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Decision Support System in Public Transport Planning for Promoting Urban Adaptation to Climate Change

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Abstract. Current land use policy in developed countries result in many new constructions sites and urban development. Depending on the geodesign solutions, newly developed areas may influence their citizens to use private or public transport. Therefore, to design more resilient and eco-friendly neighbourhoods, it is important to incorporate public transport planning at the early stage of urban planning. In order to promote urban adaptation to climate change it is crucial to activate citizens to participate in decisions making process related to the common space and available facilities. Suitable for this purpose are the right tools for the presentation of various design solutions. This group of tools is called decision support systems. The aim of the research is verification of the suitability of the use of decision support system (CommunityViz) for public transport planning at the level for a master plan (local planning). The paper presents the possibility of using the CommunityViz system to create various scenarios of accessible public transport. Simulations were performed on the newly designed housing area in San Sebastian (Spain). The designed model for the neighbourhood was used during the workshop with citizens of San Sebastian, to incorporate their knowledge as local experts. Based on the master plan, three scenarios of bus stops location were proposed. The dynamic model enabled to assess how many citizens may probably live in acceptable distance to bus stops, which may reflect the number of people for whom public transport may be an attractive solution for transportation needs. The results showed high usefulness of the analyzed decision support system to solve the problem of public transport designing. Intuitive graphical presentation makes different variants clearly identified by all stakeholder groups.

1. Introduction

The current process of urban development results in the high level of land consumption, mostly for residential purposes [1]. This phenomenon involves social [2-3], economic [4-5] and environmental consequences [6-7]. This phenomenon is so called urban sprawl [8], however, in many European studies is described as suburbanisation [9]. However, that is not the only possible pattern of future urban development. Contrary to urban sprawl the compact city idea is promoted as an alternative way of sustainable urban design [10]. This paradigm is based on assumption that the density of build-up areas is higher, urban structure improve social relations by creating public spaces, include accessible green urban areas, and finally is economically feasible. As a result, it is a way to find a balance point between social, environmental and economic issues, positively influencing quality of life [11]. In the field of


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transportation issues, compact cities help to mitigate environmental problems as long distance journeys influence water pollution [12] and car transportation and low emission are the main sources of air pollution [13]. Compact city with close proximity to many services might be also an answer to current global challenges for instance ageing society issue [14-15]. Therefore, implementation of solutions that will help to mitigate negative environmental impacts support cities to adapt to climate change, and influence on more resilient urban areas.

Due to higher level of social understanding and awareness of urban design processes, there is a need to involve citizens in decision making process. That can refer to many aspects of urban planning, e.g. land use [16-17], transport [18-19], energy [20-21] and water demand [22]. Different decision support models can be used depending on the level of the analysis (national, regional, local) and, therefore, are prepared for different stakeholders. As mentioned, one of the fields of local management that can be supported by those tools is public transport. The development of that aspect is especially important to prevent future problems caused by traffic congestion. Local authorities can mitigate that problem by planning sufficient public transport solutions which would be suitable for the needs of citizens. It aims to improve the quality of life [23], but from the economic side, it is often a heavy burden on the municipal budget [24]. However, in holistic assessment of urban metabolism it seems to be the most optimal way for sustainable management to invest in public transport and to offer high quality of transportation services to citizens [25], implementing at the same time urban adaptation to climate change actions.

The aim of the study is check suitability of the use of decision support system for public transport planning at the level of master plan (local planning).

2. Method and research area

The research was conducted with the use of scenario analysis in geographical information system, ArcGIS software (version 10.3.1) with CommunityViz extension. The model includes (1) masterplan and (2) planned bus stops in shapefile layer version (vector format). For the purpose of created model, the bus stops layer was made dynamic in order to allow recalculations in the real-time. The model was tested during the workshop organised with the citizens of San Sebastian in order to verify the usefulness of the model during public consultations process.

The case study presented in the research is the masterplan of Auditz Akular, the district of San Sebastian (Spain). San Sebastian is located in mountainous part of Spain (the Basque Country) which influence irregular road network in some parts of the city. However, the masterplan used in the study contains geometrical road network, based on repeatable pattern.

