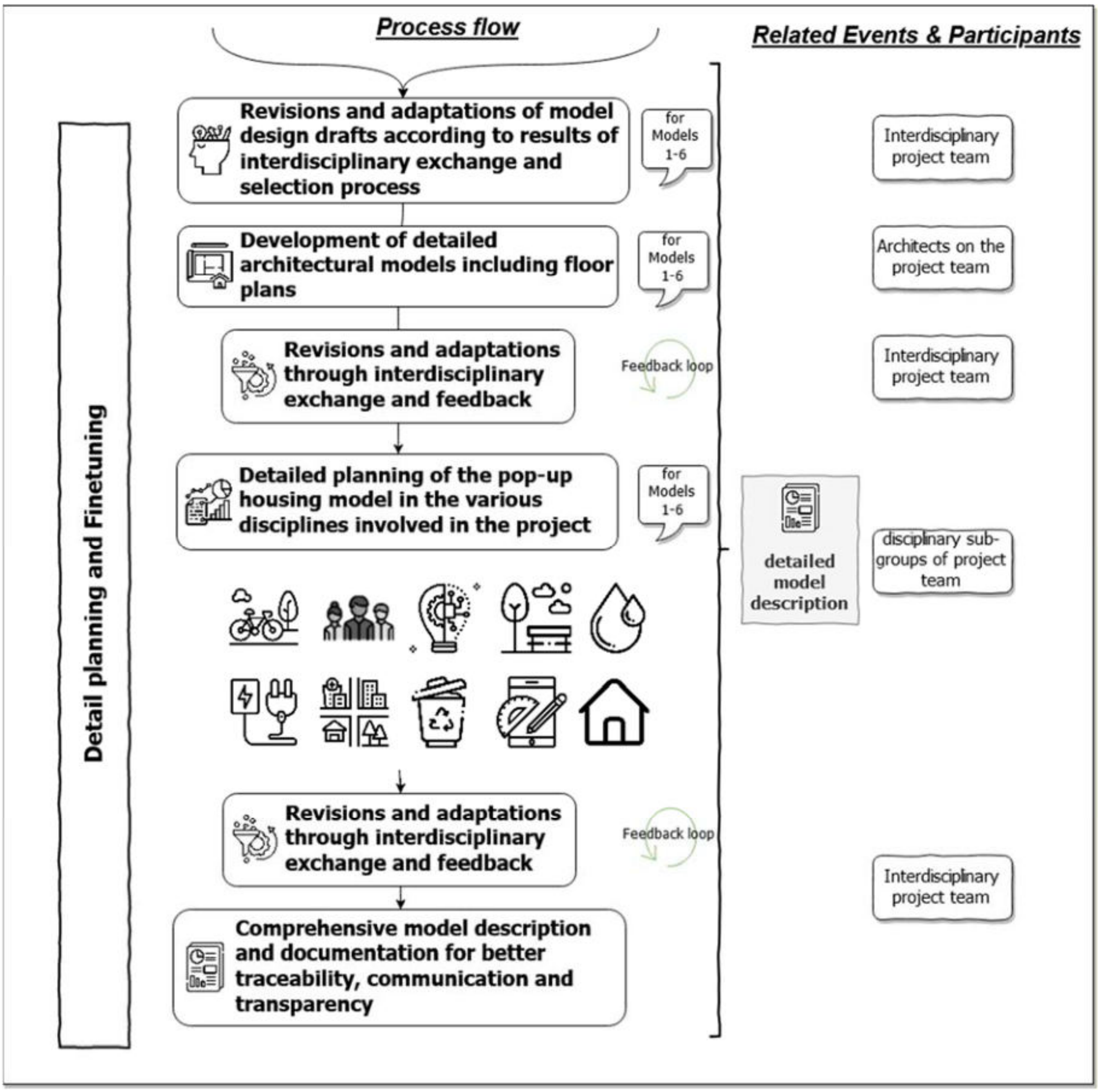


Figure 7: Process flow of scenario and model development IV: Detail planning and finetuning[8]

The architects in the project group checked and corrected the model design drafts and drawings provided by the students and elaborated on design elements that have not been the focal point of the students. Finally, detailed architectural plans, including floor plans were generated using ArchiCAD[9] software and presented to the interdisciplinary group. In an iterative process, the architectural model was further improved by feedback and revisions suggested by the interdisciplinary group.

[8] This chart was created by Zeilinger using resources from diagrammeditor.de and Flaticon.com. The icons were designed by Eucalyp, Surang, freepik, icongeek26, phatplus, bqlqn,dDara, geotatah, prettycons, golubev, umtimatearm, flat_icons and pixelmeetup.
[9] https://graphisoft.com/solutions/archicad

After this first iteration regarding the architectural model, detail planning regarding all involved disciplines could start, resulting in a higher and higher level of detail. Bills of materials were defined, as well as open spaces in and in the surrounding of the pop-up housing model. Energy, water, waste, resource concepts were developed as well as considerations regarding organization and co-living of different user groups, etc. Those different disciplinary concepts and approaches were reflected in an interdisciplinary setting by the other project team members on a regular basis and revised according to these feedback loops, to achieve an overall balanced and consistent pop-up housing model. If no consensus between all disciplines could be achieved on de-tails of the models, this was documented in the internal protocols of the meetings. Main concerns are reflected in the chapter “critical issues” as well as in Deliverable D4 and D5.

The findings, knowledge generated, and critical issues are summarized for each scenario and pop-up housing model in this report, which forms a comprehensive model description and enables better transparency, communication and traceability of details. This is also the last step with-in the process flow of WP3.

1.3.2 Inter- and transdisciplinary cooperation as a systematic approach

There is no standard methodology on how to develop new and innovative, sustainable pop-up housing models in an urban context. The process chosen in this project is described in much detail in the previous sections.

A substantial part of the process was an interplay between interdisciplinary, transdisciplinary, and disciplinary stages, aiming for the inclusion of many different viewpoints and building on the strengths of all three approaches.

Where there were clearly and thematically defined tasks to work through, the efficiency of disciplinary work was utilized. In many phases of developing pop-up housing models, the lines be-tween the disciplines were blurred, and tasks would benefit from a multi-perspective approach, therefore interdisciplinary settings were the preferred option. Discussions, disagreements, and negotiations between disciplines took a lot of time, but also enabled learning from each other and finding a common project language. The goal was to achieve an interdisciplinary consensus in the final scenario and model description. However, if a consensus was not possible, the differing viewpoints were documented. To avoid “operational blindness” and to integrate completely different (practical) experiences on certain issues, also transdisciplinary sessions and inter-change were integrated into the development process. Through regular exchanges of internal project team members and external stakeholders or cooperation partners it was ensured that different and new ideas could be integrated into the process. This interplay was implemented to place the development process on a broad footing. Regular feedback loops in various settings (frequent smaller working groups up to yearly project retreats) were another step to incremental-ly improve on design suggestions and ideas.

However, it must be recognized, that even such a broad approach reaches limitations. There is limited influence on who is willing to participate in transdisciplinary events and it remains un-known, how different the results of a stakeholder workshop might have been with a varying audience. Cooperating with external institutions can be time-consuming, in both preparation and post-processing. Having students at the centre of model design development requires double-checking all calculations and assumptions, e.g., regarding statics and structural design, as they are still in training. The process flow could have been streamlined, less complex and time-consuming, if the model development was mainly undertaken by the internal project team, without external contributors. However, in that case, most probably additional ideas and concepts would have been missed, and the focus would have been much narrower. Especially in a research project aiming for innovative solutions, the application of inter- and transdisciplinary approaches, which should involve young ideas, "out-of-the-box"-thinking and new perspectives seem appropriate.

1.3.3 Selection niche experimentation model

[The content of this chapter is taken directly and abbreviated from the paper: The Learning City: Temporary Housing Projects as Urban Niches for Sustainability Experiments by Gloria Rose, Mirjam Stocker, Michael Ornetzeder, Sustainability 2022, 14(9), 5198; https://doi.org/10.3390/su14095198]

The models formulated within the project differ in characteristics, contexts, and goals. They can be matched to the varying existing experiment approaches and conceptualized as such experiments. Since the models were not fully finalized while the conceptualization as experiments was being conducted, there may be minor deviations between the models described within the experiment designs and the models ultimately presented in this report. To conceptualize the models for temporary housing from the WWTF project as experiments for Sustain-ability Transitions, we applied a 2-step process. The first step consists of a matching process between the described experiment concepts and the temporary housing model. Within this matching process the objective is to determine which experiment concepts are compatible with the model and could be taken into further consideration and which concepts can be ruled out because there is not enough congruence. To conduct the first step in a systematic way, questions A-G (see below) have been formulated which address the core characteristics of experiment types, based on Table 3. While this represents a simplification, it serves to break. Table 8 presents an overview of the five experiment types organized according to these questions, allowing for a comparison with a project idea. The same categorization according to the questions A-G is performed for the temporary housing models, depicted in Table 9.

The questions A-G have been formulated as follows:

A. Does the research interest primarily revolve around the functionality and acceptance of a technology or service?
B. Does the research interest primarily revolve around new forms of living and cooperation?
C. Does the experiment aim allow actors and participants to question overarching practices, systems, and infrastructures?
D. Does the experiment aim require monitoring of user behaviour and acceptance? (e.g., when testing a novel technology or service in real-world conditions)

E. Does the experiment require a co-creation or co-production process? (e.g., seeking flexible problem-solving for specific local contexts or exploring alternative pathways)
F. Does the experiment involve participants as initiators of core elements of the experiment? (e.g., needs-oriented experiments exploring alternative pathways)
G. Does the experiment require a high level of control? (Taking into consideration factors such as e.g., available project budget, involved actors and user groups, main objectives)

Table 8: Characterization of experimentation concepts according to the question catalogue A-G ("x" represents "yes")

Question	Niche exp.	ULL	BSTE	Transition exp.	Grassroots exp.
A	x	x	x		
B			x	x	x
C			x	x	x
D	x	x	(x)	(x)	
E		x	x	x	x
F					x
G	x	x	(x)		

Table 9: Characterization of temporary housing models according to the question catalogue A-G ("x" represents "yes")

Question	Beat the Heat	Life Sharing to go	Gap Module	Life on track(s)	Flat-Pack	DonAutonom
A	x		x	x	x	x
B		x	x		x	(x)
C		x	x			
D	x		(x)	x	x	x
E		x	(x)			(x)
F		(x)				
G	x		(x)	x	x	(x)

A comparison can then be made between the experimentation concepts and temporary housing models, the results of which can be read in Table 11 in the following chapters.

Before delving into the pop-up housing models as specific niche experimentation models, Chapter 2 provides an overview of all the models and scenarios developed in this project.

The models are also described in more detail in Chapters 3 to 8.

2 OVERVIEW OF SCENARIOS AND FACTSHEETS OF HOUSING MODELS AND NICHE EXPERIMENTATION MODELS

Table 10 and Table 11 provide an overview of all six scenarios, which are summarized and briefly described. Moreover, the so-called “fact-sheets” of the six conceptualized pop-up housing models are presented in brief in Figure 8 to Figure 13[10]. A much more detailed description of the housing models can be found in Chapters 3 to 8. In the last section of this chapter, the pop-up housing models are con-textualized as specific niche experimentation models.

2.1 OVERVIEW OF TEMPORARY HOUSING SCENARIOS

Table 10: Overview of temporary housing scenarios 1-3

	Beat the Heat	Life Sharing to go	Gap Module
User group	People vulnerable to heat waves, e.g., elderly people, pregnant women, families with babies / young children	User mix: people interested in communal living, people with limited housing options, persons eligible for asylum	User mix: people interested in communal living, people with limited housing options, persons eligible for asylum
Usage Time	Several days to weeks (duration of a heat wave)	Up to one year per resident	2-5 years
Building characteristics and open spaces	Newly constructed buildings using recycled construction elements (EUR-pallets) and sustainable raw materials. Natural cooling Private terrace and communal space for recreation	Temporary living in halls of vacant (factory, garage, market, …) buildings in small living modules. Reduced private living space, generous communal spaces and multifunctional areas	Building based on modular components and prefabricated elements, Private loggias, Generous communal spaces and multifunctional areas at ground floor level
Site characteristics	Well ventilated open areas with high potential for natural cooling, Flat area (<5%)	Site of vacant factory/building is not in disrepair (health hazards, danger of building collapse, site contamination)	Vacant building lots, brownfields in urban areas
Resources	Power supply via grid connection, natural ventilation and cooling with sun sails and water mist sprays, on-site elevated water tanks and dry toilets	Power and water supply via grid connection, centralized sewage connection, wood chip heating, PV	Power and water supply via grid connection, centralized sewage connection

[10] The factsheets of the pop-up housing models are available for download on the project website: https://popupenvironments.boku.ac.at/. The factsheets have been designed by Roman Löffler (BOKU / IRUB).

Neighbourhood characteristics	Connection to public transport, connection to social infrastructure	Active involvement of the neighbourhood Connection to public transport, connection to social infrastructure	Active involvement of the neighbourhood Connection to public transport, connection to social infrastructure
Special features	Rapid deployment in crisis situations (heat waves)	Repurposed building envelope, only indoor living modules are newly constructed. Living modules are easily dismountable and reusable	Communal rooms at ground floor level suitable as neighbourhood centre (for storage, meetings etc.)

Table 11: Overview of temporary housing scenarios 4-6

	Life on tracks	**FlatPack**	**DonAutonom**
User group	Flexible: ranging from people with sudden housing needs to short-term stays	Individuals / families with temporary housing needs, e.g., expats	People interested in sustainable and resource autonomous living
Usage Time	Several days to weeks	6-24 months	flexible; several months to 3 years
Building characteristics and open spaces	Fully equipped mobile housing unit on railway wagons Repurposed ISO shipping container as a tiny house hinged private terrace mounted to housing container	Temporary living in vacant ground-floor retail space. Reusable, mobile living boxes („furniture in a box"), easy to adapt to different retail space layouts. Appropriation of inner courtyards or public areas in front of the retail premise	Temporary living in a vacant cargo ship in repurposed ISO shipping containers. Aiming for (partial) self-sufficiency and autonomy regarding Resource, energy and food supply. Private loggias and communal Roof terrace (gardening options)
Site characteristics	Railroad areas: Rails, tracks, disused stations and track systems	Vacant retail space on ground floor level (< 100m²)	River/water system with berth for ship
Resources	Power supply via grid connection, semi-centralized water and sanitation solution with storage tanks	Power and water supply via grid connection, centralized sewage connection	Circularity concepts: high degree of resource autonomy: PV, rainwater treatment, greywater system, nutrients
Neighbourhood characteristics	Varies, as the building scenario is mobile, connection to public transport connection to social infrastructure	Connection to public transport, connection to social infrastructure	Connection to public transport, connection to social infrastructure
Special features	Mobile building solution, can be transported to other locations or cities without dismantling	Mobile living boxes are reused and transported from one vacant retail space to the next after use	Partially autonomous resource supply

2.2 FACT SHEETS OF POP-UP HOUSING SCENARIOS AND MODELS

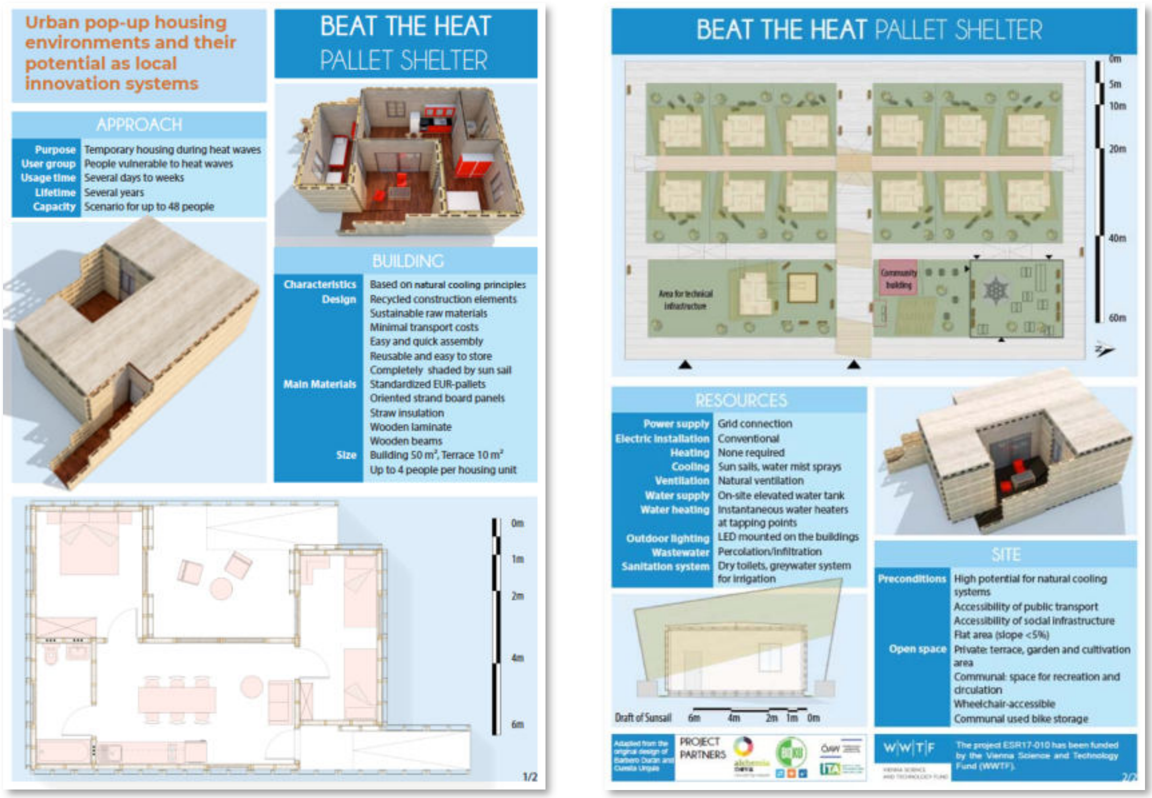


Figure 8: Fact Sheet: Beat the Heat - Pallet Shelter

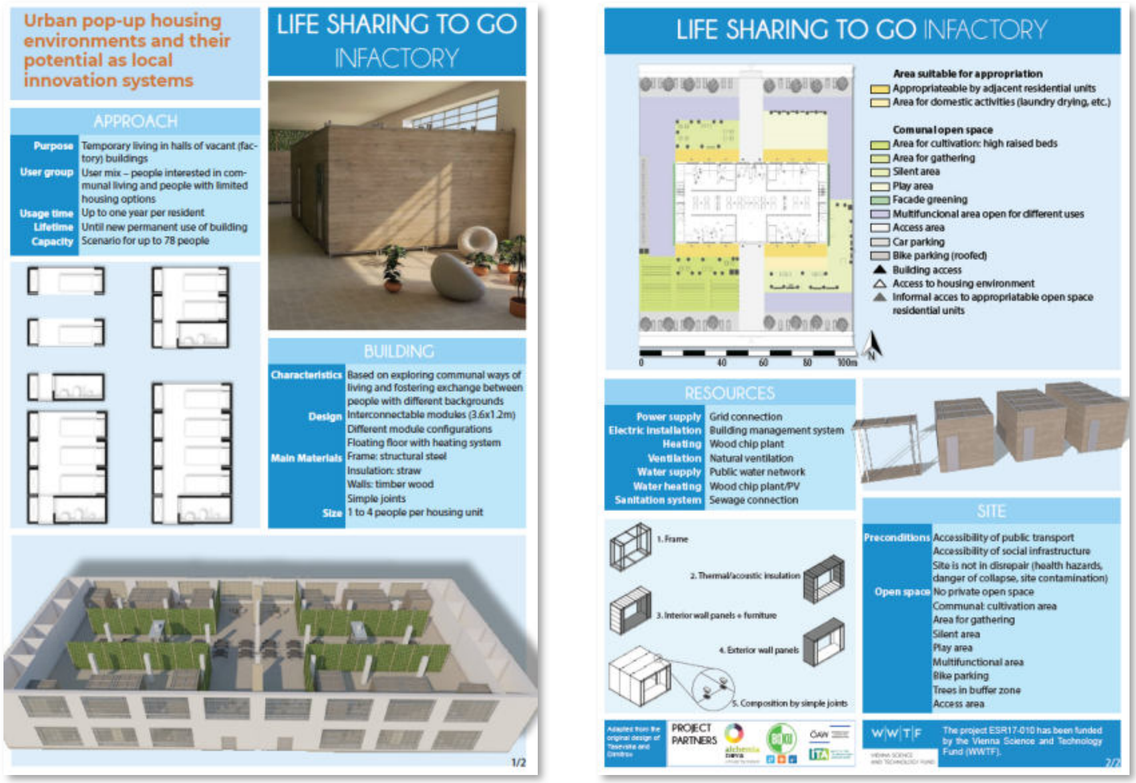


Figure 9: Fact Sheet: Life sharing to go – InFactory

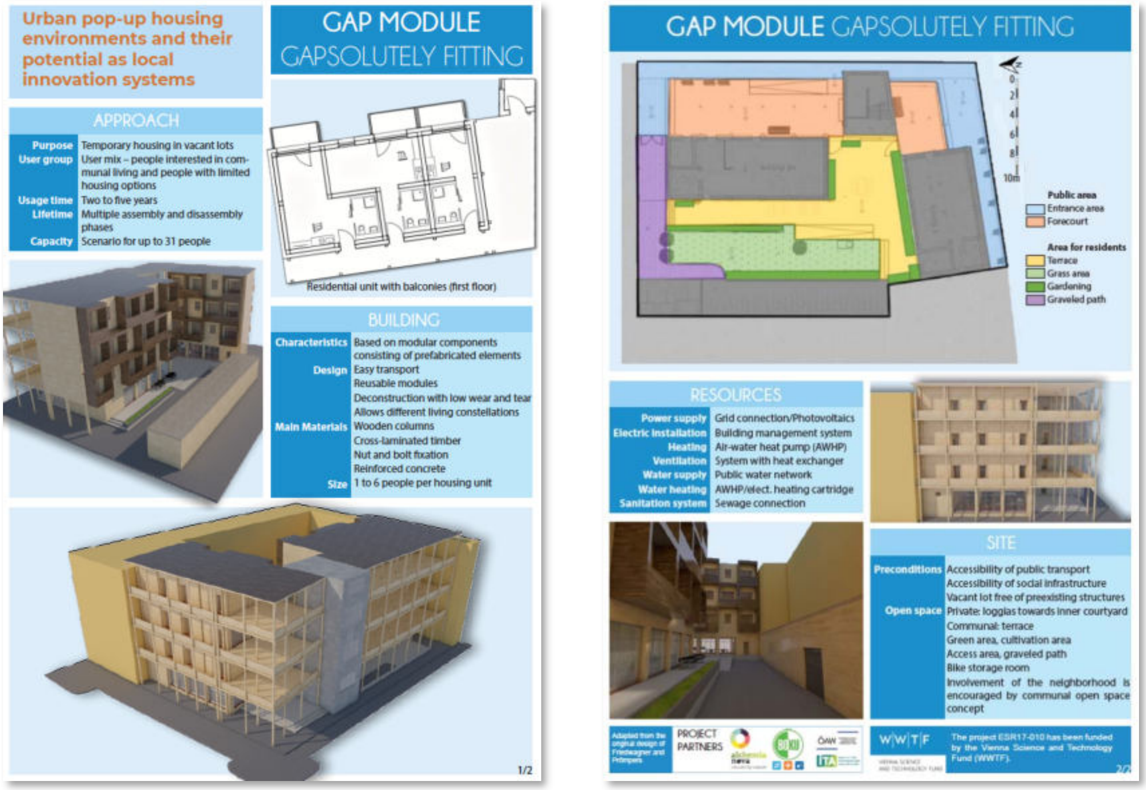


Figure 10: Gap Module - Gapsolutely fitting

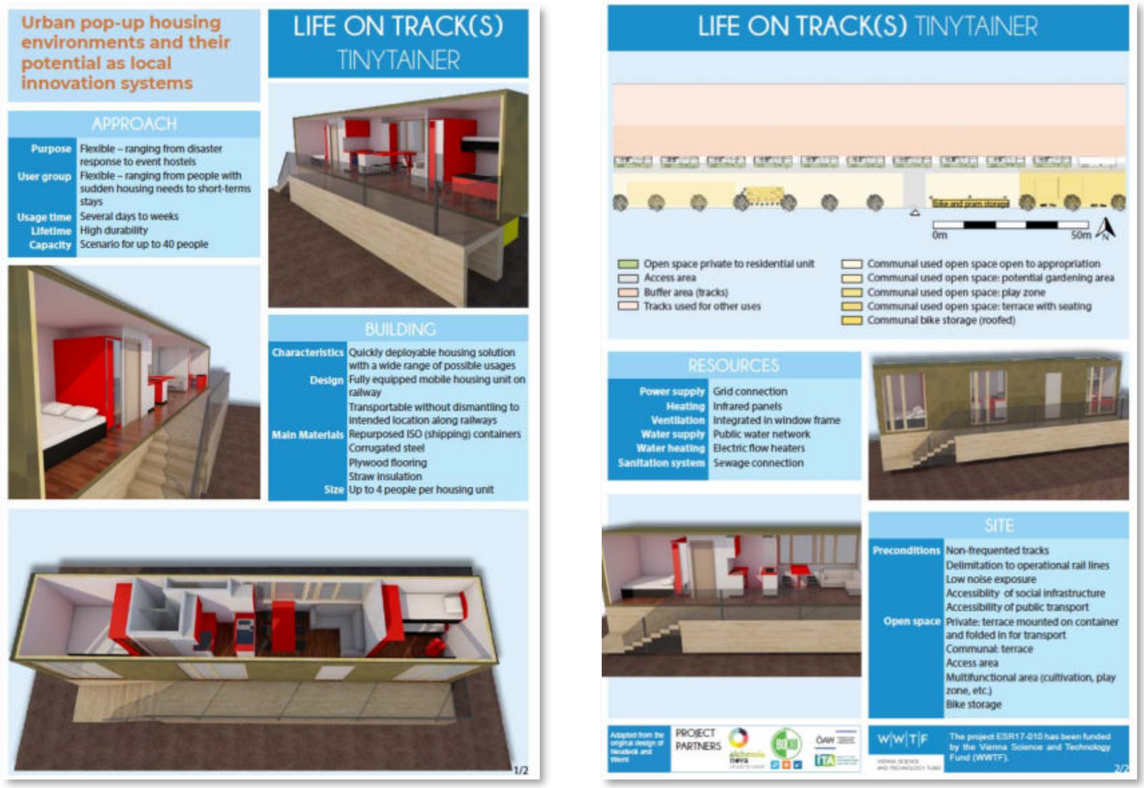


Figure 11: Life on track(s) – TinyTainer

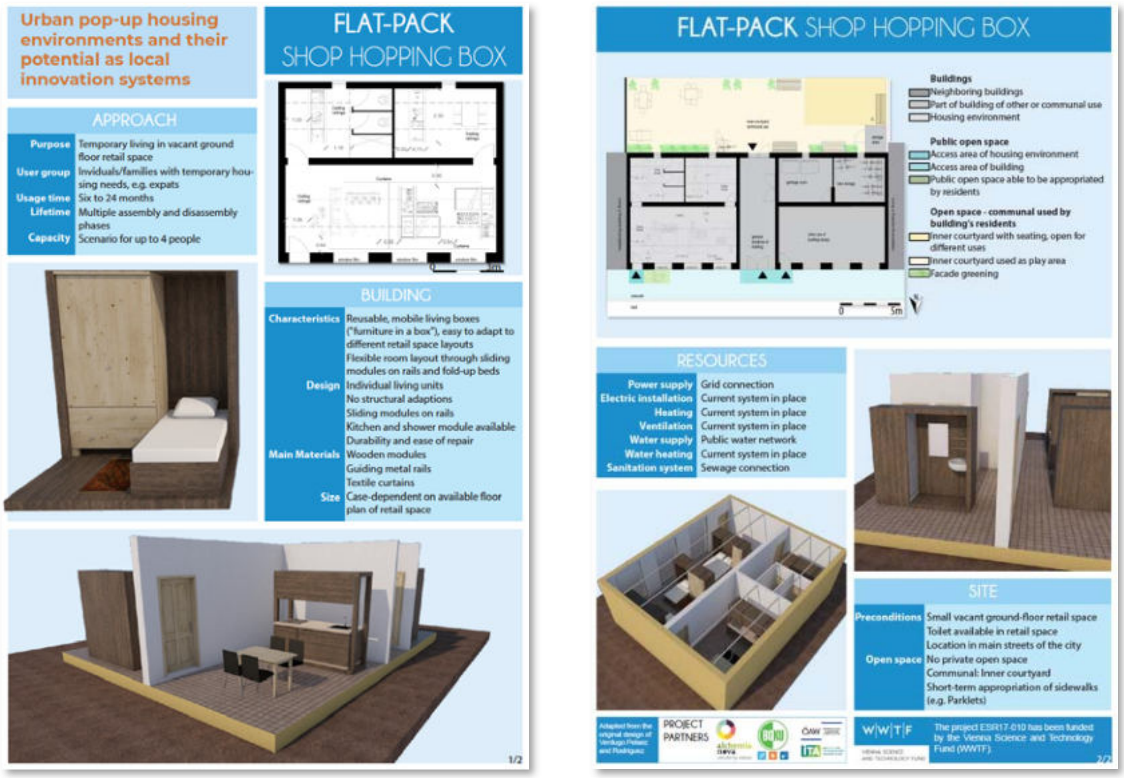


Figure 12: Fact Sheet: Flat-Pack - Shop hopping box

Figure 13: Fact Sheet: Donautonom - Binnen bleiben

2.3 SPECIFIC NICHE EXPERIMENTATION MODELS

In Chapter 1, the concept of niche experimentation models is described in detail. In this chapter, the temporary pop-up housing models were described in detail as a specific experiment type.

Table 12 shows the results of a comparison between the experimentation concepts and temporary housing models. The purpose is not to exclude experiment conceptualizations based on single deviations from the table, but to exclude those experiment types which deviate clearly in several aspects. It is likely that two or three experiment types can pose viable options for an experiment idea, depending on the experiment aim.

Table 12: Overview of 6 temporary housing scenarios and associated models for Vienna

Scenario	Beat the Heat	Life Sharing to go	Gap Module	Life on track(s)	Shop- Flat-Pack	Don Autonom
Model	**Pallet Shelter**	**InFactoy**	**Gapsolutely fitting**	**TinyTainer**	**Shop-Hopping Box**	**Binnen bleiben**
Description	Temporary housing environment with a natural cooling system and circularity solutions for individuals at particular risk during heat waves	Housing solutions in industrial buildings with mix of user groups including refugees with positive asylum status and individuals currently not well-integrated into society	Housing on temporarily unused building gaps in a densely populated area with mix of user groups including refugees with positive asylum status	Retrofitted train wagons or containers on flat wagons for people affected by disasters or people with high interest and need for temporary accommodation (e.g., festivals)	Housing in temporarily unused ground floor retail spaces for families in need of or interested in affordable interim solutions	Housing solutions on a converted old (Danube) ship with high levels of autonomy and self-sufficiency in the use of resources for people temporarily residing there for work, researchers, or students
Relevance	Increasing urban heat islands and rising average temperatures in summers	Vacancy activation or temporary use of former industrial buildings	Existence of vacant building gaps which remain unused for several years	Post-disaster relief; existence of unused tracks	Vacancy of ground floor retail spaces	Utilization of the Danube as an alternative to building on vacant land
Suitable experiment concepts	Niche experiment, ULL, BSTE	Transition experiment, Grassroots experiment	BSTE, (Transition experiment)	Niche experiment, ULL	Niche experiment	BSTE, ULL

Within the second step, the models were described in detail as a specific experiment type. These descriptions can be found in the respective subchapters of Chapters 3 to 8.

2.3.1 Experimentation model for Pallet Shelter

Pallet shelter explores sustainable housing options with appropriate climate comfort for accommodating vulnerable individuals for a brief period. This starting point frames the experiment in certain ways. It provides a good opportunity to explore several subjects, such as circular building concepts, low-tech green technology, or the process of recruiting and supporting inhabitants who find themselves in a disruptive new situation. Pallet shelter is essentially a risk management measure that is government-initiated, and which requires a high level of control and structure.

When comparing the data from Pallet Shelter in Table 9 with the experiment concepts in Table 8, it shows the most similarities with the concepts of niche experiments and ULLs. Due to the short duration of the housing phase of this experiment (days to weeks), no co-production process will be designed, and well-being will be assessed via monitoring. Therefore, the choice is to conceptualize the next phase in the development of Pallet Shelter as a niche experiment.

2.3.2 Experimentation model for InFactory

InFactory does not primarily revolve around the functionality and acceptance of a new technology or service, but rather provides a frame, space, and materials for participants to create and explore new forms of living and interaction, providing the possibility to develop alternative ideas of how sustainable living can be organized. The experiment design should therefore be as open as possible and include a strong co-creation aspect, with participants being empowered to initiate and carry out their own activities. Participants are given a central role as initiators of core elements of the experiment, allowing processes to be needs-oriented and creative. For an experiment of this kind the level of control is inherently low.

When comparing the column of InFactory in Table 9 with the experiment concepts in Table 8, we find that we can exclude niche experiments and ULLs as experiment design options. While it would be possible to conceive of InFactory as a BSTE, transition experiments or grassroots experiments appear to be the best fit. The starting point is a societal challenge, with the experiment attempting to innovate how integration can take place through new forms of living, which is characteristic of both transition and grassroots experiments. We conceptualize InFactory as a grass-roots experiment, aiming to explore innovative variety and alternative pathways for sustainable and communal living through a do-it-yourself approach. This exercise serves to explore to what extent it is possible to introduce grassroots elements into a research project by providing a space with resources that can be freely organized and utilized to support bottom-up solutions. It is evident that an authentic grassroots experiment cannot be planned as a research project, seeing as research projects inevitably possess structures not compatible with bottom-up grassroots processes. This should therefore be regarded more as a hybrid between transition and grass-roots experiments.

2.3.3 Experimentation model for Gapsolutely fitting

For this experiment, the research focus is placed on the aspect of neighbourhood integration, which involves testing the acceptance and resonance of different offers and services the inhabit-ants provide. While some of these activities are predetermined by a project team, the experiment also allows inhabitants to develop and realize their own project ideas. A fundamental element of the experiment design is the exploration of new forms of living and communication with great emphasis on communal spaces.

