Bridging the gap between resilience research and resilience planning in conflict contexts. Application of a federated urban resilience Model toward rapid recovery and sustainable development.

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Abstract
The proliferation of global crises, such as climate and war-related issues, underscores the need for resilience assessment in urban systems to restore balance and achieve sustainable development. Despite extensive resilience research, a gap remains in adopting a common concept and effectively integrating resilience assessment into operational planning. This gap is especially critical in conflict contexts requiring rapid recovery. This paper aims to identify causes behind this gap and suggests integrating a federated urban resilience model into digital platforms. Focused on the case of Ukrainian cities, the preliminary findings from a cooperation project between the HafenCity University Hamburg and the German Corporation for International Cooperation (GIZ) GmbH, aim to enhance planning approaches for rapid recovery and sustainable urban growth, applicable to various crisis-affected contexts.

Keywords: urban resilience, digital tools, rapid recovery, conflict, Ukraine.

1. Introduction

Urban Systems are becoming ever more complex. As urban centres are becoming denser and population growth is dramatically shifting to urban areas, the frequency of natural and anthropogenic disasters in cities seems to be correlatively increasing (Council & Hov, 2013; Hoffmann, n.d.). The consequences of unexpected disaster events also evidence higher economic impact on its governments (Mohr et al.,2022). The planning of cities must devise new approaches, as well as agile and rapid means of planning for long-term solutions in view of the uncertainty of such events. Traditional planning comes to the limits of its capacities to deal with such circumstances.

In the context of rapid urban planning strategies, particularly in the adaptation to natural or man-made disasters (such as cities recovering from climate-related flooding or enduring war conflict) resilience frameworks emerge as crucial solutions. They optimize variables like uncertainty, which comes with risk and unexpected threats (OECD, 2019; Folke, 2016). Nevertheless, despite the existence of numerous models and frameworks, the integration of resilience-based strategies into operational instruments for urban planning has not been consolidated. Existing instruments for resilience assessment are mostly intended for higher level of policy and governance, but not fully integrated yet into the strategic planning practice at the local level. (Krishnan et al., 2023; Sharifi & Yamagata, 2018).

Based on a preliminary literature review and the empirical work carried out during an ongoing project in the context of Ukraine´s rapid recovery during and in a post-war situation, the first objective of this paper is to show the significance of integrating urban resilience assessment methods into the practical realm of strategic spatial planning. A secondary objective of this paper is to open a space for further exploration and debate towards reducing the identified gap between theoretical resilience frameworks and practical urban planning tools. An essential aspect to explore is the identification of current obstacles hindering the effective incorporation of urban resilience assessments into digital spatial platforms. The discussion section argues how digital tools can potentially address this gap and contribute to both rapid recovery and sustainable growth in conflict contexts. The outcome of this contribution should extend toward further research and implementation measures which should provide insights towards innovative integration and adaptation of urban resilience models into spatial planning practices and instruments, enhancing their utility in the realm of rapid urban planning strategies.

2. Theoretical Framework

2.1. Challenges faced by urban planning

As cities expand and evolve, the myriad of components that they hold are becoming increasingly intertwined and dynamically influential upon each other. Dynamic analyses have proven necessary to assess urban challenges from a scientific perspective, i.e. city-science and complexities of flows and networks (Batty, 2012), in opposition to a static and fragmented perspective which would otherwise focus merely on isolated parameters of the urban morphology, such as its physical characteristics. From the perspective of urban planning strategies, innovative approaches must be adopted to identify the source of urban challenges and understand the connections between its triggering parameters. Not only transdisciplinary perspectives (holistic approach, system thinking, adaptive governance) are enough to prepare for the formulation of solutions, but also innovative instruments to dissect the problems and their causes are urgently demanded.

In this sense, understanding cities as complex and adaptive systems allows to better recognize the interdependent relations of flows, material, and relationships inherent to cities (Alberti, 2016; Batty, 2009; Bettencourt, 2021; Ortman et al., 2020). The complex character of cities stresses the concentration and interdependencies of assets, systems, functions, flow, and population. Moreover, hazards and risks to which urban areas are exposed, have shown greater impact upon occurrence. For instance, in the cases of natural disasters such as the Haiti Earthquake (2010), the Sichuan earthquake (2008), Cyclone Nargis (2008), the European heat wave (2003) (Dickson, et al., 2012), or anthropogenic disasters such as the COVID-19 pandemic (2019) or the recurrence of armed-conflicts in such areas as Ukraine, Afghanistan or the Middle East, have led to devastating consequences not only on the physical, but also economic, environmental, and socio-psychological levels, especially for urban dwellers.

