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On-line reverse auctions in construction industry

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Preliminary note

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The paper examines factors influencing the decision to use, and adoption rate, of online reverse auctions in construction sector. The main factors are identified and comprehensively discussed taking into account particularities of construction industry. The adoption level of this procurement route is examined via a web survey based on a selected sample of construction companies and clients from the Czech construction sector. It was established that online reverse auctions are the most widely used e-procurement tool in the Czech construction sector. Advantages of this procurement procedure are more significantly perceived by investors.

Key words:

construction industry, cost management, online reverse auctions, purchasing management

Prethodno priopćenje

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Elektroničke reverzne aukcije u građevinarstvu

U radu se analiziraju faktori koji utječu na donošenje odluka te brzina uvođenja postupka elektroničke reverzne aukcije u području građevinarstva. Određuju se i detaljno razmatraju osnovni faktori uzimajući u obzir posebnosti građevinskog sektora. Stupanj prihvaćenosti ovog načina nabave ispitan je kroz on line anketu na odabranom uzorku građevinskih tvrtki i naručitelja iz građevinskog sektora u Češkoj. Ustanovljeno je da su elektroničke reverzne aukcije najzastupljeniji način on line nabave u češkom sektoru građevinarstva. Prednosti ovakvog postupka nabave više uočavaju investitori.

Ključne riječi:

građevinarstvo, upravljanje troškovima, reverzne e-aukcije, upravljanje nabavom

Vorherige Mitteilung

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Elektronische inverse Auktionen im Bauwesen

In der Arbeit werden die Faktoren analysiert, die sich auf die Beschlussfassung und die Schnelligkeit der Einführung von inversen Auktionen im Bereich des Bauwesens auswirken. Die grundlegenden Faktoren werden festgelegt und ausführlich analysiert, wobei die Besonderheiten des Bausektors beachtet werden. Die Akzeptanz dieser Form von Beschaffung wurde durch eine Online-Umfrage auf einem ausgewählten Muster von Baufirmen und Auftraggebern aus dem Bausektor in Tschechien untersucht. Es konnte festgestellt werden, dass die elektronischen inversen Auktionen die häufigste Art der Online-Beschaffung im tschechischen Bausektor sind. Die Vorteile eines solchen Beschaffungsverfahrens werden eher von den Bauherren bemerkt.

Schlüsselwörter:

Bausektor, Kostenverwaltung, inverse E-Auktionen, Beschaffungsverwaltung

1. Introduction

Contemporary enterprises and public institutions need to rationalize their operations in order to achieve their business goals. This need is also present in construction sector, which, since 2008, has been affected by a significant decrease in demand with regard to both buildings and engineering structures. For this reason, purchasing management is certainly one of the processes that need to be streamlined. Presutti [1] even considers the improvement of procurement management to be an important priority in corporate decision-making. Due to the availability of new web-based technologies, which are becoming widely accessible and feature low purchasing prices and operating costs, institutions have been increasingly considering adoption of contemporary IT tools in the field of e-procurement [2]. The use of modern online methods and applications through an interface makes it unnecessary to purchase expensive IT systems, which would otherwise be a considerable financial barrier for small and mid-size enterprises. One of the electronic commerce technology options is the Online Reverse Auction (ORA), where sellers bid for the prices at which they are willing to sell their goods and services (unlike a regular auction where bids are placed by the buyer) [3]. ORA is designed to facilitate the acquisition of goods over the internet, in addition to other options such as e-Procurement software, internet B2B auctions, and internet purchasing consortia [4]. From the buyers' standpoint, the starting point for efficient use of ORA is:

- a) to be able to precisely describe the product in demand
- b) to define and quantify the selection criteria.