Comparing the data from Gapsoluetly fitting in Table 9 with the experiment concepts in Table 8, we find that it is well suited as a BSTE.

2.3.4 Experimentation model for TinyTainer

TinyTainer provides temporary housing solutions which could be deployed swiftly using the rail-way system without the use of additional carriers. This makes TinyTainer attractive as temporary housing for workers employed by the national railway company, for festival participants, or as a solution for cases where an unexpected need for temporary housing suddenly arises, e.g., following a gas explosion or a flooding. While users from Profile A can therefore be considered an important target group for this model, they will not be involved in the TinyTainer experiment conceptualized here. Instead, the experiment will involve individuals participating voluntarily and not currently affected by existential threats, for example, members of humanitarian organizations. Since TinyTainer can serve as a disaster risk management and resilience measure providing post-disaster relief, the focus of the experiment must therefore lie in assessing the effectiveness of TinyTainer as, for instance, a post-disaster relief measure, which includes ensuring the safety and well-being of the inhabitants for a span of days or weeks. The aspect of safety is a crucial one, considering the location could involve risks of electric shocks from overhead lines, tripping hazards, and vicinity to active train traffic, which must all be addressed and mitigated. Exploring safe solutions will be a central focus of the experiment. On-site or semi-centralized solutions for water supply and the sanitation system could also be studied, seeing as connection to a centralized system might be trivial. The subject of investigation will also be whether the retrofitted wagons and freight containers succeed in providing the basic comforts required to ensure well-being (e.g., regarding temperature).

When comparing the data from TinyTainer in Table 9 with the experiment concepts in Table 8, it shows the most similarities with the concepts of niche experiments and ULLs. Due to the short duration of the housing phase of this experiment (days to weeks), no co-production process will be designed, and well-being will be assessed via monitoring. Therefore, the choice is made to conceptualize the next phase of TinyTainer as a niche experiment.

2.3.5 Experimentation model for ShopHoppingBox

ShopHoppingBox addresses the high vacancy rates for floor retail spaces, conceptualizing these as temporary living spaces analogous to pop-up stores for families or other constellations of people who are co-habiting. No structural adaptations are undertaken, instead, the retail space is given a new room division using modules (kitchen, bathroom, bed) and partitions, which serve very swift and adaptable assembly and disassembly and flexibility regarding the placement and arrangement. The modules and partitions consist of a unit which function as a wall or privacy screens, meaning that they can function as room divisions, they do not, however, consist of units made up of an enclosed space to create new rooms. It is for this reason that the target group are individuals who form a family unit, or individuals co-habiting as partners or roommates with a certain degree of familiarity. The modules are attached to rails on the ceiling and can be moved back and forth in one direction. The experiment will explore the functionality of this housing solution over a span of multiple inhabitation cycles, and how the inhabitants experience living in the Shop-Hopping Box and how they interact with the modules.

When comparing the data from ShopHoppingBox in Table 9 with the experiment concepts in Table 8, it shows the most similarities with the concepts of niche experiments, with the additional aspect of addressing new forms of living. This results from the focus for the first implementation being placed on the technical aspects of the model in order to answer the question “Does it work?”. It is, however, also feasible to combine this temporary housing design with other pop-up activities and projects. This would make for interesting follow-up experiments which would include co-creation and co-production processes and affect the choice of which experiment concept is drawn on.

2.3.6 Experimentation model for Binnen bleiben

Binnen bleiben involves temporary living in a redesigned and reused old cargo ship on the Danube. Binnen bleiben consists of a lower deck where common areas are located and upper decks, of which the first deck consists of living units made from repurposed freight containers, and the highest deck exclusively consists of raised garden beds and areas for cultivation and food production. This experiment revolves around self-sufficiency in the use of resources. Rainwater and river water could be reused as service water, biogenic waste and faeces could be con-verted into biogas (although not considered in our theoretical model), which could be used as an alternative mode of propulsion for short distances, and the raised-bed gardening provides a food supply. It is also possible to raise chickens or other small livestock on the ship. The use of trans-parent solar panels on the roof and solar panels which can function as walkways along the side of the ship can also be tested. The targeted users are people with a temporary need for housing for work and researchers, staff or students accompanying the project. It is important that the inhabitants have an interest in self-sufficiency and closed-loop processes. While a strong focus of the experiment lies on the technical aspects, it is also explored how the inhabitants organize work on the ship and divide potential products (e.g., regarding the gardens and potentially chickens).

When comparing the data from Binnen bleiben in Table 9 with the experiment concepts in Table 8, it shows the most similarities with the concepts of ULLs and BSTEs. Concerning the division of labour and yields from the productive elements of this project (food production), the inhabit-ants must self-organize. While the experiment could be designed as a BSTE surrounding “new life on the arc of the 21st century”, exploring how we wish to live in the city of the future, the idea pursued in this case is to develop Binnen bleiben as an alternative kind of innovation centre for sustainable living, serving as an organizational bracket for all kinds of projects and initiatives. The choice is therefore made to conceptualize the next phase in the development of Binnen bleiben as an ULL.

In the following chapter, the selected scenarios and the corresponding housing models are described in detail. This step to define frame conditions and to describe an exemplary, virtual situation in the context of Vienna as detailed as possible was necessary, to create a basis for simulating and modelling the environmental, resource-related, wellbeing and social effects, and finally, to evaluate the housing models – which is the core of WP4 (see also D4 and D5). Thus, one must keep in mind, that these models are just theoretical concepts and cannot be translated into reality one by one, also economic aspects were not considered yet.

3 BEAT THE HEAT / PALLET SHELTER

3.1 SCENARIO DESCRIPTION AND RELEVANCE FOR VIENNA

Beat the Heat can be described as a pilot study to explore temporary housing for heat waves. It addresses people who are most affected by and vulnerable to heat waves: senior citizens, families with small children, and pregnant women living in accommodations within the city which are particularly affected. This scenario offers temporary accommodation for the duration of the heatwave by temporarily setting up reusable and storable housing in cooler areas of the city, such as open spaces in well-ventilated urban areas.

The temporary environment encompasses private housing units for up to four individuals with private kitchen and bathroom facilities and accessibility for wheelchair users. The structures are assembled at the beginning of each heatwave and disassembled once the temperatures decrease, with the substantial features of quick and easy mantling and dismantling, transportation, and storage for future use. The residents use the housing units just for only a few days or weeks at a time, but the housing units themselves are expected to endure several years following cycles of assembly-use-dismantling-storage-maintenance every season. The housing units have a cool and comfortable indoor climate, due to the use of passive cooling systems, such as ventilated walls that allow the least possible use of energy and evaporative cooling.

Heat waves are becoming an increasing issue for many cities around the world, forecasts for Vienna expect a significant increase in heat waves in the range of several days up to weeks (de-pending on the scenario) (ÖKS 15). Due to the urban heat island effect, temperatures are also expected to rise at night, which will cause stress for vulnerable people.

According to the current population forecasts for Vienna, a further growth trend can be expected, which will further increase the pressure, especially on open spaces. In addition, a particularly strong increase can be expected in the vulnerable group of people over 65 years of age (Bauer et al., 2018).

3.2 USER GROUPS

The target group is made up of people vulnerable to heat waves, consisting of small children, pregnant individuals, and the elderly. To inhabit the Pallet Shelter, individuals must first apply in the early months of the year. Applicants must currently be living independently without required assistance and not have such pre-existing conditions that require constant observation by a professional.

Due to the conditions of there being a heatwave, we can consider the target group to correspond with User Profile B (the user profiles are described in detail in D1 and briefly outlined in Chapter 1). This is argued as follows: the possibilities of self-organizing their needs in the broader urban neighbourhood must be severely impacted by the climate conditions. The housing environment must therefore be equipped with an infrastructure that can provide appropriate means on-site to cover these needs.

While some individuals in this target group can be assumed to be well-integrated into the city and have access to private contacts and support, the sub-group of elderly individuals may also be particularly prone to social isolation and the presence of social networks as a resource for support cannot be assumed. In contrast to Profile A, however, this model does not describe a sudden and unforeseen event, but rather a foreseeable and repetitive event, which allows for increased time resources for the planning and implementation and entails degrees of freedom for the users, for instance, a choice in whether they wish to participate or not.

3.3 SPATIAL PLANNING

The location for these units must be carefully chosen to ensure the possibility to make use of natural cooling systems, e.g., forested open spaces within micro-climatically suitable areas of the city (connection to areas with cold air production and local wind systems). In addition, the sites should have a slope of less than 5 % to be able to guarantee general accessibility and not require too much effort in the erection of the modules.

The requirements for accessibility by public transport depend strongly on the intended use and user groups. Families with children have a higher frequency of trips and therefore need better public transport quality (according to the Austrian system of public transport quality classes: A-C) (Hiess 2017). For older groups of people, the maximum distances to public transport stops are relevant in case of high heat stress. The maximum distance to public transport stops should be 500 meters. A lack of public transport quality can be partly compensated by good equipment for "active mobility in the neighbourhood". This includes attractive footpath connections, cycling facilities and bicycle stands in the surrounding area of the location.

The necessary quality of accessibility to central facilities (local supply, health, education, leisure, and recreation) depends strongly on the intended use and user groups. The local supply can, however, be provided by organizational measures (e.g.: central supply facilities at the site).

Due to the intended use, special attention should be paid to conforming to the noise threshold values at night (L_{night} < 45 dB) when selecting a location.

3.3.1 Principles of housing environment

In this application of the model, we chose an elongated paved site, oriented North-South (area around 7000 m²), which will be temporarily greened with mobile plants. The plot is placed in a cool surrounding with a large share of green open space and a high number of trees. It is expected that the air cools down during the night owed to the absence of barriers and the efficient positioning of wind corridors (to be assessed in a niche experiment – see below).

To ensure the cooling effect, of course the implementation of the Pallet Shelters on an already green open area would be more efficient; however, the above-mentioned approach has been chosen in order not to hinder the general access to cool, green open spaces for the public during the heat waves. Every green area in a city contributes to the cooling effect; thus, every grey area turned (temporary) into a green one, counts. However, the effort to transform and maintain an urban grey open space temporarily into a functioning (in the sense of cooling) green open space is significant. Detailed considerations on greening variants of this housing model can be found in D4.

3.3.2 Communal facilities and communal open space

There is a path surrounding the housing environments and one road each crossing North to South and East to West (Figure 14). The access area amounts around a little less than one-third and is partially the plot's surface (since it is paved it is accessible) or on a 35 cm high platform (consisting of two layers of pallets on top of each other). (If necessary for accessibility, the pathways made from pallets can be covered with flooring panels). The footbridge is necessary to overcome the height difference of the ground to the units that are placed on a two-pallet footing and to cover the water and sanitation pipes and electricity cables underneath. Depending on the application and user groups, railings might be necessary. They could be helpful for elderly people (especially close to ramps) and for young children (to prevent falling off the high raised pathway – in this case, it would be required to include a grid of little distance between the bars).

There is an area of over 600 m² dedicated to the playground (370 m²) and a shaded relax area with modular furniture, like those in Figure 15 and Figure 16. The community building is placed next to this area; depending on the weather conditions, (evening) meetings can be held outside.

Centrally placed, South of the entrance path, there is a communally used open space dedicated to helping the residents to cool down: water installations, such as water mist spray facilities, water sprinklers and showers help to refresh. Optionally, also a narrow (max. 50cm high) basin (5 x 5 m) could be provided, which would allow the residents to further cool down, refresh their feet and sit in the shade (Consideration should then be given to how this could be implemented in a wheelchair accessible manner). The water for the basin may be treated greywater. For security reasons this area is fenced, and children are only allowed to enter with accompanying persons. This “cool down area” does not only allow refreshment but also social exchange among residents.

There is one administrative building and one communal building on the plot. The administrative building has the same floor plan as the residential units and is primarily used as office space by staff. The communal building is a lightweight tent-like wood construction that can be used for meetings. A potential provider of such a community building could be Strohboid, a company that offers constructions such as shown in Figure 17 of different sizes for purchase or rent (Strohboid 2021).

Figure 14: Pallet Shelter – Site plan[11]

An area of around 350 m² is reserved for technical infrastructure. This area has an additional direct access from the street for maintenance. This area will house facility building(s) for among

[11] Drawings by Stocker based on Bertino

other things, freshwater tanks, greywater collection tanks, water treatment equipment, pumps and control equipment, and waste and sanitation containers.

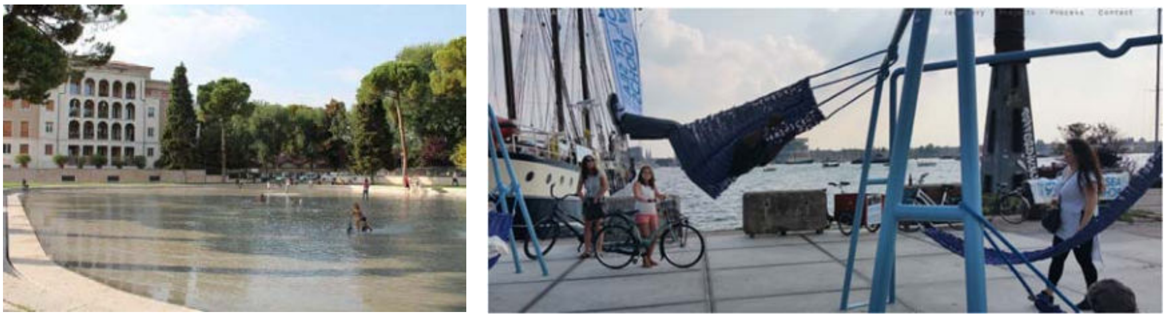


Figure 15: Examples: water basins[12]

Figure 16: Examples: mobile open space equipment[13]

Figure 17: Examples: Strohboid for communal building[14]

3.3.3 Private and semi-private open space

There are 12 residential units (with a maximum capacity of four individuals each) on the plot (see Figure 18). The units are accommodated in a way that allows cross-ventilation from East to West, the main façades are oriented South-West, as recommended by Ahuja R. & Rao V.M., 2003. The building density is rather low, the gross floor space ratio/index (FAR) is around 0,1.

[12]https://www.tripadvisor.at/Attraction_Review-g187871-d4597889-Reviews-Giardini_Pubblici_Arsenale-Verona_Province_of_Verona_Veneto.html, accessed 31/08/2020) and sample picture for modular, mobile playground equipment: Off ground by Jair Strachnow and Gitte Nygaard @SVFK Copenhagen (http://www.gittenygaard.com/Off-Ground/, accessed 31/08/2020.

[13] Hammocks by Hector Eswawe @ Atlanta's Woodruff Arts Center (http://www.knstrct.com/art-blog/2014/7/29/home-is-where-the-hammock-is-mi-casa-your-casa-by-esrawe, https://www.atlanta.net/Blog/Mi-Casa,-Your-Casa--The-High-Opens-Its-Piazza/, accessed 31/08/2020)

[14]https://www.eveosblog.de/2020/02/17/nachhaltiges-eventzelt-aus-holz-und-holzfasern-strohboid/, accessed 31/08/2020.

Each residential unit is placed on a plot of around 240 m², of which around 70 m² are built (dwelling and access), 10 m² are a terrace towards the backside of the building, the remaining area is open space to be used by the unit's residents. The residential units are placed close to the pathway, in the Southern corner of the plot so that the biggest area of the private open space is on the backside and can benefit from shade thrown by the dwelling.

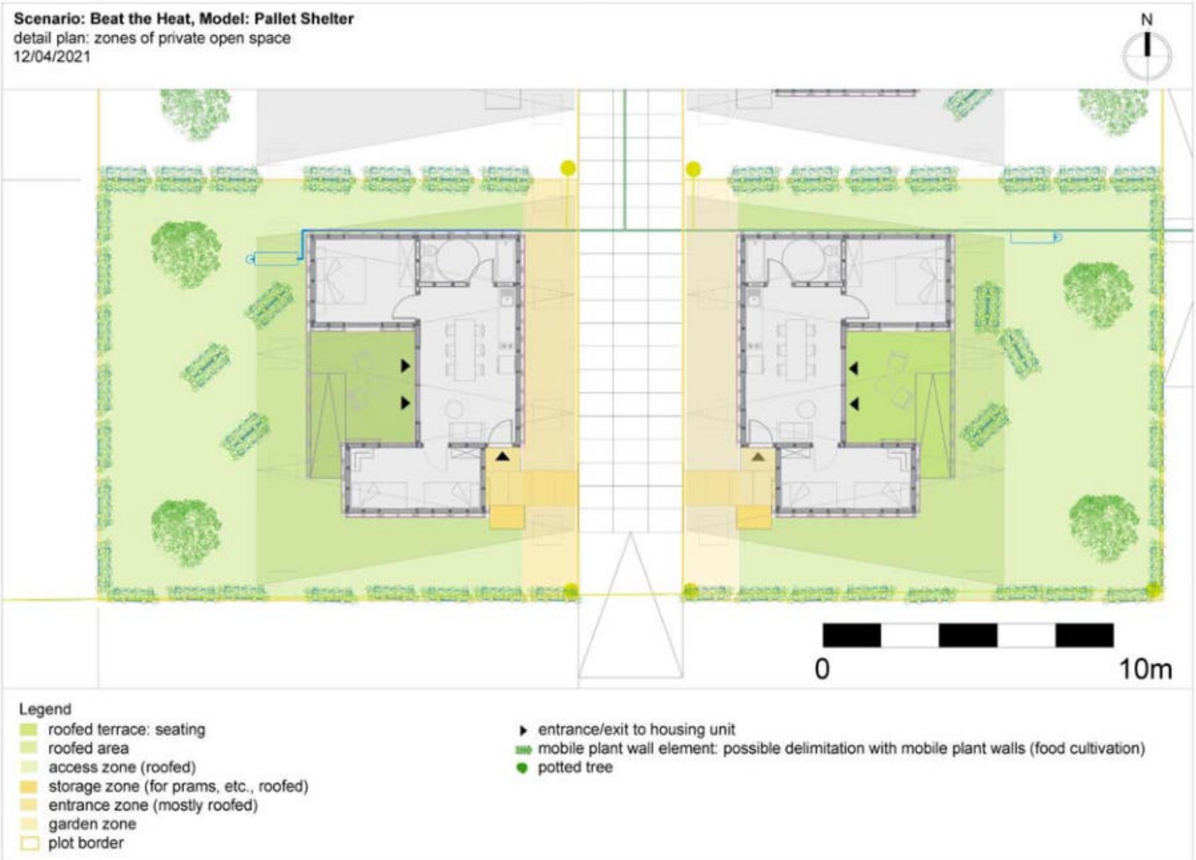


Figure 18: Pallet Shelter - open space[15]

Each unit is assigned three mobile plant walls (length x width x height =1,3 x 0,7 x 1,7 m) and two potted trees to provide additional solar protection or give more privacy, protecting from unwanted glimpses of passers-by. The plant walls could be used for food production as well (e.g., herbs or fast-growing vegetables). The plant walls and trees may be irrigated and maintained by the residents or the facility staff. For irrigation, (treated) greywater can be used.

The plot borders were drawn in a way that on each plot there is a tree that provides shade and contributes to a cooled down microclimate.

The total private open space area will be covered with a drainage layer, fleece textiles and soil, on top of which rolled turf will be placed. The rolled-out turf should include a variety of different species of grasses and herbs such as those offered by Schwab (2021), for example. It is a technical experiment if the turf will flourish on top of the fleece or not, nevertheless, if successful it will provide a cooler environment than the paved area. However, the effort and resources required are considerable.

[15] Drawings by Stocker based on Bertino

Additional mobile gardening possibilities (high raised beds, etc.) and vegetation (trees in pots, etc.) can be placed on demand on each unit. The care for the plants is carried out by the residents. An outside tap at each residential building facilitates irrigation tasks. If residents' caretaking does not work out, staff members must take over these activities.

3.4 ARCHITECTURE

This section concerns the architectural 3D modelling of the Pallet Shelter design, created by the students of the TU Wien architecture faculty Carlos Barbero Duràn and Laura Cuesta Urquia. Their initial draft was revised and elaborated by the project team, but the original concept remained the same. The students attempted to incorporate sustainability aspects in their design, using recycled construction materials and sustainable raw materials. Another objective was an efficient design to save costs on logistics and transport, as well as using prefabricated elements for the buildings (e.g. wall segments, slabs) to promote easy and fast assembly (and disassembly). The core element of the building is the use of EUR-pallets, which double as ventilated facades and should therefore help against overheating (Barbero Durán, and Cuesta Urquía 2019).

As mentioned in the previous section, the basic project is a simplex unit of 50 m² and is part of the unbuilt plot in a predominantly open area of the city. In this application, 12 housing units allow hosting up to 48 individuals. Additional structures, such as administrative and community buildings, as well as open space facilities that help to cool down the residents and the environment, are also part of the setting.

3.4.1 Architectural design

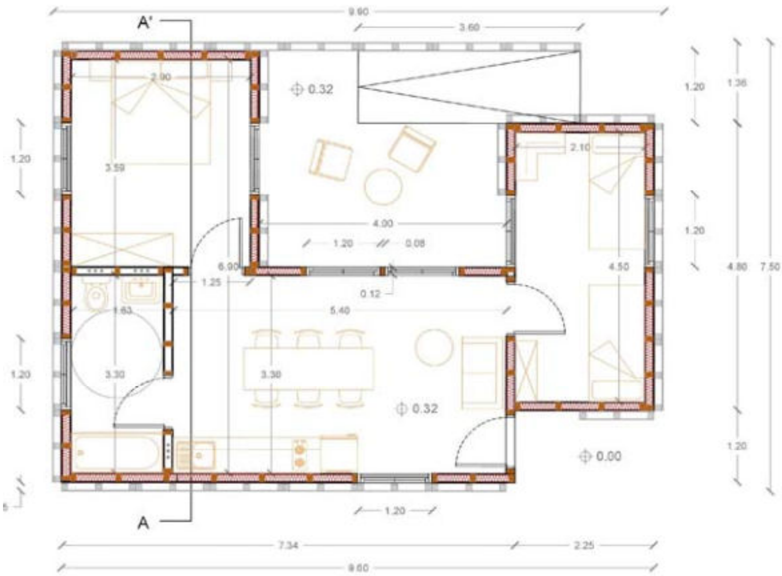


Figure 19: Pallet Shelter - Ground floor plan[16]

[16] Drawings by Bertino, based on Barbero Durán and Cuesta Urquía

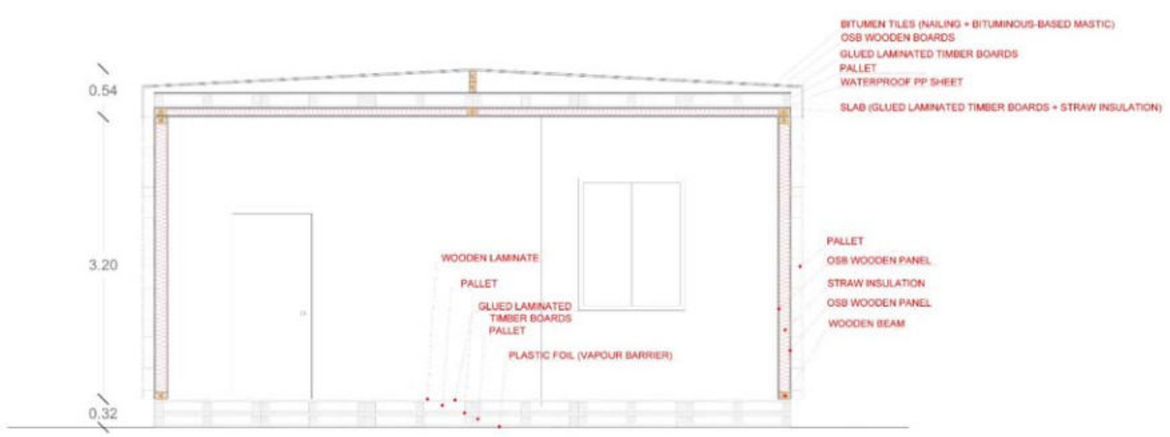


Figure 20: Pallet Shelter - Section and details of walls and floors[17]

The design finally chosen for the modelling phase was a simplex unit of 50 m² which corresponds with a "Type 1" building in the original drafts of the students Barbero Durán, and Cuesta Urquía (2019). The housing unit is displayed in Figure 19 and Figure 20.

3.4.2 Components and materials

Main materials and structure

The main component of the building design is a EUR-pallet, which makes up walls and slabs. Pallets are flat structures, which stably support goods while being lifted by a forklift. Wooden pallets typically consist of three or four stringers that support several deck boards, on top of which goods are placed. A EUR-pallet has a size of 800 x 1200 mm (see Figure 21). Pallets have a load capacity in stacking on shelves or in the transport with the forks of a forklift truck of 2000 kg (Wikipedia 2021).

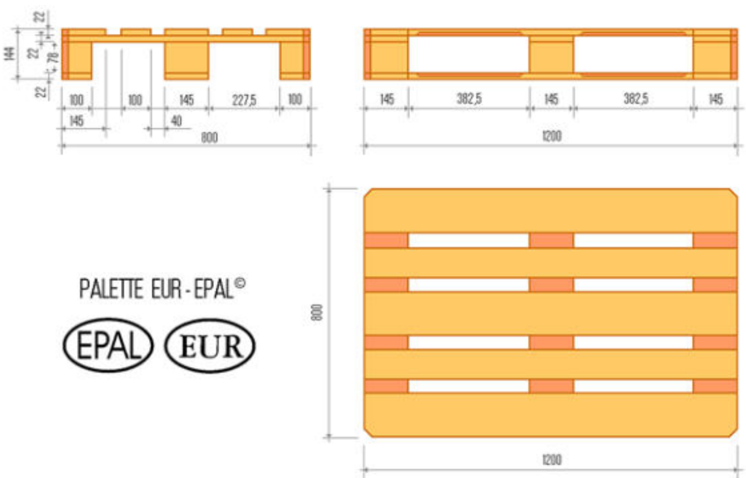


Figure 21: Technical specifications of the EUR-pallet[18]

[17] Drawings by Bertino
[18] White Timberwolf Pil56, 2010; White Timberwolf PlI56 (2010). EURO Pallet technical specifications. Available at: https://en.wikipedia.org/wiki/Pallet#/media/File:Plan_palette-europe.svg [accessed on August 12th, 2021]

The foundation of Pallet Shelter consists of pallets. Two layers of pallets are needed, so the unit is elevated 32 cm from the ground. This should prevent any rising damp and water problems.

The foundation system consists of the following materials (from the bottom to the top):

- Plastic foil (vapour barrier) directly on the ground (≅ 0.2 cm)
- Pallet grid (14.5 cm)
- Glued laminated timber (2 cm)
- Pallet grid (14.5 cm)
- Glued laminated timber and Wooden laminate flooring finishing (3.5 cm)

The wall system of Pallet Shelter (Figure 23 is enclosed in a wooden frame structure, for a thickness of 15 cm and 14.5 cm (structure and outdoor pallet), and consists of the following materials (from indoor to outdoor):

- OSB Wooden panel (1.5 cm)
- Straw insulation (12 cm)
- OSB Wooden panel (1.5 cm)
- Outdoor pallet (not structural) (14.5 cm)
- Wooden beams and pillars are structural and made by glued laminated timber (dimensions: 0.12 x 0.08 x 3.00)

Some openings must be realized in Pallet Shelter, such as windows, entrance and terrace doors and a service hatch for the dry toilet.

Figure 22 shows details of the Pallet Shelter foundation and wall.

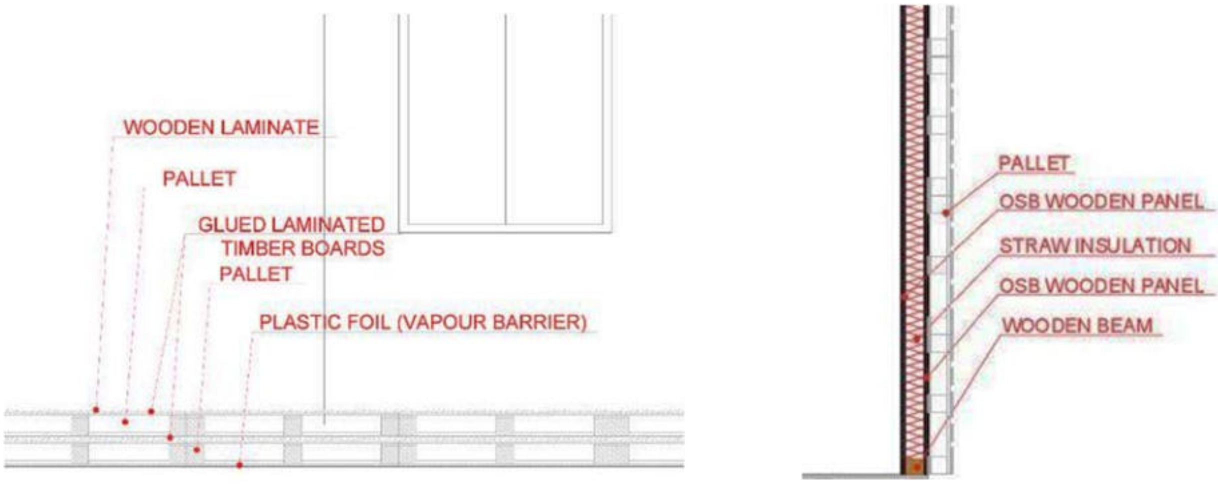


Figure 22: Pallet shelter - Foundation and wall details[19]

[19] Drawings by Bertino

Sun sail structure

To protect the building from excessive heat, a sun sail construction is roofing the dwellings. The sun sail is not water-resistant and has to be rolled up in cases of rain, especially heavy rainfall (could be done manually by residents or maintenance staff, or automatically). It inclines 9° and has a minimum distance to the roof of 50 cm. This minimum distance derives from ÖNORM B 4119, as can be seen in Table 2, which is available there, in the ÖNORM for back ventilated roofs (Austrian Standards International, 2018). We took the recommendations listed there and increased the dimensions to make sure to avoid heat accumulation between the roof and sun sail. Every housing unit is covered by six sails, accumulated air can escape through the slots in between. The inclination of the sun sail is 9° = 15,8 %. The sails have a triangular shape for better tightening. The poles have a 10° inclination towards the exterior for maximum stability.

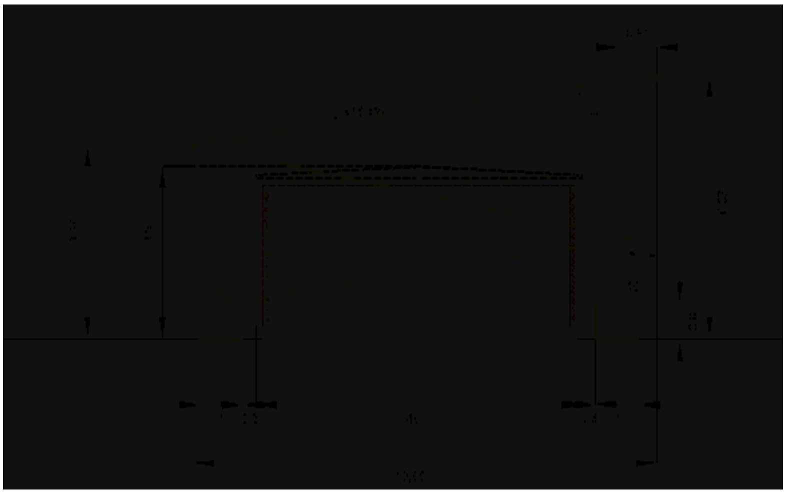


Figure 23: Pallet Shelter – Detailed section of housing unit with sun sail[20]

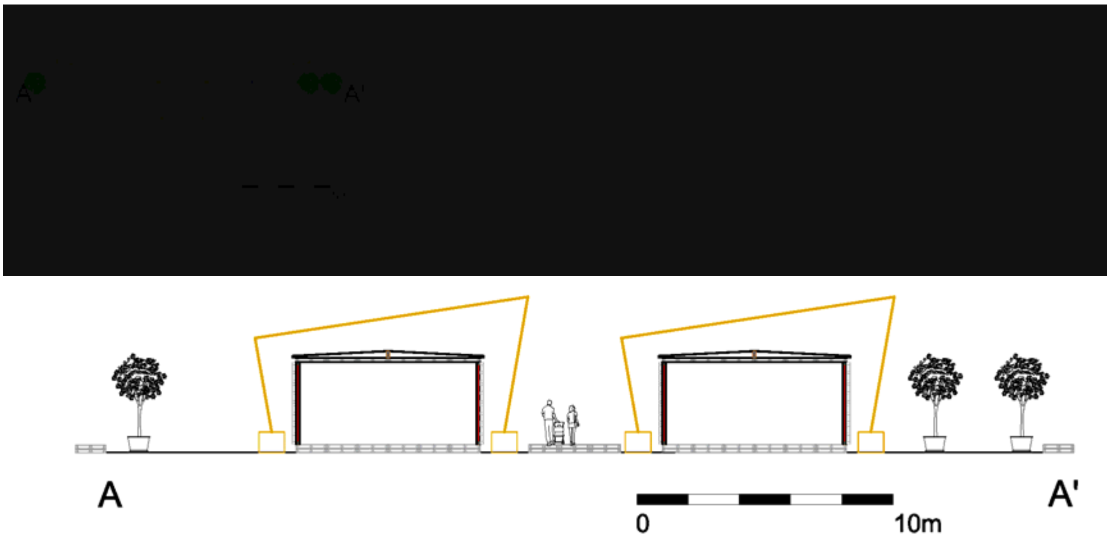


Figure 24: Pallet Shelter - Sections of housing units with sun sail[21]

[20] Drawings by Stocker based on Bertino
[21] Drawings by Stocker based on Bertino

3.4.3 3D visualisation

Figure 25 shows a Northern and Southern view of Pallet Shelter, including the private shaded terrace. A standard housing unit is shown in Figure 26, including a double room and a twin-bed room, a bathroom with dry toilet facilities and a kitchen living room.

