



# Using announcement options in the bid construction phase for disaster relief procurement

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## ABSTRACT

This paper presents an analysis of the bid construction phase of procurement auctions in disaster relief and humanitarian logistics. Substitution and partial fulfillment options are presented in formulations to allow bidders with fewer inventories to offer substitute item types and partial bids in auctions. During the auction announcement phase, a coordinating platform for disaster locations (i.e., auctioneer) allows substitution and partial fulfillment options to the relief suppliers (i.e., bidders) when acceptable. Thus, suppliers with fewer inventories can offer substitute item types and participate in more auctions by partially bidding. A genetic algorithm, a simulated annealing algorithm and an integer program are used for the analysis of the bid construction phase with different announcement options. Heuristic solution techniques and an IP formulation help understand the dynamics of the bid construction problem. It is shown that the addition of substitution and partial fulfillment options is essential to diversify and increase the usable capacity of the supplier base. Additionally, the partial fulfillment option enables better usage of supplier inventories in an environment with scarce supplies.

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## 1. Introduction

During the last decade, research on disaster planning and disaster relief logistics has received an increasing interest from many disciplines due to the emerging need for effective relief operations. Many studies have investigated disaster planning and relief logistics [1–3] whereas many others have focused on resource allocation and procurement operations in an emergency planning and response context [4–7]. Procurement is necessary to have the required goods readily available for the relief operations. Estimates show that 65% of the total disaster relief budget is dedicated to the procurement of relief supplies and equipment [8], which makes it the step in the disaster relief process where the majority of donor funding is spent. In addition, organization of funding mechanisms, donor expectations, diversity of stakeholders, unpredictability of disasters and resource scarcity/oversupply are some of the factors [9] that contribute to the complexity of the procurement operations. This complexity poses important

decisions on the type, quantity, timing, source and destination, as well as the method of delivery procuring relief goods.

Although a few humanitarian organizations have utilized auction-based approaches in procurement by the help of logistics software [10–13], the use of procurement auctions in disaster relief still needs thorough and practical investigations. The practice of Humanitarian Procurement Centres (HPC) of the European Commission (EC) is a practical example for the organized procurement operations when the operations are conducted on behalf of its partners [14]. During a typical procurement operation, first, HPCs receive procurement requests from the partners. Then, they consolidate these requests and conduct the procurement following the principles of ethics, transparency, proportionality, and equal treatment of potential suppliers [15]. This study proposes a procurement auction-based approach for procurement operations in similar environments where a coordinating platform at the disaster location represents the auctioneer and suppliers around the disaster location represent the bidders.

Although the number of studies and publications on procurement auctions has increased in recent years [16], this research area could still benefit from the attention of OR/MS practitioners [17]. Besides, most of the research on this topic is in a commercial context and usually concentrates on the auctioneer's perspective. This study focuses on the bidders' perspective in a disaster relief

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context when there is a coordinating platform which collects needs and conducts the auctions. The motivation for this study is to enable the design of procurement auctions for an effective disaster response. The research question that we seek to answer in this paper is: “What are the specific design parameters for an effective procurement auction in disaster relief setting?” The contribution of this study is that we focus on the suppliers’ perspective in a procurement auction and investigate different techniques for the suppliers to construct bids effectively. New procurement auction design parameters are introduced to facilitate following the EC procurement principles and to better utilize suppliers’ capacities in a scarce resource environment. Thus, the purpose of the paper is to show that announcement options are beneficial to the suppliers as well as the auctioneer.

**2. Literature review**

There are a number of factors that necessitate procurement in disaster relief operations. First, pre-positioned inventories are usually insufficient in many disaster relief operations [18]. Second, a demand/supply mismatch and operational problems are frequently observed in practice for gifts-in-kind [19–21]. Third, funding for the disaster is proliferated after the disaster [22] which requires dynamic spending strategies for the available funds. One way to effectively acquire the needs in an environment with scarce resources is procurement auctions. A procurement auction is a mechanism that outlines procedures to establish procurement of supplies based on bids submitted by participants [23]. Two parties are defined for an auction: auctioneer and bidder. A buyer and multiple sellers are present in a procurement auction. In a disaster relief environment the buyer is typically a coordinating platform near the disaster location and acts as the auctioneer whereas the suppliers are bidders that bid on the auctions.

