Full abstract

Many societal and ecological challenges of the 21st century are characterized by complex interconnected feedback mechanisms. Urban planners and decision makers find themselves simultaneously confronted with, for instance, matters of competing land use interests, demographic change, urban heat islands, good ecological conditions, local supply by services of general interest, gentrification and social segregation. In order to gain this evidence basis and to assess the consequences of certain planning strategies, it is crucial to think systemically and to have an understanding of the dynamics of these highly interconnected urban systems. However, given their great complexity, foreseeing numerous possible cause-effect pathways of certain planning strategies is an intricate task.

Systemic simulations provide informative assistance for urban planners and policy makers in order to meet the interconnected challenges of complex urban systems and to estimate consequences of specific planning strategies. In the last couple of years, a considerable number of theoretical and applied studies provided suitable simulation platforms as decision support tools by combining aspects of system dynamics and agent based modelling. Most of these tools, however, require great volumes of data input, intensive data preparation, programming, modelling, analysis or other specialized technical skills. A deficit in financial and staff resources is a universal phenomenon among city administrations. Consequently, spatial simulations are usually hardly applied in practice, and particularly in municipalities of small size, the use of simulations and latest software tools can be expected to have even less priority among day-to-day planning routines. Accordingly, systemic feedbacks and respective reasonable measures are usually not considered for urban planning strategies for these communities. Another drawback of most spatial simulations for urban planning is a predominant technical perspective rather than addressing the overall well-being of citizens which is the main objective of urban planning.

This thesis aims to mainstream insights on complex systemic feedback behavior into practically applied communal planning processes. This requires the simulation platform to be cost effective, easy-to-use by non-technical users, automatically handle data preparation and utilize the overall well-being of citizens as its main benchmark. It approaches these objectives by an integration of (1) mixed quantitative and qualitative methods for measuring spatial attractiveness as a benchmark for urban simulations, (2) automatically integrating mixed data from various data sources for cross-scale analysis and (3) integrating system dynamics and

agent-based modelling with the gamification approach and geostatistical techniques (Fig. A1). By investigating and exploiting synergies of this mixed methodological approach, a novel platform for spatial simulations of urban systems (SimUSys) was developed which is easy-to-use by non-technical users.

As an empirical part of the thesis, SimUSys was applied for three use cases regarding suitable positions for new infrastructure facilities in the cities of Bochum, Herdecke and Herten which are considered representatives for large, medium and small sized cities in a post-industrial area, the Ruhr-Area in Western Germany. These use cases revealed sites for new facilities of basic goods and services which were most appropriate for increasing the spatial attractiveness.

The presented framework for exploiting mixed methodological synergies which was implemented as an easy-to-use simulation platform is suitable for practical application in everyday administrative municipal planning processes. It thereby facilitates the mainstreaming of systemic thinking into applicable planning measures, provides an evidence base for more informed cross-silo communication and cooperation and thereby contributes to more targeted, expedient and sustainable urban planning.

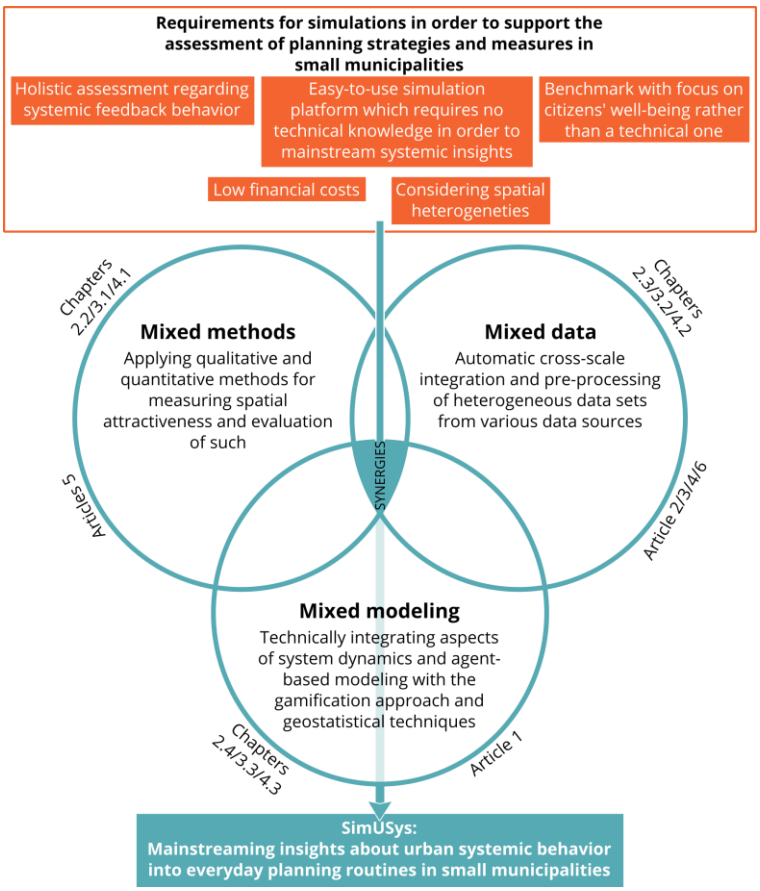

Fig. A1: Graphical abstract (see chapter 1.4 for more information) - Overview of the integrated application of mixed methodologies (blue circles) and exploitation of their synergies in order to fulfill the requirements for SimUSys (red squares).