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## MULTI-ATTRIBUTE REVERSE AUCTIONS IN THE ROMANIAN PRIVATE SECTOR

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**Abstract:** *The mandatory integration of green and social requirements in key procurements launched by Romanian public institution invites questions about the readiness of the supply chain to align accordingly. In corporate private sector procurement, the reverse auction has been deployed over time as a particularly useful technique, which has the potential to integrate other attributes besides the price. Hence, it would be a transparent and automated solution to the timely integration of green criteria into private sector procurement, driven by public sector procurement policy. The purpose of this paper is to understand the access of Romanian private sector companies to reliable academic resources to build knowledge in undertaking successful multi-attribute reverse auctions. The research method employed entails the search of Open Access academic databases for relevant studies, government reports and company report of major companies awarded public contracts, as most likely to set an example. Furthermore, results are scarce, and furthermore limited to private sector cognizant keywords and Open Access sources. The authors conclude that from such sources smaller companies could not materially benefit from publicly available sources in undertaking a multi-attribute reverse auction. More research on the utility of reverse auction in a Romanian context is of value, with a particular consideration given to the causation for the lack of local case studies.*

**Key words:** *Reverse Auction; Procurement; Multi-attribute; Sustainability.*

### 1. INTRODUCTION

In 2020 a European Union's (EU) Policy Department for Economic, Scientific and Quality of Life Policies report found that national public procurements by member states did not sufficiently integrate green and social requirements [1]. Further, it was stated that a mandatory approach to increasing such requirements is necessary. Additionally, it reiterated the impact public procurement standards have on the practices of supply chains, private contractors, and their subcontractors.

In Romania, a combination of public and private sector facing initiatives have updated the regulated environment with mandatory green requirements. Amongst these, the mandatory integration of ecological evaluation factors in the procurement of certain products categories which are considered to have an environmental impact (e.g., computers, paper, furniture, cleaning products, food stuff, textiles, etc.) [2], or the n-ZEB standard for all newly built

buildings or those undergoing major renovation [3]. Therefore, we are interested in how and if there is an uptake of green practices in the largely unregulated private sector procurement, considering its slow voluntary uptake in public procurement is increasingly addressed with mandatory regulations.

In terms of the procurement process, we have narrowed the focus to the reverse auction technique. The use of reverse auctions is used by almost all Fortune 500 companies due to a need to automate the negotiation process [4].

Known also as e-auctions, reverse auctions "use web-based software to enable suppliers to compete for goods or services in real-time at electronic marketplaces", and can be based on price or a blend of criteria, known also as 'multi-attribute' reverse auctions [5].

Consequently, they are traditionally popular due to their association with cost savings and increased efficiency [5] rather than with obtaining greener products, services or building works.

As such, the aim of this paper is to explore if smaller companies in the Romanian private sector could successfully use multi-attribute reverse auction for greener procurement. To achieve this aim, this exploratory research has three objectives.

Firstly, identifying if there is publicly available and easily accessible data on how many and which of the Romanian private sector economic operators have used the reverse auction technique at least once.

Secondly, identifying scholarly case studies which highlight whether and how multi-attribute reverse auctions have been successful. Lastly, this research aims at understanding if current publicly available information can be used by smaller private sector companies to undertake successful multi-attribute reverse auctions which integrate green criteria, in keeping up with the similar yet mandatory EU driven integration of green criteria in the public sector procurement.

This paper, following the introduction, is structured as follows. First, a literature review of the wider context and work already done on the topic of Open Access content for non-academic purposes, followed by a presentation of the methods chosen and employed to achieve the aim of the paper. The search results are summarized in the subsequent section, which is followed by an expanded presentation of the most relevant studies found. The last sections of this paper make notes of limitations, followed by the conclusion and proposal for future research.

## 2. LITERATURE REVIEW OF OPEN ACCESS BENEFITS

To set this study in a wider context and to describe how it complements work that has already been done on the topic, an understanding of the growing debate on Open Access and its benefits to society has been necessary.

