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# Significance of Enhancing Resilience in the Urban System towards Sustainable Future Cities

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## ABSTRACT

*The term resilience has been defined as the ability to bounce back or bounce forward. Building resilience in the urban systems is an upcoming research field pertaining to the various challenges posed by the climatic and environmental changes. The resilience of an urban system depends upon the available infrastructure to maintain acceptable levels of functionality during and after disruptive events and to recover full functionality within the specified period of time. Urban Systems is the worst hit in the global environmental change. This present research paper intends to examine the significance of resilience, its challenges and prospects towards future cities. It also makes an attempt in identifying the barriers to resilience and finally concludes with a SWOC (Strength, Weakness, Opportunities and Challenges) analysis in building resilience in the urban system by identifying research gaps, suggesting potential research areas which can be explored to strengthen the prevailing scenario. The paper concludes with the plausible recommendations which ensure feasible resilience, adding a new perspective to the issue of sustainability in the urban system.*

**Keywords:** *Urban Resilience, Sustainability, SWOC Analysis, Urban System*

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## INTRODUCTION

The concept of resilience was first used in the field of ecology to enumerate the system's capacity to endure or to retaliate during disruptions. It is of particular relevance to researchers and practitioners working in the field of urban development, where the concept of urban resilience provides insight into managing persistent shocks by raising alarms extensively to prevent the collapse of a system. Resilience has also helped to bridge the gap between reducing the risks of a disaster and adapting to a climate change by focusing on strengthening the functioning of a system during hazards, rather than preventing those hazards from occurring. Urban systems are the worst affected by climatic changes and other impacts. The rapid urbanisation and extremities of climatic conditions are interlinked with the various issues like frequent floods, earthquake, droughts, overexploitation of natural resources, seawater intrusion, untapped rainwater, air, land and water pollution.

### **Methodology**

This research is developed based on the secondary data collected by the authors. The reliable sources of the data are from various government organisations and their published reports, peer-reviewed journals. The purpose of this research has been to analyse the literature available in urban resilience to understand the need, impact and the purpose of the conceptual framework of urban resilience. Relevant data are collected in the present study to understand the concept of resilience towards building sustainable future cities.

### **Resilience and Sustainability**

Resilience focuses on not only how the environment retaliates to disturbances that are associated with climatic changes, but also how well they can withstand and re-structure with the growing demands and needs. Sustainability, on the other hand, is defined as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The concept of resilience enhances the viewpoint on the idea of sustainability by reiterating that resilient planning should also be considered while designing for sustainable cities. Various quantitative methods have been proposed for integrating resilience as a component of sustainability. Walker et al. (2010) attempted to include resilience aspects like probabilistic risk analysis in quantifying sustainability. The addition of resilience as a subclause of sustainability was a welcoming start. Becker (2015) further explored this idea with various earthquake prone case studies in New Zealand and inferred that reducing risk leads to increased resilience

and sustainability. Seagar (2008) developed a framework for sustainability delving with resilience, reliability, renewal, and safety. Combined framework for sustainability and resilience are also studied by analysing their commonalities. Bocchini et al. (2014) designed a quantitative framework for the combined strategy by analysing the risk and temporal factors.

### **Dimensions of Resilience**

The resilient urban system majorly focused on natural and man-made disasters, climatic and environmental disruptions. The concept of resilience not only includes the dimensions which can withstand stress but also to recover and retaliate by impregnating certain qualities which reduces the vulnerability of a particular shock. The major characteristics of the urban resilient system discerned from the literature are presented in Table 1. The major attributes of resilience discussed here are the multifunctionality, redundancy, modularity, interdependence, robustness, adaptability and efficacy prevailing in the urban system. These characteristics not only distinguish an urban resilient system but also help the authors to understand how well these resilient dimensions can be imbued in the framework devised for sustainable cities.

### **Understanding the Gaps and Challenges**

There are gaps prevailing in understanding the risk as a whole and composite character consisting not only the external disturbances but also the internal characteristics which could be vulnerable to the functional capacity of a system. The term urban risks are not clearly understood or acted upon. The recent examples like the acute water crisis in Capetown and California clearly state that the hazards related to the scarcity of water are still perceived in the rural context until the severity hits. More detailed research on this is vital to enumerate the risks and to identify the required actions. Although the recent policies worldwide are slightly forwarding towards the inclusive risk reduction approach but the laws and funding are more towards the rescue and response measures. Provisions are being made in development plans for risk reduction, but the technical and institutional mechanism in development authorities are still inadequate towards the comprehensive resilient planning approach. Adaptation towards climate change in resilient planning poses challenges of various decision-makers at diverse scale. This demands a comprehensive and inter- or transdisciplinary collaboration in analysing the comprehensive system including all the subsystem: physical, social, economic, ecological, environmental, infrastructural and institutional and their interlinkages, implementation in the urban system by enhancing resilience capacity which is a