The correlation between the growing trend of global urbanization and the levels of risk and vulnerability in urban environments still demands further research (Leichenko & O'Brien, 2008; Cutter, 2021). In combination with the notion of hazard, understanding *threat* is an important part of the equation. Agents capable of triggering a potential hazard can be linked to a specific situation. From a complex-systems approach, resilience and by extension concepts such as risk, threat, and vulnerability share common patterns and interrelations. A city, as a dynamic network of interconnected activities and resources (e.g. human, natural, and built environment) can therefore be more vulnerable to any given risk or threat, triggering hazardous situations. Given the higher risks cities face, risk analysis has become more of a common practice, adopted not only by financial or cyber-security sectors but also by insurers advising the governance sector at higher levels. From this risk assessment practice, certain frameworks have also gained relevance within the field of spatial planning. Furthermore, these concepts and frameworks have been applied and transferred to other specific complex-systems fields of study such as cybersecurity, insurance and governance (World Economic Forum, 2022; Rangu, et al, 2024; Alibasic, et al, 2017). Such existing workflows can potentially offer a relatable scheme capable of serving as a reference amongst to-be proposed resilience frameworks for urban planning.

Endeavours on developing urban resilience frameworks resulted in several thorough efforts from different agencies, mainly governmental and of international development. Such frameworks (for instance, City Resilience Framework by 100RC; UN-Habitat City Resilience Profiling Tool, Resilient Cities Scorecard, by IBM and AECOM; City Resilience Index by ARUP and Rockefeller Foundation; Urban Resilience Indicators by the European Commission's joint Research Center; among others) often require complex metrics for rigid standards, making it difficult to rapidly operationalize such frameworks or provide guidance to further planning and projects (Datola, et al. 2022; Figueiredo, et al, 2018; Meerow, et al, 2016; Da Silva, 2013; Jabareen, 2013). Hence, a flexible tool adaptable to each specific case, data availability, and local expertise might prove useful to be operationalized for planning strategies under scenarios of uncertainty.

2.2. Considerations of urban resilience concepts for planning

Resilience comes into play as a relevant concept for planning, as it can inform how ready a system is to face a given risk and react towards recovery (Ribeiro and Goncalves, 2019; Datola, 2023). Within the specific context of urban systems, urban resilience is a crucial measure towards the achievement of sustainable development (Li et al., 2014; Meerow et al., 2016). It contributes to a better understanding of the interdependencies and trade-offs of the various urban sub-systems constituents of any city, including infrastructure, social networks, economic

structures, and environmental factors (Derrible et al., 2023; Chelleri, 2012). It also considers risk assessments to draw adaptation and mitigation measures. It aids in the balance between the redundancy and efficiency of a system´s resources. Urban Resilience can drive towards long-term sustainability, by withstanding shocks and maintaining stable urban environments over time.

The advantage of urban resilience, as Goldschalk (2003) notes, is that it is not a state bound to specific patterns or urban form. It offers flexibility to respond to each specific urban condition, and by doing so, fostering creative thinking to achieve it. Such quality opens a wide range for adaptability in the approaches that each of its frameworks addresses. Furthermore, through the awareness of the complex, dynamic, and open nature of urban systems, the need for a holistic, integrated and yet flexible (i.e. easy to adapt to each individual urban and disaster situation) approach to achieve urban resilience is acknowledged when understood in this way.

Nevertheless, how are resilience measures effectively integrated into the common workflows of planning approaches at more local levels of cities is still cumbersome in many cases. Measures can be planned for, in view of known risks faced by cities, but when uncertainty is also a determining factor, and the functional network of cities has become not only more complex but also vulnerable, solutions are more difficult to be devised. Interdependencies among correlating factors, and their cascading effects upon impact are still hard to identify and even measure (Cimellaro et al., 2019).

2.3. Artificial disasters in conflict contexts

Cities facing post-shock damage and subsequent reconstruction must carry out innovative policy and planning approaches in the midst of critical situations (e.g. emergent but fragmented plans, sudden inflows of aid, weak legislation, unregistered displaced people, scarcity of resources, unstable economy) all against the need for rapid recovery. Added to the complexity of this task, is that of coordinating activities across multiple levels of governance, understanding which measures are carried out at the national level and at the local level. Once again, resilience is a pertinent approach, as it is based on a conception of urban contexts as a composition of sub-systems within a larger system (Folke, 2016; Chelleri, 2012). This approach opens the scope of addressing challenges in the midst of rapid recovery, with considerations of time and scale dependencies, and allows the segregated understanding of parts of a system, in order to devise effective solutions for specific situations.