Implementation of ORA in an enterprise can lead to a considerable increase in efficiency. This can be particularly important for construction companies, which typically need to purchase various products and services. It should be noted, however, that the conservative attitude and project-oriented character of the construction sector may lead to more challenges when this procurement route is being implemented. In order to overcome these obstacles, a research project has been implemented in order to determine the current level of ORA adoption in construction industry, and to identify measures that would facilitate implementation of this particular procurement route. The overall goal of the reported research is to examine the level of ORA adoption in construction sector. The first objective is to identify the main barriers and advantages that influence adoption of this procurement route, as well as their perceived importance. The second objective is to make qualitative and quantitative assessment of the ORA use within the construction industry in the Czech Republic. The construction sector in the Czech Republic, which has been selected as the study population, is considered to be a valid representative of national construction sectors in Central Europe. It can therefore be assumed that the results obtained can be used as a starting point for further actions, such as preparation of guidelines, both

in the Czech Republic and in other Central European countries, in order to encourage the use of ORA.

A systematic literature review served as research method for achieving the first objective. A qualitative and quantitative assessment of the use of ORA in the Czech Republic was carried out by using an online survey as a research tool. The content of the web-based questionnaire used in the survey was systematically checked on the basis of literature review, list of advantages and barriers affecting ORA implementation in construction industry, and hypotheses established in the scope of the study. The survey was distributed to various construction-industry stakeholders in order to make a qualitative and quantitative assessment of their viewpoints and the use of ORA, and to test the hypotheses.

2. Literature review

ISM/Forrester Research Report [5] stated in a study conducted in 2003 that 7 out of 10 US companies use e-procurement to obtain strategic items. Similarly, 64 % of respondents use some kind of an e-procurement system in Austrian construction industry [6]. The buyers are most often motivated to adopt this system due to an expected price decrease [7] that leads to better performance of their companies. The manufacturing processes are usually already sufficiently effective and economical, so it is necessary to turn one's attention to the prices of the inputs. For this reason, the proportion of online reverse auctions in the area of e-procurement is not negligible.

Over the past decade, online reverse auctions (or downward price auctions) have become a popular method, typically among large organisations, for decreasing the purchase price of durables [8]. These auctions are based on the principle of real-time bidding events, where the buying organization demands a product or a service (in other words, offers a contract) and two or more contenders lower their prices to win the contract. Due to its functionality, user-friendly interface and substantial benefits, it has been very popular from the very beginning. Because ORA eliminate the influence of human factor on the buying process, its practical application evokes certain ethical questions. Ethical issues surrounding ORA have been extensively discussed in [9].

The key benefit of ORA use is a significant decrease in bid prices during online price negotiations. The extent of this decrease depends on a whole range of factors. Many researchers place emphasis on the influence of the type of the product in demand, the competition, and the number of contenders [10]. However, some other factors are also important, such as the attractiveness of the demanded volume, the prestige of the buyer, or the ratio of supply and demand. It can generally be stated that the decrease in bid prices is also influenced by the level of competition among the suppliers [11]. The savings gained in this way amount to 5–40 % [12] and the usual overall level of savings is 10–40 % [13]. The percentage of savings is usually higher in supplementary items and lower in

strategic items. This results from the fact that the preceding price negotiations regarding strategic items are certainly more rigorous than those regarding less important items. Nevertheless, in the case of large volume purchases, even a price decrease of 2–3 % is important, and its positive influence on the firm's competitiveness can be significant. The size of an organization can be an indicator for the timeline of adopting online auctions. According to research presented in [14], smaller firms tend to lag in terms of adoption of online auctions, whereas larger- and medium-sized firms are primarily early adopters. The use of online auctions varies with individual areas of production and provision of services. Only a handful of papers dealing with application of ORA in the field of the construction industry (such as [15]) were found during literature search. The position of this industrial sector is considered special for the following reasons: it is difficult to adequately evaluate overhead costs [16], projects involve complex, inter-dependent, uncertain and labour-intensive processes, and the product quality is often subject to criticism [17]. It is therefore clear that the study of ORA use in construction sector is justified, as it may provide a closer insight into this particular procurement type, while also enabling identification of measures that may lead to higher efficiency.

