Disaster Modelling and Emergency Facilities Location under Uncertainties: A case study of the Moroccan Relief Supply Chain

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Abstract

Disaster modelling and facility location are critical aspects of disaster management that help to improve the effectiveness and efficiency of relief supply chains. However, the inherent uncertainties associated with disasters and relief supply chains can significantly impact the effectiveness of such models. To address this challenge, the thesis proposes the use of uncertainty quantification-based models and hidden Markov based models for disaster modelling in the context of the Moroccan relief supply chain. The thesis initiates by conceptualizing the Moroccan relief supply chain, comprehensively outlining its design, activities, and the various actors involved in the humanitarian process, then, a detailed analysis was conducted to highlight the strengths and weaknesses of the Moroccan relief supply chain. This involved a deep examination of uncertainty sources within the humanitarian process, to make a good understanding of challenges faced within the Moroccan relief supply chain and identify the specific requirements. Following this conceptual groundwork, the proposed models are then applied to a dedicated case study of the Moroccan relief supply chain. This practical application aims to validate the effectiveness of the uncertainty quantification-based models and hidden Markov-based models in a real-world scenario, providing valuable insights into their applicability, utility, and potential impact on the complex dynamics of the humanitarian field. The results demonstrate that the uncertainty quantification-based model and the hidden Markov based model can significantly improve the robustness and efficiency of the supply chain network in term of disaster prediction. The uncertainty quantification-based model enables to make prediction of the potential human impact of disasters and the most sensitive regions which can help in the evaluation of the robustness of the supply chain network under different scenarios, considering various sources of uncertainty, such as demand and uncertainties on documented data. On the other hand, the hidden Markov based model is used to predict the disaster behaviour in next occurrence, based on historical data and trends. This model provides important insights into the potential of HMMs in disaster

management and humanitarian logistics and emphasize the importance of these models in protecting disasters impact, vulnerable populations and mitigating the effects of natural disasters in the future. The thesis aims also to identify the optimal facility locations and develop an efficient disaster response plan that can mitigate the impact of disasters, this stations will have for function the reception, control, support and the distribution of help in case of natural disasters (earthquakes, floods, torrential floods, locust invasions, drought, landslides ...) or man-made disasters (technological accidents, terrorist attacks, road accidents, pollution ...), through the integration of different actors in the Moroccan relief supply chain (Ministry of the Interior, Ministry of Planning of Moroccan Territories, the civil protection, military, NGOs ...) and by considering various sources of uncertainty, such as demand, transportation time, and supply disruptions . The optimal facility locations identified by the models provide a better coverage of the affected areas, thereby improving the speed and effectiveness of the disaster response plan. The thesis highlights the significance of incorporating uncertainty analysis in disaster modelling and provides insights into the relief supply chain management in Morocco. The findings of this thesis can be useful for policymakers and practitioners in disaster management to improve the effectiveness and efficiency of relief supply chains.