Differences between natural and artificial disasters.

It is, however, important to mark the distinction between two determining factors: the type of disaster and the context of the situation. The type of disaster affecting an urban system can be natural _e.g. earthquakes, flash floods, volcanic eruptions_ or they can be anthropogenic _e.g. an industrial leak of pollutants or the failure of an entire city´s electrical grid system due to lack of maintenance. Both types of disasters can have specific causes, but its impact on an urban system´s failure might be more dependent on the system´s conditions at the moment of impact. An urban system can also be broken down into two relevant context situations, when it comes to assessing resilience: stable or unstable. A significant distinction can be made on how disasters would affect an urban system, depending whether this finds itself in a stable (peaceful) condition or in a more vulnerable (conflict) condition (Fig. 1). Further knowledge on this topic,

collected from empirical cases, should shed insight on new and relevant parameters to take under consideration for an adapted resilience framework for urban planning measures. The definition of an urban resilience model which considers this differentiation could inform more about the different impacts of disasters, understand their behaviour according to this distinction of the urban system (stable or unstable) and the way they unfold and their path of cascading effects differently.

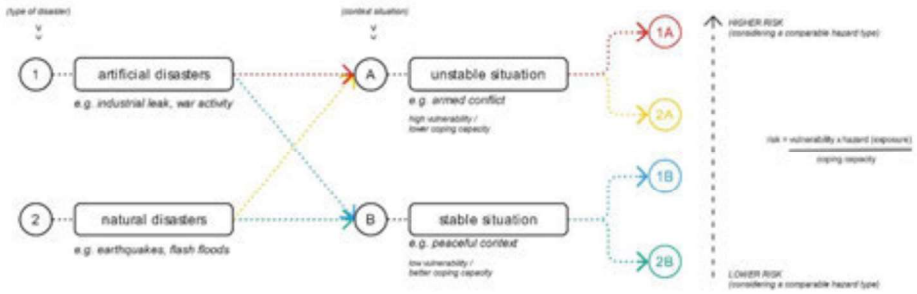

Fig. 1. Scenarios of Resilience assessment based on type of disaster combined with its context situation (authors, 2024).

The relationship between resilience and conflict.

Studies have coincided in the strong correlation between resilience and armed conflict (McCandless & Onbargi, 2023). However, this correlation has been identified in more studies from the perspective of disasters causing conflict, rather than in the opposite direction, when it comes to cause and effect contexts (Elfversson & Höglund, 2023; Rosvold, 2023). More extensive research has been conducted from the perspective of understanding how vulnerable areas impacted by disaster (e.g. climate-related) have a higher tendency of dealing afterwards with escalating conflict, in other words, how disaster consequently shapes conflict (Fig. 2).

On the other hand, when it comes to research on how areas already undergoing conflict are dealing with its low resilience capacities, less research is found and nevertheless it is still heavily demanded (McCandless & Onbargi, 2023; Rosvold, 2023). This refers, in opposition to the previous case, to the specific case of conflict triggering negatively the level of risk of disaster in a given situation, affecting a system's resilience. This first assessment collected from the available literature overview sheds light on the importance of exploring further what pre-existing conditions of areas undergoing conflict should be registered and acknowledged into a resilience framework for recovery planning.

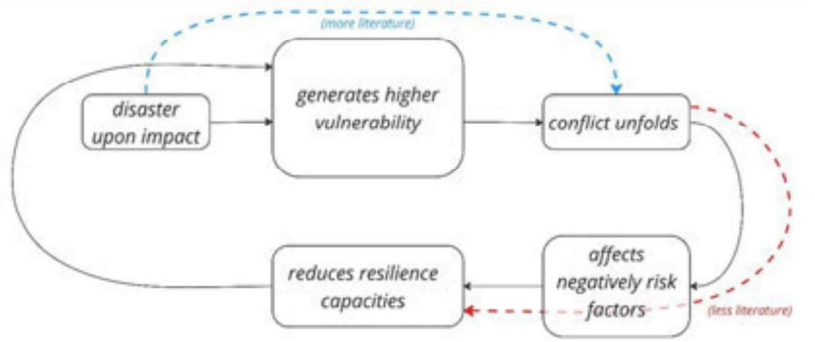

Fig. 2. Correlation between disaster and conflict and its coverage in literature (authors, 2024).

