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Effective Emergency Response and Disaster Prevention: A Decision Support System for Urban Critical Infrastructure Management

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Abstract : Currently more than half of the world's populations are living in cities, and the number and sizes of cities are growing faster than ever. Cities rely on the effective functioning of complex and interdependent critical infrastructures networks to provide public services, enhance the quality of life, and save the community from hazards and disasters. In contrast, complex connectivity and interdependency among the urban critical infrastructures bring management challenges and make the urban system prone to the domino effect. Unplanned rapid growth, increased connectivity, and interdependency among the infrastructures, resource scarcity, and many other socio-political factors are affecting the typical state of an urban system and making it susceptible to numerous sorts of diversion. In addition to internal vulnerabilities, urban systems are consistently facing external threats from natural and manmade hazards. Cities are not just complex, interdependent system, but also makeup hubs of the economy, politics, culture, education, etc. For survival and sustainability, complex urban systems in the current world need to manage their vulnerabilities and hazardous incidents more wisely and more interactively. Coordinated management in such systems makes for huge potential when it comes to absorbing negative effects in case some of its components were to function improperly. On the other hand, ineffective management during a similar situation of overall disorder from hazards devastation may make the system more fragile and push the system to an ultimate collapse. Following the quantum, the current research hypothesizes that a hazardous event starts its journey as an emergency, and the system's internal vulnerability and response capacity determine its destination. Connectivity and interdependency among the urban critical infrastructures during this stage may transform its vulnerabilities into dynamic damaging force. An emergency may turn into a disaster in the absence of effective management; similarly, mismanagement or lack of management may lead the situation towards a catastrophe. Situation awareness and factual decision-making is the key to win a battle. The current research proposed a contextual decision support system for an urban critical infrastructure system while integrating three different models: 1) Damage cascade model which demonstrates damage propagation among the infrastructures through their connectivity and interdependency, 2) Restoration model, a dynamic restoration process of individual infrastructure, which is based on facility damage state and overall disruptions in surrounding support environment, and 3) Optimization model that ensures optimized utilization and distribution of available resources in and among the facilities. All three models are tightly connected, mutually interdependent, and together can assess the situation and forecast the dynamic outputs of every input. Moreover, this integrated model will hold disaster managers and decision makers responsible when it comes to checking all the alternative decision before any implementation, and support to produce maximum possible outputs from the available limited inputs. This proposed model will not only support to reduce the extent of damage cascade but will ensure priority restoration and optimize resource utilization through adaptive and collaborative management. Complex systems predictably fail but in unpredictable ways. System understanding, situation awareness, and factual decisions may significantly help urban system to survive and sustain.

Keywords : disaster prevention, decision support system, emergency response, urban critical infrastructure system
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