BIM/GIS-based Graph Framework for Emergency Response: A Case Simulation for Fire Protection

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SUMMARY

Effective emergency response requires rapid decision-making supported by accurate and comprehensive spatial information. Traditional risk assessment methods associated with emergency management (EM) systems often rely on simplified two-dimensional maps, static models, and experience-based decision-making within the urban context, thus limiting their ability to adapt to dynamic conditions. The core challenge in building emergency response lies in leveraging vast amounts of static and dynamic geographic, urban, and building data for rapid, informed decision-making. The synergy of Building Information Modeling (BIM) and Geographic Information Systems (GIS) offers a powerful foundation for enhancing EM. This paper proposes a conceptual framework for a BIM/GIS-based graph model designed to leverage BIM technology within the comprehensive geospatial context of the urban environment. This model can be used for simulations of situations that are difficult or impossible to perform in a real environment. Guided by a bibliometric analysis of the research landscape concerning BIM/GIS integration, specifically focusing on the application of graph models for EM, this study aims to advance knowledge on information exchange between BIM and GIS for holistic disaster management within the Prevention, Preparedness, Response, and Recovery (PPRR) framework. The analysis will be confined to publications since 2016 relevant to EM. Results from this study address common data integration and interoperability challenges through a structured data schema, ensuring a unified network representation for both indoor and outdoor emergency navigation. To validate its feasibility, we estimate room-to-room risk levels by simulating the dynamic spread of fire and smoke within a multistory smart building that incorporates BIM attributes, including occupant density. The resulting framework has potential applications for dynamic risk assessment in emergency response related to natural disasters, emergency medicine, safe construction, and fire protection.