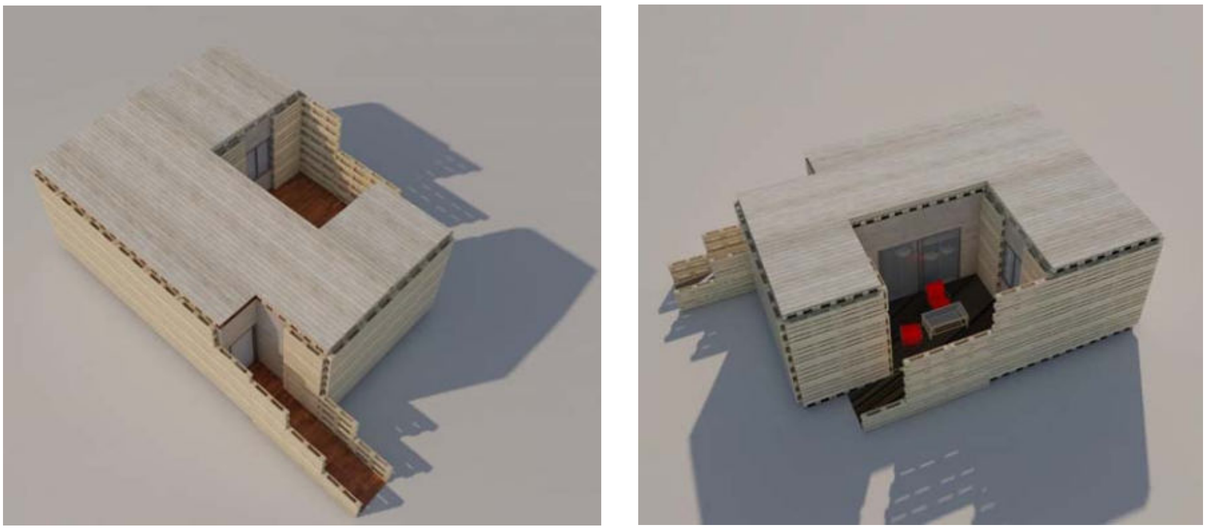


Figure 25: Pallet Shelter - External renderings[22]

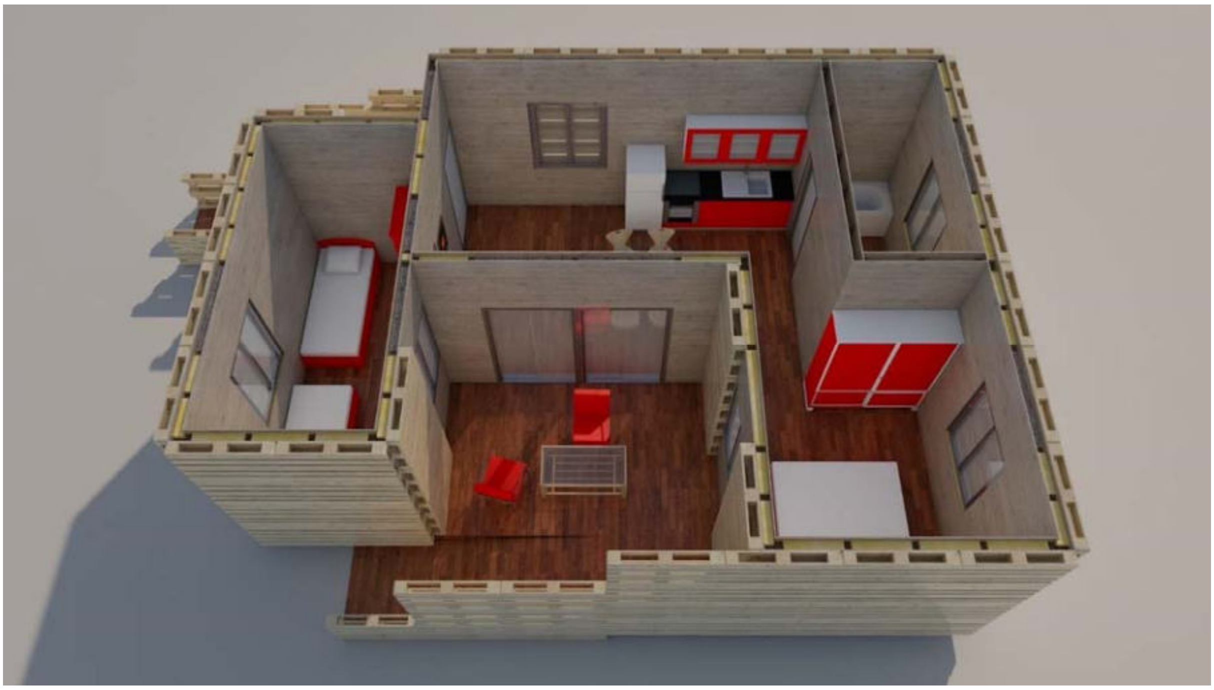


Figure 26: Pallet Shelter – Internal renderings[23]

[22] Drawings by Bertino
[23] Drawings by Bertino

3.5 TECHNICAL AND RESOURCE ASPECTS

3.5.1 Energy concept

The following assumptions were made for the selection and design of the technical infrastructure.

- An annual operating time of 1.5 to max 2 months is assumed.
- It is assumed that a cost-effective connection to the electrical grid is possible within Vienna. Moreover, due to the required shading using sun sails PV panels were expected to be ineffective, and thus, not considered in this model.
- Pallet Shelter is planned without technical cooling equipment (such as air conditioners). For reasons of sustainability, the main part of the cooling will be provided by the site and vegetation and will be achieved by shading methods. By this, technical cooling in the buildings should be avoided. If a site is chosen that does not meet the required framework conditions, mitigation measures by landscape planners must be implemented.
    a. The building must be protected from excessive heat radiation by the location or via suitable shading systems.
    b. The building is ventilated by means of natural ventilation systems, in which case sufficient cooling must be provided by the location, especially during the night.

Specification of the technical systems

Heating: Due to the limited use during periods with tropical nights in the cities, the building is designed without a heating system.

Domestic hot water: Domestic hot water is provided by decentralized electric instantaneous water heaters at the tapping points. This choice can save a large part of the installation work. Due to the short operating life, this is also the most reasonable solution from an economic point of view. There is also no noise pollution due to this option. Due to the short operating time, a central plant is not considered since the additional infrastructure required for this and its construction would not be justified. From the choice of location or the required shading, it follows that an installation of thermal solar systems on the roof or facade is not reasonable. In particular, the use of solar thermal systems as shading would not pay off due to the short operating times and the increased installation costs.

Electrical supply: Due to the location being in an urban area, the prerequisite of a possible grid connection is foreseen. In such an environment it is in any case possible to have a temporary grid connection available. As mentioned before, thermal solar systems (on roofs or facades) are not considered in Pallet Shelter, as shading for heat protection is needed and an auxiliary construction for the PV modules would be necessary for a self-sufficient electrical supply. However, due to the short operating time and the high construction costs, this construction seems not economically viable. As an example, a rough calculation regarding the annual construction and dismantling of the plant with figures from Photovoltaik Solarstrom (2021). For a 7 kWp system without storage, costs of 9500 to 11000 EUR are given. Of this, approx. 15 % to 20 % are given for the craftsman costs of assembly and installation. The annual production is given with 7000 kWh. From this follows for a single assembly a lower amount for the erection costs of 0.15 * 9500 EUR= 1425 EUR must be considered. Whereby a possible saving of 7000 kWh/a * 0.2 EUR/kWh= 1400 EUR can be compared to the total expenses. Since Pallet Shelter is in operation only 1 to 2 months in a year only a fraction of the possible savings remains. As can be seen from the calculation, the necessary recurring assembly work is not economically reasonable, not even taking amortization into account. For a self-sufficient operation, there is also a storage option needed, which would amount to additional costs. Taking this into account, a self-sufficient operation is not recommended.

Due to the low-tech approach chosen in this scenario and the short operating times, a conventional design of the electrical installation is considered.

3.5.2 Water and sanitation concept

Like a key assumption regarding power supply, it can be expected that with Pallet Shelter being in an urban area of Vienna, a “conventional” centralized water supply and sanitation system should be possible. However, Pallet shelter should also be suitable for on-site water and sanitation solutions and might even provide a learning space to explore unusual or innovative alternative water supply and sanitation systems. Therefore, considerations in this section relate to an on-site system in which water-saving technologies and greywater systems are to be used.

For the water concept, diverse points of water consumption, water quality, water quantities and logistical considerations for an on-site water distribution system are taken into consideration. For the sanitation concept, a dry toilet system is suggested, as it reduces the water quantities needed per day and is especially suited for areas without access to a sewage system.

Points of water consumption

In Pallet Shelter, the following points of water consumption are considered:

Points of water consumption requiring drinking water quality:

Domestic drinking water: Every resident must have access to drinking water in sufficient quantities. This is important because in the case of summer heatwaves, care must be taken to ensure a sufficient supply of liquid to avoid health problems such as heat stroke.

Water for preparing food: Sufficient drinking water must also be provided for food preparation.

Domestic rinsing and cleaning water: cleaning work can usually be done with service water. However, since the most common water points are most likely the taps in the kitchen and bathroom, which are also used for drinking, food preparation, brushing teeth, etc., the quantities of water used for cleaning activities have also been included in the drinking water quantities.

Water for shower and bathtub: It is common practice in Vienna to have drinking water available for the shower and bathtub. Although it is not an absolute necessity, drinking water was considered for these systems to avoid acceptance problems as well as to avoid the need to lay both a service water pipe and a drinking water pipe in the residential buildings.

Water for fog system: An essential aspect of Pallet Shelter is that it is to be used during the summer heat waves. Thus, the perceived coolness and comfort is an essential aspect. Fog systems (mist sprayers) are considered a suitable approach to allow the residents to cool down with relatively little effort and water consumption. Due to the risk of clogging of the pipes and mainly hygienic requirements, most manufacturers demand drinking water quality for sprayers (Ulpiani, G. 2019).

Points of water consumption that could be operated with service water (drinking water quality not necessarily required):

Water for washing machines: laundry machines could be operated with greywater / service water, if there are no suspended or interfering materials that could damage the machines.

Irrigation water: As highlighted in the previous chapters, several (mobile) plant beds, rolled turf etc. are part of Pallet Shelter's open space concept. For irrigation, on-site-treated greywater might be suitable to save drinking water. However, the quantities for proper irrigation of an artificial green area can be considerable, so the quantities of water needed for irrigation could exceed the quantities of available greywater. It is of utmost importance to label service water as such, especially, if the Pallet Shelter residents are not used to service water that does not fulfil drinking water quality. Shower and kitchen water of residents will be collected in wastewater tanks and be treated on-site to be used as greywater.

Rainwater collection is not considered for Pallet Shelter as during heat waves, it is not necessarily possible to rely on regular enough rainwater.

Water quantity requirements

Estimates of the amount of water required should be monitored with water meters in a real-life application of this pop-up housing model. It can also be estimated from reference publications. According to Neunteufel et al. (2012), the average per capita water consumption in Austria is around 135 L/person and day on a yearly average, respectively 150 L/person and day in summer. This number includes water used for flushing toilets, showers, bathtubs, washing machines, faucets in bathrooms, toilets, kitchens, etc. (this includes water for drinking and eating), dishwashers, leaks, outdoor plants, and outdoor swimming pools. The difference between the annual average and the summer average water consumption results from the water consumption for swimming pools. However, as the additional daily water consumption of 150 L/person and day is linked to swimming pools, which are not part of Pallet Shelter, the annual average of 135 L/person and day can be used as a reference. As an on-site sanitation system with a waterless toilet is planned, the average daily water consumption might be even lower than that. However, there are also additional communal points of water consumption, e.g. for spraying systems, water basins or irrigation purposes. Also, due to the hot weather, residents might likely shower more often for cooling reasons. With a water treatment facility on-site, this water can be used for irrigation purposes. It can therefore be expected that the daily water demand per person will be between 135 and 150 L.

On-site water distribution and dry toilet

A decentralized water supply system is suggested for Pallet Shelter if a connection to a centralized water network is not available. A water truck will deliver drinking water to an elevated water tank regularly. The water tank will be elevated to implement a gravity-fed water distribution system. The water tank is situated on top of the facility building for technical infrastructure to achieve enough head to ensure suitable water pressure in the housing units. The facility building must therefore be constructed in a way to support the weight of the water tank, or an additional load-bearing framework for the water tank must be constructed. An essential point is the prevention of recontamination in the water pipes and thus ensuring drinking water quality at all points of use. Water disinfection and water quality monitoring with regular testing must be implemented.

The second part of the water system refers to service water. Water from shower and kitchen drains is collected in a greywater tank and treated on-site with sand filters or other simple technologies if necessary. As faeces are collected in a separate system (see below), the faecal contamination of the water should be minimal. After treatment, the water can then be used for irrigation and laundry. Communal areas must be irrigated either with an automated irrigation system, designated persons from the residents or by a caretaker or facility manager.

Pallet shelter will include dry toilets (like various camping toilet types, GIZ 2011) rather than flush toilets, which are common practice in Vienna (Figure 27). The user interface of this container-based sanitation system is designed in a way that looks familiar to the users. To avoid unpleasant doors, materials such as sawdust can be used. It can be assumed that the residents of Pallet shelter are not familiar with waterless toilet technology, so an information campaign and training is necessary. To implement this system, a maintenance hatch is installed in the sidewall of the building, where a collection container is situated. This allows removing a full container and exchanging it with a new one without major disturbance of the residents. Service and cleaning personnel and regular emptying intervals are necessary for this system to work. The collected container will then be picked up by a sewer tanker and delivered to a suitable service facility.

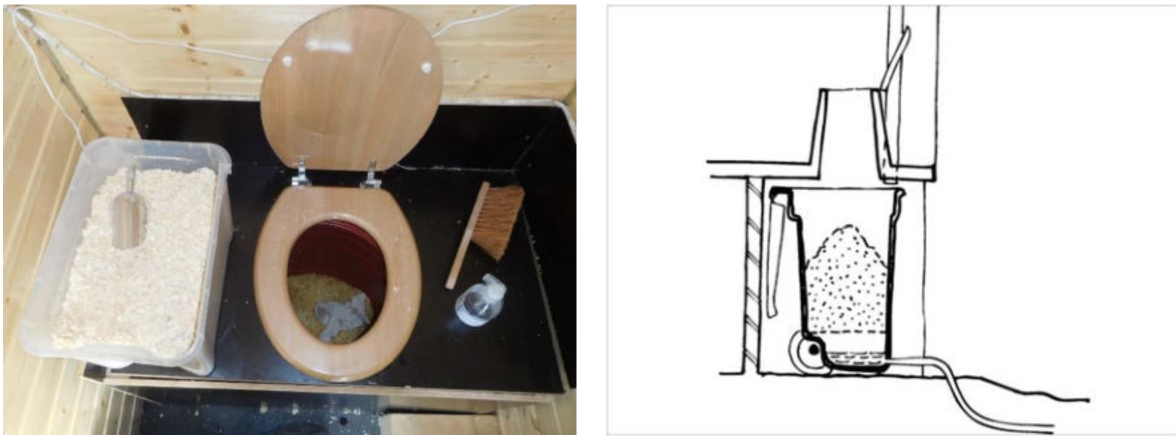


Figure 27: Examples: Container based dry toilet[24]

[24] Zeilinger, https://www.yourhome.gov.au/water/waterless-toilets

Many dry toilets are conceptualised as composting toilets. Composting the collected faeces is possible in theory, but currently not allowed in a commercial technical composting plant considering the legal framework condition in Vienna, and also not recommendable on-site in home-composting considering the unsuitable waste composition and the short operation time of Pallet Shelter, which is not long enough for a proper composting process. Hence, the main benefit of this option is the reduction in overall water demand, as the toilets are operated without flush water. However, an increased logistical effort is needed as the faeces have to be transported to an off-site centralised service facility.

3.5.3 Resource concept and waste management

The resource concept focuses on the circularity potential of building materials, as well as furniture and living equipment, whereas the solid waste management part will focus on the set-up of a household waste system.

Building materials and circularity

Ideally, a sustainable design is an important cornerstone of all the developed temporary housing models. In terms of building materials and furniture, a focus should be on circularity and careful use of resources. Preference should be given to second-hand, reused, and recycled products over new products where possible. Especially, considering the relatively short use phase of Pallet Shelter during heat waves in summer (weeks or months at a time), new products and building materials should be avoided or at least used and implemented in a way that allows (preferably) continued used without downtime or storage facilities and conditions that prevent wear and tear. If storage is necessary, additional costs must be considered as well.

Standardized EUR-pallets are the main building blocks for the residential units. These have quite good properties and circularity potentials, which make reuse or further use possible. In the architectural design, an attempt was made to install and use the pallets largely without structural changes. Exceptions only concern delimited areas, e.g., to gain access to the exchange containers for the dry toilets (here a cut-out for installation of a maintenance hatch is required). These pallets will therefore lose some of their reuse potential. Additionally, one must probably assume quality gradations, depending on where in the housing model the pallets are installed (floor, wall, inside, outside, etc.) and how invasive wall fittings and connections are.

There are providers of pallets, who offer them (usually with a deposit) for loan, buy-back or offer repair and maintenance services for pallets with signs of use. This opens potential second life applications even for defective pallets, which then would not have to be disposed of, but instead can also be repaired and put back into operation professionally. For the implementation of Pallet Shelter, suppliers of pallets should be considered as strategic partners, and business models and contracts might be established.

Informal online platforms such as Willhaben.at represent further sources of supply or possible sales or reuse options for used or even damaged pallets, where pallets are repeatedly sold at low prices or even given away for free. Here pallets which have lost their original functionality or stability, could possibly also be distributed to hobbyists for upcycling projects and such. Depending on available budget and (time) resources, it seems as if there are promising possibilities available to either obtain used EUR-pallets for Pallet Shelters or to allow reuse of those EUR-pallets that were used as building materials in Pallet Shelter.

Also, other building components (doors, windows) could possibly be obtained over reuse and second-hand initiatives, e.g., Baukarussel. However, the stock levels are volatile in such second-hand initiatives and the required quantities or formats of building components are not always available at the right time and the right price (Salem 2020).

Furniture and living equipment: potential for used items

In Pallet Shelter, the kitchen, and the bathroom (including large electrical appliances) are considered part of the living unit and must therefore also be equipped when Pallet Shelter is erected. Kitchen appliances, such as stove, oven, refrigerator, if necessary, dishwasher (and shared washing machine in area for technical infrastructure) should preferably not be purchased as new goods for Pallet Shelter either, since they are not at the end of their lifespan after the heat waves have passed after some weeks or months and therefore cannot be discarded, also from an economic perspective. On the other hand, it is also costly to put them in storage: the costs of storage area and logistical considerations have to be taken into account since there is also a risk that furniture and equipment will wear out during the long-standing periods (in cold seasons, when Pallet Shelter is in storage), e.g., by water residues in washing machines, etc.

When Pallet Shelter is in operation, the equipment must work reliably, but not necessarily include the latest features. Since the housing environments are not cooled down actively in the interior, any heat source should be kept to a minimum. For example, it is advantageous to offer induction plates as a cooking option, as the lowest heat input is to be expected here. For this reason, co-operation could be sought with companies that specialize in refurbished large appliances and white goods, e.g., by implementing a rent-based system for the hot summer months. This could potentially also be advantageous for Second-Hand enterprises as the attention can be drawn to their product range and possibly also "psychological barriers" (“Hemmschwellen”) to buy second-hand electrical appliances in the private life can be reduced. There are still reservations prevalent whether the used equipment really is reliable and still working well or whether one would not rather invest in a new product (a risk-averse way and slightly more expensive, but common decision). Such cooperation and business models for renting second-hand appliances could possibly set new impulses for the Second-Hand market. A possible contact point to initiate such a co-operation might be Repanet and its members (Reuse and Reparaturnetzwerk Österreich) (Repanet 2018) and other institutions and companies in the second-hand market (e.g., RUSZ, DRZ, MA48 Tandler, etc.). RUSZ for example offers an option for renting washing machines (RUSZ 2021).

Also, regarding the furniture used in Pallet Shelter, considerations regarding reused items can be fruitful, although it is up to the residents to bring (part of) their own furniture to feel more at home (e.g., a comfy chair to relax). Alternatively, used furniture and furnishing could be the implementation of a business arrangement with re-use stores. An example of this would be

Carla of Caritas (Caritas Wien, 2021), where furniture is rented for the summer months and "test lived in" by Pallet Shelter residents. When Pallet Shelter is closed again, there could either be an option to buy cherished pieces for the permanent living space of residents or they are returned to the permanent salesrooms of the re-use stores that provided them. To be prepared in case of damage, there could be a deposit system. The housing units in Pallet Shelter could thus act as "show-rooms" and could also serve as an opportunity for public relations and publicity for second-hand businesses.

Figure 28: Examples: Reused furniture at Carla Nord[25]

For outdoor furniture (for terraces or open spaces), pallet furniture could also be rented or possibly built-in workshops with the neighbourhood or volunteers as community activities. Pallet furniture would fit harmoniously into the overall aesthetics of Pallet Shelter and could provide an opportunity for getting to know the fellow Palter Shelter residents.

In conclusion, it is important to look for sources of supply, cooperation and possibly new business ideas that can cleverly combine second-hand products and temporary living. Establishing and maintaining sources of supply for Pallets and building components via second-hand businesses requires more time and logistics and should therefore be considered in the organizational planning steps of Pallet Shelter.

Solid waste management

It is assumed that the solid waste characteristics of this temporary housing environment correspond to that of Viennese households. The temporary residents of Pallet Shelter are Viennese residents; therefore, they should be aware of the guidelines and regulations regarding the Viennese waste regime. Even though the residents will leave their permanent homes for a limited time during heat waves in summer, it is not likely that they will significantly change their waste management behaviour, although these new temporary surroundings might offer an opportunity to initiate an awareness campaign regarding waste reduction.

As Pallet Shelter is planned to be in the urban area of Vienna, the provision of waste collection containers follows the guidelines for planning and design of garbage room (Stadt Wien and

[25] Caritas Wien, 2020

MA 48 2016): For residential buildings with 10-15 apartment units, one residual waste container of 1.100 L, one wastepaper container of 700 L and depending on the location in Vienna, two organic waste containers of 240 L each should be provided. Those are to be collected by waste collection vehicles from the plot (curb side collection / "Holsystem"). Taking the requirements for size, layout, functions, and features listed in Stadt Wien and MA48 (2016) into consideration, a garbage place or room of approx. 18 m² has to be provided on the plot. It will be situated in the area on the plot reserved for technical infrastructure and requires easy access for waste collection vehicles.

Since it is common in Vienna to separately collect recyclables (glass, metal, plastic containers) at neighbourhood waste collection sites ("Sammelinseln") in a bring system, this system will also be adopted for Pallet Shelter. The City of Vienna provides a useful feature in the digital city map (Stadt Wien, 2021): All recycling collection points can be displayed. Depending on the eventual location of Pallet Shelter, the suggested procedure is to assess the distance to the neighbourhood waste collection sites and if they are in a reasonable proximity to the temporary housing environment, no additional waste containers for recyclables must be provided. If the distance is too far, additional arrangements with the municipal waste management of Vienna (MA48) should be sought.

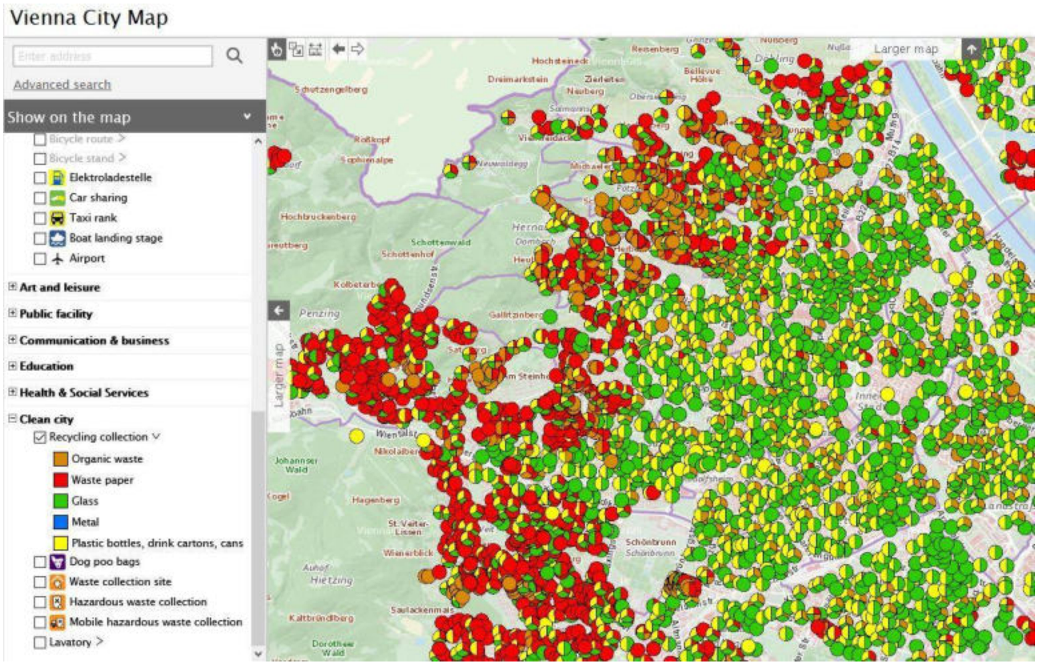


Figure 29: Clean city features in Viennese digital city map[26]

3.6 NICHE EXPERIMENT

[The content of this chapter is taken directly and abbreviated from the paper: The Learning City: Temporary Housing Projects as Urban Niches for Sustainability Experiments by Gloria Rose, Mirjam Stocker, Michael Ornetzeder, Sustainability 2022, 14(9), 5198; https://doi.org/10.3390/su14095198].

[26] https://www.wien.gv.at/stadtplan/en/, accessed 31/08/2020

This experiment explores the following questions: what are the health and social benefits? How can technical aspects of the experiment be optimized regarding construction and deconstruction, as well as sanitary solutions and energy provision? How can the target group effectively be reached and mobilized? What activities can be provided on-site to increase well-being and pro-mote social interactions?

The initiators and coordinators of the Beat the Heat experiment are individuals from government and interdisciplinary research institutions. The implementation team on-site includes medical, care and facility staff. The experiment consists of the following phases: planning, recruitment and registration, construction, housing, deconstruction and storage, assessment, and adaptation. Planning, recruitment and registration of participants take place months before the housing phase in the summer, whereby different ways of identifying and recruiting interested participants can be explored. A focus is placed on the districts most affected by heat islands in Vienna, with the project team collecting applications. Applicants must currently be living independently without required assistance and not have pre-existing conditions requiring constant observation by a professional.

The construction of the building units takes place sometime between June and August.

For this experiment, up to 50 people can be housed, offering a mix of housing units for singles, couples, and families (1-4 people), with each unit possessing a kitchen and bathroom. Housing units designed for 4 people have a kitchen, a bathroom, and two bedrooms, of which one contains a double bed and the other two single beds. It is therefore possible to combine a household with individuals who do not know each other. The housing stage itself is relatively short, spanning two weeks. For this phase someone from the medical and care team is always on-site to ensure the safety of the participants.

The experiment aims to assess the effectiveness of the model as a solution for particularly vulnerable groups during heat waves in Vienna, therefore the health and social benefits are assessed using both quantitative and qualitative methods. The air temperature differences between the apartments of the inhabitants and the “Beat the Heat” housing units are measured during the housing phase, as are key data for the applied technical solutions and observations concerning their use. Members of the medical and care team visit each household every day for a brief personal check-up on the participants, filling out a short checklist on the perception of the thermal environment and well-being.

An important aspect of this experiment is to provide activities for the inhabitants. While participants are of course free to move around the city, it is unlikely for them to be overly mobile during a heat wave. Being removed from their usual everyday environment and possessions may additionally result in boredom and lethargy and seeing as school is not in session during many weeks of the summer months, children must be provided with activities on-site. Group activities are carried out in the communal unit, which also provides children a shaded space to play. During the first days, activities focus on the residents getting to know each other and collecting information on what they would like to do during the day (such as card games, yoga, and painting).

At the end of the housing phase, the inhabitants feedback how they perceived their lived experience to the project team within a brief concluding interview. Once the housing phase has concluded, the building units are deconstructed and transported for storage and the research team analyses the collected data. This concludes with concrete suggestions for adaptations to be incorporated in future implementations of the model, which are discussed and further elaborated within the larger project team, including the funding bodies.

3.7 INNOVATION ASPECTS, CRITICAL ISSUES AND OUTLOOK

As mentioned, climate forecasts for Vienna indicate a significant increase in air temperatures during days and nights and longer lasting heat waves (ÖKS 15). As a result, prolonged periods of elevated temperatures can lead to severe physiological burden on vulnerable groups. Due to the urban island effect, long periods of elevated night temperatures are also to be expected, which represent a particular physiological burden. Beat the Heat is essentially a risk management measure which is government-initiated, and which requires a high level of control and structure.

This model provides a good opportunity to explore a number of subjects, such as alternative cooling options, circular building concepts, low-tech green technology, the rapid generation of green spaces on top of paved or gravelled areas or on roofs, the application and interaction of inhabitants with e.g. mobile wetlands for water treatment, dry (composting) toilets, sun sails or plant walls, or the process of recruiting and support of inhabitants who find themselves in a disruptive new situation. The fact that there is only a brief timespan in which appliances such as stoves or refrigerators are needed provides a good opportunity to test new business models and patterns of consumption, e.g., through a cooperation with a company specializing in refurbished large appliances in the form of a rent-based system for the summer months. Social activities and ways of promoting a sense of community, familiarity and increasing wellbeing can also be examined. First and foremost, however, the experiment must contain an assessment of the health and social benefits of Beat the Heat, to ascertain if the main objective (accommodation of vulnerable groups in a cooler and therefore safer environment during heatwaves) is achieved.

However, one of the biggest uncertainties, and thus risk issue is, that unshaded and paved open spaces can reach extreme surface temperatures during long-lasting heat waves. Shaded and greened open spaces would, however, be under increased pressure of use due to the generally growing population, and were therefore, not considered as suitable space for placing this temporary housing model. In addition, purely passive cooling measures could be limited particularly during long-lasting heat-periods and then would not create physiologically tolerable conditions at the predicted night temperatures. In this context, the question may arise whether suitable locations for the planned modules would be available in Vienna.

The implementation of this scenario, respectively housing model, may lead to a conflict of priorities. The site type that was chosen in this scenario (public green space) is not compatible with the values of open space planning, therefore a possibility would be to place the temporary housing environment on a site that is not "green", paved, or unpaved (gravelled e.g., “wassergebundene Decke”), which can be parking areas or other undeveloped sites. In this case these sites have to be placed in "cool areas" of the city. These can be taken from urban heat exposure maps and the map of Urban adaptive capacity to heat from the Urban Heat Vulnerability Assessment of Vienna, Austria[27].

Waterless or rather dry toilets are by far not commonplace in Vienna. Therefore, residents of Pallet Shelter might be reluctant to use them. It must therefore be ensured that the toilets are maintained properly and regularly, so odours and other inconveniences will not become a problem. Additionally, sufficient and appropriate information must be available for the users. It might also be an opportunity for awareness raising regarding resource use, closing the loops and circularity in general.

Once decided to implement the housing model, a series of considerations regarding the social aspects emerges. Considering the constellation of user groups (people particularly vulnerable to heat, such as small children, pregnant people, or the elderly), and the materials used for the structure of the units, noise may become an issue. Moreover, the rather invasive disruption in the everyday lives (and considering the elderly as part of the target group), the health and social benefits which Pallet Shelter offers must be very evident. While it is not possible to predict in advance, it is feasible that the results achieved through passive cooling systems are not strong enough to compensate for the expenditure and potential stress caused, particularly when "green" spaces or sites close to rivers must be excluded.

What seems promising, however is the fact that in Vienna, there is already some experience with such passive cooling systems, as they are part of the climate resilience strategy and smart city concept of Vienna (see Figure 30). During the first year of the Covid-19 pandemic, a total of 22 temporary cool streets were implemented (Mobilitätsagentur Wien 2021), four of which are now permanently implemented. According to the evaluation report of the pilot project “cool streets” in 2019, people's subjective feeling was that the measures (water mist sprays, shading, providing seating areas) made it cooler and more pleasant (MA28 2019).

Figure 30: Already existing examples in Vienna concerning similar aspects: Initiatives of cool city Vienna[28]

[27] (https://urban-comfort.eu/wp-content/uploads/2019/11/Booklet_UHVM_Vienna.pdf, accessed 31/08/2020). The chosen sites have to be cooled down by adequate surface covering and shading.
[28] Stadt Wien, 2021

Depending on where the Pallet Shelter is located, it must yet be seen how the locals living or moving within the environment will interact with the Pallet Shelter. This can range from no interactions to positive or negative encounters (e.g., uninvited interactions may become an issue when placed in a public space). In the search for suitable sites, the use of ecologically sensitive areas should be avoided as far as possible. The use of potential sites should be evaluated in terms of their extent and impact. The results should be discussed with decision-makers about their acceptance.

As the discussion above shows, a challenging issue within the project elaboration was the accord of all project members. Their disciplinary background and personal opinions influenced whether in their eyes the suggested solutions are feasible or acceptable. Examples are the discussion if green spaces can be temporarily built during a heat wave to host a small group of population, meanwhile the (in this season very crucial) open space is withdrawn from all city's residents. The ecological effect and impact, e.g., of greening grey paved areas for such a scenario, was further evaluated in LCA-considerations in WP4 (see D4).

The interdisciplinary team also conducted a SWOT-analysis for this scenario, which is summarized in the following table. The matrix shows the main strengths (innovations), weaknesses, opportunities and threats (risks). For additional risk considerations please see Deliverable D5 (theoretical risk assessment report).