Although there is general consensus on the industry benefits of the unstoppable globalisation of research [6], claims that Open Access is beneficial outside its academic boundaries are found to be lacking in evidence [7]. The rationale for reviewing Open Access seeks to understand if smaller companies or those less likely to invest in access to proprietary

journal subscriptions would be able to find information on successfully integrating into their procurement process reverse auctions with both price and green criteria. It has been found that proprietary research costs are a knowledge transfer barrier for smaller companies [8], especially in developing countries such as Romania [9], [10]. Moreover, on a background of static or declining library funding, rising journal prices could also become a problem for the academic community as well [6]. Nevertheless, the European Union recognizes the ultimate advantage of Open Access science as being a driver for innovation in the public and private sectors[11], especially important in the context of a need for a more sustainable society [7].

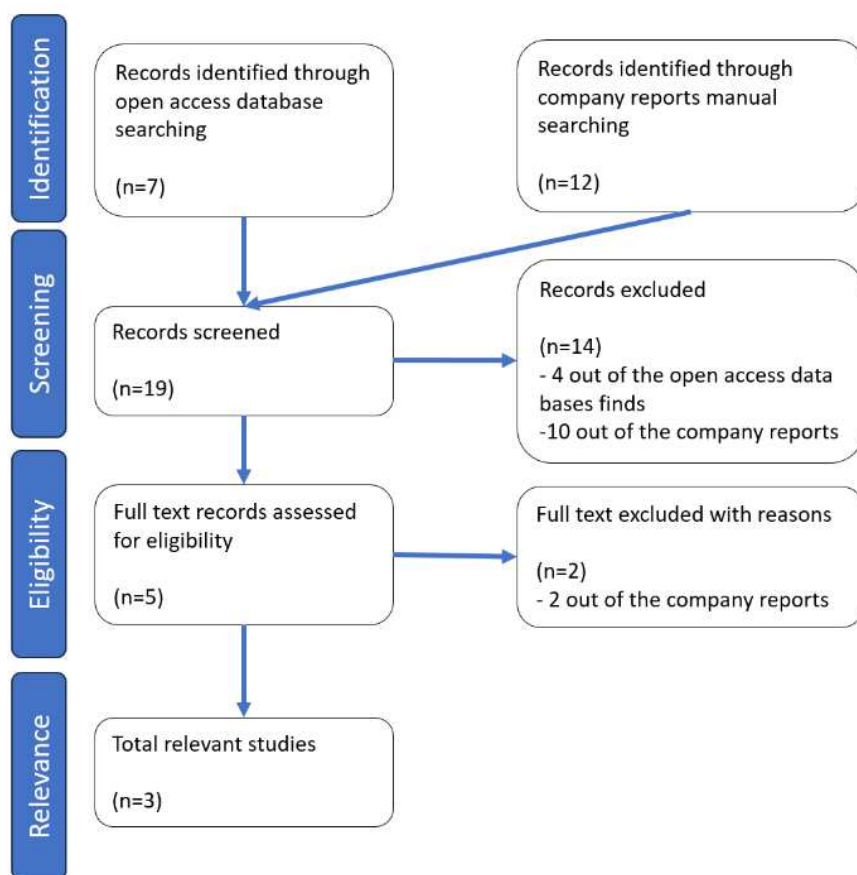
## 3. METHODS

This bibliometric exploration of Open Access academic literature has been undertaken on publicly available primary (e.g., company reports, government publications) and secondary literary sources (e.g., journals and databases). The parameters of the literature review are illustrated below.

*Table 1*

**Research parameters.**

Parameter	Wider	Narrow
Language	English language academic literature	Romanian and English language company reports or government publications
Subject areas	Procurement techniques	Reverse auction and green award criteria
Business sector	Any	Any
Geography	Global for the multi-attribute reverse auction case studies	Romanian for insights on economic operators using the reverse auction at least once
Publication period	All dates	All dates
Literature type	Open Access academic journals and data bases, company reports and government publications	Directory of Open Access Journals (DOAJ) ScienceDirect MDPI Romanian national statistical data Public company report of top economic operators by value of public contracts in the year 2021, based on the latest ANAP published reports [12]



**Fig. 1.** Study selection process.

The key words used for the research are in two sets.

