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Human Factors and Strategic Decision Making: The Case of Humanitarian Logistics

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ABSTRACT

The present paper discusses key aspects of managerial human factors in research, specifically when implementing decision support systems in the context of Humanitarian Logistics. It is framed as a follow-up of an Operations Research-based project developing a decision support framework for relief distribution in the event of a catastrophic blackout. Specifically, the main lessons learned from this project are explored to understand the role that experts and decision makers play when conducting research in the fast-growing area of Humanitarian Logistics.

Keywords: Management, Human factors, Decision support, Humanitarian logistics

INTRODUCTION

The field of humanitarian logistics (HL) is characterized by complex and challenging problems that try to reconcile the ever-increasing impact from disasters with a declining funding (Apte, 2009; Besiou & van Wassenhove, 2020). Owing to a highly dynamic operating environment, large number of involved stakeholders, and the need for extremely time-dependent responses, the underlying systems defined by HL can be classified within the umbrella of complex systems (Schiffling, Hannibal, Tickle, & Fan, 2020). Adding to this inherent operative complexity, problems within this field have been frequently deemed as "wicked" or "ill-structured", meaning that an additional layer of uncertainty surrounds these problems, both in formulation and in the acceptance criteria for their solution. Broadly, addressing an ill-structured problem often begins by abstracting away its wickedness, leaving for consideration a tamed problem approachable by the paradigm of the explanatory sciences (Alford & Head, 2017; Churchman, 1967).

Specifically for HL, this wickedness embodies complex requirements that cannot be ignored in the design process of proposed solutions. Failing to understand the basic motivations behind these problems, or unwillingly oversimplifying their inherent structure and depth, may lead to misrepresent the situations faced in practice, compromising the provision of humanitarian assistance and its success, and potentially leading to catastrophic outcomes

(Apte, 2009; Day, Melnyk, Larson, Davis, & Whybark, 2012). In order to overcome these issues, HL has witnessed an increase in the development and implementation of decision support systems and frameworks, together with the participation of domain experts in academic research. These support systems have facilitated the assessment of large amounts of data and the provision of scenarios, enabling a faster decision-making process, and relieving practitioners from the burden of repetitive tasks. Nevertheless, the pure application of these systems has been argued to be insufficient for different reasons, such as not being sufficiently grounded in empirical observations (Pedraza-Martinez & Van Wassenhove, 2016) and being capable of creating cognitive biases in the practitioners that use them, e.g. automation bias, should they over-rely in these systems (Skitka, Mosier, & Burdick, 1999). Thus, involving domain experts and disaster management practitioners in academic research becomes necessary, both to understand the problems in HL, as well as the factors affecting teams in humanitarian assistance, typically outside the logistics literature.

The goal of this paper is to highlight the role of experts and decision makers within the process of designing and validating a decision support framework in HL. To this end, three main expert-defined aspects will be considered, namely the *strategic decision-making capability*, the *capacity for short-term action* and the *division of responsibilities* derived of these decisions and actions.

HUMAN FACTORS AND DECISION MAKING IN THE CONTEXT OF HUMANITARIAN LOGISTICS

Owing to an ill-structure, many problems within HL cannot be represented as pure, objective analytical abstractions (Sternberg & Lee, 2009; Tatham & Houghton, 2011). Approaching them means to comprehensibly consider the real-world motivations that justify their existence, as well as the real constraints that significantly increase their complexity. Concretely, this paper succinctly describes lessons learned while designing an expert-driven relief distribution framework to cope with the aftermath of a catastrophic power outage.

Project Context and Framework Overview

The project that precedes this paper focused on designing a relief distribution framework at a strategic level. This meant to simultaneously anticipate strategies for the disaster and provide operative guidelines for immediate action after the event. Both development and concept were jointly defined with experts and practitioners in disaster management. Due to privacy considerations, however, most institutional partners as well as sensible details on the project had to be left out of this paper.