3. Results

The decision support model build for the purpose of the research include fixed features based on planned land use structure and the location of buildings and an assumption describing acceptable distance to the bus stops. The assumption allows the users to modify the values due to local conditions. Some studies claim that the acceptable distance to the bus stops is 400 m [26], however, taking into account mountainous character of the area and cultural issues that value may be different locally. The assumption can be freely edited by users on the simple and intuitive slider (Figure 1). This form of presentation of the objectives is to maximize readability. It may be, therefore, accessible to the participants of public consultation. The defined initial value of the variable in this example was set at 400 meters, however, due to the workshop organized in order to test the model, final results were based on smaller value due to participants' opinion. Nevertheless, you can edit the value of the assumption using the slider, and after accepting all the changes the formulas are recalculated with the new principles of calculations.

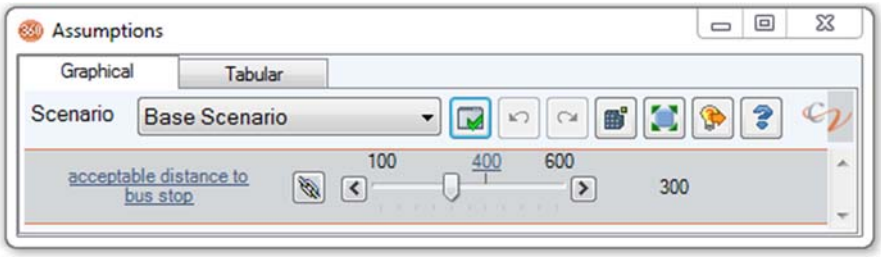


Figure 1. Edition of the assumptions values

This operation is possible by the use of the CommunityViz dynamic layers. After creating a new one or converting the existing layer into a dynamic layer there is a possibility of such a formulation of attributes that the value of the records is not introduced directly. Final values are characterized by a written formula, so that after each change of the scenario, the results are updated.

The modification of assumptions is not the only possible modification. Users are able to change the location of objects in the space which also influence calculations, and finally results of each scenario. In case of the workshop, such bus stops were editable objects. Participants were modifying the location of bus stops while checking the effect of their actions. The iterative process of calculations allows them to identify the impact of their decisions automatically. There was no need to first decide about final version of each scenario and then see the results. Therefore, the model not only enable indicator-based evaluation of the scenario of future actions but also helps in explaining the impact. That can be defined as social innovation as technological solution supports people in their decision making tasks.

Based on the constructed model, three alternative scenarios were created during the workshop. Each of a new scenario had a slightly different allocation of the bus stops, additionally all scenarios had smaller than default value of acceptable distance to the bus stops. In order to illustrate the results of the workshop scenario comparison by maps (Figure 2) and by indicators (Table 1) was prepared.

Table 1. Parameters of scenarios

Scenario	Acceptable distance to the bus stops (assumption)	Approximate number of citizens (indicator)
Base scenario	300	11 132
Workshop #1	300	11 659
Workshop #2	300	10 911
Workshop #3	250	10 087

The basic assumption for acceptable distance to bus stops was 300 m. This value was changed only in one workshop scenario (Workshop #3), however, it can be seen that it did not change the result of analysis significantly. While developing new scenarios, participants were changing locations of bus stops, and after the exact location was accepted by the group, they decided to propose a final layout of the scenario. It is important to highlight that during discussions not only the location of bus stops was debated. Participant were also discussing possible routes of a bus lane. Therefore, we can say that they understood the context of the workshop better.

In each scenario houses situated closer to the bus stops have lighter colours, while others have more intense red colours. This information shows the stakeholders which parts of the area be supported by better public services in the future and what should be the direction of change and the development of this form of transport in order to offer people similar quality of life.