Set 1, informing the first objective of this research, is comprised of *reverse auction, Romania*.

Set 2, informing the second objective of this research, is comprised of *multi-attribute, auction, case study*.

For completeness, the third objective does not need a search set since it endeavors to respond to a question based on previous search results. The search approach is summarized in the figure below.

#### 4. RESULTS AND REVIEW OF FINDINGS

The results of each set of searches are illustrated in the tables below.

Since the results were minimal, a short overview of the titles, publication year and aim are presented below first in tabular form.

Public procurement efficiency reports conducted by the Romanian National Agency for Public Procurement (ANAP) indicate the following as the top 5 foreign economic operators with the highest value contracts awarded in the year 2021 [12].

*Table 2*

**DOAJ set 1 key word search.**

Database	DOAJ
Subject	All subjects
Dates	All dates
Search	"Reverse auction" AND Romania
Fields searched	All fields
Date of search	3 <sup>rd</sup> of September 2023
Total items retrieved	0

*Table 3*

**DOAJ set 2 key word search.**

Database	DOAJ
Subject	All subjects
Dates	All dates

Search	“multi-attribute” AND auction AND case study
Fields searched	All fields
Date of search	3 <sup>rd</sup> of September 2023
Total items retrieved	1

Table 4

**ScienceDirect set 1 key word search.**

Database	ScienceDirect
Subject	All subjects
Dates	All dates
Search	“Reverse auction” AND Romania
Fields searched	Title, abstract, keywords
Date of search	3 <sup>rd</sup> of September 2023
Total items retrieved	1

Table 5

**ScienceDirect set 2 key word search.**

Database	ScienceDirect
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Subject	All subjects
Dates	All dates
Search	“multi-attribute” AND auction AND case study
Fields searched	Title, abstract, keywords
Date of search	3 <sup>rd</sup> of September 2023
Total items retrieved	4

Table 6

**MDPI set 1 key word search.**

Database	MDPI
Subject	All classifications
Dates	All dates
Search	“Reverse auction” AND Romania
Fields searched	Title, keywords
Date of search	3 <sup>rd</sup> of September 2023
Total items retrieved	0

Table 7

**MDPI set 2 key word search.**

Database	MDPI
Subject	All subjects
Dates	All dates
Search	“multi-attribute” AND auction AND case study
Fields searched	Title, keywords
Date of search	3 <sup>rd</sup> of September 2023
Total items retrieved	1

Table 8

**Research parameters.**

Title	Publication year	Aim
Bidding decision in land auction using prospect theory [13]	2015 (DOAJ result)	To present a Chinese land bidding case study and models helping decision makers make better bidding price decisions.
Demanding development: The political economy of climate finance and overseas investments from China [14]	2022 (ScienceDirect result)	To examine Chinese overseas financing in renewable energy and climate-friendly political economic factors in recipient countries (incl. Romania) who might consider reverse auctions to obtain the lowest bid.
Efficient and truthful multi-attribute auctions for crowdsourced delivery [15]	2021 (ScienceDirect result)	To study the multi-attribute auction design for crowdsourced delivery for social welfare maximization.
A multi-objective robust possibilistic programming approach to coordinating procurement operations in the disaster supply chain using a multi-attribute reverse auction mechanism [16]	2021 (ScienceDirect result)	To present a multi-attribute reverse auction framework which facilitates the purchase operations between suppliers and a relief organization; tested through an Iran case study.
A fair multi-attribute combinatorial double auction model for resource allocation in cloud computing [17]	2015 (ScienceDirect result)	To present a multi-attribute (price and quality of service parameters) auction for the allocation of Cloud resources; performance of the method is demonstrated by simulation.
Multi attribute auction based incentivized solution against DDoS attacks [18]	2020 (ScienceDirect result)	To propose a better performing approach to mitigate cyber-attacks.
Sustainable Winner Determination for Public-Private Partnership Infrastructure Projects in Multi-Attribute Reverse Auctions [19]	2018 (MDPI result)	To illustrate the potential of multi-attribute reverse auctions for selecting a sustainable contractor through a public-private partnership project of a subway construction case study in China.

