Doctoral Dissertation
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Toward resilient cities: assessing urban resilience performance using a System Dynamics Model-based approach

By

Giulia Datola
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Supervisors
Prof. Marta Bottero, Supervisor
Prof. Elena De Angelis, Co-Supervisor

Doctoral Examination Committee:
Prof. Ivan Blecic, Università degli Studi di Cagliari, *Referee*
Prof. Grazia Napoli, Università degli Studi di Palermo, *Referee*
Prof. Maria Cerreta, Università degli Studi di Napoli Federico II
Prof. Chiara D'Alpaos, Università degli Studi di Padova
Prof. Giulio Mondini, Politecnico di Torino
Prof. Ana Jacinta Soares, University of Minho (Portugal)

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Summary

Cities face continuous challenges and additional stresses concerning the supply of essential services, job creation, health coverage, education offer, land use, and management of natural resources, among others. Furthermore, urban systems are also exposed to several natural shocks, increased due to climate change (Berke et al., 2021). The global community is thus striving to enhance and improve urban resilience for cities to make them able to adapt and transform themselves to face these stresses (Da Silva & Moench, 2014; Gencer, 2017). Planning for resilient cities is thus recognized as a critical target of the current urban agenda (Johnston, 2016; Masnavi et al., 2018; Vaništa Lazarević et al., 2018; Wardekker, 2018). This challenge is pursued at a different level of action, from the international (Gencer, 2017), to the national (Consiglio dei Ministri, 2021) and local level (Roberts et al., 2020; Spaans & Waterhout, 2017). The target of making cities resilient involves the emergence of new operative needs, as well evaluation tools able to assess the urban resilience performance of urban systems both at the current and the future state (Schwind et al., 2016). Following these new requirements, this thesis proposes a SDM-based approach to evaluate the performance of urban resilience (URI) and urban resilience capacities (URCs) at the current state and to address the potential URI and URCs of urban systems in the future. The proposed evaluation framework is an indicator-based model grounded on the integration of Multicriteria Decision Analysis (MCDA) techniques with the System Dynamics Model (SDM). Indicators are thus used to construct the SDM and perform the evaluation through MCDA. The SDM is applied to address the complexity of urban systems, as well to provide the simulation of the dynamic behavior of cities according to the evolution of current conditions and strategic scenarios. MCDA techniques are thus used to get the synthetic indices of URI and URCs, referred both to the current state and the future state of the urban system, according to the results of SDM simulation. The

integrated SDM-based approach was first developed through two preliminary case studies and secondly tested with its complete framework to the city of Turin (Italy) and the city of Riga (Latvia).
The final result is a flexible and adaptable evaluation framework that can assess the URI and URCs at the state of the art of urban systems, as well the effects of strategic scenarios over time on URI and URCs. The SDM-based approach is thus a suitable decision-support tool, able to manage the uncertainty that characterizes the implementation of urban resilience in the urban context. Moreover, thanks to its final output of synthetic indices, which are easily understandable, the proposed SDM-based approach is oriented to Decision-Makers, municipalities, planners, and engaged stakeholders.

Keywords: Urban resilience, urban systems, System Dynamics Model (SDM), Multicriteria Decision Analysis (MCDA), complex and adaptive systems, Decision-Making support tool, integrated evaluation approach, scenario simulation

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