Rimini Harbor Docks with Virtual Reality

Subjects: Environmental Studies

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The human factor plays an important role in the successful design of infrastructure to support sustainable mobility. By engaging users early in the design process, information can be obtained before physical environments are built, making designed spaces more attractive and safer for users.

Keywords: urban redevelopment ; human-centered design ; virtual reality

1. Creating Resilient Urbanism with Streetscape Design

The analysis began with on-site inspections to assess the urban and territorial system of the Canal of the Port of Rimini in Italy, illustrated in **Figure 1**, to identify deficiencies in terms of services, connections, availability of spaces, cycle-pedestrian paths, and carriageable roads [1]. This analysis led us to identify needs to support the functionality of the port as a whole, on the basis of which various alternative project scenario were proposed for the urban redevelopment of the Canal Port.

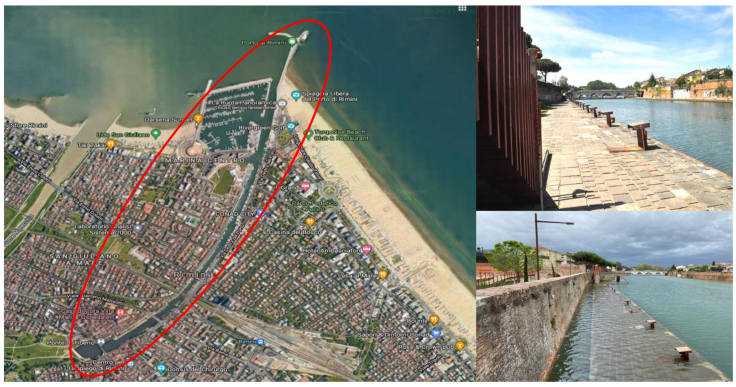

Figure 1. Canal of the Port of Rimini (in red) and pictures of its current quays. Imagery taken from Google Earth.

After proposition of a regeneration project of the canal by architects, described in [2], a before–after comparison between the design scenarios was necessary in order to evaluate the improvement of the future layout of the canal. Researchers decided to do this using virtual reality; the present research describes the scene construction and methodology used to visually compare the baseline scenario and the project situation. Using TwinMotion software, a model was created in virtual reality representing the existing infrastructure and current situation of the Port of Rimini. A second VR model was created, the post-intervention scenario, to analyze mobility and infrastructure in the study area by evaluating opportunities and risks in the new port area envisioned as part of the project.

The research previously begun in [1][2] suggests a method of supporting and justifying project proposals in the complex case of regeneration of port areas. The aim is to show how important sustainable mobility is within a deep urban redevelopment of a historical context, such as the Canal Port of Rimini. The reconnection of cycle-pedestrian paths, the redevelopment of the quays, and the creation of urban spaces for tourists and citizens are possible solutions to improve quality of life in degraded and underutilized urban areas.

The design phase began with the identification of the height to which to lift the docks in order to solve the problem of frequent flooding due to tides and adverse weather conditions. Following an in-depth hydraulic study of the area, raising of the quays was justified and verified. Access to platforms and public spaces was designed to identify new functions for the benefit of the community. As a result of raising the docks, the cycling and pedestrian paths along the two banks of the Canal Port were revised accordingly. The new cycle and pedestrian infrastructure can improve public health and make cities more active and environmentally friendly. Recent studies have shown that the regeneration of urban public spaces is

closely related to the presence of safe and connected cycling and pedestrian paths. The proposed solutions are currently being defined and refined, and could receive funding from the Municipality of Rimini to be implemented; however, they need to be validated.

The solutions proposed in this contribution represent targeted and specific interventions that are designed precisely for the context to which they are dedicated in order to make the Canal Port area a continuum with its urban context and to improve its perception by tourists and inhabitants. Although the proposed solution is tailor-made for this specific case, the developed approach is based on a strong scientific basis of urban regeneration projects founded on multi-criteria analysis and sets of indicators. The applied strategy can be replicated in any other similar case requiring an urban regeneration intervention. The benefits of this urban regeneration project include:

- Improved aesthetic quality of urban spaces
- Improved environmental quality of urban spaces
- Reduction of pollutant emissions through the increase in green and permeable areas
- Increased user flow (residents and tourists) in areas that are currently poorly frequented
- Increased social well-being of the regenerated area.

All these aspects could potentially result in higher economic productivity in the area. Better urban quality may lead to an increase in the real estate value of the area and implementation of new economic activities. As a future development of the research, it is proposed to deepen an economic feasibility study of the interventions. This should be convenient for the municipality, as it does not involve actions of deep urban transformation and demolition, only simple local interventions of renovation of public spaces. The proposed urban regeneration project focuses exclusively on the redevelopment of bicycle and pedestrian routes, and aims to represent a good example of how soft mobility plays a fundamental role in urban regeneration.

