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A Decision-Support Tool for Humanitarian Distribution Planners in the Face of Congestion at Security Checkpoints: A Real-World Case Study

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Abstract : In times of armed conflicts, various security checkpoints are placed by authorities to control the flow of merchandise into and within areas of conflict. The flow of humanitarian trucks that is added to the regular flow of commercial trucks, together with the complex security procedures, creates congestion and long waiting times at the security checkpoints. This causes distribution costs to increase and shortages of relief aid to the affected people to occur. Our research proposes a decision-support tool to assist planners and policymakers in building efficient plans for the distribution of relief aid, taking into account congestion at security checkpoints. The proposed tool is built around a multi-item humanitarian distribution planning model based on multi-phase design science methodology that has as its objective to minimize distribution and back ordering costs subject to capacity constraints that reflect congestion effects using nonlinear clearing functions. Using the 2014 Gaza War as a case study, we illustrate the application of the proposed tool, model the underlying relief-aid humanitarian supply chain, estimate clearing functions at different security checkpoints, and conduct computational experiments. The decision support tool generated a shipment plan that was compared to two benchmarks in terms of total distribution cost, average lead time and work in progress (WIP) at security checkpoints, and average inventory and backorders at distribution centers. The first benchmark is the shipment plan generated by the fixed capacity model, and the second is the actual shipment plan implemented by the planners during the armed conflict. According to our findings, modeling and optimizing supply chain flows reduce total distribution costs, average truck wait times at security checkpoints, and average backorders when compared to the executed plan and the fixed-capacity model. Finally, scenario analysis concludes that increasing capacity at security checkpoints can lower total operations costs by reducing the average lead time.

Keywords : humanitarian distribution planning, relief-aid distribution, congestion, clearing functions
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