3. Identification of advantages and barriers influencing ORA adoption in construction

3.1. Advantages of the application

From the buyers' perspective, typical expected advantages for ORA adoption are lower prices and, in general, a more efficient purchasing process [18]. Decrease in bid prices can be considered as the primary factor, as clearly shown in a majority of research studies on ORA, such as in [7]. When evaluating potential savings, it is necessary to remember that the savings advertised by the ORA operator and gained through the auction can only be considered as gross savings (GS) [8]. To evaluate an auction event, one must take into account associated costs and related losses, such as acquisition costs to realize ORA, switching costs, or higher transportation costs. Practical experience shows that including switching costs in the decision-making after the event may be a reason for rejecting the contract from the investor's side, since the buyer can consider that it would be better off keeping its incumbent supplier [11].

The criteria to be used in ORA must include transport costs incurred due to the distance between the supplier and the construction site, as they can sometimes exceed the acquisition price of the product itself. It is therefore essential that the client requires that all costs related to the acquisition, transport, storage, packaging, etc. be included in the bid price.

On some projects, e.g. school renovations, road infrastructure projects, etc., meeting deadlines is crucial for the provision of planned services. As a consequence, the client needs to specify the maximum duration of works as one of evaluation criteria in the

tender. The multi-criteria evaluation used in such cases results in selection of the winning bid on the basis of the so-called best value for money. Various additional time-related criteria can also be applied, such as the invoice due dates, the binding maximum time for realization of works, or the warranty period.

Another benefit identified in available literature [7] is the enhanced market transparency. Since ORAs provide transparency in terms of how contracts are awarded, they should be of particular interest primarily for public authorities and private investors in countries where the level of corruption in construction sector is high. Because the system records all operations that are carried out in the tender, and provides monitoring access to the auction house for the management of the buying institutions or for institutions otherwise involved in the process (e.g. the bank which grants a loan), ORA can serve as an important tool for eradication of corruption, a phenomenon too often present in construction sector, as observed e.g. in the Czech Republic [19].

Participants in the construction process face more challenges in dealing with the problem of corruption compared to other sectors due to the nature of construction works [20]. The typical construction process consists of a series of demanding tasks and activities throughout the entire life cycle of the project, which contributes to the occurrence of corruption activities at all phases of the project. The research presented in [21] shows that 43 % of the respondents who are professionally engaged in construction feel that corruption can occur at all stages of the construction process, and identify the pre-qualification and tendering phase as the ones that are the most susceptible to corruption. Corrupt activities usually occur in connection with conflicts of interest, terms of tender rigging and collusive pricing [22]. Obviously, ORA can not prevent intentional setting of terms of tender rigging, but it can provide a clear, plain and verifiable history of the buying process that serves as prevention against manipulation of bid prices. As such, it can significantly hinder the occurrence of corruption in the tender.

Purchase time reduction is another benefit often-cited in scientific literature [23, 18]. More precisely, ORA reduces the time needed to negotiate and award a contract. ORA users report time savings as an important positive effect, even though these effects were not initially expected [23]. If a product is being purchased repeatedly, ORA can even automate the purchasing process, as it is very easy to copy parameters of the past auction to the new auction event. It should be noted, however, that such situations are mainly applicable for industrial mass production, rather than to the project-based construction industry. In the construction sector, the automation of the purchasing process can therefore be implemented in the construction product manufacturing industry, e.g. in concrete plants that can use cement and aggregate of various characteristics (fractions etc.).

Elimination of spatial, geographical and language barriers plays a very important role in increasing competition within the auction house environment. Because quality auction systems offer

several language versions, it is very easy for investors to invite foreign suppliers from different countries to participate in the auction. Contractors, on the other hand, may get an opportunity to enter new markets. Furthermore, since the price of specific building construction materials can differ significantly across different countries, the savings potential for the supplier may be increased. If the purchase volume is large, it may be more economical to buy the goods abroad even when transport costs are higher. This barrier is also eliminated because there is no need to be physically present at the auction house.

In addition to the above-mentioned advantages, ORAs also allow easy benchmarking of purchase prices. The ORA system can easily be implemented within a company, as it can be hired from the software provider. In summary, the ORA concept is oriented towards lowering the market price, and it sets equal conditions for all contenders.