Table 13: Beat the heat / Pallet shelter - SWOT analysis

SWOT: Beat the heat / Pallet shelter	
Strengths - Flexible and quick assembly / disassembly - Predominantly reuse materials - Possibility of bridging heat phases in Vienna for socially disadvantaged and vulnerable people (apartment without cooling facilities; previous illness, etc.) - "Holiday feeling" in Vienna	**Weaknesses** - Relatively high resource requirements (area/person) - Logistics and storage requirements - High coordination (also in advance) / ongoing support necessary (on-site) - Potentially high effort for preparation and decommissioning of open spaces
Opportunities - Opportunity for urban policy to proactively address future challenges - Test case for circular economy - Raising awareness for passive cooling systems and alternative sanitation systems - Through (natural) passive cooling systems, corresponding energy use and heat sources (waste heat from air-conditioning units) in the city could be avoided	**Threats** - Lacking availability of space (e.g., not using public cool green spaces for this purpose) - Lack of acceptance - Potentially increased frequency of use in emergencies for vulnerable users - Required cooling effect not achieved - Vulnerability to severe weather - Increased user pressure on suitable areas (conflicts of use and interest) - High (resource) demands due to the construction and dismantling of temporary housing solutions, which must be compared with local technical cooling solutions in existing flats of the potential residents

4 LIFE SHARING TO GO / INFACTORY

4.1 SCENARIO DESCRIPTION AND RELEVANCE FOR VIENNA

The main idea of “Life Sharing to go” is to implement the concept of communal living within vacant or unused industrial buildings in a residential (not exclusively industrial) area. The indoor spaces of vacant industrial buildings will be used for a limited time for the construction of temporary pop-up housing units until the industrial building is given a different permanent purpose. The housing units are realized with the use of prefabricated components and light materials, designed to be transportable as modules by trucks and then assembled with mobile cranes, allowing for fast and easy mantling and dismantling. The housing units are designed to allow further extensions of the modules according to the number and type of users (single, couple, family): starting from a base modular unit, the unit’s dimensions may be up to 40 m². This scenario is meant to accommodate a mixed group of migrants and locals interested in this type of living between the ages of 18 and 40. The building provides accommodation for up to 100 people. The bathrooms are private, while cooking facilities and community garden are shared to promote communication and social interactions. The internal areas of the industrial building which surround the private housing units are also used as common areas for collective use. As an industrial facility is used for this temporary housing environment, it can be assumed that a central water, sewage, and power supply connected to the city grid is available. A good connection to the public transport system should be provided.

In this concrete application of the housing model InFactory, 89 individuals are housed on two floors (38 on ground floor and 51 on the first floor) of an industrial building. The units vary between 14 and 26 m². Each module contains a private bathroom (to be shared with the roommates).

In the thematic concept "Productive City" (Magistrat der Stadt Wien 2017) as part of the STEP 2025 of the City of Vienna, an attempt is made to coordinate the overriding trends such as transformation of the economy (digitalization and specialization) with a long-term securing of areas for trade and industry in the city. The scenario “Life sharing to go” can provide an approach to revitalize vacant or underused areas and enhance their image. As well as an innovative approach for innovative examples of how a close link between working and living can be functional. In addition, the temporary character of the project does not limit the future scope of action for long-term urban development.

The design of the scenario represents an opportunity for the administration to react to disruptive events (e.g.: migration events, natural disasters) in a high-quality manner. The potential areas could be used to meet temporary housing needs without competing with existing uses.

4.2 USER GROUPS

The target group is made up of refugees with positive asylum status, people currently affected by homelessness and long-term unemployment, and young individuals with high motivation for inter-cultural exchange and an interest in exploring new communal ways of living. Seeing as these user groups involve individuals with limited options regarding housing, much care must be taken to ensure that participation is optional, and the expertise of social workers should inform the involvement of the participants (e.g., social workers could nominate who they believe would be interested in and well-suited). Much freedom is provided for the inhabitants to self-organize, including possibilities to structure space and for do-it-yourself building. Care must also be taken to ensure that the participants are not faced with having no place to go after conclusion of the project.

Life Sharing mixes users from User Profile B and User Profile C to promote social integration. At maximum capacity, the environment houses 84 people, of which at least a third should be individuals from User Profile B. The duration of stay should span between several months and one year for the residents. This type of experiment should not involve users of User Profile A, where sufficient choice whether to participate or not cannot be guaranteed. (The user profiles are detailed in Deliverable D1).

4.3 SPATIAL PLANNING

Commercial or industrial areas consistently show a good suitability for the implementation of the modules. From a spatial planning perspective, the re-use or interim use of vacant structures is advantageous. The areas usually have a low ecological value and are hardly in a conflict of use with other residential or recreational uses.

If the implementation is accompanied by a cultural and publicly accessible open space offer (e.g.: community gardens), the use would even create added value for the local population.

The areas are well suited, especially with respect to slope. Thus, barrier-free accessibility of the modules by residents can be ensured. The areas are also easily accessible for assembly and disassembly. However, any existing contamination of the areas should be clarified and evaluated before implementation.

The supply of public transport can be considered sufficient, but in commercial areas there is often a reduced supply in the evening and on weekends. However, these deficits can be compensated with measures to promote active mobility. In this way, the scarce but sufficient supply of facilities for health, education and local supply in the surrounding area can also be ensured.

The existing burden of environmental noise should be reduced by the chosen implementation in an existing building. Through which a sufficient shielding of the noise sources can be expected.

4.3.1 Principles of housing environment

The industrial building is in an area of industrial and mixed-use in an intermediately densely built area in the outskirt districts of Vienna. The network of streets is wide-meshed, pedestrian distances rather long to urban infrastructure, places of daily use, and parks. Parks of intermediate size are within a 1,2 km beeline. The network of bike infrastructure is mostly constituted of infrastructure on the road, in some cases, there are independent bike lanes.

The built area of the surrounding includes industrial buildings, residential buildings that were built from 1960 on, and residential areas of lower density with gardens. The FAR is of maximum 2,0.

4.3.2 Communal facilities and communal open space

The factory in which the housing environment is set up is placed on a square plot (approx. 10.000 m²) that is bounded by two streets in the North and South. As is typical for an industrial area, the area is paved. The plot is delimited by a fence with two entrance gates. In addition to the present vegetation (trees on the North and South side), mobile equipment and vegetation are applied.

The communal used open space contains various zones to be used for different uses. Gathering areas with seats, a silent area where calm and relaxing uses can be carried out and play area for children. The paved area that is not dedicated to any use can be appropriated by the residents according to their needs and preferences (Figure 31).

Figure 31: InFactory – Site zoning plan[29]

Selected areas get greened by rolled out turf (e.g., grass-herb-mixture[30]) that is put on top of a layer of suitable substrate that retains water and nutrients and allows the turf to flourish. If wanted by residents and holders, this flooring can be extended and applied in other areas as well. Since the present open space does not offer any equipment, mobile equipment for the communal and recreational uses must be brought on site: playground equipment, bike stands,

[29] Drawings by Stocker based on Bertino
[30] e.g., https://schwab-rollrasen.de/garten/rollrasen/2438/graeser-kraeuter-rasen, Accessed: 1.3.2021

tables, chairs, benches, loungers, and mobile green infrastructure. Over 30 trees in plots are placed in the communal gathering area and silent area, shrubs in plots provide additional greenery and function as division between areas. In the cultivation area (of around) high raised beds for gardening are applied.

The bike parking is organized by bike racks under a covered roof (bike carport). There is one spot per person.

Since for the duration of the housing environment, the building's only use is housing, there are no open spaces of areas with mixed use. The whole plot is lockable with gates, residents have keys for the gate.

4.3.3 Private and semi-private open space

In the open space, in proximity of the residential units there is space provided for private appropriation. The big windows allow an informal, more direct access to those spaces. Additionally, there is another area provided for domestic activities that can be appropriated independently.

The residents have the possibility to take responsibility for high raised beds and cultivate vegetables, herbs, and ornamental plants there. The size of the assigned area depends on the number of residents participating and personal preferences. The minimum bed size that is assigned to a resident is 1 m². A water intake must be installed close to the beds, as well as a shed to store tools.

Figure 32: Examples: High raised beds for food production[31]

4.4 ARCHITECTURE

This chapter concerns the architectural 3D modelling of the InFactory design, created mainly based on diverse design drafts by the students of the TU Wien architecture faculty Tina Tasevska and Antoni Dimitrov. The main idea of "Life Sharing to go" is to implement the

[31] https://urbanes-gaertnern.at/Veranstaltung/urban-gardening-jour-fixe-1-2018/, accessed 26/01/2021

concept of communal living within vacant or unused industrial buildings. Units of different sizes can host from 2 to 4 people. The open space surrounding the building can be accessed from the ground floor and is intended for communal use of all residents. The project focuses on establishing a caring environment that allows people from different cultures and lifestyles to share their experiences and socialize. To accomplish this, an attraction common space as well as private units where people would be able to retreat and enjoy their privacy. The units are meant for different user groups, leaving enough space for accomplishing the goal of socializing. With their flexibility, adaptability and sustainability, the housing units allow stepwise extensions of modules depending on the number and type of users (single, couple, family), starting from a base modular unit, and allowing the possibilities to create different spaces of variable size appropriate for the different needs (Tasevska and Dimitrov 2019).

4.4.1 Architectural design

In the present application, there are different composition of units, based on the module 3,60 x 1,20 m:

- 2-bedroom-unit with service module
    a. 4 units at ground floor
    b. 4 units at exemplary floor
- 3-bedroom-unit with service module
    a. 4 units at ground floor
    b. 8 units at exemplary floor
- 4-bedroom-unit with service module
    a. 4 units at ground floor
    b. 4 units at exemplary floor

The below drawings show the overall ground floor plans (ground floor and first floor) and the unit ground floor plans (Figure 33 and Figure 34).

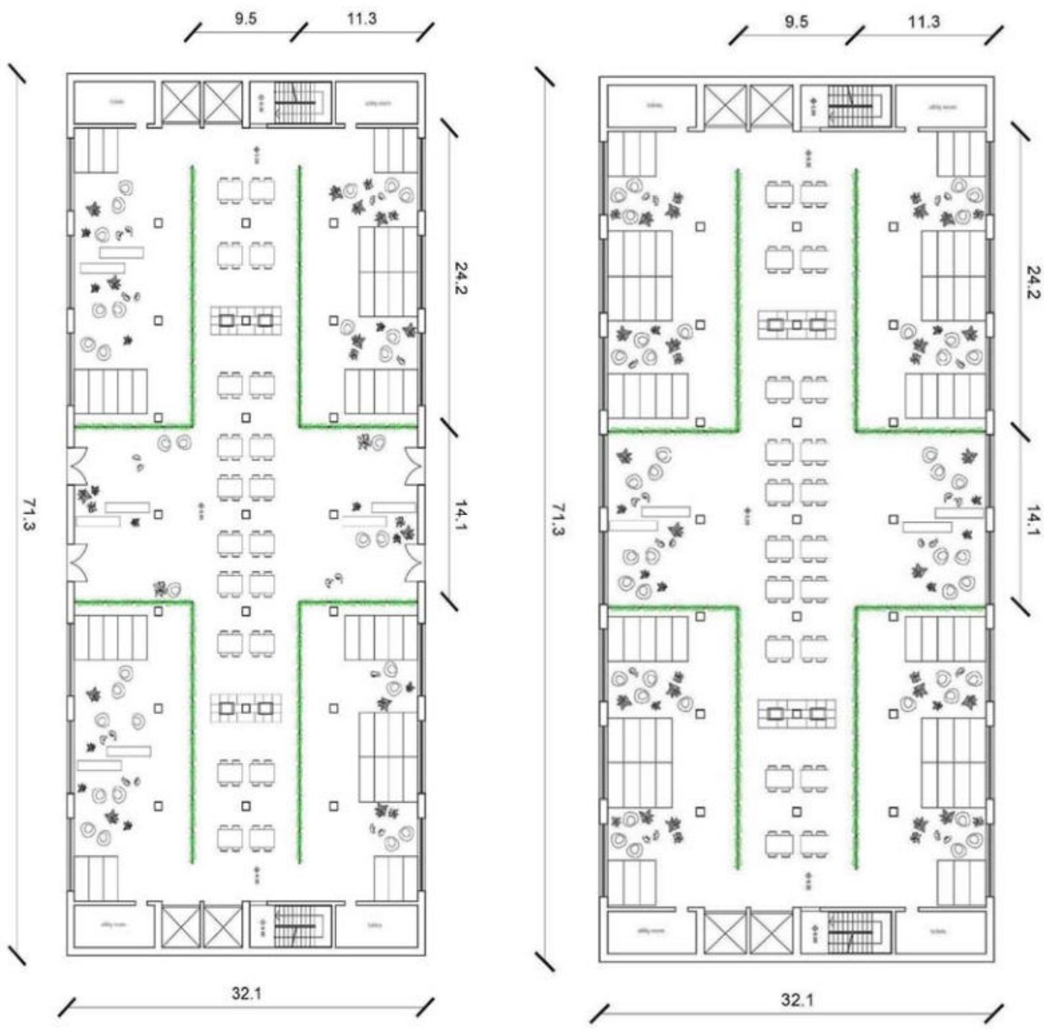


Figure 33: InFactory – Ground floor plans[32]

Figure 34: InFactory – Unit ground floor plans[33]

[32] Drawings by Bertino
[33] Drawings by Bertino

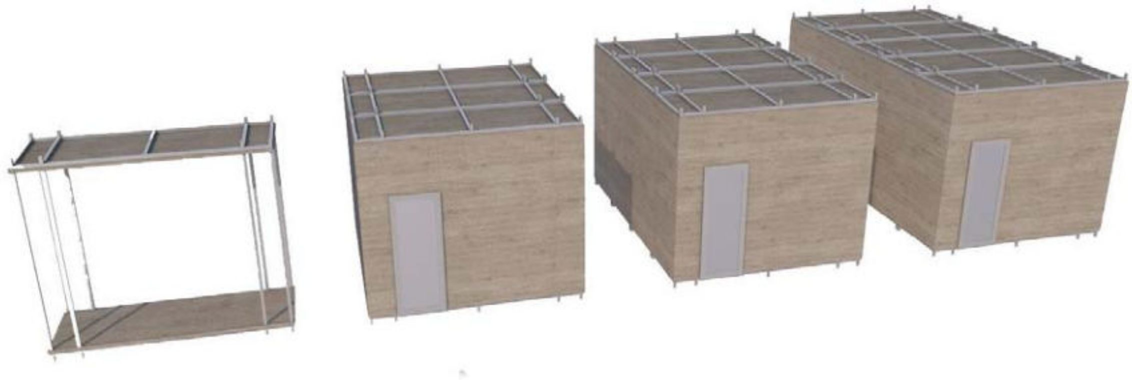


Figure 35: InFactory – Composition of units[34]

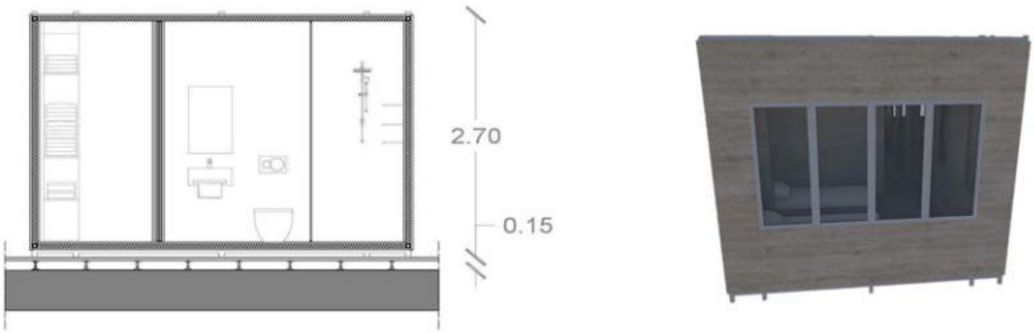


Figure 36: InFactory – Section of bathroom module and side view[35]

4.4.2 Components and materials

Main materials and structure

The overall structure consists of an aluminium frame, thermal and acoustic insulation, interior wall panels and furniture and exterior wall panels. The assembly is carried out by single joints for easy construction and de-construction (Figure 37).

[34] Drawings by Bertino
[35] Drawings by Bertino

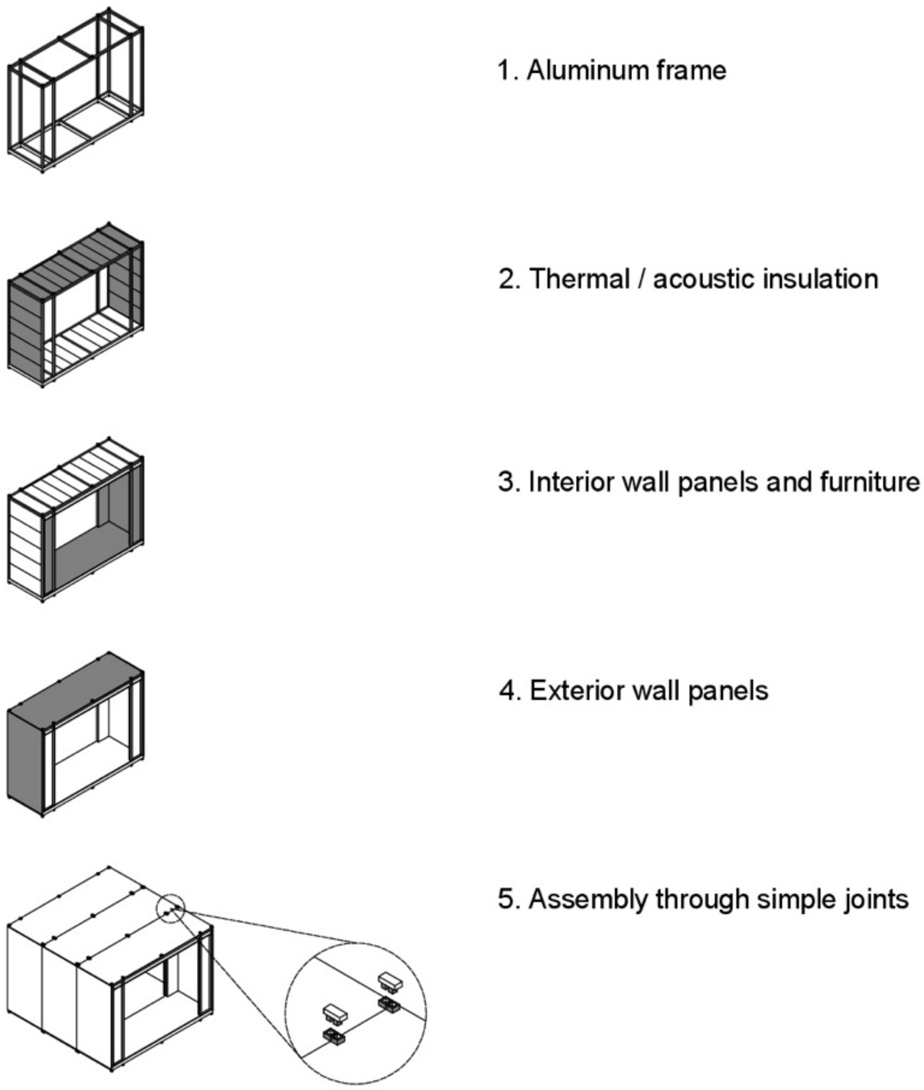


Figure 37: InFactory – Mounting of the unit[36]

Floating floor with heating system

Instead of heating via infrared panels, a floating floor will be realized, with an integrated heating system made with dry techniques (without the use of binders). This follows the overall concept of de-constructability so that the units can be re-used multiple times (Nesite 2021).

[36] Drawings by Tasevska and Dimitrov

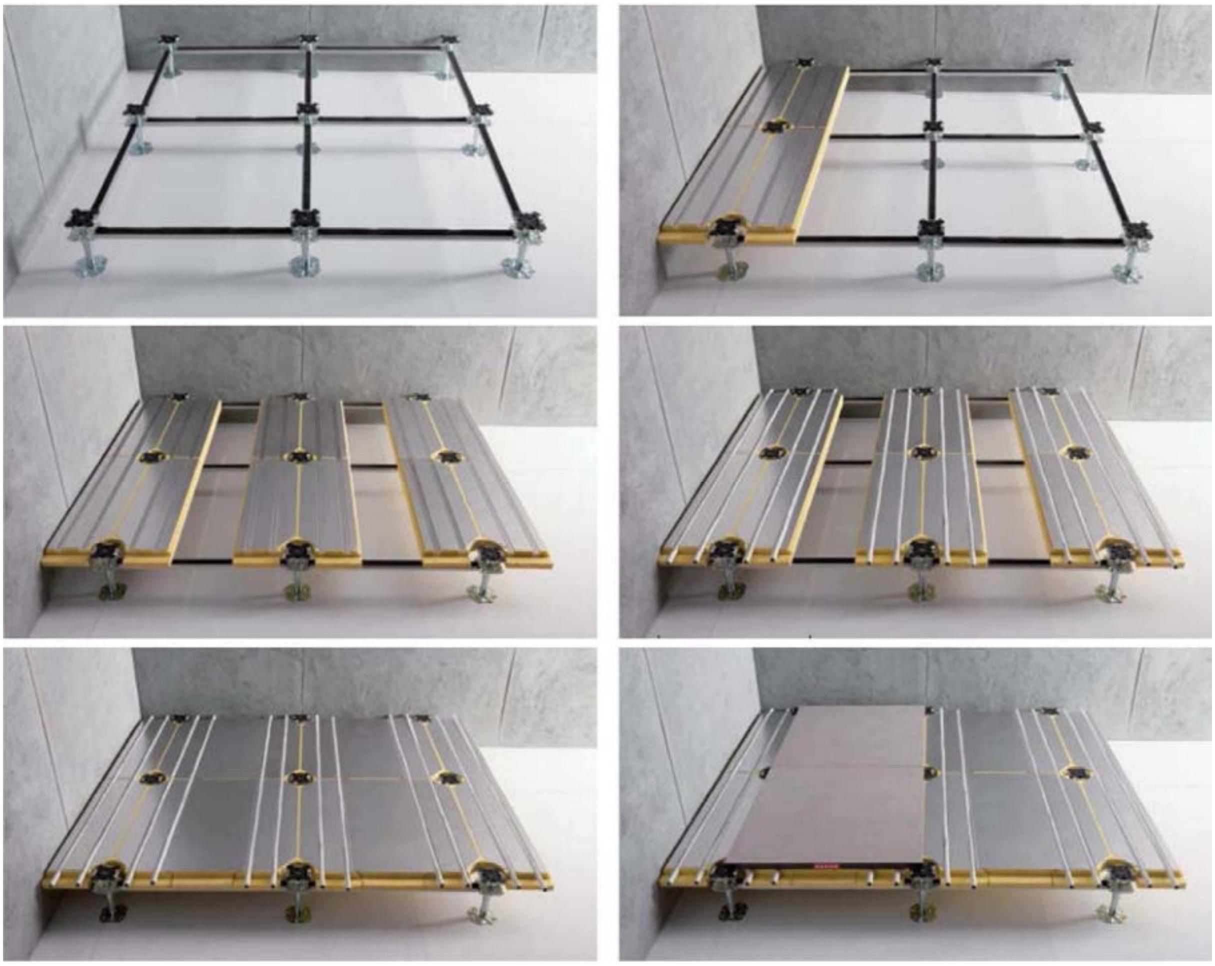
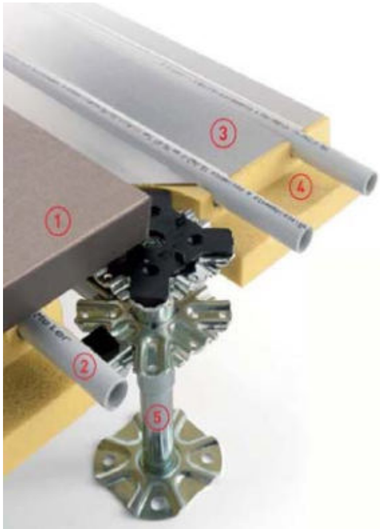


Figure 38: InFactory - Floating floor with heating system mounting phases[37]

The floating floor system is explained in detail in Figure 39 (Nesite s.a.):



(1) *Removable modular finishing panels that make up the walking surface;* composed of core of various materials (inert and inorganic), very high density and finishing materials that can be among the most varied (ceramic, natural stones, carpet, vinyl, plastic laminate)

(2) and (3) *Patented radiant system* which, in combination with the thermal insulation system, allows diffusion towards the room to be air-conditioned.

(4) *Thermal insulation*

(5) Special structure that guarantees the joint *elevation of the thermal insulation system* and of the finishing panels allowing total accessibility to the underfloor plenum.

Figure 39: InFactory – Floating floor with heating system / structure[38]

[37] source: https://www.nesite.com/en/

[38] source: https://www.nesite.com/en/

The use of the floating floor will also allow to realize the wastewater piping system in its empty spaces (assuring manageable maintenance operations, thanks to the dry technology that allows easy demounting operations).

Figure 40: InFactory – Floating floor detail[39]

The floating floor is extended for 1920 m² in each floor. The floor is made by a basic constructive frame of 60 x 60 cm where there are: 4 metal beams, 4 aluminium feet, 1 0.36 m² of heating system floor (composed as mentioned above). From the basic constructive frame is possible to calculate the materials quantities of the entire surface.

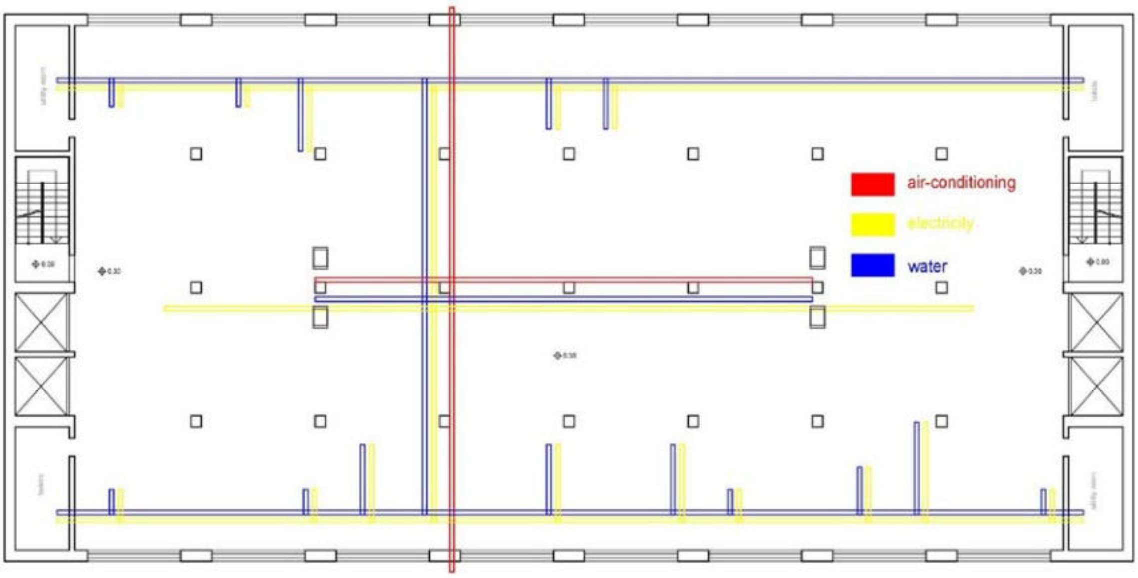


Figure 41: InFactory – Piping system plan[40]

The possibility of realizing the living units in a double-storey system was evaluated, with the idea in mind of making good use of the high ceiling heights of the halls. However, that would entail several issues, especially regarding stability, since the use of a heavy metal frame that

[39] Source: nesite.com
[40] Drawings by Bertino

can adequately support the loads must be applied. In this version is not possible to have a floating heating floor because of the realization of the structural frame that needs to directly touch the old fabric floor, and moreover, this version would require a lot of additional resources. Therefore, the living units will be implemented with only one floor.

4.4.3 3D visualisation

Figure 42 and Figure 43 show the layout and subdivision with the individual living units close to the hall windows and communal areas and kitchens in the inner hall areas.

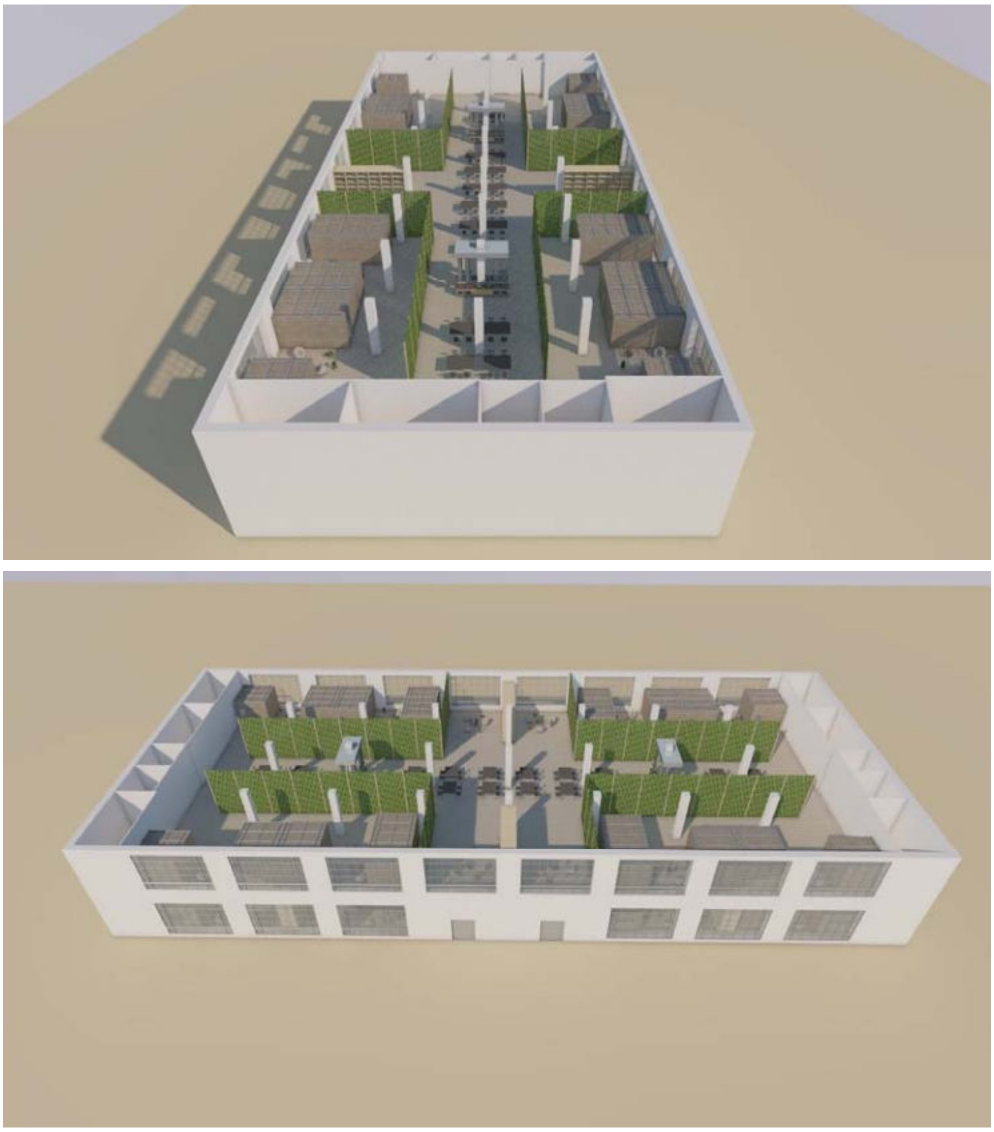


Figure 42: InFactory – Sectional renderings[41]

[41] Drawings by Bertino

Figure 43: InFactory – Internal renderings[42]

4.5 TECHNICAL AND RESOURCE ASPECTS

4.5.1 Energy concept

The following assumptions were made for the selection and design of the technical infrastructure.

- Year-round operation is assumed.
- It is assumed that the building is connected to the electrical grid.
- Due to the fact the building is not designed for residential purposes, some challenges arise, especially in the winter months.
    a. Only floors where the ceiling does not border on the outside air should be used for residential purposes.
    b. Particular attention is paid to places where condensation of warm indoor air can occur.
    c. The pipes for domestic hot water distribution should be kept as short as possible.
    d. The storage of biomass for heating is positioned on the ground floor.
    e. If possible, from the building statics, a PV system will be installed.

Specification of the technical systems

Heating: To provide the large amount of heating energy, a container with a wood chip plant is installed.

Domestic hot water: Hot water is provided by the wood chip system in winter. Due to the low power demand in summer, the hot water is generated via a PV system with Electric Cartridge in the hot water tank during this time. A thermal solar system is not installed due to its greater weight. In times with insufficient solar radiation, the hot water supply is provided by the existing wood chip system.

Electrical supply: It is assumed that an existing hall is already connected to the electrical grid. Due to the high electrical energy demand, which is caused to a large extent by the choice of the technical infrastructure, a PV system is installed.

Electric building systems: Due to the different technical systems, a building management system is installed.

[42] Drawings by Bertino

Ventilation system: For reasons of energy efficiency and justified by the different uses in the large common area, a ventilation system with heat exchanger will be installed.

4.5.2 Water and sanitation concept

For “Life sharing to go” an existing industrial or commercial building is appropriated for a temporary housing environment. Therefore, it can be confidently assumed that the facilities will be connected to the centralized water supply and sewage system of Vienna. To make best use of already existing infrastructure, the existing water and sewage connection will be used. This therefore means that the individual living units have to be connected to the existing pipe network.

The communal kitchens and private bathrooms have to be supplied with drinking water. A floating floor is constructed to provide a floor heating system, but it also allows the installation of water and wastewater pipes. Maintenance shafts must be accessible in case of pipe ruptures or other issues. The wastewater pipes will lead the blackwater into the sewage system of Vienna. Vacuum toilets which require less water for flushing can be considered.

Additionally, irrigation water is needed for the raised plant beds and the rolled turf. A rainwater collection system is therefore implemented. It can be assumed that the roof of suitable industrial and commercial buildings is reasonably large, and a rainwater collection tank can be installed on ground level, with a sufficiently large discharge valve for the first flush. However, this must be coordinated with the PV system, that might be installed. The rainwater collection tank needs to be sufficiently sized, so that rainless periods can be bridged, and no drinking water needs to be used for plant watering.

4.5.3 Resource concept and waste management

A key aspect of InFactory is to utilize vacant buildings. In this way, existing building structure is continued in use and significantly less material is put into the design and construction of the actual living boxes, as the building envelope already exists and provides protection against natural forces such as rain and wind. As a result, the residential boxes can have a simpler structure than if they were located outdoors and thus, less material must be consumed. When procuring materials, preference should be given to local materials or second-hand materials. The use of standardized elements, such as for the floating floor, allows for wear-free removal when the temporary housing environment needs to be dismantled.

