Temporary urban environments - framework conditions and solutions for sustainable short-term pop-up living systems

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Abstract. In a constantly changing world, cities are becoming a focal point for housing in times of social and political crisis. Subsequently, the need for temporary living systems, particularly in urban environments, is expected to increase significantly. To address these urgent demands, it is important to find affordable, flexible, sustainable and reusable concepts, easy to construct and rapid to implement, that can fulfil a range of requirements in order to be sustainable from an environmental, economic and social perspective. In an interdisciplinary research project innovative and sustainable models for pop-up living systems in urban environments are developed. Methods from urban planning, architecture and building systems technologies are interlinked to resource related disciplines such as energy optimization, green technologies, waste management, water supply, wastewater treatment and social and political sciences. Diverse modelling approaches are integrated into a cross-disciplinary approach to provide potential scenarios for pop-up environments. This paper describes the required framework conditions and presents potential solutions for temporary environments for specific scenarios, aiming at delivering answers to the question of how temporary housing can rapidly fulfil short-term living needs in a sustainable and integrative manner.

1. Introduction
In modern society characterized by political and social crisis, cities and their sustainability are becoming a focal point of discussion. The worldwide rise of the urban population, change of family structures unit, rising real estate costs and migration are all factors that influence cities and their urban development. The need for living systems in urban environments is expected to continually increase and new habitability models to answer current social questions are needed. To address these urgent demands, the development of pop-up environments can offer a potential solution. These structures are intended to only temporarily occupy the ground as due to characteristics such as lightweight technologies, fast and easy assembly–disassembly and flexibility they are adaptable to different uses and target groups. Thanks to their temporary nature, they are usually designed following economy, construction reversibility and environmental sustainability principles as they are open for various life-ending possibilities, such as reuse or recycling, and with advantages in terms of speed and affordability that normally would not be achieved with a traditional permanent design [1]. Temporary pop-up environments could present alternatives to fill the gaps left by unsuccessful urban policies and offer the opportunity to study unconventional solutions, allowing quick and flexible answers and circumventing potential bureaucratic planning procedures. Therefore, the temporary nature of pop-up
environments can allow to plan city development in the short-term perspective, envisaging the creation of structures that meet the current needs of the community, without compromising the future development of different activities [2]. Despite being a fairly new topic, in the literature it is possible to find several fields of application in which pop-up environments have been realised. The first examples of pop-up environments occurred in the so-called “pop-up retail” trend of opening short-term sales spaces that last for days or weeks before closing down. Then later, temporary pop-up environments have been used in emergency contexts due to natural disasters, such as earthquakes, to be intended as places that serve the function to shelter people until they are resettled in a permanent place to live, allowing them to return to their normal activities [3]. The financial crisis, the migration flows and the global population growth has as well encouraged the use of temporary pop-up housing that can be economically and rapidly implemented. Finally, pop-up environments have been used as a method of re-appropriation of spaces cut off from the city, as in the case of vacant plots and empty buildings, before a future permanent destination is identified, or in contexts of densely populated urban areas, where there are practical and legal limitations due to the rigidity of urban plans and the preservation of historical heritage. It appears clear that the global need for temporary housing is expected to increase [4]. The present research paper aims at setting out a preliminary study of pop-up environments in order to provide recommendations for research, policies, and implementation for the realization of temporary strategies that allow an appropriate, healthy, and sustainable development of the city. The purpose of this study is not to imagine them as replacements of traditional construction, but to suggest their use in the cases where modern urban planning fails to propose adequate solutions and where a temporary approach could be more appropriate, allowing the accomplishment of the Sustainable Development Goals (SDGs) considered in the 2030 Agenda for Sustainable Development, in particular regarding the path towards “Sustainable cities and communities” (SDG11).

The present paper is part of the research project “Urban Pop-Up Housing Environments and Their Potential as Local Innovation Systems” funded by the Vienna Science and Technology Fund (WWTF), that aims to research urban systems in an interdisciplinary manner and focusing on the investigation and evaluation of existing temporary housing options and the creation of innovative models of pop-up living systems in urban environments.

2. Research approach

2.1. Criteria and requirements

New methods and tools are needed for sustainable urban development strategies, and the use of pop-up environments, understood as something that is deliberately programmed to be temporary, can represent a possible solution. But, following which criteria should pop-up environments be realized? What are the requirements that their design should be based on to positively contribute in the context in which they find themselves? A critical evaluation was carried out by identifying the requirements that pop-up environments and temporary structures must have in order to satisfy the needs of users. Firstly, such as for the realization of a good traditional architecture, the Vitruvian triad have been considered. Based on this triad, architecture must be equipped simultaneously with **utilitas**, **firmitas** and **venustas**: an architectural construction must, at the same time, guarantee structural stability and provide a functional and productive use of space that is also pleasant and liveable. This can be translated into general requirements, valid for both permanent and temporary structures, such as structural stability, good space arrangement, adequate insulation and beauty to be accepted by users.