2. Virtual Scene for Streetscape Assessment

New urban planning and design tools making the use of public space more efficient are now being sought in all cities in order to build healthy and liveable urban environments and encourage the development of infrastructure [3]. Good urban planning should consider several aspects, such as the physical environment (location, climate, resources, etc.), the social environment (planning the right areas to promote socialization among people), and the economic environment supporting business [4]. The same global and integrated vision applies to urban regeneration, which aims to establish satisfactory government conditions for areas subject to transformation [5][6] and to make lasting economic, social, physical, and environmental changes by reducing problems towards a more sustainable city [7]. Urban regeneration is a new way of rethinking the use of space by combining and harmonizing economic, social, physical, and environmental issues in the same context [8]. Urban regeneration aims to redevelop abandoned areas and transform them into new attractive centers [9][10], encouraging inclusive growth of urban spaces. By focusing on social progress rather than on progress for its own sake, urban regeneration fosters the transition from an individualistic model to a more participatory one involving the development of collective thinking.

Urban planning and regeneration, along with model design, have always taken a very long time due to the many requirements involved in proposing ideas, looking for investments, presenting and adapting projects, etc. It is often months or even years before a project is approved and work can begin. Moreover, many projects are rejected because investors cannot obtain financing. In addition, the different needs and expectations of stakeholders and different perceptions of the project are sometimes not recognized or respected, and this may give rise to conflicts [11][12]. Shared urban regeneration planning is an opportunity to understand how stakeholders perceive urban heritage and how they can contribute [13]. Moreover, the participation and empowerment of stakeholders in the processes of planning and territorial regeneration is essential to overcome disparities of power and commitment of the different parties and possible lack of communication [14]. For this reason, stakeholders should be involved from the beginning to identify the criticalities of an area, rather than asking them about proposals for urban redevelopment after the project has been approved [15]. However, although it is important, few citizens participate in urban planning [16], and when they do it is unfortunately only possible to do so passively. Du et al. (2019) [16] asserted that this can lead to the exclusion of many people, resulting regret around urban projects when they are carried out. Thanks to technology, eParticipation and mParticipation have been introduced, and mobile web devices can be useful communication channels between institutions and citizens to facilitate the participation of a digital and network-connected society.

To encourage active participation in public planning, the right tools for understanding the scope of innovation should be identified. Citizens, investors, and stakeholders sometimes reject projects because of a lack of visualization and intuitive observation of how the resulting project may appear in reality [17].

An intuitive, engaging, and user-friendly approach such as VR is capable of offering a 3D vision of the project, and can be used to connect stakeholders and groups from different strata of society by bridging the information gap. Researchers in completely different fields, such as education [18][19], entertainment [20], health [21], and marketing [22] agree that the use of virtual reality improves learning experiences, promotes cooperation [23], and can enhance creativity and commitment [24].

3D models have been used in urban planning through CAD (Computer Aided Design) software for about thirty years. From the initial execution of 2D projects with maps presented on fixed screen or drawn or printed on paper, CAD has moved to support 3D virtualization [25] thanks to data access and the internet. The resulting maps are dynamic and highly interactive tools modifiable by a human by interacting with a computer, thereby becoming a real human processing system. Depending on the context, maps are likely to become increasingly interactive and intelligent in the near future, and may even be able to imitate the human brain [26]. In their paper, Jamei et al. [27] considered VR as the next step in 3D visualization.

Today, Computer-Aided Design technologies are among the most advanced tools for urban planning and modelling processes [28]. In this context, Virtual Reality (VR) is becoming common in urban planning and design [29]. By applying virtual reality technology, a project can be displayed on a computer, allowing architects and engineers to intuitively model, visualize, and observe the entire project in a realistic three-dimensional environment [30][31]. Adjustments can be made to the project to make it similar to the desired reality. Real objects and people can be placed and moved on a surface, and thanks to image recognition, these can be digitally recorded [32]. Depending on the hardware and software configurations available, the applications of VR in urban planning can be very different. Further studies on VR for architectural representation are recommended by [33], who highlighted its importance as an effective tool in urban planning.

The World Economic Forum has recognized that Virtual Reality in the public sector can help support citizen engagement, strengthen resource management and maintenance, improve public safety and emergency services, and aid in public health, sustainability, transport, urban mobility, common heritage, and tourism. In addition, virtual reality is a useful tool to demonstrate the efficiency of infrastructure initiatives by involving stakeholders in decision-making processes that directly or indirectly affect city life.

Two extremes of Virtual Reality can be recognized depending on the level of interaction with the artificial environment, namely, immersive or non-immersive. As the definition suggests, immersive technology allows users to feel fully immersed in virtual reality, blurring the boundary between real and virtual worlds [34][35]. Through a head-mounted display (HMD), the user is transported into a three-dimensional virtual world (3D), providing a truly realistic and more visceral experience than other models [36]. On the contrary, in non-immersive virtual reality the project is displayed on the screen of a computer, television, or mobile phone; no special devices are needed, and the user is not surrounded by a virtual environment [37] [38]. The difference in use between the two technologies is strongly affected by the context and the type of user they are directed at. A study of age-related differences was conducted in 2019 by Plechatá et al. [39]. The performance of the elderly was much higher when using immersive reality, while for the young it was unchanged. However, in both groups immersive reality caused stress and fatigue.

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