In addition to resources needed for the living boxes, this housing model also focuses on working, crafting, and learning together. Working materials should be procured from second-hand markets. Workshops and trainings for upcycling and closed-loop thinking can accompany the process and facilitate the co-learning aspect.

Solid waste

The temporary housing environment is implemented within the city of Vienna, therefore also the solid waste management system will adhere to the Viennese system and consists of both a curb side system (residual waste and paper) and a bring system for recyclables. If the property is not part of a conventional collection route (this could be the case as it is located on an industrial site and therefore serviced by companies for commercial waste), an agreement must be made with MA48 (responsible for Vienna's household waste). Kitchen waste and green waste from gardening initiatives are suitable for creating an on-site composting system. The generated compost should be used as soil fertilizer in on-site gardening initiatives.

4.6 NICHE EXPERIMENT

Life sharing to go as a hybrid between transition and grass-roots experiments.

[The content of this chapter is taken directly and abbreviated from the paper: The Learning City: Temporary Housing Projects as Urban Niches for Sustainability Experiments by Gloria Rose, Mirjam Stocker, Michael Ornetzeder, Sustainability 2022, 14(9), 5198; https://doi.org/10.3390/su14095198]

The experiment strives to enhance capacity for inclusive, integrated, resilient and sustainable urban living. Inhabitants are actively engaged in shaping their living environments in context of more sustainable lifestyles characterized by communal living, waste prevention, recycling, and reuse. A particular focus of Life Sharing to go lies in the integration of individuals who find themselves in a phase of transition, seeking to build and maintain a community. These aims correspond with the Sustainable Development Goals SDG 11 (inclusive development of cities and communities) and SDG 12 (responsible consumption and production).

The initiators and coordinators of the project are made up of individuals from government, research institutions and NGOs. The research team should be interdisciplinary, possessing competence in social science methods, with expertise in organizing participatory processes. Given that the target group involves individuals with limited options regarding housing, much care must be taken that participation is optional, and the expertise of social workers should inform the involvement of these individuals. Inhabitants must be able to end their participation during the duration of the experiment without facing uncertainty regarding housing.

This experiment attempts to capture elements of the grassroots spirit, introducing a sandbox component within the Life Sharing model where inhabitants can freely create and shape, led by their own needs and creative energy. More specifically, “Life Sharing to go” contains a strong do-it-yourself building and self-organization approach, allowing for the generation of novel bottom-up solutions and learning-by-doing. The experiment will provide space in the form of the industrial building with all necessary fixtures and resources made available. The project also provides flexible modules for both private units and for communal units, which can be rearranged to serve a multitude of different purposes, such as creating spaces for living, for relaxation, for doing group or sports activities, pursuing creative or educative activities and more. The inhabitants are given complete control over these multifunctional modules, restricted only by the given infrastructure which predetermines the arrangement of the private units, the bathrooms, and the kitchen appliances. The modules themselves are also predetermined to a certain degree to ensure the stability and safety of construction. The role of the research team is restricted to introducing the project, managing the available resources, organizing workshops, serving as contacts for inhabit-ants and monitoring developments to ensure safety and well-being.

The project consists of the following phases: recruitment, planning, construction, housing, deconstruction, and assessment. It is to be assumed that alterations and rebuilding activities will also take place during the housing phase. During the planning phase the project members partake to provide information and provide guiding information on possibilities and limits and a small number of practical workshops are organized for the participants to acquire and learn new skills related to building. During the construction phase the activities must take place under supervision of professionals to minimize the risk of injury and ensure the safety of the constructions. During the housing phase the members of the project team take turns to regularly visit and monitor the site. To ensure the well-being of the inhabitants, a house manager is assigned. Deconstruction again takes place in the presence of professional supervision.

This experiment is explorative in nature, making it difficult to predict the development and requiring much flexibility from the project team. Near the end of the experiment interviews are held with the inhabitants, exploring in greater depth how they experienced life within Life Sharing to go and elaborating on questions of community-building and integration, decision-making processes, and the challenges they encountered.

4.7 INNOVATION ASPECTS, CRITICAL ISSUES AND OUTLOOK

“Life Sharing to go” provides a frame, space and materials for participants to create and explore new forms of living and interaction. This provides the possibility to develop alternative ideas of how sustainable living can be organized. The experiment design should therefore be as open as possible and include a strong co-creation aspect, with participants being empowered to initiate and carry out their own activities. In this way innovative variety and alternative pathways for sustainable and communal living through a do-it-yourself approach can be explored. It can also be explored how the modular way of building can allow for adaptations over time, making it possible for the living environment to grow and adapt to the needs of the inhabitants (flexibility, adaptability). It is feasible to conceptualize “Life Sharing to go” in a way, where inhabitants can learn new skills related to sustainable living and building, and even provide goods or services to generate income.

The reuse and recycling of the materials also presents an important aspect which can be investigated. The available space could be used for a variety of projects, such as urban gardening or a resource metabolization hub.

An interesting example in Vienna, that shares some conceptual ideas with InFactory is the initiative Garage Grande in the district of Ottakring (Garage Grande 2021). An above ground multi-storey car park that has been decommissioned is temporarily used as a neighbourhood centre for 3 years. Whilst Garage Grande is not used for temporary living, there are similarities in the social and communal interactions and activities that are to be facilitates or for which a space is to be provided and implemented by the users. According to Garage Grande (2021) it should be a space for building furniture, repairing bicycles, planting vegetables and herbs, even beekeeping and many more. The objective is to improve the microclimate in the neighbourhood and district and promote social cohesion and integration together – thus creating a good climate at all levels. The large open spaces that result from the fact that it was formerly used as a multi-storey car park are also quite comparable to the floorplan of halls used in InFactory and can be flexibly adapted to the needs of the users.

Figure 44: Already existing examples in Vienna concerning similar aspects: Garage Grande, 1160 Wien[43]

The interdisciplinary team also conducted a SWOT-analysis for this scenario, which is summarized in the following table. The matrix shows the main strengths (innovations), weaknesses, opportunities and threats (risks). For additional risk considerations please see Deliverable D5 (theoretical risk assessment report).

Table 14: Life Sharing to go / InFactory – SWOT analysis

SWOT: Life Sharing to go / InFactory	
Strengths - Use of existing structure - Integration model (user groups) - Relatively simple reuse of modules - Potential for participation	**Weaknesses** - Preliminary phases / extensive pre-check (planning, checking safety agendas (statics, fire safety, accessibility, potential site / house contamination, aeration ...) - Low privacy, increased conflict potential - High fluctuation of users - Much ongoing support is necessary - High energy consumption for heating
Opportunities - Learning / income opportunity for users / residents - Higher autonomy and shapeability due to self-reliance (self-construction) - Upgrading of the area, increasing security of neighbourhood - Development of a community (provided there is sufficient opportunity for participation)	**Threats** - Location with limited infrastructure / accessibility / connection / infrastructure - High noise pollution (industrial area) - Lack of availability / willingness - Lack of follow-up options for users - Increased risk of exposure to substances hazardous to health (e.g., mould in winter months)

[43] Tim Drnaus, https://www.gbstern.at/themen-projekte/garage-grande/

5 GAP MODULE / GAPSULTELY FITTING

5.1 SCENARIO DESCRIPTION AND RELEVANCE FOR VIENNA

In “Gap Module” the pop-up environment is placed in a building gap, a vacant lot between buildings in a residential area, until a new designation is provided for the area. To adapt easily to the layout conditions of the plot, the temporary structure is made of modular components, made from prefabricated elements and designed to endure several mantling and dismantling operations. The modules are transported via trucks on site and are assembled with mostly dry techniques by mobile cranes. Only the foundation also requires the use of cement. Mantling and dismantling operations should take approximately three months each, not exceeding a total period of six months. The assembled units are used for living about five years before they are dismounted and placed into storage or directly reused/rebuilt on other locations until being recycled during their disposal phase. As the plot is within the urban grid, a connection to the existing water and wastewater, electricity and waste management facilities is assumed. Modular green facades and if possible green roofs are applied in order to prevent the increase of urban heat islands. This scenario is designed to accommodate a mixed user group of college students and migrants aged between 18 and 30 years, in order to promote social integration.

The housing model Gapsolutely fitting, that has been chosen for this scenario is a modular building that is placed on a corner lot, bordered by two plots which are part of a perimeter block (Blockrandbebauung) (they cover the whole width of the unit (grenzständige, geschlossene Bebauung) directly border the street). The building is around half a meter higher than the street level and contains community rooms on the “ground floor” that can be used by the residents and people from the neighbourhood and the city on special occasions, such as workshops or other events. On top of that, there are three floors with residential units housing 44 people in 18 apartments. The apartments include one to three beds and individual bathrooms and kitchenettes (to be shared only with flatmates). Gapsolutely fitting is intended for young adults, not necessarily for families with children.

Since no explicit figures are available on the extent and duration of building gaps, the potential of building gaps and their availability cannot be estimated. Nevertheless, the Gap Module scenario can be seen as a possible tool in urban planning that can meet temporary needs while remaining open to future demands. The use of building gaps is considered resource efficient in terms of the use of land and existing infrastructure.

5.2 USER GROUPS

To promote social integration, the resident mix consists of students or individuals in higher education, individuals with an interest in intercultural exchange and sustainability projects, refugees with approved asylum, and individuals affected by homelessness or long-time unemployment. The users are therefore made up of a mix of User Profile B and User Profile C (the user profiles are detailed in Deliverable D1). Seeing as the private rooms are very small, the model is well-suited for childless individuals. No barrier-free access is given for people with disabilities in mobility, as the building is a multi-level structure, and no elevator is constructed due to high costs.

Some of these users have limited options regarding housing, and much care must be taken to ensure that participation is optional. The expertise of social workers should inform the involvement of the participants. The duration of residence and stay of the building would ideally span about 5 years.

Certain community spaces, especially on ground floor level are designed to be available for both residents and non-residents for activities or events, making Gapsolutely fitting a neighbourhood hub for specific functions and interactions. This creates a pace where different groups of people can come together.

5.3 SPATIAL PLANNING

The use of vacant building land is advantageous from the point of view of spatial planning and landscape protection. By using vacant building land, there is no expansion into green spaces or the use of ecologically valuable areas. In addition, building land areas usually have good accessibility and supply with central facilities.

5.3.1 Principles of housing environment

The supply with public transport and facilities for health, education and local supply in the surrounding area can be assumed to be very good and can cover the needs of all user groups. Likewise, the conditions for active mobility are very good. The areas are well suited due to their general suitability, especially regarding the slope. This means that barrier-free access to the ground floor areas can be ensured. The areas are also easily accessible for assembly and disassembly. However, the building ground should be clarified and evaluated for existing installations or building remains and the load-bearing capacity before implementation.

Exposure to ambient noise is equivalent to that of residential areas. The selected design should ensure compliance with the limit values.

The housing environment is placed in a central location with intermediate building density (FAR around 3,4).

5.3.2 Communal facilities and communal open space

The elongated plot of approx. 850 m² is placed on a street crossing with two sides facing the street. The (semi-covered) open spaces facing the street are accessible to residents and visitors (participants of workshops, etc.), whereas the inner courtyard is only accessible to residents. The rooms on the ground floor are accessed via stairs resp. a ramp, the residential units are accessed via a lockable staircase. The inner open space can be accessed via the building (doors next to staircase) or via the vehicle entrance in the North.

The building bounds the inner courtyard, leaving two accesses in the North (pedestrian, wheelchair users, and vehicles) and the South-Eastern corner (pedestrians and wheelchair users only). The open spaces towards the street are covered by the upper floors of the building and partly raised (access via steps and ramp). Various plant pots with climbers' function to green up the façade (9 pots) towards the East and South. In this area, there are also two benches that offer visitors, neighbours, and residents the possibility to stay and chat. The mailboxes and intercom system are also located here. If desired, other community services, such as public bookshelves, may be located here.

The area that is bounded by the buildings has a spacious terrace (120 m²) and a green area (75 m²) on the ground level. In this courtyard, there is also a bike storage room (30 pitches) and a garbage room that are accessed via a gravel road in the North (wassergebundene Decke), still being stable enough for easy handling of waste containers in accordance to respective guidelines (Stadt Wien and MA 48 2016). In contrast to the spaces towards the street, this area is only accessible to residents (and their guests) since it is closed with doors or a gate. The terrace is made from timber wood slabs and has various seating options (benches and tables with chairs).

Along the green area, there are two lines of high raised beds that can be cultivated by the residents. On the terrace, there are mobile plant pots for the same purpose (11 pots). There is also a composter and water connections to facilitate garden work. Equipment can be stored in the storage room that is accessed via the terrace. Several potted trees are distributed on the lawn to create shade. There is a mobile barbeque area that can be used by residents. Seating areas with chairs and tables are on the terrace. The entire open space is also wheelchair accessible since there is a ramp and an entrance on the ground level.

In addition to these shared open spaces on ground level, there are further semi-open spaces on the upper floors: external footbridges towards the Southern Street and two shared terraces of around 50 m² and 120 m² on the three upper floors; all these spaces are roofed but have natural ventilation.

Gapsolutely Fitting: Plan of zones of ground level

<u>publicly accessible area, useable by neighbors and workshop participants</u>
- entrance area – encounter, shelter, waiting
- forecourt – encounter, exchange, stay, linger

<u>area accessible for residents of the housing project</u>
- terrace – sojourn, staying longer (sitting, eating,)
- grass area – sojourn, staying longer (play, barbecue)
- gardening (beds, pots, compost, water intake) – produce, activate, learn, gain experience
- graveled path – access, possibly repairing, playing, etc.

- plot'sbuilding
- plot borders

13.04.2021

Figure 45: Gapsolutely fitting – Site zoning plan[44]

[44] Drawings by Stocker based on Bertino

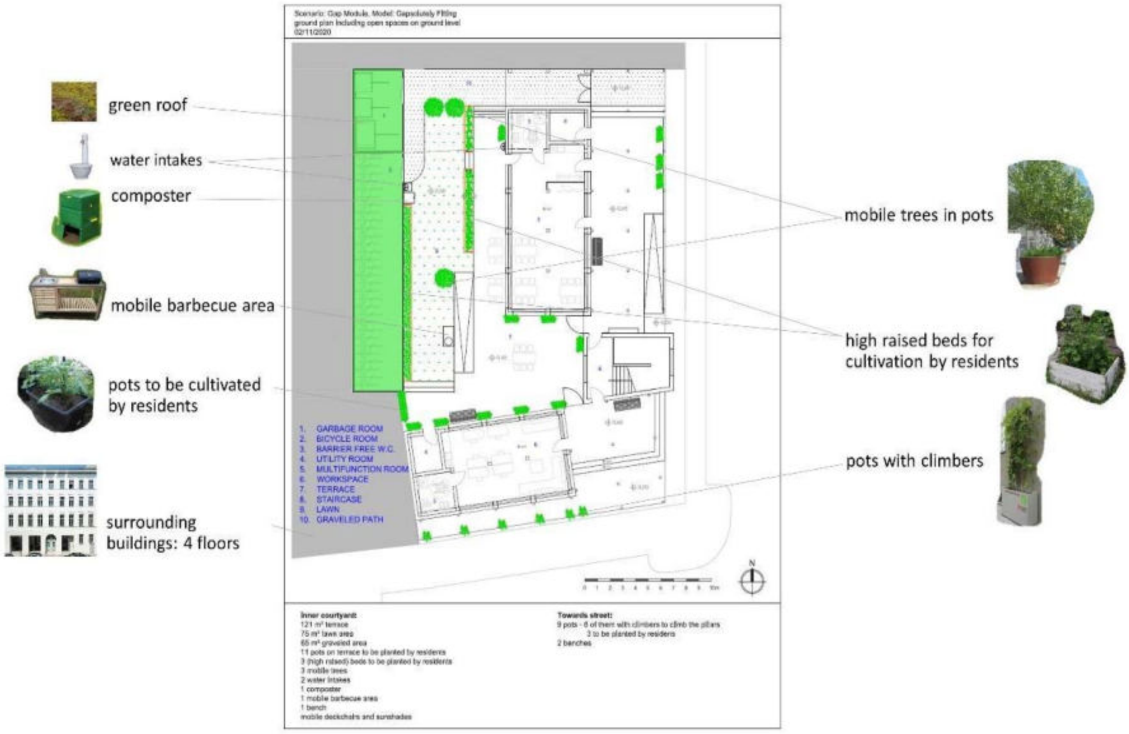


Figure 46: Gapsolutely fitting – Landscape plan[45]

5.3.3 Private and semi-private open space

Each unit has a private loggia of 3,3 m² (1,20 x 2,75 m). They are oriented towards the inner courtyard which provides a greater amount of privacy than the access pathways facing the street. In this application, the loggias are oriented towards the West and North receiving sun light in the mornings and during the day. The loggias are directly connected with the apartments. On the first and third floor there are larger apartments with two loggias. Depending on the number of residents, the private open space they provide is 1,1 to 1,65 m²/person. Since the residents have the loggia at their own disposal (to be shared with partner or flatmates), appropriation is facilitated.

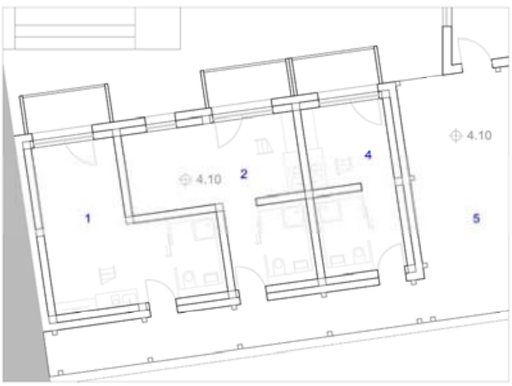


Figure 47: Gapsolutely fitting – Private open space[46]

[45] Drawings by Stocker based on Bertino
[46] Drawings by Bertino

5.4 ARCHITECTURE

This chapter concerns the architectural 3D modelling of the Gapsolutely fitting design, partly based on the design drafts created by the students of the TU Wien architecture faculty Friedwagner and Prömpers. With the architectural proposal of Gapsolutely fitting, the students intended to provide a comprehensive solution for temporary living quarters constructed on transitionally available building gaps in densely populated areas. Due to the temporary nature of the housing model, short assembly times are essential and the whole building must be deconstructable without major material wear. To facilitate easy adaptation of the module to different plots, a small constructive grid of 3 x 3 m was chosen. This grid is the main constraint for the prefabrication of a set of small construction elements that provide flexible solutions for different living constellations through variable configuration of the standardized components.

This construction method is furthermore very suitable for the task at hand because the compact elements can be stored and transported with minimal consumption of space. Another great advantage is that these parts can be prefabricated and maintained by small local companies. As opposed to fully factory fabricated room modules, the construction elements can be assembled on any available site, without oversized trucks and heavy-duty cranes. Furthermore, no scaffolding is necessary during the assembly. The load bearing construction consists of wooden columns and cross laminated timber ceiling plates. The connection points are executed through steel elements with simple nut and bolt fixation, thus being also easy to take apart at the end of use.

With these elements, modular living blocks of variable size and height can be developed. All apartments are entered through an access balcony. Outside of their constructive grid every single living block is connected to an external staircase with foot bridges and shared balconies. The combination of building volumes following a strict constructive grid with flexible terraces, balconies and pathways is the conceptional basis for an architectural proposition, that can easily be applied to a vast variety of specific sites, needs and circumstances (Friedwagner and Prömpers 2019).

5.4.1 Architectural design

- Plot size: 850 m^2
- Floor area for residential use: 740 m^2
- Staircase: 136 m^2
- Garbage room: 25 m^2
- Bicycle room: 70 m^2
- Total number of housing units: 18
- People: 44
- Staircase: It can be placed freely on site and disconnected to the dwelling units through a flexible network of balconies and pathways. Prefabricated modules provide short assembly times.
- Communal balconies: They can be placed freely on site and are independent in design from the main construction-grid due to their lightweight construction they connect the pathways and staircases on certain floors.

- Bicycle room: prefabricated area, this frame can also be placed freely on any site.
- Private loggias: every dwelling-units provided 3 m² loggia which shelters the open face of the apartment from weather and increases privacy.
- Flexible access balconies are semi-enclosed with façade panels and connect the dwelling units to the staircase.
- Flexible terraces: a light construction enables the system to adapt to any given site condition and provides an inviting public space to foster successful immersion in an existing neighbourhood.
- Variable apartment settings: the 3 x 3 m construction grid combined with a high degree of prefabrication in small elements allows for the assembly of elements in many different configurations to provide living units suitable for 1-6 people.
- Ground floor communal spaces: to increase privacy, no living units are placed on ground level. This creates the opportunity for ample community spaces that interconnect with the courtyard and provide anything from a kitchen to a co-working space or event rooms.

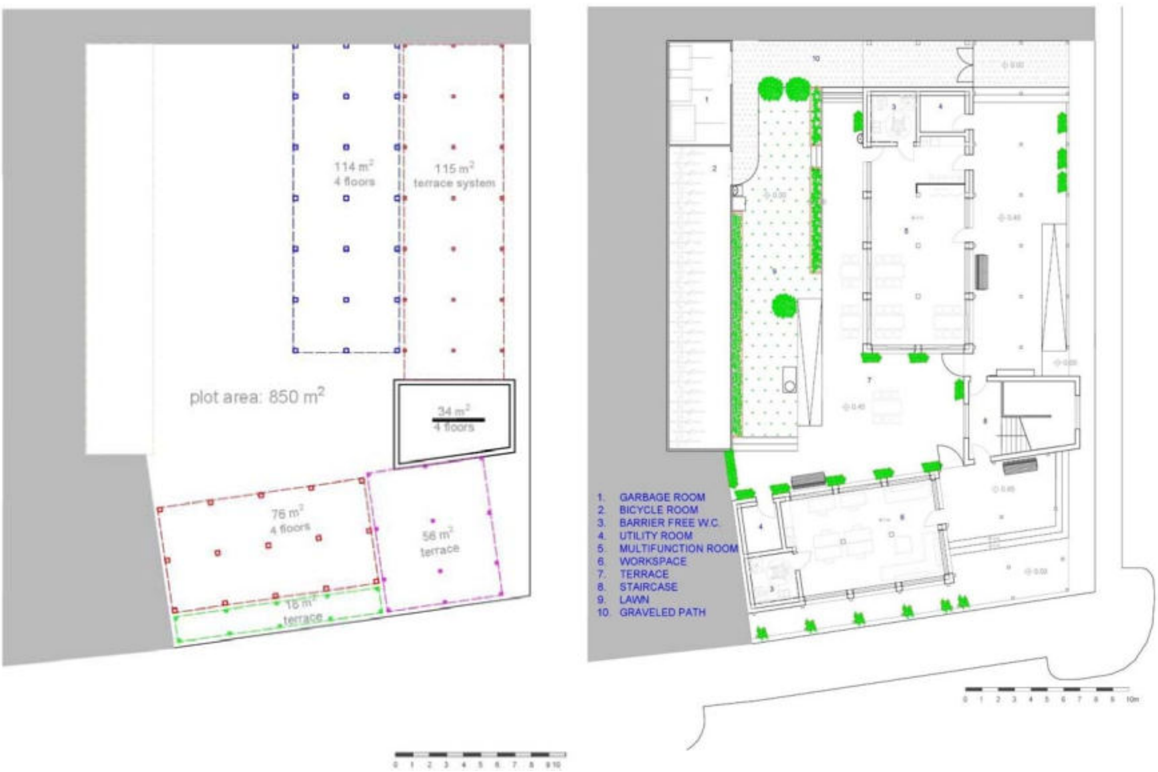


Figure 48: Gapsolutely fitting – Structural plan and ground floor plan[47]

[47] Drawings by Bertino

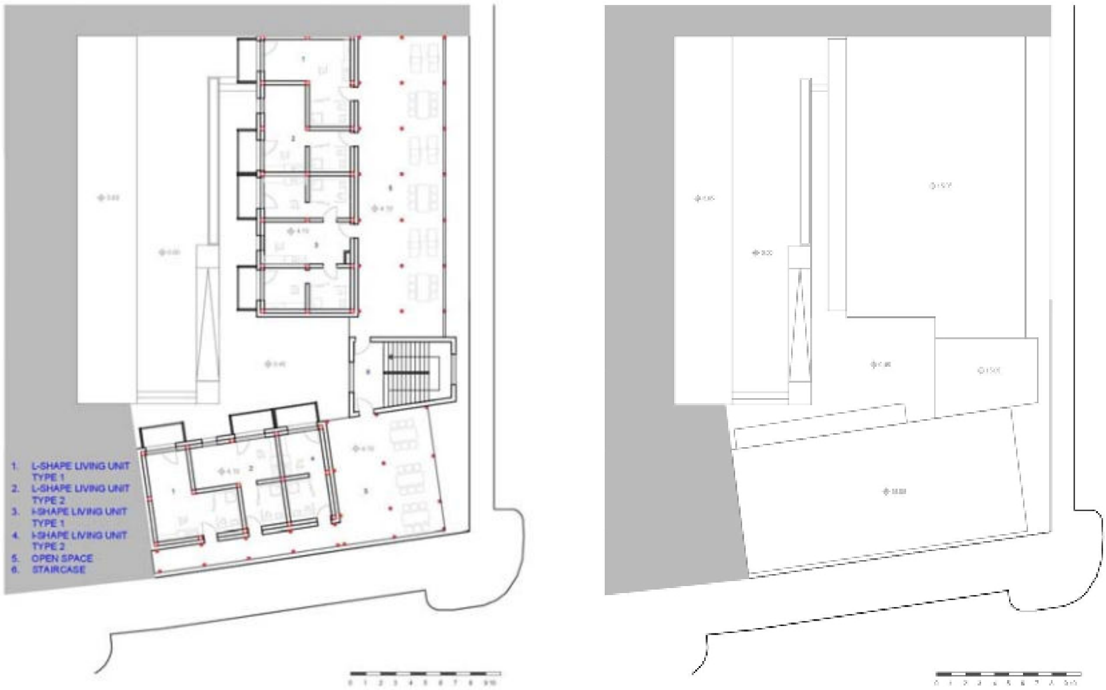


Figure 49: Gapsolutely fitting – Standard floor plan and roof plan[48]

5.4.2 3D visualisation

Figure 50: Gapsultely fitting – External renderings[49]

[48] Drawings by Bertino
[49] Drawings by Bertino

5.5 TECHNICAL AND RESOURCE ASPECTS

5.5.1 Energy concept

- Year-round operation is assumed.
- It is assumed that the building is connected to the electrical grid.
- The prerequisite for the building site is a building gap in the urban environment.
- It is not assumed that a district heating connection is necessarily available.

Specification of the technical systems

Heating: Due to the necessary flexibility regarding the location, an air-water heat pump will be installed.

Domestic hot water: The installed air-water heat pump in combination with an electric heating cartridge in the hot water tank is used for domestic hot water supply. To achieve an acceptable waiting time for the hot water at the tapping points, a circulation line is used.

Electrical supply: It can be assumed that a grid connection is available in the case of a construction gap. To reduce the required grid consumption, due to the systems selected for the heat supply, a PV system is installed on the rooftop.

Electric building systems: Due to the different technical systems, a building management system is installed.

Ventilation system: Ventilation is provided by natural ventilation for cost reasons and for lower operating power consumption. In the wet rooms, the possibility for a controlled exit air flow is created for this reason.

5.5.2 Water and sanitation concept

Gapsolutely fitting is situated in a vacant plot, which is assumed to have all necessary infrastructure connections needed for an apartment house, including drinking water and sewage connection. Therefore, both the water and sanitation concept follow the conventional system that is prevalent in Vienna.

As there are gardening activities on the plot, it is suggested that a small rainwater collection system is installed.

5.5.3 Resource concept and waste management

Large quantities of material are used in this 3-storey building. Security and structural integrity must be always ensured of course, at the same time attention must be paid to the highest possible reusability of the building components. For the foundations and staircase, although they are made of reinforced concrete, solutions should be considered that make reuse possible.

The living units are prefabricated and standardized and should therefore allow for low wear and tear in construction and deconstruction. The living modules are using a nut and bolt system for connection and are not glued, so they should also be easy to take apart again. It therefore should be avoidable that when moving from one location to another, many elements are broken and need to be replaced, allowing for an overall longer lifespan.

Also, furniture and household appliances should be purchased second-hand or from local resources in the first place if possible.

Solid waste management

Gapsolutely fitting will be part of the conventional solid waste collection system in Vienna and consists of both a curb side system (residual waste and paper) and a bring system for recyclables. For residual waste there will be a waste collection room erected in the courtyard next to the bicycle shed allowing easy access for the waste collection personnel.

Gardening activities on-site suggest that a small composter should be installed as well, with residents responsible to observe and manage the composting process. This entails careful management and information about which waste can be composted and providing proper aeration, so that the home composting process is optimized and there is no odour nuisance for the residents. The finished compost should then be used for soil improvement in both the communal green area, as well as the private loggias.

5.6 NICHE EXPERIMENT

Gap module as a bounded socio-technical experiment (BSTE).

[All content of this chapter is taken directly and abbreviated from the paper: The Learning City: Temporary Housing Projects as Urban Niches for Sustainability Experiments by Gloria Rose, Mirjam Stocker, Michael Ornetzeder, Sustainability 2022, 14(9), 5198; https://doi.org/10.3390/su14095198]

The experiment pursues among others the following questions: how small can the private living spaces be (provided there are sufficient shared spaces in context of minimalism and shared spaces as a sustainability strategy)? What kind of integration potential with relation to the neighbourhood do different services, events and activities hold? What does sustainable urban living mean in a densely populated area?

The initiators and coordinators of the project are individuals from government, interdisciplinary research institutions and NGOs. The project team also consists of social workers to ensure the needs of vulnerable inhabitants who have limited options regarding housing are met. No dependencies should arise which could prevent the participation in the experiment and related activities from being entirely optional. The duration of this experiment spans 2 years. For the recruitment of participants, close cooperation with social workers is required to ensure that suitable candidates are found for this type of living. Different recruitment strategies are explored for the different groups in the resident mix. To examine the effects of small private living spaces, the Gap Module accommodates private living spaces of different sizes, allowing for comparisons in frequency and type of use of shared spaces and well-being of the inhabitants. During the housing phase the inhabitants are offered the opportunity to actively engage in and provide services and activities for the neighbourhood to promote exchange and integration. There are four activities which are initiated and organized by the project team, and an undetermined number of additional events and activities that the inhabitants can initiate and develop with the available rooms and resources. A weekly meeting takes place on a voluntary basis to facilitate communication between the project team and the inhabitants. These meetings serve to inform, consult, and make decisions and aim to include all inhabitants. Next to these meetings there are working groups led by project team members and frequented by interested participants with the objective of organizing the activities. These are: an ongoing paid storage service managed by the inhabitants for the neighbourhood; weekly joint cooking and dinner events with the neighbourhood in the community kitchen; creative workshops surrounding sustainable urban living, allowing deeper insight into the “Gap Module” as a sustainability project and providing the possibility to develop and share visions and practical knowledge of sustainable living; and an annual open house event, where participating inhabitants share their experiences with this form of living and results from the urban sustainability workshops can be presented. New working groups for project ideas can of course be initiated by the inhabitants.

It is feasible, that not all offers will be taken up by the inhabitants and that some activities may fail. To assess the different types of activities, the research team will continuously observe their development throughout the housing phase. The neighbourhood response will also be queried to gain insights on what kind of impact the different activities have.

5.7 INNOVATIVE ASPECTS, CRITICAL ISSUES AND OUTLOOK

Gap Module provides a good setting to explore social innovations, involving mixed groups in shared spaces. A fundamental element is the exploration of new forms of living and communication with great emphasis on communal spaces. Next to the concept of minimalism and collectivism as a strategy for sustainability, this model also focuses on possibilities of integrating temporary housing into the neighbourhood and promoting exchange by offering various events or services to the public. New innovative business models could be developed. This model could also host an innovation hub, where material flows can be processed (collection and treatment of old plastic or treatment of wastewater and use of nutrients in urban farming). It can also be expected that much can be learned from the mantling and dismantling operations of this design.

A similar example to Gapsolutely fitting can be found in PopUp dorms in Seestadt Aspern, Vienna (home4students 2021). It is a student residence, which is temporarily located in the urban development area Seestadt Aspern and has managed its first move into a new building gap in summer 2021 without damages. Such temporary uses can add value in terms of flexibility in implementation and use of areas.

Figure 51: Already existing examples in Vienna concerning similar aspects: Moving of Pop-up dorms[50]

The interdisciplinary team also conducted a SWOT-analysis for this scenario, which is summarized in the following table. The matrix shows the main strengths (innovations), weaknesses, opportunities, and threats (risks). For additional risk considerations please see Deliverable D5 (theoretical risk assessment report).

Table 15: Gap module / Gapsolutely fitting - SWOT analysis

SWOT: Gap Module / Gapsolutely fitting	
Strengths - Interim use of brownfields / gaps between buildings - Flexible construction - Familiar residential feeling - Publicly accessible common areas within housing model, openness to the neighbourhood - Central location in developed urban area	**Weaknesses** - High planning and installation costs - High logistical effort for relocation - No elevator - limited user groups
Opportunities - Upgrading of the area - Gathering further practical experience of modular / lightweight construction in dense urban areas (construction, operation, dismantling)	**Threats** - Higher risk of permanent use - Competition for use (e.g., loss of temporary parking space for vehicles) - Lack of land availability / willingness on the part of the owners

[50] Puschögl, https://www.derstandard.at/story/2000128496332/pop-up-dorms-seestadt-ein-haus-zieht-weiter

6 LIFE ON TRACK(S) / TINYTAINER

6.1 SCENARIO DESCRIPTION AND RELEVANCE FOR VIENNA

This scenario includes a variety of application possibilities. The selected housing model consists of an ISO shipping container that is placed on a standard freight wagon, such as "Zweiachsiger Flachwagen für den Kombinierten Verkehr"[51].

A specific application was chosen to show the application in an urban environment: In this case, 10 coaches are placed on a railway or loading sidings. Such a temporary housing model could be applied in the event of a major incident (Großschadensereignis), accident or similar, that cause temporary loss of conventional permanent living space. In recent years, there have been building collapses due to gas explosions or major fires[52], for example, in which the residents needed quick and temporary accommodation.