Table 9

**Top 5 foreign economic operators by value of Romanian public contracts in 2021.**

<b>Economic operators</b>	<b>Contract scope</b>	<b>Value (approx.)</b>
Kalyon Insaat [20] Sanayi Ve Ticaret [21] Anonim Sirketi (Turkey)	Gas piping works	325 Mil EURO
SOLARIS BUS & COACH Sp. Z. O. O [22] (Poland)	Electrical buses	63 Mil EURO
Hydrostroy Ad [23] (Bulgaria)	Road infrastructure works	47 Mil EURO
Todini Costruzioni Generali S.P.A. [24] (Italy)	Road infrastructure works	38 Mil EURO
Pojazdy Szynowe Pesa Bydgoszcz Spółka Akcyjna [25] (Poland)	Public transport trams	31 Mil EURO

Table 10

**Top SMEs by value of Romanian public contracts in 2021.**

<b>Economic operators</b>	<b>Contract scope</b>	<b>Value (approx.)</b>
Tehnostrade S.R.L. [26] (consortium)	Road infrastructure works	167 Mil EURO
Tehnostrade S.R.L. (consortium)	Road infrastructure works	142 Mil EURO
Tehnostrade S.R.L. (consortium)	Road infrastructure works	124 Mil EURO
Leviatan Design [27]	Defence infrastructure	99 Mil EURO
Modern Power Systems [28]	Water meters	67 Mil EURO
Elm Electromontaj Cluj [29] (consortium)	Electrical works	50 Mil EURO
Hydrostroy Ad [23] (consortium)	Road infrastructure works	47 Mil EURO
Societatea de Transport Public SA Alba Iulia [30]	Public transport services	46 Mil EURO
Aduro Impex [31]	Defence infrastructure	40 Mil EURO

The review of Open Access data bases therefore provided a limited number of academic papers useful to build the knowledge of Romanian economic operators on multi-attribute reverse auctions. A total of 7 studies were identified based on the selected key words, with no limits on the publication period. 3 were helpful in terms of reverse auction insights. Reinforcing the reduced number of search results from Open Access literature, a number of papers that have been reviewed have made reference to the scarcity of literature on auction mechanisms in support of the their particular context [19] [18].

Pertinent to our topic is a recent study about the application of multi-attribute reverse auction in a disaster relief procurement context [16]. Price, quantity and delivery time are the

attributes integrated in the reverse auction mechanism, the disaster response context validating logically the need for more than price as an attribute, without compromising on negotiation efficiency.

Another useful study is on using the reverse auction for the procurement of Cloud computing services, as a market with services treated as a utility and priced [17]. Apart from price, such services benefit from assessing the quality of service (e.g., response time) attribute. Auctions are opportune for the procurement of Cloud resources since prices are determined by supply and demand at any moment.

And a last, most helpful and unique search result study presents a multi-attribute reverse auction for the determination of a sustainable winner in an infrastructure project [19]. A key

insight of this study is the need to consider the interrelationships between attributes, illustrated through the example of two attributes, solid waste management and public health and safety, which clearly have a strong complementary effect. Also, it introduces the idea of third-party experts assessing manually the bidders' response in alignment with the established sustainability attributes, rather than have them integrated automatically into an auction platform. The integration of all the negotiated attributes to determine the winner is the challenge.

Of the companies having been awarded the highest value public contracts in 2021 [12] in Romania, only two address the supplier relationship, supplier access and sustainable procurement. Transparency in terms of the types of negotiation techniques employed is limited or absent and no information can be found on the use of reverse auction.