Methodologically, the development process merged aspects of Operations Research (OR) with the design sciences, combined under the umbrella of the Design-Oriented OR framework (O'Keefe, 2014). In this sense, optimization and simulation techniques were borrowed from the OR paradigm, while the design sciences guided the development of a usable research artifact

(Hevner, 2007), in the form of a strategic decision support framework. Technically, this framework was built upon a novel mathematical model capable of optimizing distribution strategies under uncertainty, and an experiment environment to create and test strategies under a multitude of disaster scenarios. Wrapped around these modules, a graphical user interface allows for advance visualization and navigation capabilities, bridging the gap between complex mathematical concepts and the specific needs of the users. For conciseness, further technical details of this framework will be left out of this paper, focusing instead in the experience of working with domain experts.

The Role of Experts in Designing a Strategic Decision Framework

In the context of HL, experts can provide valuable insights on the subjective nature of each problem, as well as the conditions they require for a usable solution. In this sense, roles at a strategic level are particularly well-suited to provide these insights, especially when considering the "strategic macro-level". This paper places the focus on three expert-defined aspects, broadly connected with foundational concepts discussed, among others, in (Apte, 2009; Besiou & van Wassenhove, 2020), and considering their value for the process of designing and validating a relief distribution framework. The next paragraphs condense a conceptual perspective on these aspects, as described by the experts participating in the project. Following this description, the next section will analyze how each individual aspect was addressed in the project using a case study.

Strategic Decision-Making Capacities: Timely and sensible decision-making is critical in the redistribution and implementation of relief activities (Rottkemper & Fischer, 2013). It accounts for the process to deliberately select a possibility of action to be realized from a number of given possibilities. The available options to select from are characterized by the threat of damage or loss, the decisions taken are subject to risk or uncertainty, and course and result can only be stated as possibilities, but accurate statements about their occurrence are not possible.

Capacity for Short Term-Action: Action is a reason- and mind-based, volitional activity motivated by the higher goal or purpose upon which a decision was made. Acting therefore presupposes decision-making, and includes activities of organization, real-life design as well as knowledge and values. Correct acting assumes reason, understanding and responsibility and must be striven for by the will and pursue a purpose. In this way, while strategic decision-making focuses more on the long-term goals and overall organization, short term-action looks at the specific activities to be taken given a specific context, in order to achieve the goals defined at the strategic level.

Ability to Take Responsibility Into Consideration: The classical concept of responsibility relates responsibility to the deciding and acting person, who initiates a process with free will in awareness of the framework conditions and thus, if no reasons for exclusion of guilt are present, becomes responsible for his or her actions. It means giving an account of one's own free and autonomous action and its consequences as a moral person or as an organizational unit before an authority. As such, it underlies decision making and

acting processes, delimiting the alternatives to be considered. In an increasingly complex society, however, with organizations based on the division of labor, the assignment of responsibility is changing. Responsibility, therefore, is not a one-dimensional concept of assignment between decision and action or action and consequences, but a multi-dimensional concept of relation of different elements. Likewise, in the complex field of HL, taking responsibility should be understood as a multi-dimensional concept, concerning multiple actors and their actions, and governed by the four fundamental humanitarian principles of humanity, impartiality, neutrality and independence described in (Hilhorst, 2005).

Having provided a brief description on the three expert-defined aspects that circumscribed the development of the framework in this project, the following section concretizes these aspects, using a generic case study.

ANALYSIS AND DISCUSSION

An important part of the development process in this project involved the assessment of the underlying models designed for the framework. This followed two main perspectives: the *objective metrics associated to the performance of mathematical and computational models*, and the *alignment of the solution with the needs of the community*. Concretely, this paper focuses on the later, leveraging the three expert-defined aspects previously introduced (decision, action and responsibility).