Each unit houses the residents of the residential unit in the building (each household is given a coach). To house the residents of this building temporarily, the coaches are provided in an area that is well-connected to urban infrastructure and services. In addition to the 10 housing units, a service coach is provided that includes equipment that must be set up on-site (e.g., the stairs) and distributes the services (e.g., electricity equipment). The situation requires fast set-up; therefore, the coaches are brought on-site and immediately the remaining set-up is carried out: terraces are folded out, the stairs attached, and the water and electricity equipment connected.

This scenario represents a very urban-friendly solution for meeting temporary housing needs. During and after the use, the usability of the used areas for their intended purpose is not impaired. The extent of the suitable areas would have to be clarified with the railroad operators beforehand or surveyed in the event of an occasion (i.e., the reason for the specific need).

6.2 USER GROUPS

"Life on Track(s)" can be utilized as temporary housing in context of post-disaster relief for people affected by a sudden unexpected need for housing, for instance following a gas explosion, a flooding, or fire. In addition, "Life on Track(s)" could also be used as temporary housing for workers employed by the national railway company or as temporary housing for festival participants. Depending on the context, the users are made up of Profile A or Profile C. For the pilot experiment, the suitability for use is assessed for a major incident scenario. While Profile A is therefore the target group, the experiment must be conducted with individuals from Profile C, for instance with members of relief organizations such as the Red Cross, volunteer firefighters, or participants of the annual Disaster Research Days of the Disaster Competence Network Austria. "Life on Track(s)" is suited for a 4-person family or group per coach, however, there is no barrier-free access for people with disabilities in mobility, as the wagons are raised, and access is provided by stairs and not ramps. The duration of residence and stay of the building would ideally span between a matter of days to weeks.

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51 https://www.railcargo.com/dam/jcr:8a794421-0d13-4c29-ab8d-6954a0a57c0b/wagen_folder.pdf page 46f; accessed 26.01.2021

52 See https://wien.orf.at/stories/3012330/, https://wien.orf.at/v2/news/stories/2644001/

6.3 SPATIAL PLANNING

The temporary use of sidings basically does not result in any change of use and therefore no conflicts with existing urban planning objectives arise. The use must only be coordinated with the railroad operator.

The provision of public transport can be considered sufficient. Measures for the promotion of active mobility can improve the accessibility of the surrounding area. Thus, the scarce, but sufficient, supply of facilities for health, education, and local supply in the surrounding area, can also be ensured.

The areas are basically barrier-free accessibility, however, the accessibility over the tracks must be ensured by suitable measures. The existing railroad tracks serve for the construction and dismantling.

An increased exposure to ambient noise is given due to the location. Exceeding the limit values cannot be completely ruled out even by the selected design.

6.3.1 Principles of housing environment

In this application the housing environment is put on not-frequented tracks of a loading siding/freight station. Closeby, there are streets of different importance, frequency and allowed maximum speed levels. Bike infrastructure is mostly combined with the motorized traffic. The surrounding includes a variety of open spaces including neighbourhood parks and larger green areas (>10 ha). The surrounding built structures derives from before WWII and has an average FAR of around 1,00 or higher.

Along the segment in which the housing environment is placed, billboards and a vegetation curtain separate the plot from the public open space. The access to the housing environment is facilitated by the communal access towards the plot. 11 coaches provide 10 housing environments and a service coach. The units face the South where a paved area functions as an access area.

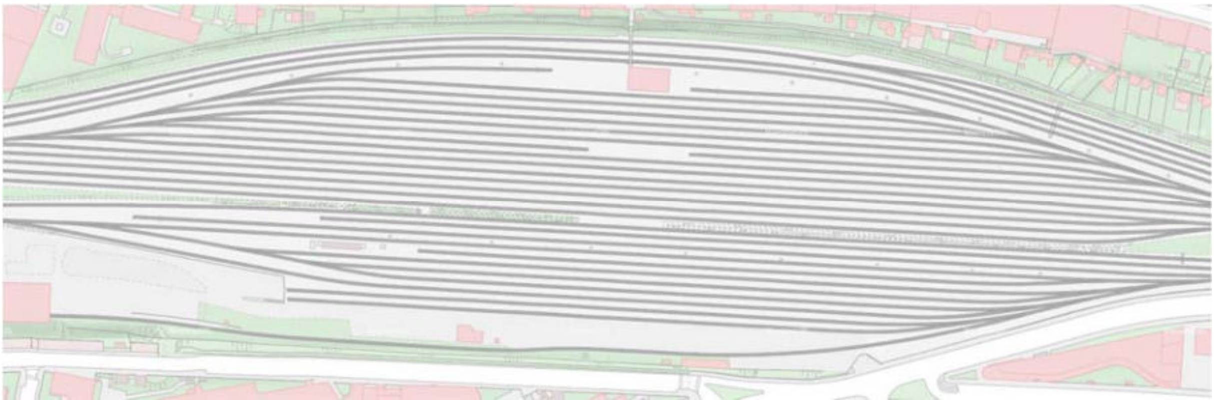

Figure 52: TinyTainer - Exemplary location[53]

53 ViennaGIS, accessed 30/08/2020

6.3.2 Communal facilities and communal open space

The open space depends on the environment in which the coaches are put. The open space functions majorly as an access area. Depending on the duration and season of application, open space equipment and potted plants can be applied.

Only a part of the plot is used for the housing environment, other areas of the plot are of other uses. For security reasons, the area behind the coaches is made inaccessible for residents, since the area may comprise great danger by passing trains, overhead lines, tracks, etc. It is recommended that the tracks directly bordering the housing environment are not used for train traffic to avoid noise nuisance.

Most of the space provided to the housing environment is the paved area in front of the tracks which is used for access and can be used for various other uses (such as playing, etc.) For communal use there is a slightly elevated terrace and a container that provides bike and pram parking. The containers are lockable and provide a secure and weatherproof parking possibility.

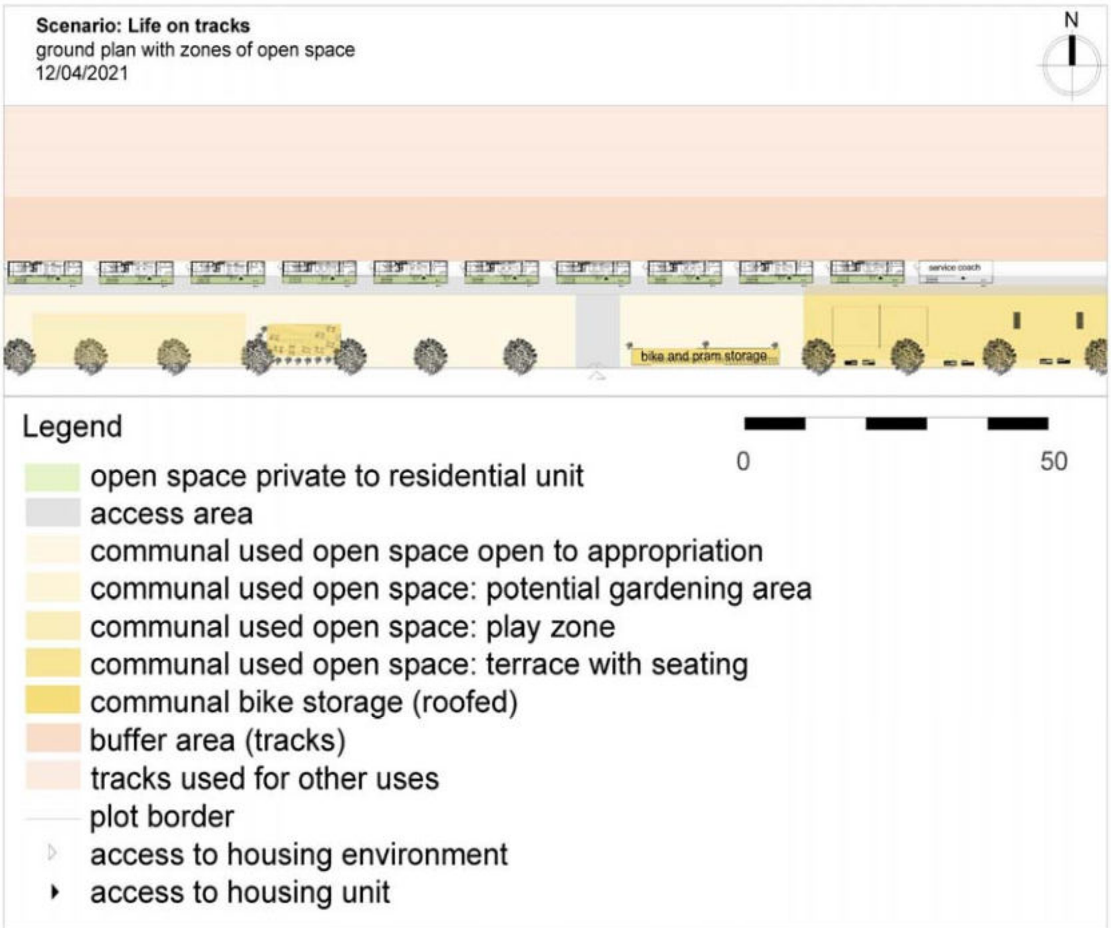

Figure 53: TinyTainer – Site zoning plan[54]

[54] Drawings by Stocker based on Bertino

6.3.3 Private and semi-private open space

Each housing environment contains a terrace of around 11 m² that functions as access and appropriate private open space. The unit and the terrace are elevated 1 m from the tracks and are accessed via steps from one side. It is mounted to the bottom of the container with hinges and supported by cables. The terrace is made from timber and folded out when the housing environment is set up to house residents and folded in for transport. The stairs are set up separately on-site. Railings delimit the terrace and prevent falling. A small table and chairs/stools are provided in each unit as outdoor equipment. Depending on the period of residence, residents can appropriate the space for occasions (e.g., placing a yoga mat, playing, sitting, working, hanging laundry) or for longer (e.g., placing potted plants). The terraces can be shaded with a marquee that can be rolled out.

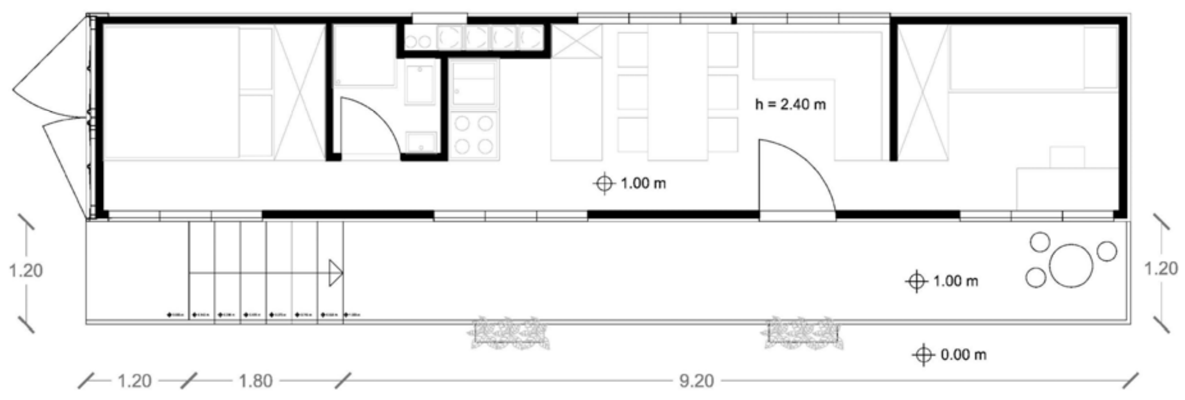

Figure 54: TinyTainer – Private open space[55]

6.4 ARCHITECTURE

The original architectural design of the scenario Life on track(s) was created by the students of the TU Wien architecture faculty Neudeck and Werni. As the students were asked to develop a cost-effective, labour-effective and widely adaptable housing solution that can be deployed via trains intermodal or ISO shipping containers seemed the best approach. The containers are made from corrugated steel and are equipped with plywood flooring on the inside. The main challenge in using them as a living space lies in their poor thermal performance, meaning they must be insulated. Also, condensation becomes a factor. This creates a challenge since thereby the narrow layout of 2,35 m is narrowed even further. To address these issues, appropriate materials and techniques have to be selected for the respective situation (e.g., vacuum panels, vapour barrier, plasterboard or wood-based panels). Also cutting any additional holes into their hull requires building a frame to uphold structural integrity.

Self-sufficient living units contain all the functions a group of people needs to live in continental climate. This includes sleeping, cooking, water, electricity, heating, waste, and sanitary facilities. Realistically, only 40 ft containers are suitable for this housing model.

In another application, e.g., housing for event or festival visitors, it might be more efficient to designate certain coaches to certain functions rather than providing fully equipped living units.

[55] Drawings by Bertino

There would then be for example a coach only for sleeping, a kitchen coach, a sanitary coach, etc. By this, certain functions could be outsourced (e.g., cooking) and provided by a central entity and in total more people could be accommodated. The more people there are the more functions could be centralised or even introduced in the first place (e.g., schools). The decision on the division of the coach functions must be carefully adapted to the respective situation. In the following, only the case of coaches with fully equipped living units will be considered (Neudeck, F., Werni K., 2020).

6.4.1 Architectural design

Figure 55-58 show floor plans, layouts and interior design suggestions for the living units on the coaches.

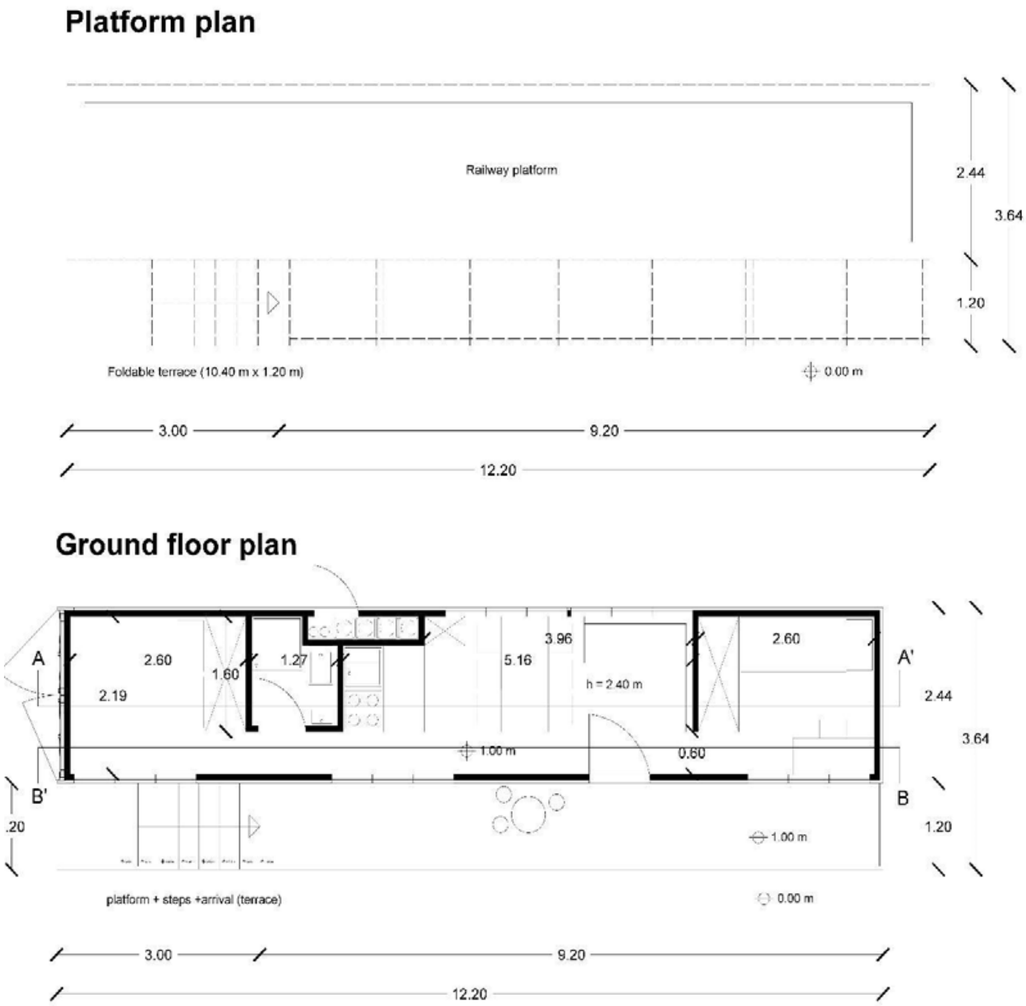

Figure 55: TinyTainer – Floor plans[56]

[56] Drawings by Bertino

Figure 56: TinyTainer – Sections[57]

6.4.2 3D visualisation

Figure 57: TinyTainer – Sectional renderings[58]

[57] Drawings by Bertino
[58] Drawings by Bertino

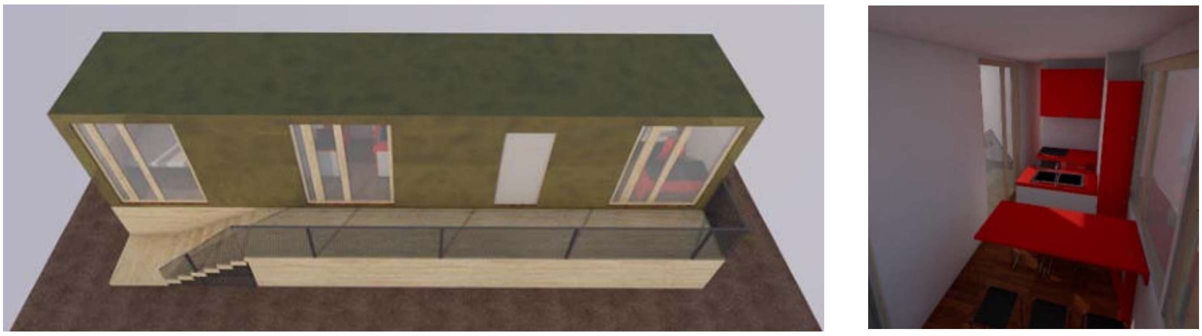

Figure 58: TinyTainer – External and internal renderings[59]

6.5 TECHNICAL AND RESOURCE ASPECTS

6.5.1 Energy concept

The following assumptions were made for the selection and design of the technical infrastructure.

- Year-round operation is assumed.
- It is assumed that the building is connected to the electrical grid. Here, a connection to the rail operator's power grid is to be implemented. This connection is made centrally at one point for all residential units via a specially equipped wagon.

Specification of the technical systems

Heating: Due to the limited space in the container, a heating system is chosen that does not reduce the living area. Furthermore, the system should keep the number of connections to the living container as low as possible. These two conditions can be achieved by infrared panels.

Domestic hot water: Due to the above-mentioned reasons, the domestic hot water production is realized through electric flow heaters.

Electrical supply: Since it can be assumed that the existing rail systems in the urban area are equipped with electric overhead lines, these are used to supply power to the units. For reasons of safety and economy, this connection is established via a supply wagon equipped for this purpose.

Ventilation system: In this model it is necessary to provide technical ventilation. Due to the limited space available in the container, it is necessary to select a decentralized ventilation system that does not require any additional space and still provides ventilation without excessive heat loss. This can be achieved by a ventilation system integrated into the window frames with integrated heat exchangers.

6.5.2 Water and sanitation concept

[59] Drawings by Bertino

Providing water and sanitation for the temporary housing environment of TinyTainer is not without challenges. It must be suitable for mobile application and adhere to the Vienna legislative framework. Space restrictions also must be considered.

Since the location of TinyTainer will nevertheless be in the city area, it might be suitable for the water supply to lay a water pipe from a public hydrant. A water meter is installed to measure water consumption and regular water quality checks are to be performed at the point of use. In addition, it must be considered whether a water pump is necessary or whether the water pressure is sufficient without it. But this depends very much on the location. The (above-ground) water pipe must be secured against tripping and marked clearly. Laying water pipes in the ground seems to cause too much effort for the short duration of use, even if it is possibly safer (no risk of tripping). If a hydrant supply is not possible, water would have to be provided by a water tanker. In any case, the individual residential units or coaches are supplied via a sufficiently large central water container, that has to be conscientiously placed to avoid tipping and to ensure sufficient water pressure.

Wastewater from the kitchen, bathroom and toilet must also be collected in a sewage tank, as it cannot be assumed that there is access to the Vienna wastewater system in the track area. Therefore, it is necessary to ensure regular emptying of the tank. Vacuum toilets could be implemented to reduce water demand for toilet flushing. It is therefore essential that a tanker truck can drive up to the temporary living environment to be able to pump out the wastewater collection tank for the various residential units together. This should be done without contact if possible due to the potential pathogens in the wastewater. This system is comparable to toilet facilities in alpine regions, which are also serviced by tankers. The tanker then brings the wastewater to a central treatment plant. The collection tank is located on ground level next to or under the living containers.

6.5.3 Resource concept and waste management

It is crucial, that the materials used to implement this temporary housing model are reused. Both the wagons as well as the containers that are refurbished as living containers must be acquired from second-hand sources as they are both resource intensive and building wagons and containers just for this temporary housing example does not make sense, as other, less resource intensive solutions could be easily found instead. This model can only fulfil its potential if used wagons are available. The wagons themselves do not need adjustments or conversions – they should be left unaltered, so they can be in their original use all the time this temporary housing model is not in use.

The shipping containers however are heavily modified to be used as living units: Openings for doors, windows and water, wastewater and electricity or heating and ventilation must be cut into the containers, appropriate insulation and wall coverings, floors and ceilings must be constructed. Therefore, the containers lose their potential to be used as shipping containers forever and start their new life as living units. Therefore, also all the furniture, appliances and building services are built-in permanently. The housing unit itself is not planned temporarily, only its presence on a particular location. This is made possible by the fact that the temporary living environment is mobile on rail tracks. Again, if only for this purpose a brand-new shipping container would be acquired, it would not make sense from a resource perspective, as there would be better solutions available. Only discarded containers may therefore be considered to give them a new purpose in a second-life application rather than turning into scrap metal.

Solid waste management

The waste collection system in this temporary housing environment will be integrated into the Viennese waste collection system. Residual waste and paper waste will be collected close to the wagons at a point where access for a waste collection vehicle is possible. Recyclables are collected in a bring system.

6.6 NICHE EXPERIMENT

Life on tracks(s) is understood as niche experiment. The experiment pursues the following questions: what safety measures can be taken to protect the inhabitants from hazards related to living in the vicinity of railroad tracks? How can technical aspects of the experiment be optimized regarding construction/deconstruction, as well as sanitary solutions and energy provisions? How quickly can “Life on Track(s)” arrive at a desired destination? Is “Life on Track(s)” best suited to house people affected by disaster or the emergency respondents?

For this first implementation, a simplified and cost-efficient prototype is sufficient. The initiators and coordinators of the project are composed of individuals from government, from organizations tasked with the emergency response to disaster relief and an interdisciplinary research team. While the target group of “Life on Track(s)” are people affected by disasters (Profile A), the experiment will involve people from Profile C to address the formulated research questions in this first pilot project. For this experiment, prototypes of the wagon are used during a training course of a given relief organisation. It is located on a side-track outside of Vienna, where the suitability of the concept is tested for emergencies such as floods, fires or major incidences for a matter of a few days. The local population and local organizations can be invited to participate, such as for instance the voluntary firefighters. It is also feasible to coordinate this practical experiment with the Disaster Research Days, organized by the Disaster Competence Network Austria every year. The experiment would itself become an emergency training exercise or be embedded in training and/or civil defence exercises, simulating real-life situations such as flooding. The first part of the experiment is dedicated to questions regarding arrival time at destination, construction (terrace and stairs) and set-up (water and electricity supply, as well as safety measures), which greatly impacts the suitability of “Life on Track(s)” as an emergency response measure. The time is documented, as well as the number of people and knowledge or skill required. All participants must first be schooled about the safety hazards of the train tracks. The next phase of the experiment is dedicated to the everyday running of the temporary housing, with volunteers living in the retrofitted wagons for a week. These experiences will inform about the functionality of the water and wastewater and electricity solutions. The well-being of the inhabitants is assessed, with particular attention being paid to thermal comfort, seeing as the wagons must be usable in all seasons. Another important aspect to document is how effective and resilient the safety measures are and if and how they impact everyday life. It is feasible that the experiment shows that no measures can realistically be taken to make the site safe enough for small children, for instance, or for people without prior schooling and strict guidelines for behaviour. In such a case it must be considered whether the people affected by major incidences or disasters can safely be the target group for this type of living, or if “Life on Track(s)” should rather house the emergency responders. The third phase consists of the deconstruction and transport to storage. During this phase it is again documented how much time the tasks take and how many people and how much skill is required. The expertise and inside view of practitioners taking part in the experiment is very valuable and is collected within a concluding workshop where the experiences and ideas for improvements are processed.

6.7 INNOVATIVE ASPECTS, CRITICAL ISSUES AND OUTLOOK

First and foremost, the suitability of “Life on Track(s)” as post-disaster temporary housing must be assessed. A strong focus is therefore placed on safety aspects, considering that the location could involve risks of electric shocks from overhead lines, tripping hazards and risks stemming from the vicinity to active train traffic. Exploring safe solutions is a central matter of concern. Furthermore, one could also examine the aspect of operational suitability for contexts such as flooding or earthquakes. Questions in this regard would concern how fast the train could arrive on site and be made operational and how well it is suited for the task. It could be explored whether it is suited as temporary housing for those affected by disasters, or whether it is better suited for housing the emergency responders and other staff required on-site. A pilot experiment would also identify what necessities may still be missing, such as for example a mobile infirmary on the train. In addition to these aspects, “Life on Track(s)” also serves to explore on-site solutions for water supply and the sanitation system. The feasibility and safety of electricity provision through the overhead line is also an interesting approach to be explored.

To the knowledge of the project team, there are no comparable examples in Vienna yet. However, there are some examples where discarded railway carriages have been converted for residential purposes or as hotels (see Figure 59). Here, of course, the application is completely different from TinyTainer, which is in use for the relief effort after a major incidences or disasters, but the interior design and making it homely as a residential unit can serve as a comparative example.

Figure 59: Already existing example considering similar aspects: Hotel in alten Bahnwaggon, Bogen, Deutschland [60]

The interdisciplinary team also conducted a SWOT-analysis for this scenario, which is summarized in the following table. The matrix shows the main strengths (innovations), weaknesses, opportunities and threats (risks). For additional risk considerations please see Deliverable D5 (theoretical risk assessment report).

Table 16: Life on track(s) / TinyTainer - SWOT analysis

SWOT: Life on track(s) / TinyTainer	
Strengths - Use of existing structures - Flexible and mobile temporary housing model - Rapid availability (also for emergencies)	**Weaknesses** - Increased risk for users (electricity, active train traffic, etc.) - Preliminary phases / pre-check (check of safety agendas (statics, fire safety, accessibility, potential contamination, ...) - Restricted choice of materials and technologies - Very limited (site) availability, site adaptation necessary - Costly storage, land usage for downtime (without use) - Water supply and wastewater disposal is difficult
Opportunities - Relatively flexible deployment in other cities	**Threats** - Lacking connection to infrastructure - Legal framework (in Vienna) not suitable

[60] https://bahnwaggon-bogen.obsg.de/house

7 FLAT-PACK / SHOP-HOPPING BOX

7.1 SCENARIO DESCRIPTION AND RELEVANCE FOR VIENNA

The city of Vienna faces continuing high vacancy rates for ground floor retail spaces, especially if not situated in prime shopping streets. To make better use of the available built environment of the city, these vacancies can be temporarily appropriated as living spaces until another retailer moves in. The interim use as living spaces should be considered analogous to pop-up stores. They pop-up suddenly, serve their purpose and disappear as swift as they came. During the interim use of vacant retail space, no major structural adaptions should be undertaken, as the overarching objective is the continuing use of the retail spaces as initially intended and not transforming it permanently for living purposes. The architectural challenge is to make best use of the existing building structure (e.g., floor plan) while still providing good residential quality. Structural adjustments therefore must be envisaged either as reversible or easily removable or during anyway necessary renovation or maintenance activities of the retail spaces.

Shop-hopping Boxes address individual persons and smaller families, who voluntarily choose to participate in this rather unconventional form of housing and need living space for a limited time, for example people with a mobile lifestyle (e.g., students, digital nomads, expats). Shop-hopping Boxes can be applied all over the city, as ground floor vacancies are dispersed all over the city. Retail spaces up to 150 m² (for families) can be considered. The temporary residents will stay in their pop-up apartments for approximately 6-24 months.

Shop-hopping Boxes will be facilitated by a centralized platform that brings together potential residents and vacant retail space. Potential residents are not purchasing furniture but are provided by the platform with ready to go furnishing modules – so-called Shop-hopping Boxes which should be easily assembled, disassembled, fit through available doors or windows of the retail spaces and allow space-saving storage (if not in use). The residents use the provided furnishing modules in the vacant retail spaces, but after their temporary stay, the shop-hopping boxes are returned to the centralized platform, repaired, and refurbished if necessary, and put into storage until their next application – hopping into the next shop.

While designing the furnishing modules, durability and ease of repair must be considered in order to prolong the overall lifespan of the Shop-hopping Boxes. Flexibility regarding their application in different architectural frameworks or floor plans is necessary. Using ground floor spaces as residential areas comes with additional major challenges, for example regarding natural lighting, thermal insulation, and privacy (e.g., large road-facing shop windows).

As outlined in the City of Vienna's workshop report "Perspectives on the Ground Floor" (Magistrat der Stadt Wien 2011), the ground floor zone is affected by several developments, not only in Vienna. In addition to vacancies, some of which have persisted for a long time due to high tenant expectations, retail businesses are facing increasing competition from online retailers. As a result, a further decline of retail businesses is to be expected. The vacant ground floor zones can be seen as a resource in the city through the Shop-hopping Box, which uses existing structures and are already well integrated into the city's infrastructure. In addition, such initiatives can serve as a revitalization and image-building measure.

7.2 USER GROUPS

Shop-Hopping Box utilizes unused ground floor retail space without making any structural adaptations. The retail space is given a new room division using modules (e.g., kitchen, bathroom, bedroom), which are attached to rails on the ceiling and can be moved along these rails. This means that the rooms are very open, with the separate elements, such as sleeping areas, not necessarily being divided by four walls, depending on the given structure of the retail space. The target groups for this model are therefore people who are very familiar with each other and are open to cohabiting without much privacy. Possible user groups are for instance couples looking for affordable temporary accommodation (Profile C), or women with children seeking transitional shelter (Profile B). This could also be an attractive housing option for individuals who are going through a separation or divorce (Profile B & C).

7.3 SPATIAL PLANNING

The temporary use of vacant ground floor zones represents a particularly spatially compatible form of temporary residential use. There is very little conflict of use with existing space requirements in the existing urban fabric. In addition, these areas mostly have good accessibility and supply with central facilities.

The provision of public transport and facilities for health, education and local amenities in the surrounding area is very good and can meet the needs of all user groups. Likewise, the conditions for active mobility are very good.

Barrier-free accessibility of the areas by residents and for assembly and disassembly are ensured, but existing structural conditions (entrance stairs, narrow entrance portals) can be problematic.

Exposure to ambient noise is equivalent to that of residential areas. The selected design and the implementation within an existing building should ensure compliance with the limit values.

7.3.1 Principles of housing environment

The surrounding is a densely built area, close to the Gürtel. The built structure derives majorly from the Gründerzeit, the surrounding FAR is between 2,0 and 4,0; the population density is above 400 residents/ha. The streets are of different importance, frequency, and maximum speed limits. The streets have sidewalks but very few trees and green areas. The surrounding area has little green infrastructure, but small parks and parks <10 ha are within 1 km of bee-distance. The bike infrastructure is mostly integrated in the roads (no independent bike lanes).

The housing environment is placed in a ground floor store on a central shopping street. The street is characterized by wide streetscapes including broad areas for motorized traffic (including parking) and trams. The sidewalk in this area is relatively broad (≥ 5 m). The building is of various floors and attached to the street. On the back of the plot, there is a backyard to be used by all residents of the building.

7.3.2 Communal facilities and communal open space

There is no communal open space that is explicitly dedicated to the residents of the housing environment, but the building contains an inner courtyard that can be used together with the other residents of the building (see Figure 60).

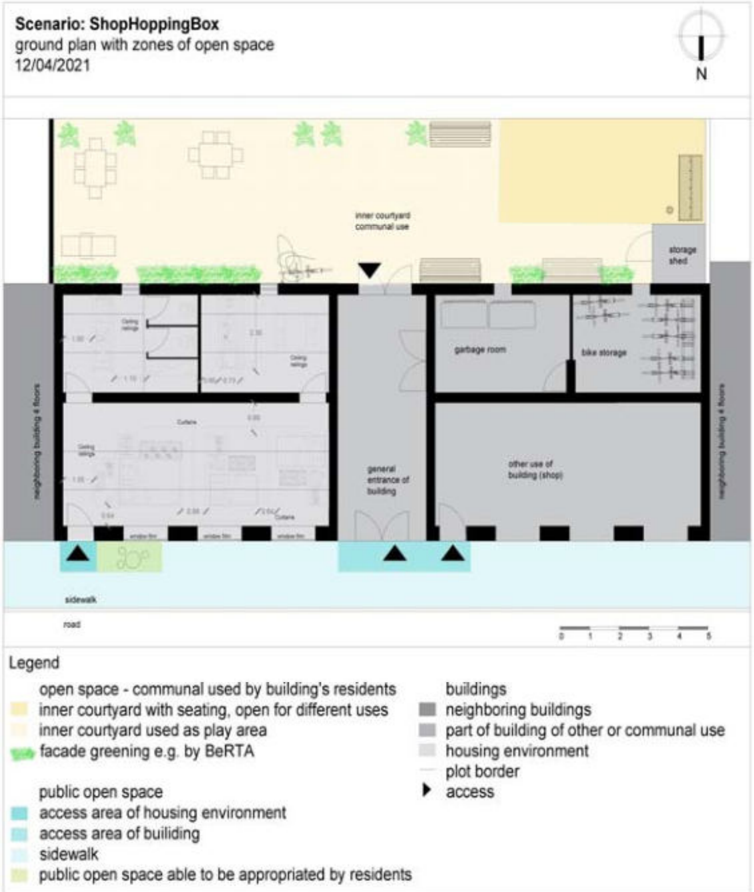

Figure 60: ShopHoppinBox – Site zoning plan[61]

The inner courtyard contains seating and playing equipment. If space, exposure, and surrounding buildings allow it, potted plants, high raised beds, and mobile trees can be applied. The plants can improve the aesthetics and microclimate of the space. An attractive open space may be beneficial for all building's residents and create a space for encounter and communication. To avoid possible conflicts, the intentions of the housing environment should be communicated to the neighbours in advance.