Anecdotal evidence indicates to the undertaking of at least one reverse auction by the largest beer producer in Romania. However, a search of the Internet does not uncover any related information.

## 5. LIMITATIONS OF THE STUDY

The academic literature reviewed is limited to Open Access databases. The selected keywords have been chosen taking cognizance of a likely practitioners' search lens. Therefore, same databases and other mixed access sources (e.g., Google Scholar) have been searched using foundational keywords, including *auction* or *reverse auction*. The list of results was higher, noting most of the studies addressed reverse auction from a mathematical and statistical perspective rather than from its potential to contribute to the sustainability of society by integrating multi-attribute criteria into the procurement processes.

## 6. CONCLUSION

The reverse auction is often associated with and requires mathematical modelling skills. Similarly, it emerges the need for an auction mechanism designer and a thorough market understanding (e.g., enough participants,

collusion opportunities) to be able to design an environmentally relevant multi-attribute reverse auction.

With regards to the three objectives targeted, it has emerged that there is none or no easily accessible data in Open Access academic literature to understand how many and which of the Romanian private sector economic operators have used the reverse auction technique at least once. At a global level, identifying case studies which highlight whether and how multi-attribute reverse auctions have been successful was also a challenge.

With these tentative findings, the authors understand that current publicly available information *cannot* be used by smaller private sector companies to inform undertaking successful multi-attribute reverse auctions which integrate green criteria, in aligning with the similar yet mandatory EU driven integration of green criteria in the public sector procurement.

## 7. FURTHER RESEARCH

Informed by this initial exploratory study, the utility of leveraging the reverse auction by the Romanian private sector to award 'greener' contracts becomes a research question. Not in the least it is necessary to understand if the auction software available and suitable for the Romanian market's procurement needs has the capability to integrate multi-attribute events. The reverse auction is a special technique which, if used to its full potential, can satisfy in a truly mathematical and transparent way the need for better performance of the procurement process. It can also elevate the sustainability performance of the contracts themselves, a directive increasingly prevalent in the corresponding regulated public procurement environment.

In terms of access to Open Access quality scholarly content to support the planning of such events, it would be useful to understand how knowledgeable the Romanian business sector on the benefits of Open Access studies is. On the other hand, the profile of the Romanian research community should be investigated, and how is the Open Access publishing of scholarly studies incentivized to be of genuine support of the business community.

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### Licitațiile reverse cu multatribut în sectorul privat roman

Integrarea obligatorie a cerințelor verzi și sociale în principalele achiziții lansate de instituțiile publice din România ridică întrebări cu privire la posibilitățile lanțului de aprovizionare de a se alinia în consecință. În achizițiile sectorului privat corporatist, licitația inversă a fost implementată de-a lungul timpului ca o tehnică deosebit de utilă, care are potențialul de a integra alte atribute în afara prețului. Prin urmare, ar fi o soluție transparentă și automatizată pentru integrarea promptă a criteriilor verzi în achizițiile derulate de sectorul privat, conduse de politica de achiziții a sectorului public. Scopul acestui studiu este de a înțelege nivelul accesului companiilor din sectorul privat românesc la resurse academice fiabile pentru a dobândi cunoștințe despre desfășurarea cu succes a licitațiilor inverse cu mai multe atribute. Metoda de cercetare utilizată implică căutarea bazelor de date academice tip Open Access de studii relevante, rapoarte guvernamentale și rapoarte ale companiilor care au câștigat contracte publice de valori mari, ca fiind cele mai bine poziționate în a servi drept exemplu. Rezultatele cercetării bibliografice sunt puține și, în plus, limitate la cuvinte cheie familiare sectorului privat și la surse Open Access. Autorii concluzionează că din astfel de surse, companiile mai mici nu ar putea beneficia în mod semnificativ de informații disponibile public în a desfășura cu succes licitații inverse cu mai multe atribute. Este necesară mai multă cercetare asupra utilității licitației inverse într-un context românesc, cu o considerație specială acordată cauzelor lipsei studiilor de caz locale.

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