3.2. Barriers of the application

The type of the product in demand may considerably influence the decision on the suitability of ORA. Foroughi et al [24] present various reports regarding the types of products that are appropriate for purchase through ORA. Based on the studies they cite, it can be concluded that standardized products are more appropriate, although even highly complex products can be auctioned successfully. It is essential that the investor specifies key characteristics of a product, such as the volume, physical characteristics, transport requirements, storage details, specialized labour requirements, service frequency, quality requirements, delivery time, location requirements, etc. [12]. On the other hand, ORA cannot replace traditional methods of setting prices for every product or service, especially if the product or service cannot be clearly specified beforehand [25]. In the construction field, this is the case with architectural and structural design. When the creativity and inventiveness level of the product is high, setting exact criteria for selecting suppliers can be extremely challenging, and therefore other methods of procurement are more appropriate.

Evaluation of auction events should embrace all costs associated with acquisition of the ORA system [26]. There are several possibilities for acquiring an ORA system: a company can create its own program, buy a standardized SW solution, or hire an existing system. The first two opportunities are associated with relatively high acquisition costs and related costs for necessary HW and SW equipment that may hinder potential user from engaging in this type of procurement. Proprietary software seems to be appropriate only in a situation where the investor needs to procure large quantities of goods, and auctions are frequently conducted. The purchase costs can then be compensated by future savings. The option of obtaining the system on hire appears to be more suitable for construction industry. In this case, ORA is hosted by a server hosting operator, who also provides the necessary user support, hotline, etc. Some buyers are worried about the unwillingness of current

suppliers to participate in ORAs [25]. This unwillingness results from a fear of losing the contract, or keeping the contract at terms that are less advantageous for the incumbent supplier. However, in a competitive environment it can be expected that there will always be a sufficient number of other companies who are willing to participate in ORA and compete to win the contract. Resistance to ORA use can also be supported by the opinion that face-to-face negotiations are the most important means of conducting procurement activities, and that ORA cannot be used for building long-term business relationships [13]. Building long-term relationships certainly brings some benefits since these relationships are based on trust and ensure e.g. that the supply delivery dates are met. Nevertheless, the prices of negotiated supplies should be continuously compared to actual market prices. From this perspective, ORA is an efficient tool for these negotiations. The question of credibility and ability to comply with commitments should be addressed in the prequalification of tenderers, which corresponds to the definition stated in [14], where ORA is considered to be a "real-time dynamic auction between a buying organization and a group of pre-qualified suppliers".

The buyers often claim that they give preference to quality over price. This should not be an obstacle to using ORA. The specification of the product provided in tender documentation should be clear so that the buyer fully understands the customer's purchasing requirements, including the quality standard [12]. The product should be described by using quantifiable parameters, such as masonry load capacity, thermal permeability, window opening options, etc. Other possible barriers to ORA acceptance include the presence of a monopoly, where other procurement routes should be employed, and lack of IT personnel.

4. Survey of ORA use in Czech construction industry

Based on the review of literature and identification of advantages and barriers, the following hypotheses were established:

- H.1: company role in a construction project has an influence on the frequency of ORA use
- H.2: company size influences the company's attitude towards ORA
- H.3: stakeholder type (client vs contractor) influences the perception of advantages and barriers related to ORA.

4.1. Methodology

The content of the questionnaire was systematically checked and defined, the intent being to gather data related to construction sector, its activities and procurement of structures. Its structure enables testing the previously established hypotheses.

A web-based questionnaire was prepared and distributed to a sample of stakeholders from construction industry. The companies invited to take part in the survey were carefully selected in order to represent all stakeholders in the construction

project: the clients, design/consulting engineering companies, general contractors, and subcontractors. The respondents were asked to answer questions from the list of questions described in Section 4.2. The obtained answers were recorded and analysed, and the hypotheses were tested.

4.2. Development of questionnaire

The questionnaire was divided into 3 sections. General data about the responding company were collected in the first section. In the second section, respondents were required to answer questions related to the use of electronic commerce, ORA in particular.