Since the sidewalk is relatively broad, the public open space in front of the shop can be appropriated by the residents. It is an informal action that might be tolerated by the district's authorities. Here, only short-term temporary appropriation can happen, such as placing seating opportunities to sit in the sun for some hours. The housing environment could provide foldable equipment for this purpose.

The residents of this housing environment don't dispose of any privately used open space.

61 Stocker based on Bertino

7.4 ARCHITECTURE

This architectural 3D modelling of the Shop-Hopping Box is based on a design approach created by the students of the TU Wien architecture faculty, Rachel Margaret Verdugo Pelaez and David Egido Rodriguez. The usage of several mobile rectangular wooden modules is suggested as it allows for a dynamic adaption for a family to move into any given space. The modules measure 2.3 m in height, 2.3 m in width and 0.7 m in depth allowing them to enter most doorways. The following modules are included in the Shop-Hopping box housing model:

- **Bathroom module** – includes a shower and a wash basin. Approximate weight: 286 kg.
- **Kitchen module –** includes the main furniture, sink, microwave, and stove. Approximate weight: 216 kg.
- **Double bedroom module** – includes a fold down murphy bed, side tables and closet space. Approximate weight: 112 kg.
- **Single bedroom module** – includes a fold down murphy bed, closet space, and also a table and 2 chairs. Approximate weigh: 124 kg.

The modules will use a system of guiding rails on the top, to avoid the modules from tilting and will be rolled into the space on its own set of wheels which allows for added security and agility. The kitchen and bathroom modules will have some fold-out supports to stay fixed to the floor and to access the pipe installation. To separate the different spaces within a room textile curtains could be attached to the ceiling rails to allow a certain division of space (Verdugo Pelaez and Egido Rodriguez 2019).

7.4.1 Architectural design

Figures 61-66 show floor plans and design ideas regarding Shop-hopping Box.

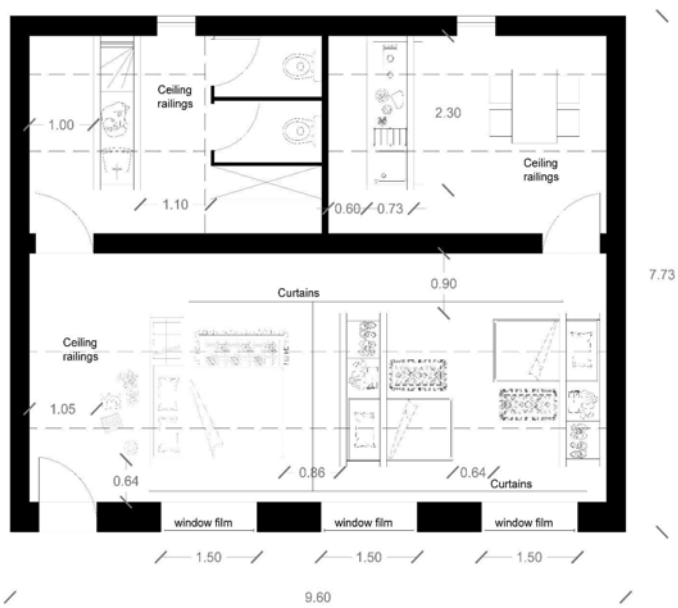

Figure 61: Shop-Hopping Box – Ground floor plan[62]

[62] Drawings by Bertino

7.4.2 3D visualisation

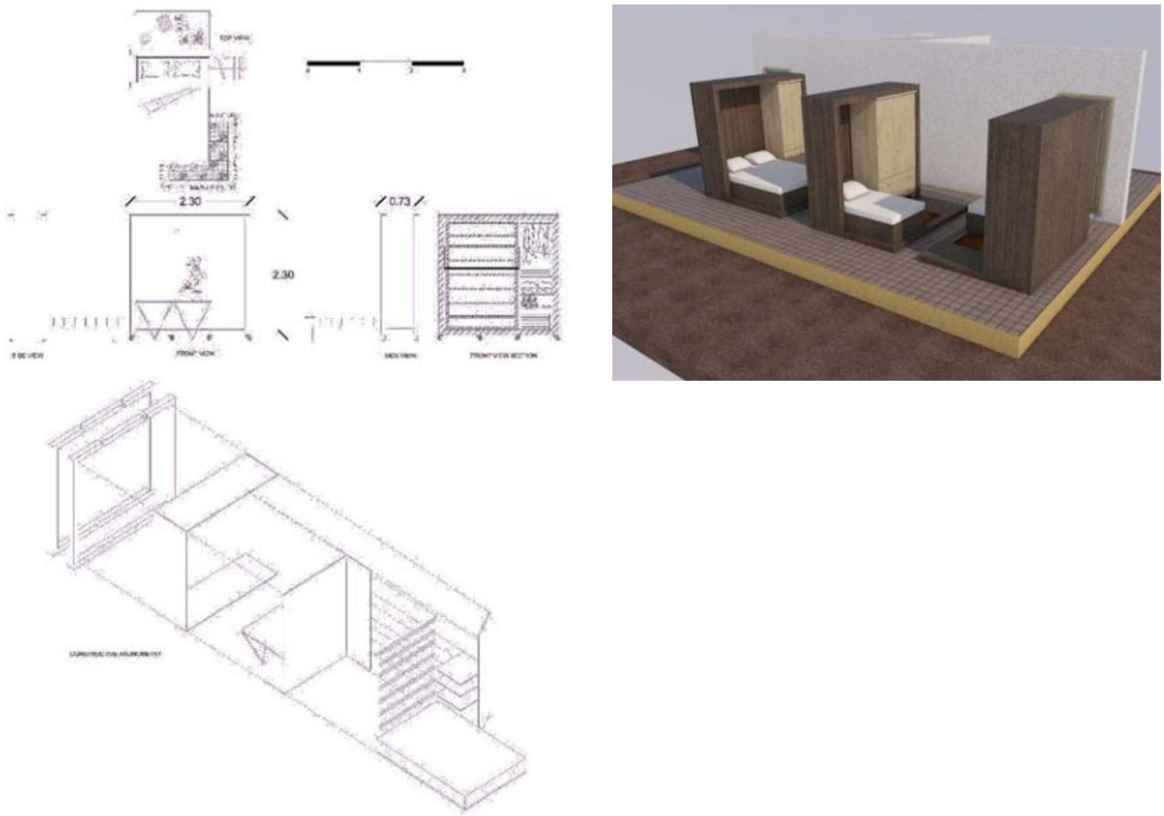

Figure 62: Shop-Hopping Box – Double bed module[63]

[63] Drawings by Bertino

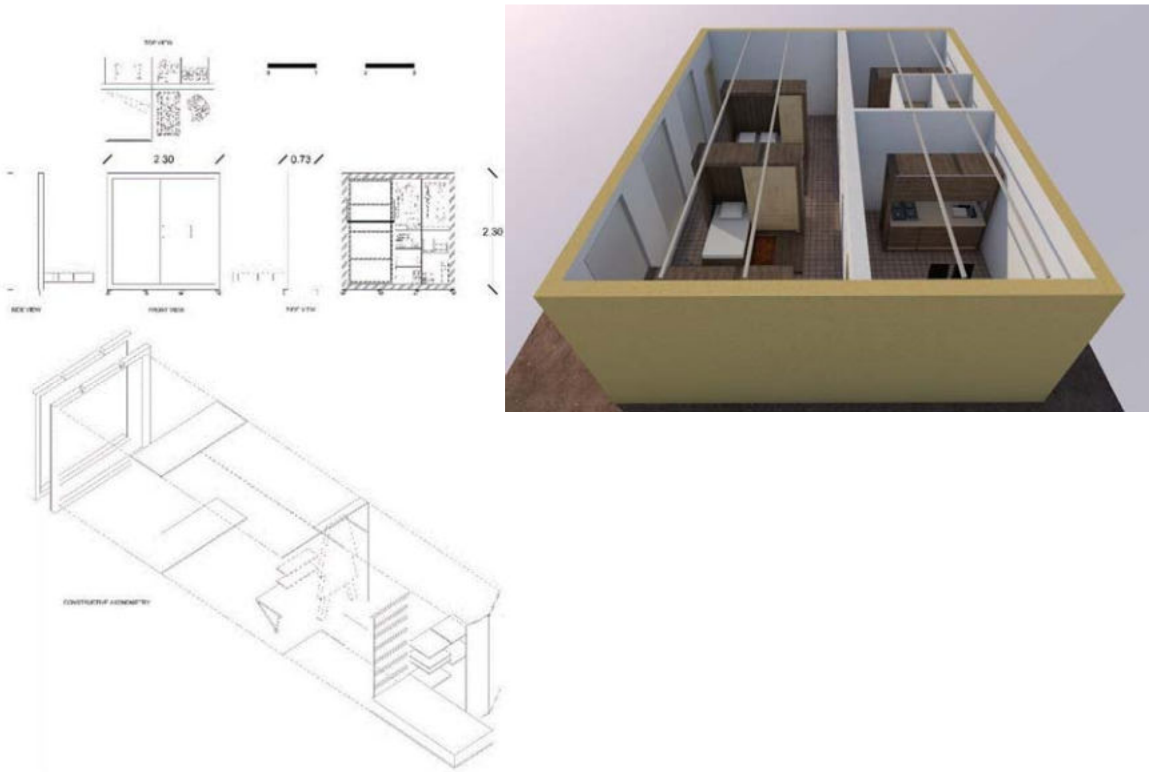

Figure 63: Shop-Hopping Box – Single bed module[64]

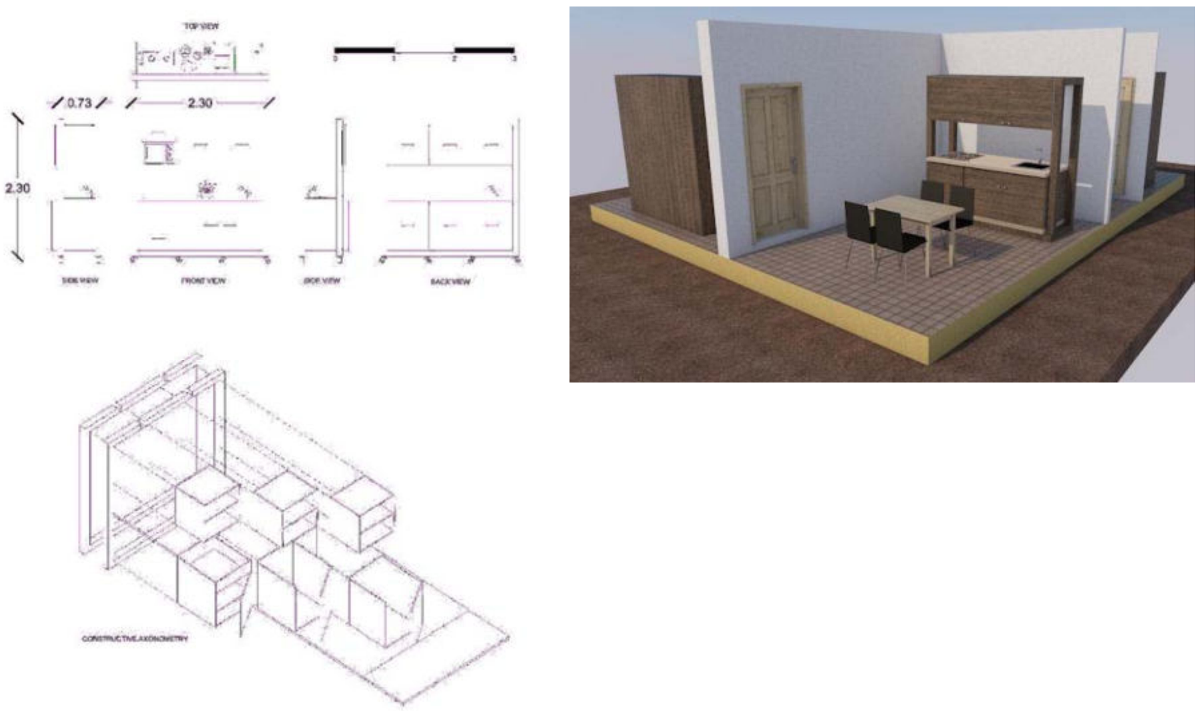

Figure 64: Shop-Hopping Box – Kitchen module[65]

[64] Drawings by Bertino
[65] Drawings by Bertino

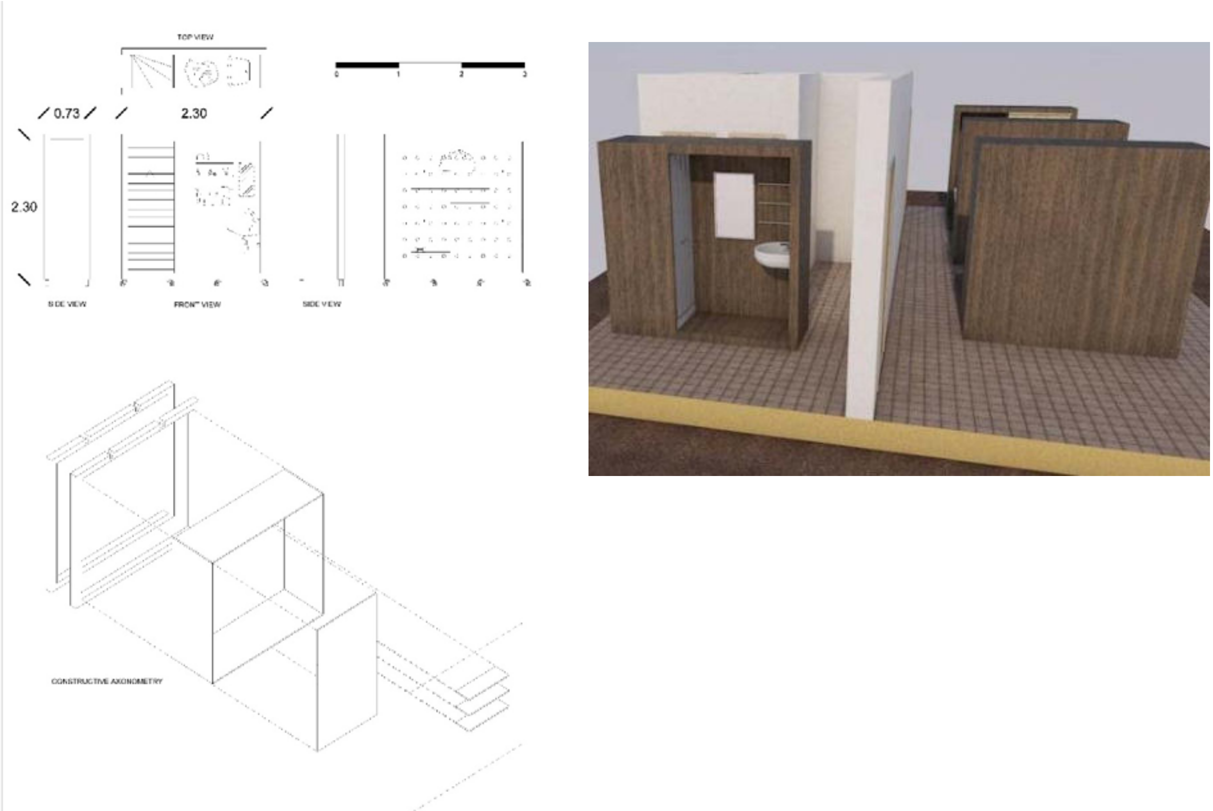

Figure 65: Shop-Hopping Box – Bathroom module[66]

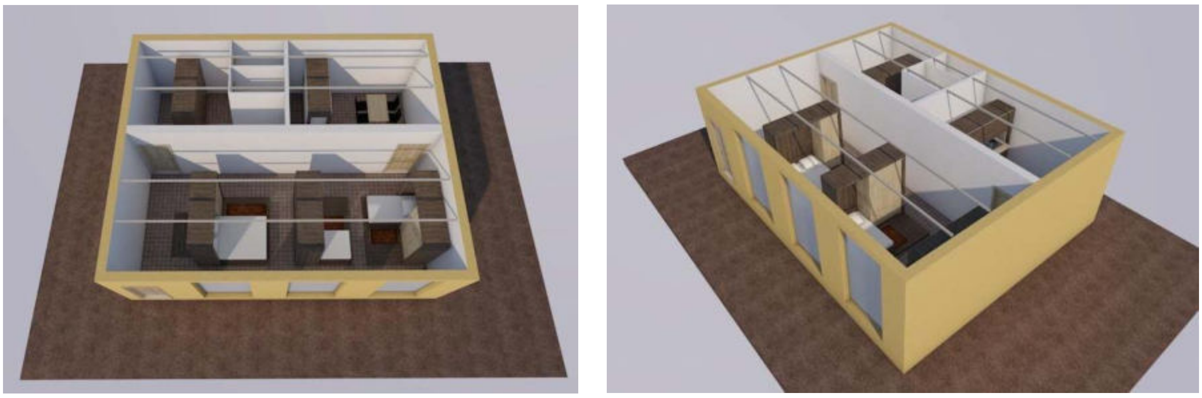

Figure 66: Shop-Hopping Box – Interior renderings[67]

7.5 TECHNICAL AND RESOURCE ASPECTS

7.5.1 Energy concept

The following assumptions were made for the selection and design of the technical infrastructure.

- Year-round operation is assumed.
- It is assumed that the building is connected to the electrical grid.

[66] Drawings by Bertino
[67] Drawings by Bertino

- It is assumed that the building already has an existing infrastructure, in terms of electricity and heat supply, which is also suitable for the purposes of Shop-hopping Box.

Specification of the technical systems

Heating: The existing heating system is used.

Domestic hot water: The existing system for providing domestic hot water is used.

Electrical supply: The existing system for power supply and distribution is used.

Ventilation system: The existing system for ventilation is used.

7.5.2 Water and sanitation concept

For this temporary housing environment, only locations can be considered that which already have a water and wastewater connection, as well as a toilet in the vacant ground floor areas. There is no transportable toilet module included in Shop-hopping box, so it has to be provided by the location itself. Similarly, if there are also cooking facilities and a shower in the vacant ground floor retail areas, this is all the better from a technical point of view, because then there is no need for extra effort on connecting water supply and waste water disposal. In this case, the shower and kitchen module are in use however, as there is no permanent kitchen and bathroom. Those modules are placed in the vacant retail space and will be provided with above ground pipelines which are placed along the edge of the room and can be enclosed for the optics and to avoid tripping hazards.

7.5.3 Resource concept and waste management

Only wooden furniture and integrated room dividers must be provided to implement this temporary housing environment. From a resource perspective, sturdy, high-quality material is preferable, so that several relocations and mantling and dismantling cycles can be realized.

There will be most likely no need for any additional effort regarding the solid waste collection. The solid waste collection will be part of the official waste management system of Vienna, the buildings that have the vacant commercial spaces for the shop hopping boxes certainly have a garbage room for municipal waste (residual and paper waste) and will be used also by this temporary housing environment. Recyclables are collected in a bring system.

7.6 NICHE EXPERIMENT

For its first implementation, the Shop-Hopping Box experiment will primarily focus on questions surrounding its functionality to address the overarching question of whether this is a viable temporary housing solution. This encompasses the following questions: How efficiently can Shop-Hopping Box be transported between locations? How many people are required for construction and deconstruction? What level of skill is required for construction and deconstruction? How does the railing system and the modules fare after multiple uses? How invasive are the required ceiling rails perceived by the property owners? In addition to these questions, these first implementations can also be used to assess the experiences made by the inhabitants, e.g., concerning how they perceived privacy, sound pollution, or the use of the shower modules. Questions which could be pursued in follow-up experiments but that are not addressed within this experiment design include the potential of integration into the neighbourhood and added value for the neighbourhood through combinations with other pop-up activities and projects. Revitalization of the neighbourhood can be considered an aspect of urban sustainability. Follow-up projects of this kind would require a more open project design with elements of co-creation and co-production.

The project is coordinated by an interdisciplinary project team (Shop-hopping box platform) and involves private owners of the retail space. The private retail space owners require a monetary incentive to make their vacant shop floors available, particularly considering that the rail system will require holes to be drilled in the ceiling. Down the line the monetary compensation could be provided in the form of rent from the inhabitants, which would have to be low enough to incentivise the inhabitants to choose this type of temporary living over other options.

For the initial experiments, the inhabitants are made up of people from Profile C, though this can be expanded to user groups from Profile B at a later stage. This might then also require the co-operation with social services, for instance if Shop-Hopping Box is used as an alternative option to existing women's shelters. Volunteers to take part in this experiment and live in the Shop-Hopping Box for a span of 1-2 weeks are recruited among architecture students and sofa-surfing networks. The timespan of inhabitation per user is purposely kept short to run through as many use-cycles as possible and investigate the wear-and-tear on the modules and the railing-mechanism.

Before the inhabitation phase can begin, the amount and type of modules required are assessed based on the shop-layout and the number and constellation of inhabitants registered to move in. The railing-mechanism is installed by experts, window foils for additional privacy are applied if necessary, and the modules are transported and placed on location. The new inhabitants are then briefly schooled in the use of the modules, regarding how they can be moved along the rails, how they can be folded away when not in use, and how the bathroom and kitchen modules function regarding the management of wastewater.

After the inhabitation phase is over, the modules and the railing system are dismounted and transported for storage. Before they go into storage they are cleaned and checked for deficiencies.

The inhabitants are asked to provide feedback on their experience, regarding their perception of privacy, sound pollution, the use of the bathroom and kitchen modules and the use of the flexibility provided by the rails and foldable features of the modules. It would also be interesting to assess how high they believe rent should be for this type of living experience.

7.7 INNOVATION ASPECTS, CRITICAL ISSUES AND OUTLOOK

The use of modules as partitions allows high flexibility and adaptability for all sorts of ground floor retail spaces without requiring expansive structural changes, and for different constellations of inhabitants. In cases where no showers or kitchen facilities are provided, shower and kitchen modules can be placed in any room, provided there are connections to the water supply and wastewater drainage. Shop-Hopping Box also holds the potential to reactivate vacancies and can be combined with additional pop-up activities, such as art projects or community projects to revitalize neighbourhoods, which can be considered an aspect of urban sustainability.

One disadvantage of this temporary housing environment is certainly the lack of private open spaces. However, it could be an interesting possibility to set up so-called parklets in front of the vacant retail areas that are used for Shop-hopping Boxes. This would be one of those additional pop-up activities just mentioned above and would also be conducive to activating the neighbourhood. Of course, a parklet is still not a private open space, but at least an open space that is very close to the living space and can be used intensively. In Vienna, parklets can be applied for by private individuals or associations and after a positive review by the city of Vienna, there is even financial support. In 2019, there were already over 30 parklets in Vienna (Grätzloase 2021).

Figure 67: Already existing examples concerning similar aspects in Vienna: Green "Parklets" in Vienna[68]

The interdisciplinary team also conducted a SWOT-analysis for this scenario, which is summarized in the following table. The matrix shows the main strengths (innovations), weaknesses, opportunities and threats (risks). For additional risk considerations please see Deliverable D5 (theoretical risk assessment report).

Table 17: Flat-Pack / ShopHoppingBox - SWOT analysis

SWOT: Flat-Pack / ShopHoppingBox	
Strengths - Vacancy revitalization - Use of existing structures - Low use of resources - Rapid and flexible construction / dismantling - Reuse possibility / capability	**Weaknesses** - Ground floor location (safety aspects, living comfort) - Little possibility for privacy due to the loft character of the floor plan - Little (private) open space - Logistics and storage requirements - Integration of bathroom
Opportunities - Enhancement of the neighbourhood („Grätzelaufwertung“)	**Threats** - Availability (resp. willingness on the part of the owners) of suitable commercial properties

[68] https://citymaking.wien/de/parklets/, https://kurier.at/chronik/wien/wegen-corona-parklets-duerfen-erstmals-auf-strasse-ueberwintern/401088402,

8 DONAUTONOM / BINNEN BLEIBEN

8.1 SCENARIO DESCRIPTION AND RELEVANCE FOR VIENNA

This concept involves the use and redesign of old Danube ships (e.g., old cargo ships) that can be purchased, with the idea of being anchored on the Danube to offer a short-term home for different types of user groups. DonAutonom is only suitable on the navigable areas of the Danube and the port facilities. This living concept pursues a degree of autonomy or self-sufficiency in the use of resources. Since ships offer a lot of conversion and remodelling potential, the possibility of a year-round or seasonal food supply (e.g., raising chickens on the ship, raised-bed gardening) is provided. At least in the summer months, the need for food could be met temporarily. Ships should be in place for about 3 years and then change their position (either at another anchor in Vienna or in another city). This concept of housing could be occupied by people who are there for short-term work. If created as a research project, researchers or students accompanying the project may also move. The presence of a "housekeeper" (in any form) who deals with the technical processes seems necessary.

The interior of the ships is converted into attractive housing units. Often in this type of ship, the interiors do not have lateral openings for the passage of light and air but only a removable roof-cover. Corrective measures, which also concern the modification of parts and components of the ship's bodywork, can be considered to remedy the limits of lighting and ventilation.

The ship is around 100 m long and 12 m long. The housing model of Binnen Bleiben accommodates 20 residents in 8 double or triple apartments on one floor. The residents participate actively in the (communal) activities of the housing environment, such as gardening and other ongoing socio-technical experiments. The ship's lowest floor contains various communal facilities such as meeting rooms, co-working spaces, and an area free for various uses (gym, etc.). On specific occasions, these spaces can be also used by the neighbourhood and other individuals who are not residents (e.g., in the context of open events such as workshops, public viewings of movies, etc.). The first floor is the entry level of the ship. The residential units include private open spaces and are on the main deck. Additional communal open space is situated on the upper floor. On the top floor, there are high raised beds for food production. The housing environment's purpose is to provide an ideally self-sufficient way of life of high residential quality for its residents.

8.2 USER GROUPS

DonAutonom provides a space where many projects (scientific, artistic, practical, etc.) can take place in parallel. The inhabitants of DonAutonom are also the organizers, operators and participants of these various initiatives and projects, made up of e.g., scientists, artists and craftspeople, particularly those with an interest in self-sufficiency and closed-loop processes (Profile C). Some rooms have double-beds, meaning that the partners of the organizers and operators can also live on board. There are no elevators, making this model unsuitable for individuals using wheelchairs.

8.3 SPATIAL PLANNING

The Danube is used as a shipping route in the selected area, with the necessary parking areas for ships. Therefore, the intended use is in harmony with the existing use.

The supply of public transport and facilities for health, education and local supply in the surrounding area is very good and can cover the needs of all user groups. Likewise, the conditions for active mobility are very good.

The areas are accessible without barriers. Likewise, the areas are well accessible for assembly and disassembly via waterway.

The exposure to ambient noise corresponds to that of residential areas. The selected design should ensure compliance with the limit values.

8.3.1 Principles of housing environment

The housing environment is moored on the Danube River in a central area (between the bridges of A22 and A23), attached to the quay of the 2nd / 20th district of Vienna. The immediate neighbourhood of the housing environment includes residential areas of intermediate to high density (FAR above 3,0). The built structure derives from after WWII, with multi-unit buildings after 1960 dominating. The surrounding streets are intermediate and of high importance and many of them are greened. The traffic of motorized vehicles is intermediate to high. There are quite many bike lanes in the area. In the surrounding, there is a variety of green open spaces including playgrounds, dog areas, and parks of different sizes. Across the river, there is the extensive green space of Danube Island.

8.3.2 Communal facilities and communal open space

On the top floor, there is a roof terrace for communal use. To make it accessible to everyone, stair lifts could be installed. Part of the upper floor is shaded with solar panels. This area regards the ceiling of the staircases and parts of the communal used area for gatherings creating a space that is usable with differing weather conditions.

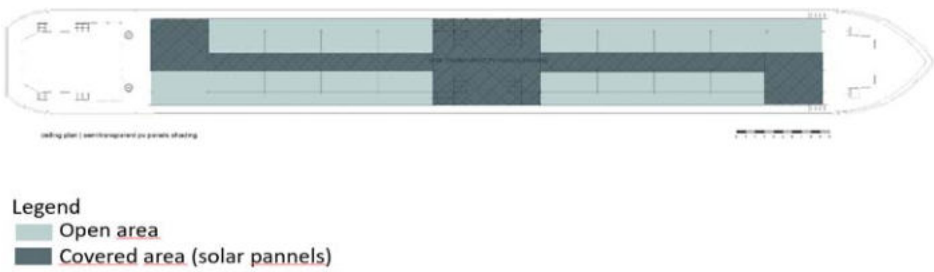

Figure 68: Binnen Bleiben – Open and covered area of the upper level[69]

On the upper floor are as well placed the high raised beds that provide food for the residents in the warm season. The beds are 0,7 m broad and accessed from one side, the length is around 5 or 6 m; an adequate height of 84-90 cm allows comfortable working positions. The entrance towards the high raised beds area is broad enough to enter with a wheelbarrow.

[69] Drawing by Stocker based on Bertino

Two sheds provide a total storage space of about 20 m² for gardening tools and equipment as well as chairs, benches, and tables.

Figure 69: Examples of a high raised bed[70]

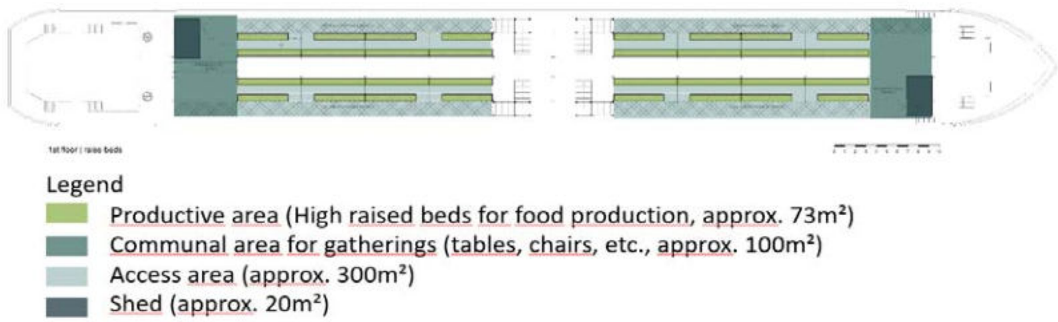

Figure 70: Binnen Bleiben – Open and covered area of the upper level[71]

8.3.3 Private and semi-private open space

Each apartment has a private open space that is of the apartment's length and 1,5 m broad (18 m² or 27 m²). The elongated loggia is for personal use and appropriation and expands the usable space of the apartments. The loggia presents a higher potential of usage on the side that faces the river since the proximity of private space towards the public open space of the quay may present conflicts of use.

[70] https://benz24.at/noor-hochbeet-vegtrug-wallhugger.html?option=433357&utm_campaign=google-shopping&utm_medium=shopping&utm_source=google&gclid=Cj0KCQiA962BBhCzARIsAIpWEL0RhhF0FZA9xecjdJc3gqY7j-S6KvrvVVCkVtmP_X6lJCjShP23x-waAsMfEALw_wcB, accessed: 16/02/2021)

[71] Drawing by Stocker based on Bertino

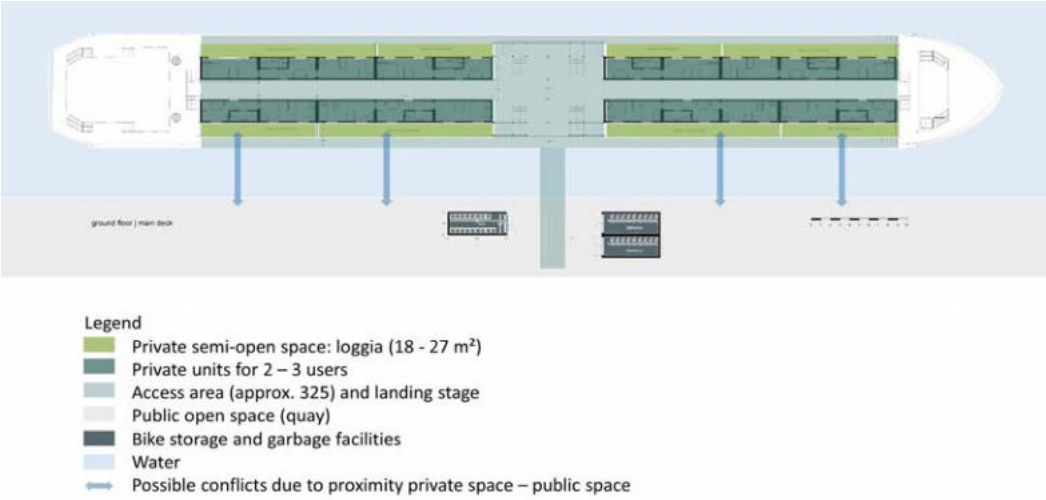

Figure 71: Binnen Bleiben – Distribution of spaces on ground floor level[72]

8.4 ARCHITECTURE

The architectural design of the DonAutonom scenario, is based on a design approach created by the student of the TU Wien architecture faculty, Victor Zugmayer-Preleitner. The basis for living units are standardised shipping containers, mounted on a ship. The design of Binnen Bleiben strives to combine two different elements: From the outside, there will be remarkable robust and industrial aesthetics. Entering the DonAutonom however, the perception changes quite a bit. While still embracing its industrial heritage, you are now in a green filled, yard like housing concept. Standard 20 ft shipping container will be used as housing units. Due to durability, upcycling and design, these containers are well suited to create a modular housing system. After insulation, e.g. using technologies developed by a German company named "containerwerk", and installation of the container, the available living space is around 12 m². An apartment consist of either two or three 20 ft containers, that are joint together and will provide space from one up to four people. Facilities in the housing units include bathroom and kitchen, bedroom(s) and a small dining area. The dining table in the kitchen folds against the wall for extra floor space. All doors - except the entrance - are sliding doors to provide easier passage through the narrow hallway. The bedroom is equipped with slidable and rotatable wall segments for individual configuration. These elements allow residents to create personal space adapted to their needs (e.g. a divider can be placed, if for example the residents choose to have a closed wall between the bed and desk area). Due to the short-term living concept, the apartments come fully furnished. The centre units - kitchen and bath - of the apartments are always stacked on top of each other because of installation and infrastructure reasons. Room-high windows maximize the light intake and visually stretch the apartment to the outside.