Typically, procurement auction-based models include two main phases: (1) the bid construction phase and (2) the winner determination phase [24,25]. In the bid construction phase, the bidders evaluate the auction and construct a bid price considering a number of objectives and constraints. When the auctioneer has all the bid prices, the winning bid is determined by utilizing a winner determination algorithm [26–28]. To date there is a limited amount

of research in the literature that concentrates on the supplier’s perspective and focuses on the bid construction phase, which directly affects the auction. Many of the studies in the literature focus on a commercial context [29–31], Trestrail et al. [32] is one of the few studies that analyze the procurement process from the bidders’ perspective and illustrate the remote procurement of the world’s largest donor of food aid (i.e., United States Department of Agriculture (USDA)). Bagchi et al. [33] proposes an optimal auction mechanism for USDA to deter gaming of suppliers and enhance bid preparation process by combining carrier and supplier bids. On the other hand, Falasca and Zobel [34] present a two-stage stochastic procurement model from the perspective of humanitarian organizations (i.e., auctioneer’s perspective).

Equal treatment of potential suppliers is explicitly required from HPCs in real disaster relief operations. Nevertheless, there is usually an imbalance of quality and availability of relief goods between local and global suppliers, which makes it harder for them to follow this principle. Local (i.e., usually smaller) suppliers often do not have the capacity to provide the best quality of relief supplies and to hold inventory of large quantities. On the other hand, procuring from local suppliers is encouraged especially in the recovery phase of disaster relief to support local the economy and contributions of local people [35,36]. Besides, it is logistically cheaper to procure from local suppliers. In order to address this issue, announcement options (i.e., substitution and partial fulfillment) are proposed in procurement auctions to alleviate the imbalance and to create an opportunity for local suppliers to bid. A spillover effect of these announcement options would be in increasing the usable capacity of the supplier base by removing the quantity restriction.

This paper specifically focuses on the bid construction phase for procurement auctions within the context of disaster relief operations. The bid construction phase includes decisions related to quantities and types of items in the bids. The decisions are compared using a Genetic Algorithm (GA), a Simulated Annealing (SA) Algorithm, and an Integer Programming (IP) formulation of the problem. A Linear Programming (LP) relaxation of the IP is used as a benchmark in this comparison. Partial fulfillment and substitution of supplies are two major considerations introduced in this auction process. The impacts of those considerations on bid construction decisions are also analyzed.

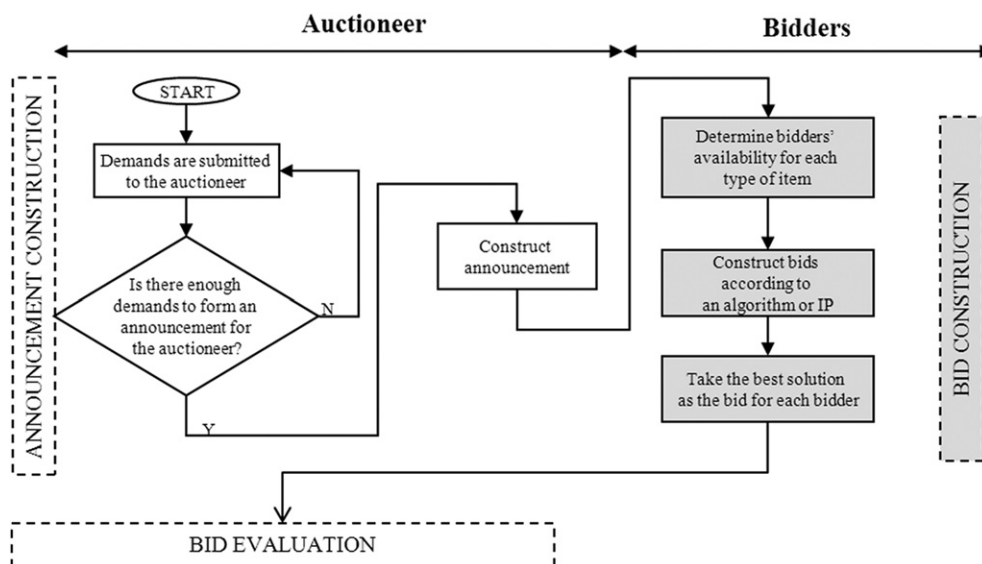


Fig. 1. Procurement auction processes.

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