TABLE 1. DIMENSIONS OF RESILIENCE

<i>Sl. No</i>	<i>Dimension</i>	<i>Explanation</i>	<i>References</i>
1.	Multifunctionality	Interlinkages of various functions; Varied response to disruptive situations; Strengthens the economic and spatial capability. Greater the adaptability speeder is the recovery duration.	<i>Ahern (2011)</i>
2.	Redundancy and modularity	Optimisation rather than maximisation. Ensures supportive capacity derived from the prevailing components to perform towards similar function during crisis situation so as to respond better, but the failure of one component does not impact/adverse effect on the entire system.	<i>Fleischhauer, M., (2006)</i>
3.	Interdependence	Combined network so as to acquire support from other systems in the network.	<i>Fleischhauer, M., (2006)</i>
4.	Robustness	Ensures the imbuing capacity of a system to strengthen the redundancy and functional linkages within the subsystems during disruptions.	<i>Ahern (2011)</i>
5.	Adaptability	Reduces the failure risks, the flexibility of the system from the past disturbances is enabled to absorb and tackle the impacts so as to minimize the loss.	<i>Martin &amp; Acss (2011)</i>
6.	Efficacy	Indicates the ratio of energy supplied by the system to the energy delivered. The positive ratio indicates the efficacy of the system.	<i>Roggema, R and Vanden Dobbelsteen, A 2012</i>

Source: Compiled by the authors.

prerequisite of sustainability. Solutions for sustainability and resilience planning unfold from the inter and transdisciplinary research.

### SWOC analysis

The SWOC analysis considering the three major attributes of a resilient system is discussed in Table 2.

TABLE 2. SWOC ANALYSIS

<i>S. No</i>	<i>Attribute</i>	<i>Strength</i>	<i>Weakness</i>	<i>Opportunities</i>	<i>Challenges</i>
1.	Linkages with sustainability	A close relation to adaptation and risk reduction.	Emphasising the resilience concepts and adaptation towards climate changes without subverting the sustainability mechanism	The phase of recovery serves as an opportunity to build resilience	Long term sustainability approaches linked with resilience.
2.	Assessment of resilience	It includes operationalising and implementable assessment mechanism with the prioritisation.	Assessing resilience is governed by spatial, temporal factors and need to be monitored effectively.	Assessment tools should be both generalised and also adaptable for context-specific applications.	Delineating the spatial and temporal boundaries.
3.	Institutional mechanism	Integrating resilience principles in the urban system with transparency, accountability. Risk anticipation and scenario-making capacities	Prevailing weak regulations set up and enforcement mechanism.	Inherent trade-offs between prompt adaptation measures versus long-term measures for resilience building.	Maintaining uninterrupted implementation of urban resilience policies on the local policy agenda, given the short-term nature of political cycles.

Source: Compiled by the authors.

## RESULTS AND DISCUSSION

Urban infrastructure-related problems have raised concerns worldwide among the scientific community (Marlow et al., 2013). The urban system needs to be designed with the capability to resist hazards, the flexibility to retaliate and endure extremities without disturbing the function by recovering quickly from the impacts where Pickett (1992) suggested that the definition of the city's resilience comparing its variations on equilibrium and non-equilibrium perspectives of resilience. In the equilibrium approach, resilience is considered as the system's capacity to return to the equilibrium position, which is very similar to the theory of elasticity. In contrast, the non-equilibrium approach of resilience defined as the ability to acclimatise to the variations and disruptions incurred. Nature, duration of external forces and duration of a system to bounce back also plays a vital role in accessing the city's resilience. Polese (2010) attempted to combine the equilibrium and non-equilibrium aspects of resilience where the resilient cities are planned considering hazards based on the past experiences and system's ability to adjust and adapt.

## RECOMMENDATIONS

A brief set of recommendations are summarised by analysing literature for planning a resilient city: Understanding the vulnerabilities, risks and threats posed in the urban system. Assessment of risk in urban system by the subsystem wise is also an inevitable requirement in resilience planning. There is also a need to identify the factors affecting the stability and the instability of these subsystems. The resilient planning involving long term and short-term planning and it must be inclusive of adaptation and mitigation. Defining the mitigation and risk reduction strategies as part of resilience planning. Need for systematic methodology rather than a technique, providing solutions to the formulated problems. System appropriate technique may be employed to deal with the inherent complexities to define the entire set of problems, analysing quantitatively and the change detections in the system. Application of System Dynamic Technique can effectively reinforce resilience as a new paradigm in sustainable development.

## CONCLUSION

The concept of resilience is a multi-faceted pertaining to various temporal and spatial analysis. This study tries to shed some light on the relation with sustainability, challenges and resilient attributes analysed with SWOC technique and end with recommendations. The present study also highlights that the underlying attributes under various subsystem are interlinked to devise a resilient system where the resilience has a correlation with sustainability as well. In order to

enhance the suitability of the resilience concept for guiding planning and assessment efforts, it is essential to have a better understanding of its underlying dimensions and characteristics. These interlinkages would be maximised for enhancing resilience in long term planning.

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