The lowest deck is dedicated as a communal area for recreation, sports, and study. The technical room for water treatment and energy supply is also located here. The first floor is the entry level of the ship. In the upper decks there are the raise beds and a walkable terrace composed by PV-panels. This level is also covered by semi-transparent PV-panels shading." (Zugmayer-Preleitner, V., 2020)

[72] Drawing by Stocker based on Bertino

8.4.1 Architectural design

The following Figures display the floor plans, interior design and room concepts of Binnen Bleiben.

Figure 72: Binnen bleiben – Floor plans of double container[73]

Figure 73: Binnen bleiben – Sectional rendering of double container[74]

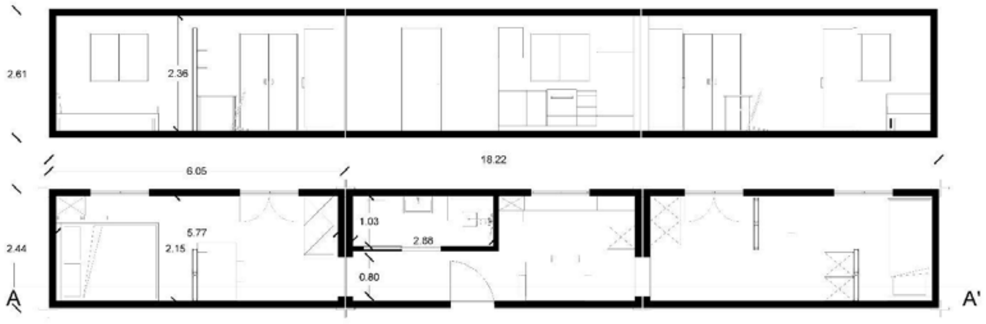

Figure 74: Binnen bleiben – Floor plans of triple container[75]

[73] Drawing by Bertino
[74] Drawing by Bertino
[75] Drawing by Bertino

Figure 75: Binnen bleiben – Sectional rendering of triple container[76]

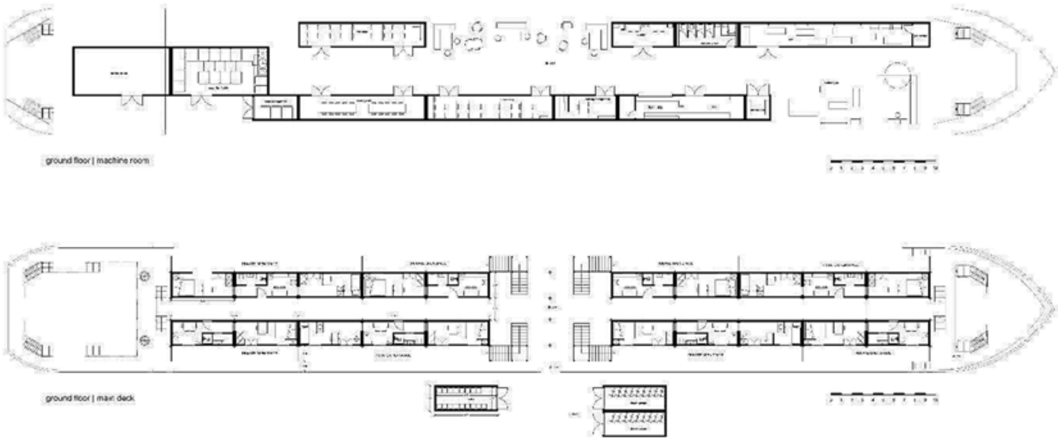

Figure 76: Binnen bleiben – Lower and ground floor deck plan[77]

8.4.2 3D visualisation

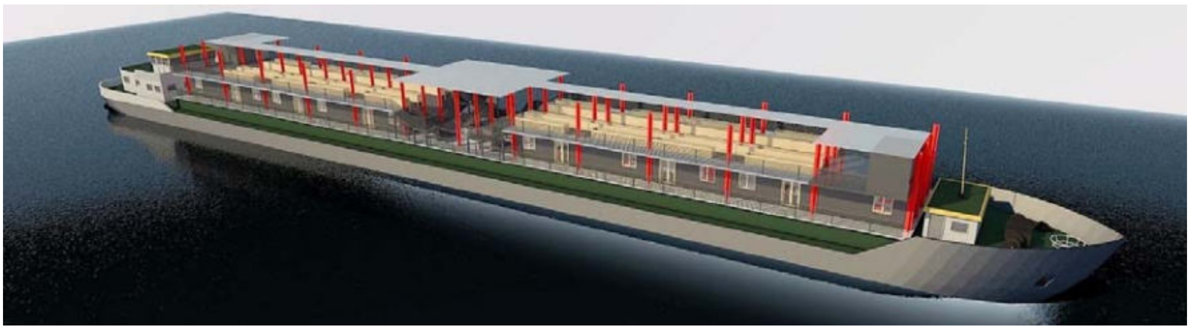

Figure 77: Binnen bleiben – External rendering[78]

[76] Drawing by Bertino
[77] Drawing by Bertino
[78] Drawing by Bertino

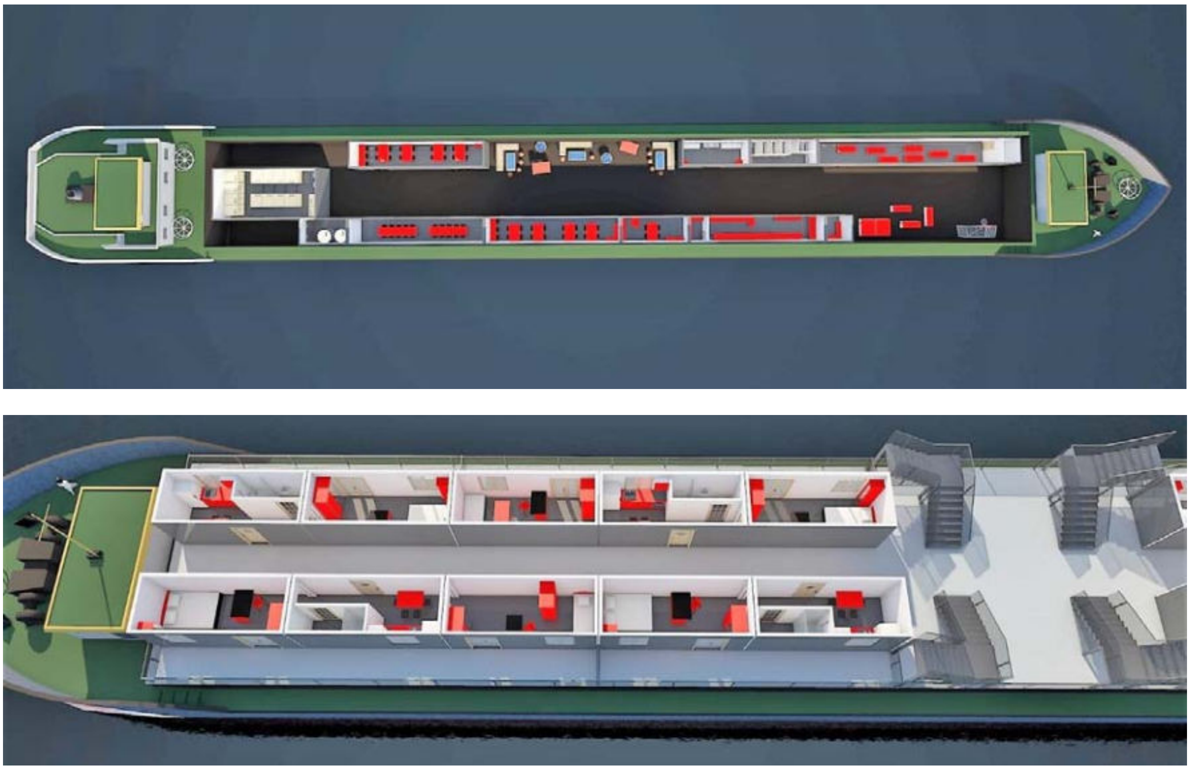

Figure 78: Binnen bleiben – Internal renderings[79]

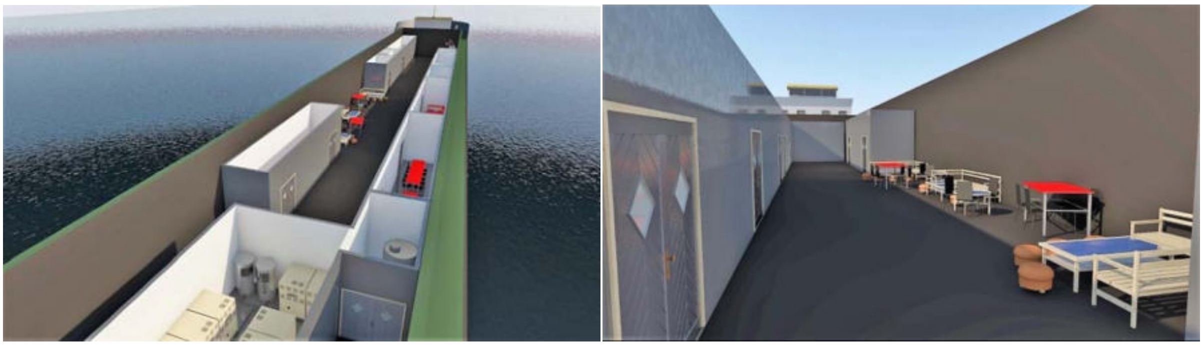

Figure 79: Binnen bleiben – Internal renderings[80]

Figure 80: Binnen bleiben – Structural renderings[81]

[79] Drawing by Bertino
[80] Drawing by Bertino
[81] Drawing by Bertino

8.5 TECHNICAL AND RESOURCE ASPECTS

8.5.1 Energy concept

The following assumptions were made for the selection and design of the technical infrastructure.

- Year-round operation is assumed.
- It is assumed that the building is not connected to the electrical grid.

Specification of the technical systems

Heating: Due to the location on a body of water, a water heat pump is chosen to provide heat. Surface heating systems are installed as a system for heating the living spaces.

Domestic hot water: Due to the above-mentioned reasons, the domestic hot water production is realized through electric flow heaters.

Electrical supply: In this housing model, a system is installed that ensures a self-sufficient energy supply from renewable energy sources without compromising user comfort. It was also considered in the design that due to the location on the water it is costly to ensure larger material flows. For these reasons, the energy supply is provided by a PV on the ship. An energy storage system is needed to balance generation and consumption. For reasons of sustainability, this is realized via a lignin-based electricity storage system. To use the sparse available space as efficiently as possible, transparent PV modules are used in the areas that necessitate shading. In the area of the uppermost corridors, walkable PV modules are used. In case of a possible realization, if the type of the used ship allows it, the energy concept can be extended by wind energy. This can increase the security of supply.

Installation: Due to the complex energy systems and for early detection of energy bottlenecks, a building management system is installed. The installation in the living areas will also be implemented as a BUS system.

Ventilation system: In this model it is necessary to provide technical ventilation. Due to the limited space available in the container, it is necessary to select a decentralized ventilation system that does not require any additional space and still provides ventilation without excessive heat loss. This can be achieved by a ventilation system integrated into the window frames with integrated heat exchangers. On the other hand, there are no windows in the hull of the ship. In this area, a centralized ventilation system with heat recovery is used.

8.5.2 Water and sanitation concept

Partially closing the loops is an objective of Binnen Bleiben. Therefore, some efforts are made regarding partly closing the water cycle on board of the ship. A drinking water and a service water system with separate pipes will be installed in the residential units. In the lower deck there is a water treatment system that treats the domestic water and if necessary, rainwater and river water. The service water is fed from shower and kitchen wastewater, rainwater and river water and is used for irrigation, toilet flushing and washing machines (see Figure 81). Greywater treatment methods range from high- to low-tech, which is reflected in the costs, treatment duration and performance. A gravity-based flow through a column containing activated carbon, sand and gravel is the principle of simple grey water treatment units (Samayamanthula et al 2019). The goal is to reuse as much water as possible on board and keep the drinking water demand to a minimum.

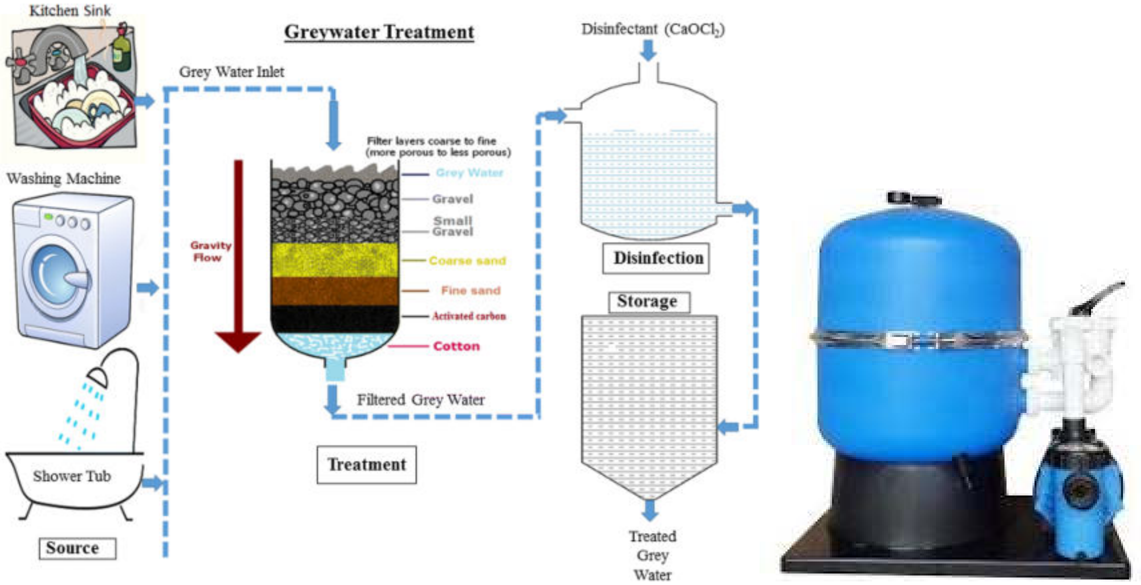

Figure 81: Examples for greywater treatment unit[82]

Additionally, a drinking water pipeline connected to the Viennese water grid should be implemented for drinking water purposes (drinking, cooking) and also as a contingency, if the on-site water treatment plant requires maintenance. The goal is however, to reduce the total water demand and reuse as much of it as possible.

Also, a sewage connection or a sewage tank has to be implemented in the system.

8.5.3 Resource concept and waste management

In Binnen Bleiben, the shipping containers are heavily modified to be transformed into living units. Openings for windows and doors must be cut in the containers and insulation and wall covering, ceilings and floors must be provided. The interior is converted into living space, with bathroom, kitchen and living and bedrooms. Therefore, the containers can never be changed back into shipping containers, as they were initially built for. Careful selection of suitable containers it therefore necessary: They should be reused and not newly built, but also not contaminated from either goods that were shipped before or coatings used to make the containers resistant to harsh environments during shipping. The containers are then permanently built into the ship vessel. So, the living units themselves are not temporary, only the housing environment itself, as it is mobile and can move or be moved from location to location.

[82] https://link.springer.com/article/10.1007/s13201-019-0966-0

Also, the ship itself should not be factory-new, only disused but still seaworthy ships should be considered as basis for this temporary housing environment.

Solid waste management

Binnen bleiben will be part of the centralized solid waste management system of Vienna. Close to the jetty, a garbage room will be provided for residual waste and paper waste, as it is common in Vienna. Recyclables are collected in bring systems in waste disposal sites.

As there are gardening activities, a worm composting system is implemented. This is a composting system where compost worms are kept in a composting box. Suitable organic kitchen waste as well as gardening waste is continuously applied to the worm compost and decomposed by the worms (Wohnwagon 2021). This results in high quality worm humus and can be used as soil conditioner for the plants that are produced on the upper deck for consumption.

Figure 82: Example for worm composting[83]

Consideration was also given to whether faeces could be used to run a small biogas plant on the ship. However, since the substrate is probably not particularly suitable for high amounts of biogas and requires a lot of know-how for safe operation, this idea was shelved for the time being, but should be calculated in detail again if the project is actually implemented.

8.6 NICHE EXPERIMENT

DonAutonom as urban living lab (ULL). DonAutonom houses several experiments dedicated to questions of self-sufficiency and use of resources. It is an experimental space for future urban, sustainable, and simpler life. Many different projects which could be scientific, artistic or practical in nature, could take place in parallel on subjects concerning e.g., energy technology, sewage, urban gardening and farming, new forms of coexistence and subsistence etc., with the ULL DonAutonom serving as an organizational bracket for all of the projects and initiatives. The organizers of these initiatives live on board. Through the cooperation with a funding agency/consortium it would even be feasible for the ULL to be the first project to also be entrusted with the search and selection of further projects, functioning as a kind of alternative innovation centre. There are therefore two main areas of investigation for the first

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implementation project of DonAutonom: firstly, there are several technologies and concepts for self-sufficient sustainable living being tested and secondly, approaches for an innovative governance structure are explored for the ULL.

The reused cargo ship for DonAutonom has been fitted with a lower deck where technical rooms and common areas are located, and on which three more container decks are stacked. The first deck consists of the living units, the second deck consists of a mix of living units and raised garden beds, and the highest level is exclusively used for raised garden beds. It is feasible to also implement chicken coops. These are elements which must be tended daily, requiring the inhabitants to have an interest in these activities and self-sufficient living. Within the common rooms of the lower deck activities can be held to invite members of the neighbourhood to explore the technologies and concepts of sustainable living that are being experimented with on the ship. The inhabitant-mix includes research teams which can also include students. Efforts are made to recruit individuals with a strong interest in self-sufficient living who are open to living on board for a temporary amount of time and engage in the experiments. The inhabitants are re-sponsible for the maintenance of technologies and care for the plants and animals on board, including documentation e.g., in the form of field diaries, whereby they are divided into teams re-sponsible for the separate experiments taking place (e.g., growing crops in the raised garden beds, the conversion of biogenic waste and faeces into biogas or the organization of classes for the neighbourhood in the common rooms). The teams meet regularly to exchange news and experiences, identify ways how their projects may enrich each other, and make joint decisions. A representative of a funding agency is invited to participate in these meetings to assist in the process of formalizing DonAutonom as an organizational bracket for a number of projects and initiatives with the ability to engage in the selection of new projects and become an innovation centre for sustainable living.

The experiments conducted within the context of DonAutonom run in parallel and can have varying durations, with new teams moving in with new experiments once an old experiment has concluded. One research team in charge of observing and managing the governance system, however, remains as a more permanent fixture to provide continuity and ensure the smooth running of DonAutonom as an innovation centre where multiple experiments can take place. The objective would be to develop a cooperation with a funding agency and be entrusted with the search and selection of further projects. During ongoing operations, it would have a similar organizational form and content orientation as an innovation centre that looks after the individual initiatives like an umbrella company, presents results and stimulates developments. All individual initiatives should be represented on the board of the ULL. This would require an innovative governance structure, such as a sociocracy administration. In this way, DonAutonom could develop into an international magnet for urban sustainable innovation.

8.7 INNOVATION ASPECTS, CRITICAL ISSUES AND OUTLOOK

DonAutonom primarily revolves around self-sufficiency and autonomy regarding the use of re-sources, the supply with energy and food, but also regarding the internal governing structures. Rainwater and river water are collected and reused as service water, and biogenic waste and considerations regarding generation of biogas were undertaken. A number of raised garden beds are used to grow food, and it is possible to add coops for chickens to produce eggs. Semi-transparent solar panels are applied to the roof and walkable solar panels function as walkways along the side of the ship. It is feasible that "DonAutonom" could be an organizational bracket for several projects and initiatives, even cooperating with a funding agency and engaging in the selection of new projects with its own governance structure. The projects and initiatives could expand to include art for instance, and the exploration of new forms of coexistence and subsistence. "DonAutonom" involves multifaceted activities and seeks to explore the future of urban sustainability.

In Vienna, Binnen Bleiben would be novel approach, since there is no tradition of living on ships, as there would be in other cities. While a resource-based partly self-sufficient ship might even trigger associations with Noah's Ark or similar, the project team is not aware of any example in which closed loops would have been the focus. The aspect of transforming containers into living units and including spacious areas for green roofs and gardening and socializing is not unheard of, for example Urban Rigger (see Figure), a student accommodation in Copenhagen (Urban Rigger 2020).

Figure 83: Already existing examples concerning similar aspects in Vienna: Urban Rigger, Denmark[84]

The interdisciplinary team also conducted a SWOT-analysis for this scenario, which is summarized in the following table. The matrix shows the main strengths (innovations), weaknesses, opportunities and threats (risks). For additional risk considerations please see Deliverable D5 (theoretical risk assessment report).

[84] https://www.urbanrigger.com/view-urban-rigger/

Table 18: DonAutonom / Binne bleiben - SWOT analysis

SWOT: DonAutonom / Binnen bleiben	
Strengths - Use of existing structures - Mobile temporary housing model - Partially self-sufficient resource supply on board - Use of water areas for residential purposes - Test opportunity for (partly or) fully self-sufficient systems	**Weaknesses** - Increased risk for certain groups of people (children, etc.) - Preliminary phases / extensive pre-check (planning, examination of safety agendas (statics, fire safety, accessibility, potential contamination, ...) - Increased coordination and maintenance effort - Restricted choice of materials and technologies - Conflicts of use with public space
Opportunities - Learning spaces are created - Relatively flexible use in other cities (with navigable rivers)	**Threats** - Potentially difficult connection to (technical) infrastructure - Lack of (site) availability - No explicit / appropriate legal framework (in Vienna) - Possible energy shortage during fully self-sufficient operation

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10 FIGURES AND TABLES

11 ANNEX

11.1 DETAIL PLANNING AND FINETUNNING / PROCESS DESCRIPTION

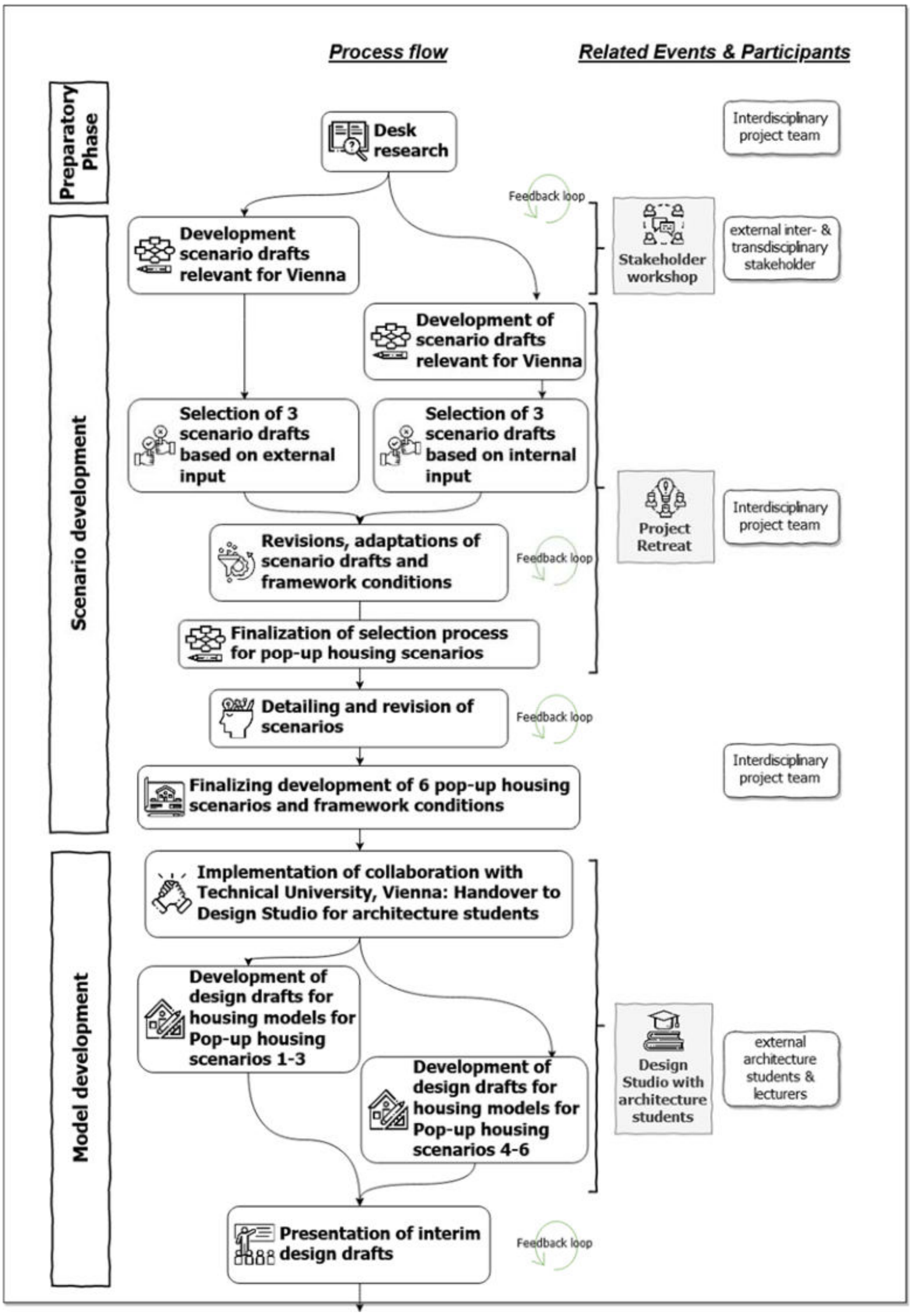

Figure 84: Process Flow of WP 3 (part 1 of 3)[85]

[85] This chart was created by Zeilinger using resources from diagrammeditor.de and Flaticon.com; The icons were designed by Eucalyp, Surang, freepik, icongeek26, phatplus, bqlqn,dDara, geotatah, prettycons, golubev, umtimatearm, flat_icons and pixelmeetup.

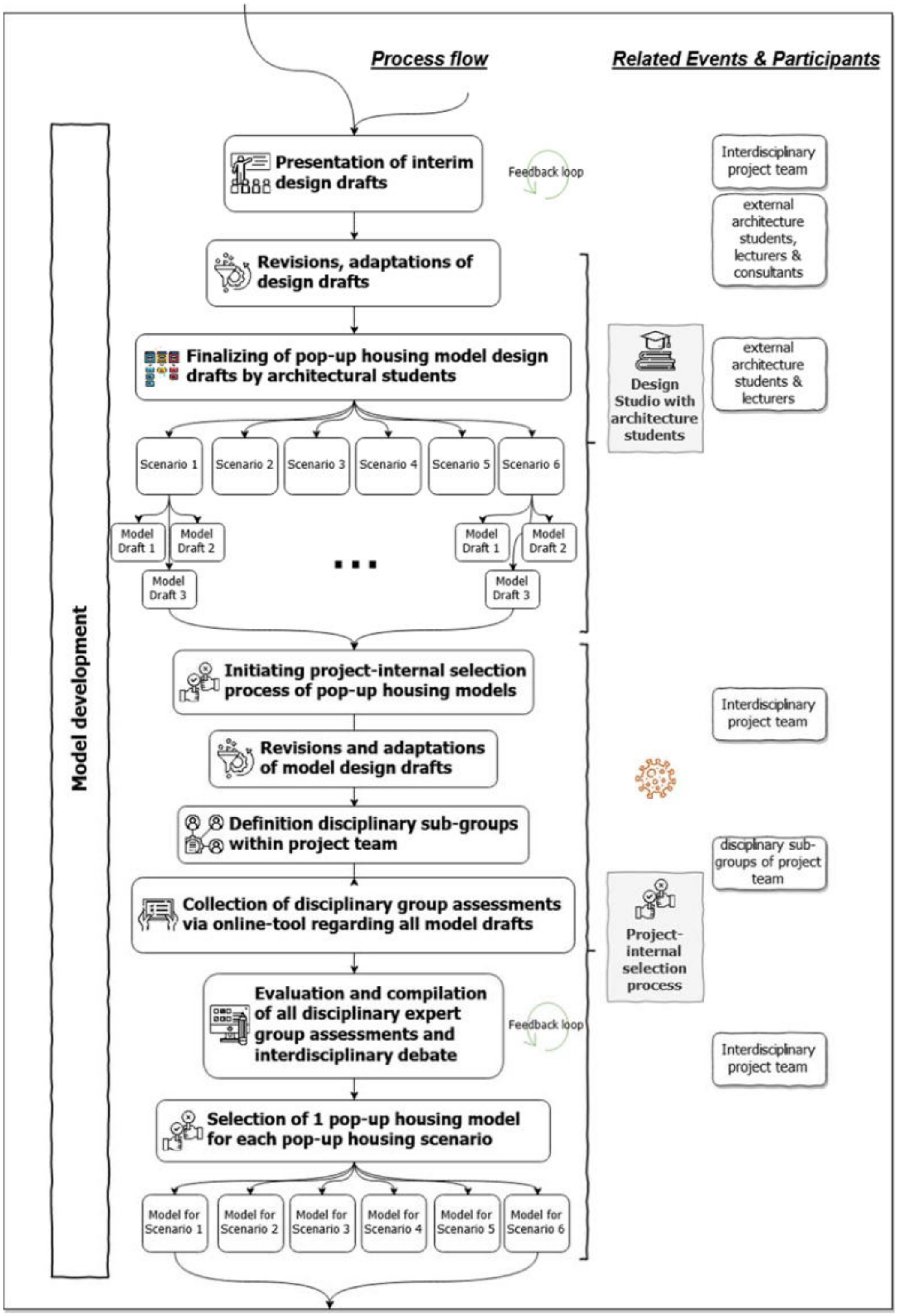

Figure 85: Process Flow of WP 3 (part 2 of 3)[86]

[86] This chart was created by Zeilinger using resources from diagrammeditor.de and Flaticon.com; The icons were designed by Eucalyp, Surang, freepik, icongeek26, phatplus, bqlqn,dDara, geotatah, prettycons, golubev, umtimatearm, flat_icons and pixelmeetup.

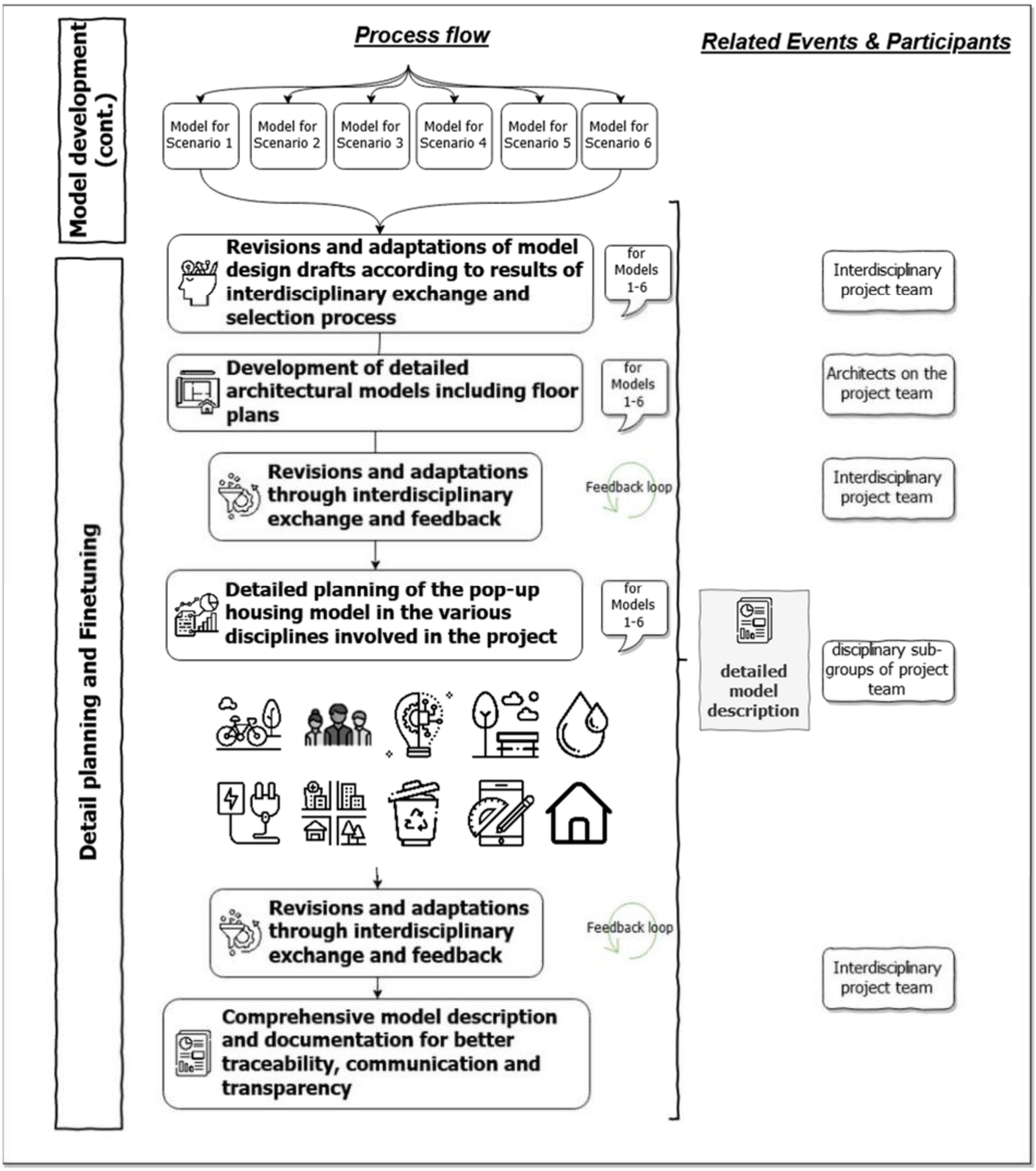

Figure 86: Process Flow of WP 3 (part 3 of 3)[87]

[87] This chart was created by Zeilinger using resources from diagrammeditor.de and Flaticon.com; The icons were designed by Eucalyp, Surang, freepik, icongeek26, phatplus, bqlqn,dDara, geotatah, prettycons, golubev, umtimatearm, flat_icons and pixelmeetup.