Urban scenarios: testing the Online What If? tool in Turin

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Summary

The contribution explores the application of the Online What If? planning support system, to identify the most suitable location for new university halls of residence in Turin (Italy). The tool can be used to create a digital model of the city and to make future projections of the allocation of these new residences. The implementation of this model demonstrated the planning support system's ability to collect, analyse and visualise large volumes of city data from different platforms and open data sources. Increased integration with cloud-connected platforms and digital tools such What if? can facilitate the creation of data driven scenarios, thereby assisting planners and policy-makers in shaping future cities and addressing future societal challenges more effectively.

KEYWORDS: Urban Scenarios, University cities, Digital Twin, Urban Growth, Planning Support Systems

1. Introduction

University halls of residence are the main accommodation option for off-campus students (Cenere et al., 2022; Gwosc, 2024). However, the growing demand for student accommodation also requires cities to adapt by expanding the services offered and developing dedicated spaces to meet their specific needs (Mangione, 2019). In this context, the possibility of exploiting cloud-based tools and instruments to support urban management represents a much-needed and relevant challenge (Borisov, 2022).

Underpinning the sustainable increase of halls of residence based on student growth predictions requires an understanding of how the city will transform and change in the future. This requires methods and analyses that allow the consideration of multiple variables and both spatial and temporal dimensions of the phenomena under investigation. The Online What If? tool (Pettit et al., 2015) has been designed to support spatial planning decisions by enabling multi-dimensional spatial analysis (Caprioli et al., 2023). This is achieved by integrating various relevant factors and criteria prepared using Geographic Information Systems (GIS) tools.

The tool is tested for the case study of the city of Turin (Italy), in order to identify suitable areas to be transformed into university halls of residences. The results of the application of the tool to the case study revealed the city's need to adapt to the ever-increasing number of new students by developing former industrial areas (now Urban Transformation Zones, ZUT) to ensure an adequate supply of services. The use of the tool further highlighted its capacity to manage substantial data from multiple sources while demonstrating resilience to minor adjustments.

2. Methodology

The location of new university accommodations is a complex urban planning issue in which several aspects come into play. The presence of services, efficient mobility infrastructure, and even proximity to green and leisure areas have been identified as very important variables for students. Consequently,

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to provide support to public decision-makers in these challenging circumstances, it is crucial to adopt tools capable of systematising all these variables and considering the spatial and temporal variability of data and phenomena. In this context, geo-information-based tools, known as Planning Support Systems (PSS), support the planning process by facilitating policy-making with integrated datasets, algorithms, and visualizations that create an informed decision (Geertman & Stillwell, 2004). Among them, the online What If?, developed as part of the Australian Housing Data Analytics Platform (AHDAP) https://www.ahdap.org/what-if1, is a tool designed to support the exploration of future urban growth scenarios. It facilitates the analysis of spatial and building expansion, as well as the identification of areas suitable for transformation in the case of a population increase (Pettit et al., 2020; Shamakhy et al., 2023). To achieve this, the tool generates various scenarios by considering different land uses, projected future demand, and urban growth as key determining factors.
The tool requires the implementation of four steps ("Project set-up", "Suitability", "Demand", and "Allocation") in addition to two preliminary steps carried out with a GIS tool (for our case study, the QGIS 3.22.11 software is adopted) (**Figure 1**).