The case of Ukraine.

The case of Ukraine is a fitting case to explore these two correlating situations. One of the most pressing challenges in the current situation for Ukrainian cities is the accelerating criticality of space after assessing damage coverage in the country, caused by ecosystems erosion, bomb-mining, leakage of industrial substances after explosion or scattered military debris. It has intensified the challenge for planning across different actors and levels. Policy-makers and planners, along with central governments and local administrations, must define priorities when the country is in urgent reconstructive demand of housing allocation, without compromising other land use demands, such as those of economic or environmental nature, agricultural activity or protection of natural ecosystems (Shnaider et al., 2024).

Another example is the volatile numbers of internally displaced people (IDP) in Ukraine since the beginning of the war. The ongoing conflict has generated additional pressure on already vulnerable areas within the country, due to the constant shift in the numbers of the registered population within each city. Registration and up-to-date record keeping of IDPs is difficult to maintain track of, in view of the constant attacks (World Bank et al., 2022), and planning for an uncertain population number is cumbersome.
A third development brought on by the war situation has been the massive influx of financial aid received by the country. This has been identified by some as an unforeseen reaction which in turn might accelerate, in the long term, unprecedented urban development or even the integration of the country into the EU (Fiott, 2023; Ukraine's Path Towards EU Accession, n.d.). From the field of international strategic support this can be seen as a case of "silver linings" opportunities (Grant et al., 2023). For this to produce a successful outcome, strategic plans and measures must be realigned to be able to achieve both goals, i.e. focusing on fast reconstruction and deep transformation of the country (Rozmaritsyna, 2023).

3. Digital Tools for Urban Resilience

In view of the exposed need to reconsider planning strategies for rapid recovery scenarios and to draw multi-dimensional capacities of planning processes and instruments, it seems relevant to seek for solutions that can address a better understanding of cascading effects upon impact and interdependencies between parts of an affected urban system, under each context. Digital tools can help to model and understand complex, dynamic systems, as they can speed up planning processes by enhancing access to relevant data, synthesizing knowledge needed for

planning and decision-making. This may accelerate the generation of new output data, in the form of analysis for concrete planning activities (e.g. citizen participation, satellite image analysis, automated design assessment) facilitating agile and iterative evaluations, such as scenario comparison, design and check or rapid urban design prototyping (Noennig et al., 2023). Integrating digitalisation to urban resilience framework should be considered as a relevant option for accelerating these needed analysis, iteration, and decision-making activities toward more transparency in the restoration of a balanced urban system after a disruption.

The current findings from our ongoing research, within the framework of a cooperation project in Ukraine supported by the German Corporation for International Cooperation (GIZ) GmbH, address the identified need to incorporate digital tools into a proposed urban resilience framework for the case of Ukraine´s rapid reconstruction planning strategies. Our research has been based on a mixed approach between literature review on the theoretical background on resilience and urban systems, and also empirical knowledge collected through different sources, i.e. workshop sessions with members of the local authorities from different cities in Ukraine, webinars with NGOs working on site since 2022, the collected knowledge on site on behalf of the GIZ as our funding partner in this project, and collaborating researchers, both from Ukraine and externals, currently carrying out as well implementation projects in the country.

In this sense, the specific research-based activities in our project focus on defining the necessary components in a federated model for urban resilience, adaptable to Ukraine. One of the preliminary reflections from this process is that certain urban-related characteristics arising from the specific situation of conflict are still to be integrated into such a federated urban resilience model. Examples of these conflict-generated characteristics are e.g. shelters, massively displaced population or aggravated land-use distribution. Others are still to be outlined.

From the set of frameworks analysed, the similarities in the hierarchical organisations of dimension, sub-dimensions, components, and indicators were identified (Fig. 3). On this basis, a simplified set of four dimensions constitute the first step of the framework. Considering the specific situation of conflict, the relevant dimension distributions are social, economic, institutional, and physical. The natural ecosystem is included into the physical dimension of the urban system, as a fitting measure from other frameworks, to better cluster common components with overlapping characteristics, i.e. environmentally protected areas, public space, water bodies.