Furthermore, it is possible to define requirements strictly associated to pop-up environments and their temporary function, outlining them into main categories related to the design, construction, operation, and after-life phases of the temporary building. In the design phase, important requirements are modularity and flexibility of use. Modularity is the degree to which a system's components may be separated and recombined, allowing the possibility of having different units' types starting from the same modules. The chance of expanding or altering a basic element is undoubtedly the simplest and most suitable method to meet ever-changing needs. On the other side, flexibility of use is the ability to
produce structures that can evolve and adapt to changes in users’ lives. A model of flexible habitability can respond to new social demands characterized by changes in family units, inaccessible property costs, and support for the enormous masses in movement. In the construction phase, important requirements are speed and simplicity of realization. Often, the fulfillment of these requirements is implemented through the use of prefabrication, process in which the elements of the construction are made off-site with industrial machinery and then assembled with codified procedures, with advantages from a technical, economic, and environmental point of view. The standardization of components and modules, with lightweight and high-quality products manufactured off-site, ensures fast transport and storage, ease of assembly and quick installation of the entire system. Regarding the operational phase, the most important requirement is the affordability, because pop-up environments, if compared to traditional permanent architecture, mostly consist of cost-effective solutions. This is mainly due to the fact that the users to whom pop-up environments are addressed to are often characterized by a precarious economic availability such as people struck by disasters, students, migrants, or low-income families that are unable to compete with the rising real estate costs.

Finally, important requirements for temporary pop-up environments are reversibility and sustainability, which define their role once their functional life is exhausted. The reversibility of the construction system depends on the attitude to retrace the steps of realization backward without requiring a high complexity of the disassembly operations, thus as the capacity of a constructive process to return to the starting point “without leaving traces.” Sustainability is the process of change in which the exploitation of resources, the investment plan and the orientation of technological development are all in harmony and enhance current and future potentials in order to meet the needs and aspirations of users [5]. Sustainability is obtained by an adequate life cycle management, especially as regards to the possibilities for the end-of-life. Reuse and recycle contribute to the reduction of energy consumption and related emissions of the construction sector, which is the largest rate of global pollution. Furthermore, pop-up environments should meet eco-efficiency requirements, with the aim of having them use very little energy for their operation and following cutting-edge construction criteria. These strategies use passive systems, involving the exploitation of resources provided by the surrounding environment (solar radiation, winds) through the correct design of the shape, orientation, and envelope and the use of plants that use renewable resources.

### 2.2. Fields of application

Having defined the general criteria and requirements that characterize the pop-up environments, it is interesting to highlight some case studies, implemented in the most diverse geographical and morphological contexts and focusing on their contribution to urban development. Although the different contexts have very different characteristics, it is however noticeable how the use of pop-up environments for temporary use has substantially responded to general needs and interests [1].

One relevant context of application of pop-up environments is related to vacant land use, intended as untenanted areas of the city that, due to a variety of reasons, has completely lost its original function. These areas usually have a negative impact on the environment around them and the presence of apparently useless spaces is unacceptable, considering the demand for open and public spaces. In this context, the possibility of using pop-up environments can allow for the reconnection of these vacant areas with the city in a fast and affordable way [6]. An interesting example of a temporary project in vacant areas is the “Limite-Limite tower” in Brussels, a nine-meter-high building, with an exterior in plastic and metal applied to a wooden structure. The aim of the project, carried out by the local community, was to create a public space in an impoverished area of the city. For five years, it was the site of exhibitions and workshops, allowing the community to regain possession of an otherwise abandoned site. In 2004, the tower was dismantled, and the material was shipped to Northern Ireland, where it was used to build a new pavilion in the Belfast botanical garden. Another field of application deals with the theme of reusing empty and abandoned buildings as a “shell” for the realisation of pop-up environments. The reuse of empty buildings has many advantages, being potentially cheaper and environmentally friendly, having a positive impact on the quality of life in...
neighbourhoods while preserving the memory of the past, but often their renovation entails huge costs. In this context, the use of pop-up environments would allow for the temporary use by the community without compromising any future permanent use and avoiding heavy renovation work in favour of simple safety measures and routine maintenance [7]. A fascinating example of this type of intervention is the NDSM Wharf in Amsterdam, a large abandoned industrial building in a central urban area of the city. With the aim of establishing a strong settlement core, an association of local artists and urban planners created a 10-year temporary reuse and management project. The strategy put in place consisted of the use of prefabricated units for the creation of ateliers and places of work, to be let at affordable prices for different periods. Following the success of this temporary experiment, the project duration has been extended and is still to date active and an integral part of the city. A third field of application deals with the theme of pop-up environments in central urban areas. Those city centre spaces are defined by a layout restricted by economic, technical and legal limitations regarding the possibility of carrying out new urban interventions, both public and private. In this context, pop-up environments can provide an opportunity for the construction of new infrastructures, allowing for flexible structures that can avoid some potential bureaucratic planning procedures, and providing viable alternatives that temporarily enhance the quality of urban spaces and allow business opportunities [8]. An interesting example of such a temporary intervention was implemented in 2005 in Vienna, with the “Add-On 20 Höhenmeter” project. This huge architectural installation consisted of a 20-m-high platform in which space modules were fitted together using low-cost light prefabricated structures based on a scaffolding model that lasted for six weeks. As a freely accessible environment, this structure allowed visitors to explore new views, offering a range of outlooks at various levels, and the result was a fascinating variety of perspectives on everyday life. At the end of the temporary use, the tower was dismantled, and a large part of its components were recycled.

3. Conclusion
The analysis shows how the use of pop-up environments has had a positive impact in the most diverse contexts that often represented a limit or a problem for urban planning due to their intrinsic nature. The temporary nature of pop-up environments is characterized by the changeability of the functions and destinations of use while maintaining recognition and local identity. They are a solution to specific temporary needs of function and use, susceptible to continuous modification and adaptability, integrating the permanent environment and completing it. The use of pop-up environments is supposed to increase sustainability, thanks to numerous advantages such as low cost, environmentally friendly construction processes, the use of raw materials with low embodied energy (including recycled materials, construction and industrial waste), reversibility of the project and time savings. research thus aims at providing recommendations for the implementation and development of associated policies of pop-up environments as temporary urban strategies that contribute to an appropriate, healthy, and sustainable development of the city.

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