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STRENGTHENING EMERGENCY DEPARTMENT RESILIENCE: SIMULATION-BASED SURGE MANAGEMENT

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ABSTRACT

This study aims to improve the resilience of the Emergency Department (ED) to handle demand surges through a combination of Discrete Event Simulation (DES) and resilience assessment techniques. By evaluating resistance and recoverability components, the analysis examines the resilience of the ED, patient flow dynamics, and resource requirements. A dedicated simulation model is developed to uncover how the ED performs during normal operations and demand surges, exploring the effects of alterations and additional resources on resilience using the resilience triangle framework for optimized resource allocation. This research improves our understanding of ED resilience, paving the way for further investigations into performance improvement during demand spikes, and the results suggest new patient flow strategies to enhance resilience.

1 INTRODUCTION

In the realm of healthcare management, surge capacity is a critical concept, which denotes the ability of a healthcare system to effectively handle a sudden and significant increase in patient volumes or clinical needs using existing resources (Mills et al. 2021). These surge events can occur unpredictably due to various hazards, ranging from infectious disease outbreaks to mass casualty incidents, and can persist for days, weeks, or even months. The ability of hospitals to provide medical care during sudden increases in patient volumes or catastrophic events underscores the significance of this paradigm. As a consequence, hospitals participate in preparedness activities and strategic measures aimed at enhancing their response capacities. Although numerous investigations have explored these strategic actions, it is important to acknowledge their adaptability depending on individual hospital resources and capabilities (Bruballa et al. 2015).

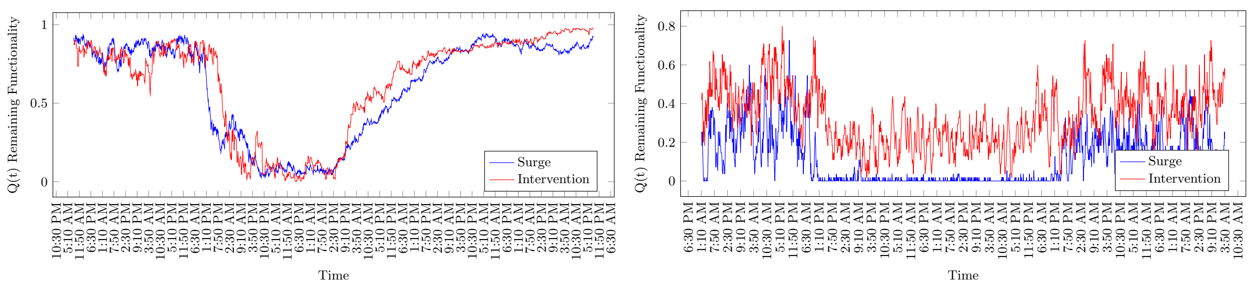
2 APPROACH: MODELING RESILIENCE THROUGH SIMULATION

This study employs Discrete Event Simulation (DES) to assess and improve the resilience of an Emergency Department (ED), using a simulation model created with AnyLogic 8 software. The model focuses on patient flow, arrival rates, and resource allocation. For the case study, an existing validated model from the AnyLogic platform aligns with research objectives (AnyLogic 2021). Scenarios are tested to enhance ED performance and resilience, considering resistance and recoverability profiles derived from the NEDOCS score. We evaluate system resilience based on Davis et al.'s comprehensive research on the NEDOCS score components (Weiss et al. 2004) and their functionality (Davis et al. 2020). NEDOCS scores are inverted and rescaled for accuracy (Davis et al. 2020). The study uses occupied beds, patients, and door-to-bed time to assess the functionality of the ED. Predicted resilience is evaluated using the area under the curve, comparing interventions to normal conditions (Table 1). Initial findings indicate that an increase 25% in physician assistants does not increase resilience, while allowing low-acuity patients to wait in the waiting room, rather than a bed, improves it (Table 1, column "configure"). Figure 1 visually depicts the improved

Table 1: Component predicted resilience at different scenarios.

Component \ Scenario	Normal	Surge	7 Physician assistants (+25%)	Configure
Door to bed time (Predicted resistance)	0.86	0.46	0.49	0.70
Bed occupation (Predicted recoverability)	0.99	0.87	0.86	0.96
Total patients (Predicted recoverability)	0.95	0.74	0.72	0.77

resilience and increased resistance and recoverability components after the intervention, quantifying the resilience of components between scenarios. This research holds significance for ED resilience during peak demand, offering insights through the DES model developed. These insights aid managers in resource allocation and emergency response planning, enhancing hospital response and community access to care.



(a) (b)

Figure 1: Emergency recoverability profile with disaster-level crowding and interventions. (a) Remaining functionality of the "door to bed time" component. (b) Remaining functionality of the "bed occupation" component.

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