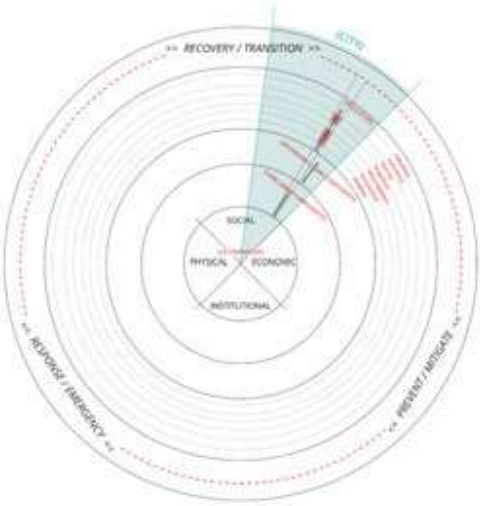

Fig. 3. Diagrammatic Chart of the proposed UR federated model scheme for the Ukraine Case (authors, 2024).

Considering the Cities Resilience Index (Rockefeller Foundation & ARUP in Da Silva, J., 2013) as one of the most adaptable references in terms of its composed set of indicators for resilience assessment, a further step in clustering components under each dimension is assumed to group sub-components in a system and better classify indicators and metrics. The final step of this process will be to identify at the indicators level of the proposed diagrammatic chart (Fig. 4) an additional set of indicators capable of measuring the new and needed urban characteristics, endogenous of an urban system undergoing conflict situations. These should be located within the proposed diagram, within fitting components and its host urban dimension.

4. Discussion

The upcoming phase of the ongoing research project will test the federated model for the urban resilience assessment in Ukrainian cities, with the objective of collecting learnings and insights on the following formulated research-related inquiries:

- On the topic of urban conflict: The outcome of the implementation of the proposed federated UR model should contribute to further identification of conflict-intrinsic urban parameters, and the need to measure their effect through newly proposed indicators. This should provide insights on how conflict, different from natural disasters, incorporates different variables, such as anthropogenic action and reaction, and to what extent these can condition the possibility of achieving a resilient urban system.

- On the topic of vulnerability and uncertainty during conflict: Based on the previous argument, it can also be discussed in what way resilience models should not be generalized and framed equally for contexts in peace and those in conflict, when facing any kind of unexpected disaster.
- On the paradox of urgency versus feasibility*:* It is in those areas with utmost urgency where the availability of up-to-date and reliable data is most difficult to be collected. From the

empirical work regarding resilience assessment to be carried out in the Ukrainian context, it is expected that a series of recommendations can be collected, in the form of learnings on how to deal with this paradox which hinders the faster take-up of digital tools for the realm of planning. The topic of overcoming urgent demands under scenarios of high uncertainty is, in any case, relevant for further study.

- On the impact of implementing digital tools for planning to address crises: Can digital and spatial tools implemented to contribute to the assessment of UR, indeed achieve faster iteration and formulation of more rapid responses in planning? The proposed model must be validated with the necessary actors, e.g. planners, authorities, citizens and regulators, in real-context scenarios, in order to address this question.

5. Conclusions

With the increasing complexity of urban systems, driven by rapid urban growth, densification, and population shifts, the risks to which cities are exposed become ever more relevant to address, encompassing challenges that combine multiple urban dimensions simultaneously. Hence, the importance and relevance of resilience frameworks that can inform about the interdependencies and adapt to each particular urban circumstance seem necessary. Furthermore, in an integrated manner, such frameworks can lead to planning strategies not only to lay out projects but also to monitor and steer its progress. The integrative character would not only be limited to planning experts but also serve as a platform to inform, collaboratively assess, and plan among various stakeholders.

Digital tools collect enough qualities to potentially address this gap by enhancing visualization, multiple scenarios validation, and quantitative deliberation of outputs which should facilitate decision-making for rapid reconstructive planning. It is nevertheless still necessary to carry out further research and validation through implementation projects to adapt a fitting urban resilience model (a federated model) into understandable digital platforms, which can ultimately address the needs of contexts in conflict, those facing not only climate-related disasters, but also artificial disasters. The critical need to incorporate novel urban resilience models and methods into strategic spatial planning is underscored.

The longer-term transference of the outcome of this research into operational activities toward more effective rapid planning for urban reconstruction could also be potentially supported by the assessment of other similar cases of contexts facing conflict, recovery and reconstruction, such as Israel, Palestine or Afghanistan.

Further research should help understand what is temporary and what remains (planned and built infrastructure, for example) when addressing fast recovery *versus* sustainable growth in a post-conflict context. The integration of digital tools supported by a validated resilience model which allow the formulation of more accurate decisions can potentially address two important challenges faced by planning in the coming years, meaning which solutions are designed for fast recovery and which are designed for long-term sustainable development.

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