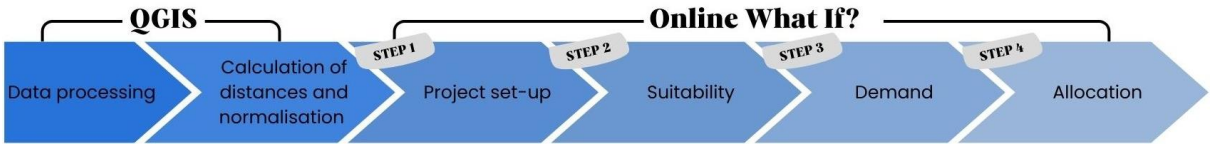

Figure 1 - Analysis steps

In the preliminary steps in QGIS, the spatial dataset is created collecting the land uses and the driving factors located in the study area. These driving factors represent the elements whose presence may have a positive or negative impact on the transformation (e.g. university buildings, public transport stops, etc.). Once all the elements are collected in QGIS, their distances from all points of the study area are calculated and normalised.
In the step 1 (i.e. set-up phase), the software requires the input of data calculated in the preliminary phase. Furthermore, it is necessary to define the two temporal parameters of the project, i.e. the projection period and the number of projections to be carried out, as well as to define the population growth trends. These latter trends are directly calculated by What-If? from the amount of population input in the reference year and previous years.
The second step (i.e. suitability phase) involves the identification of potentially transformable areas. In this phase, a score between 0 and 100 must be assigned to each driving factor, based on the importance of each in the construction of suitability. The result of the suitability phase is a set of maps, that use a gradient from red to green to indicate low to high suitability.
In the third step, the demand for land use is estimated. To do this, the number of baseline year dwellings, the future group quarter population, the future average household size and the future vacancy rate are data required by the software. Additionally, the software requires to include the assumed values for infill rate, which is "[…] the proportion of new housing units that is assumed to be allocated as "infill" to areas that are already devoted to residential uses" (Shamakhy et al., 2023), and the number of dwellings per km² (density).
In the last phase, the assumed demand is allocated in the territory, identifying the areas suitable for transformation based on all the data and parameters entered. The output consists of maps highlighting the transformable areas among all the suitable ones.

3. Case study and Data conceptualization

The tool is tested in the city of Turin (Italy), which experienced a transition from a purely industrial vocation in the first half of the 20th century to a role as a university city in the second half of the century (Cardoza & Symcox, 2006). The increase in student numbers has exposed a substantial deficit in available accommodation, with only 6,000 beds in university halls of residence, both public (EDISU Piemonte, 2024) and private (beyoo, 2024; Camplus, 2023; Campus Sanpaolo, 2024; Fondazione Collegio Universitario di Torino Renato Einaudi, 2024), for approximately 33,400 out-site students in the 2023/2024 academic year (Ministero dell'Università e della Ricerca, 2025). As a result, around 82%

of students are forced to look for temporary solutions or rent rooms from private individuals, exposing them to increases in the housing market.
To create the spatial dataset, it was necessary to classify the territory starting from Piedmont Land Cover data. Then, the territory was reclassified using analogous categories as in the What If? example project. Moreover, nine driving factors were selected for the Turin area concerning the construction of student halls of residence: university buildings, libraries and study rooms, public transport stops, train and metro stations, supermarkets, markets, green areas and sports facilities. For each element, distances were calculated using the NNJoin plug-in of QGIS, using information from various Open Data catalogues, such as the city of Turin geoportal or the Piedmont geoportal.
For the demand phase and to test the robustness of the model, several scenarios were developed, with particular attention to varying the infill rate and density data.

4. Findings

After testing different configurations of infill rate and density, the most effective scenario is shown in **Figures 2**, **3** and **4**. This scenario uses in the demand phase the inputs reported in **Table 1** and **Table 2**. These values led to the identification of areas that are more distributed throughout the city, with a greater concentration in central areas in 2026 and 2031, while shifting towards the city belt by 2036.

