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Optimal auction design for promoting sustainable practices in industrial procurement

Industrial procurement significantly impacts the environment, as companies often produce materials and services with significant environmental footprints. However, in recent years, there has been growing interest in promoting sustainable industrial procurement practices to mitigate these activities' environmental externalities. One way to achieve this is through auction design for industrial procurement processes, which can incentivize industrial suppliers to adopt more sustainable practices when bidding for procurement contracts. The design of procurement auctions can significantly influence their effectiveness in promoting sustainability in industrial practices.

The goal of this thesis is to investigate the optimal auction design for promoting sustainable practices in industrial procurement. Reverse auctions are frequently used in procurement auctions to encourage suppliers to compete by submitting progressively lower bids. This can incentivize suppliers to submit the lowest bid, increasing their chances of winning the contract. We propose to adapt reverse auction settings for the application in sustainable procurement. Therefore, the Winner Determination Problem (WDP) is adapted accordingly. The WDP helps identify the combination of bids that should be selected as winners to achieve the desired outcomes of the procurement process, such as optimizing the selection of winning bids based on multiple objectives, including minimizing costs while, in parallel, optimizing with regard to sustainability or environmental criteria.

The formulation of the WPD model in this research may include various cost components, such as production costs, transportation costs, or any other relevant expenses associated with the industrial procurement process. Additionally, it may include constraints on emission limits, energy usage, or waste generation associated with the selected bids (i.e., the selected supply) and sustainability objectives as part of the optimization criteria. Overall, thus, the developed research setting seeks to provide a problem formulation that minimizes environmental externalities, such as carbon footprint reduction or waste minimization.

Furthermore, the research will explore the relationship between economic efficiency and sustainability and the impact of bidder behavior and market outcomes. By exploring the intersection of auctions and sustainability, this research aims to provide valuable insights into the design principles and mechanisms that can effectively drive sustainable procurement practices.

Aims and scope of the thesis

It is subject of this thesis is to formulate, implement, and evaluate optimal auction design options to foster sustainability within industrial procurement. This comprises the following research tasks:

- Development of a mathematical model for The Winner Determination Problem (WDP) in the Reverse Auction Mechanism for application within industrial procurement
- Implementation of a scalable solution approach
- Generation of a suitable dataset
- Evaluation of different scenarios in the context of sustainability criteria
- Identification of the relationship between economic efficiency and sustainability, as well as the impact of on bidder behaviour and market outcomes

Related Research

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- Chaudhuri, A., Datta, P. P., Fernandes, K. J., & Xiong, Y. (2021). Optimal pricing strategies for Manufacturing-as-a Service platforms to ensure business sustainability. International Journal of Production Economics, 108065.
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