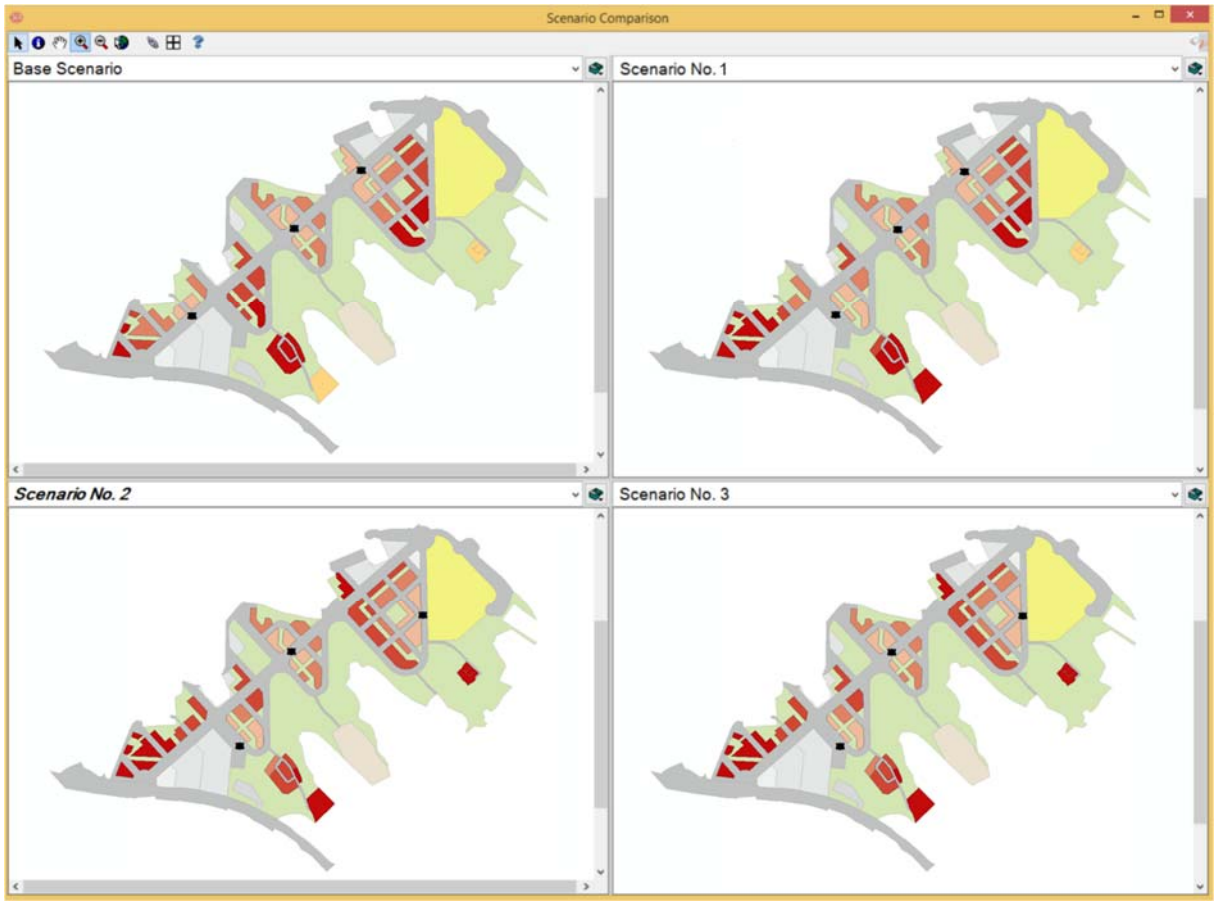


Figure 2. Scenario comparison – bus stops location.

4. Conclusions

The decisions support model constructed for the purpose of the research demonstrated high usefulness in modelling the public transport with simultaneous simplicity of its operation. A low level of complexity of the system makes it applicable in participatory planning and sustainable local management. Its service is so intuitive that the participants of public consultation, who are laymen in the field of information systems, can easily understand the mechanisms by which the final score is calculated. Simple analysis of generating results easy to interpret are often sufficient data for decision-making, where the participants are the representation of different interest groups. The workshops that have been conducted fulfilled the concept of governance by incorporating citizens in common goods management process [27].

The Community Viz gives great opportunities to modify the numerical assumptions which form the basis of spatial calculation. It gives the opportunity to build separate scenarios of the development and the possibility of editing features of spatial objects. Through the use of dynamic layers, based on the formulas that generate the final results of attribute data, making changes to scenarios is accompanied by automatic update of the indicators. A clear presentation of the data makes it easy to determine the possible effect of modifying an acceptable distance from public transport. Changing the location of bus stops can automatically generate a collection of buildings serviced by public transport. The simulations showed that the CommunityViz has the characteristics that should characterize the decision support system used in sustainable local management for adaptation to climate change and can be incorporated in participatory planning. Moreover, for better understanding of spatial development problems, 3D visualisation can be used in order to make the discussed issues more intelligible for the decision-makers

[28]. All in all, the direction of involving indicator-based assessment into transport management is a current trend, which is promoted for instance in Sustainable Cities Mobility Index [29].

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