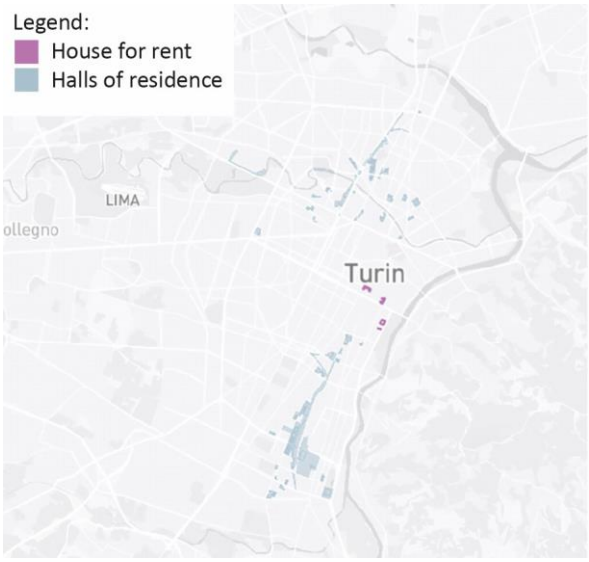

Figure 2 – Allocation map year 2026

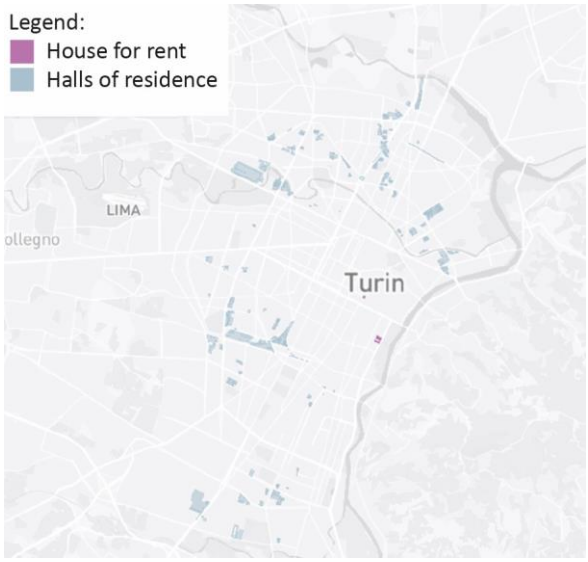

Figure 3 – Allocation map year 2031

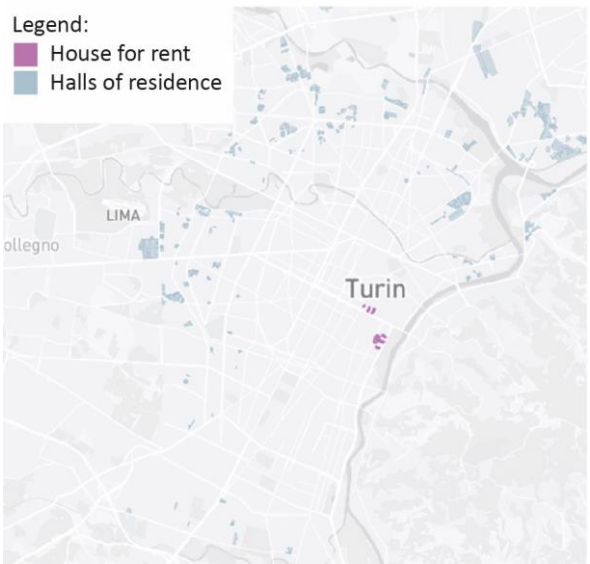

Figure 4 – Allocation map year 2036

Table 1 - Density Factors – Homes for rent

Projected year	Infill rate	Density
2026	0.98	3836
2031	0.99	3836
2036	0.99	3836

Table 2 - Density Factors – University halls of residence

Projected year	Infill rate	Density
2026	0.14	2000
2031	0.15	2000
2036	0.15	2000

5. Conclusions

The work presented the potential of the Online What if?, a tool capable of forecasting the future growth of the city and allocating new functions. The tool was used for the Turin (Italy) case study to identify the most suitable areas for new university halls of residence. The results support the choice of the most suitable areas for transformation by taking into account several factors and based on a vast amount of data. The outcomes are maps that facilitate debate and discussion within the decision-making process among the various stakeholders. Moreover, the methodology made it possible to integrate the spatial and temporal dimensions, obtaining future projections of the student situation. Furthermore, the ability to create a detailed representation of the physical space would make it possible the development of a digital twin of the city, which could potentially serve as a source of information for future governance models. In terms of future work, stakeholders involved in city dynamics, such as city administrators, real estate investors, urban researchers and students will be engaged to assign weights to the identified driving factors and any factor not yet considered.

6. Acknowledgements

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Christopher Pettit (PhD) – Scientia Professor and Director of the City Futures Research Centre UNSW Sydney. Prof Pettit's expertise is in the convergence of the fields of city planning and digital technologies including Geographical Information Systems (GIS) and Planning Support Systems (PSS). Prof Pettit is a Fellow of the Academy of Social Sciences Australia. He is a member of the Planning Institute of Australia's National Plantech Advisory Committee, the Federal Government of Australia's Urban Policy Network and the Australian Urban Research Infrastructure Network (AURIN) Scientific Committee.