The Value of Experts for the Framework Development

Following the development cycles of the design sciences (Hevner, 2007), the first crucial step was identifying the *relevance* of the project, i.e., its motivation. This stage should capture the real-world problem and associated challenges faced by the intended community for whom this research was intended. The study should mirror the cognitive and logistic challenges encountered by the personnel of humanitarian logistic, and account for the complexity and non-linearity brought by the characteristic uncertainty of HL.

Strategically, experts and stakeholders were directly and indirectly consulted to *describe the problem, to determine assumptions aimed at narrowing its scope, and to define concrete requirements for a solution*. Operatively, experts were also relevant when considering the operative capacities, capabilities and subjective context of the teams involved, in order to not overwhelm them with unrealistic tasks. *In this sense, experts and practitioners (as proxy for the human factor) played a central role in identifying the personnel, entities and organizations that should be involved in the scenario, and selecting which ones should be responsible for the tasks required* (e.g., where should the recovery efforts be concentrated).

Additionally, and according to the methodological process proposed by (Hevner, 2007), experts were also central in the *assessment* of the project output, defining several concrete case studies to evaluate the capabilities of the framework. For the purposes of this paper, only one case study is described, to clarify the possibilities of this framework. This selected study dealt with strategic aspects of relief distribution in preparation for a long-term

blackout. The motivation and concrete aspects of the problem were based on the latest risk analysis report in civil protection at the federal level (Deutscher Bundestag, 2020), and jointly developed with experts from the German Committee for Disaster Reduction (DKKV, from its German acronym). The overarching goal was to demonstrate the framework possibilities for strategic analysis in the context of relief distribution under uncertainty. The concrete challenge of this study addressed the development and assessment of distribution strategies, as well as protection and restoration guidelines in preparation for several uncertain blackouts at a regional and national level.

Finally, it is worth noting that the active participation of experts in the project significantly helped aligning the goals of the project with their needs and expected outcomes. The next section further elaborates on this alignment.

The Value of the Framework for Experts and Decision-Makers

As previously described, the domain experts had an expectation on the outcomes of this project, manifested in three different aspects (decision, action and responsibility). The following paragraphs describe how was this expectation addressed in the project.

Strategic Decision-Making Capacity: The application of the developed decision support framework to this case study enabled, at a strategic level, an objective comparison of different relief distribution strategies, some of them requiring some degree of infrastructure adaptation (e.g., larger depots, transshipment facilities or even location/relocation of existing structures). On account of the required investment and planification, the decisions at this level assumed a mid-term planning horizon, and are made in anticipation to the actual disaster (ex-ante approach). In this sense, the uncertainty and risk associated to the decision remains significant. Armed with these insights, experts and stakeholders can now make an informed decision regarding transportation, location and capabilities of the relief distribution network, to better prepare for a catastrophic blackout.

Capacity for Short-Term Action: The application of the developed framework enabled an increased capacity for short term action. This translated into concrete response guidelines for first responders (and grid operators in this specific case study) after the disaster (ex-post approach). The concrete guidelines for action provide, in the aftermath of a disaster, clear rules on how to assign resources to minimize the impact that the disaster has on the system as a whole.

Ability to Take Responsibility Into Consideration: While this aspect proved harder to objectively assess than the previous two, some insights proved useful in this context. The main takeaway being the framework's capability to divide between pre-disaster planning and response actions, while remaining observant of the fundamental humanitarian principles. Through this division, this novel framework incorporated a clear responsibility hierarchy in the decision support system, organically assigning roles according to the stage of the disaster.

CONCLUSION

This paper described the significance of human factors in HL at a strategic level. It focused on the lessons learned when designing, together with domain experts, a strategic relief distribution framework, under the umbrella of Design-Oriented OR. Through this methodological paradigm, the research output profited from the experts' knowledge and experience. Simultaneously, this development approach enabled decision-makers and stakeholders in HL to find value in the framework, by explicitly addressing strategic decision-making, operative actions and responsibility considerations.

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