Due to the differing positions and views of the participants, it is first of all important to know the role of the responding company within the construction process. Thus the responding company can be either the client/investor (private or public), or one of the suppliers (general contractor, subcontractor or supplier of special equipment or service provider). The size of the company (in terms of the numbers of employees) was recorded as one of the established hypotheses related to this indicator. For the purpose of further analysis, a question regarding the role of the person answering the survey was included within the starting section.

The second part of the questionnaire was designed with the goal of obtaining basic information regarding the use of e-commerce in the responding company: whether e-commerce is used and, if so, which types of e-commerce are used.

The core part of the survey aimed at collecting data related to online commerce, focusing on ORA, Section 3 of the questionnaire, contains specific questions regarding its use. The idea was to determine the number of companies within the sample that actually use ORA; the proportion of clients and contractors within the sample; and the frequency of their engagement in procurement process that reflects their experience. Identifying the importance of individual ORA advantages and barriers as perceived by various stakeholders was one of the key goals of this study. Consequently, the questions enabling respondents to rank the advantages and barriers according to their importance were also included. The list of advantages and barriers offered to the respondents was compiled on the basis of an extensive literature review summarized in Section 3, and based on preliminary investigation focusing on construction industry stakeholders.

Two questions about an overall opinion of the respondent on ORA were included at the end of the survey in order to confirm the respondent's previous answers. The complete list of questions is provided in Appendix 1 of this paper..

5. Results and discussion

5.1. General

102 out of 1010 invited companies returned the questionnaire; the response rate was therefore 10.1

%. The response rate is comparable to similar studies using e-surveys in the field of supply chain and purchase management, such as the study conducted by Pearcy et al. with 13.9 % [27] or Gupta & Narain with 10.9 % [28]. In this context, it should be noted that due to their essence, electronic surveys are typical for their relatively low response rate that oscillates around 10 % [29].

From the perspective of sample size, 102 respondents can be considered as a sufficiently large sample as similar studies involved lower (36 [28]; 29 [30]) or slightly higher (145, [31]) number of respondents. The presented survey cannot be considered as statistically significant. However, even with the low-response rate obtained, the findings of the survey provide useful information about the respondents and show trends and tendencies within construction industry.

Out of 102 respondents, 32.3 % were general contractors, 44.1 % were clients (predominantly public clients), and 18.6 % were subcontracting companies. Suppliers of special equipment or services accounted for 4.9 % of the responding population (Table 1). It can be seen that the proportion of client organisations in the total sample of respondents is relatively large (44.1 %). Attention should be paid to the fact that the majority (41 out of 45, or 91.1 %) of the responding clients were public bodies. The responding person was, in most cases (60.8 %), a member of the management board, or the person responsible for procurement (25.5 %) (Table 2).

Table 1. Roles of responding companies in construction projects

Role of responding companies	Number	[%]
Private investor/client	4	3.9
Public investor	41	40.2
General contractor	33	32.3
Sub-contractor	19	18.6
Supplier of special equipment/services	5	4.9
Total	102	100.0

Table 2. Position of responding person within the company

Position of responding person	Number	[%]
Project manager	12	11.8
Responsible for procurement	26	25.5
Member of management board	62	60.8
Other	2	2.0
Total	102	100.0

The majority of surveyed companies (49.0 %) had 51–250 employees, and can be classified as medium-sized; only 16.7 % employ more than 250 persons. In terms of company size, it can be concluded that the construction industry is adequately represented with the sample of respondents.

5.2. Frequency of ORA use in Czech construction industry

58 companies out of 102 respondents (56.9 %) confirm that they are familiar with e-commerce, but only 36 respondents (35.3 %) use it in their operation.

As the investigation was focused on Online Reverse Auctions, the respondents were asked to state the type of e-commerce tools used. In addition to ORA, other frequently-encountered types of online tools were offered as possible answers (Table 3). The results show that the use of ORA (alone or combined with commodity exchange) dominates within the respondents' group, as 83.3 % of respondents confirmed its use. These results show that research in the field of ORA application in construction sector is justified.

Table 3. Type of e-commerce tool employed

Type of e-commerce tool employed	No. of positive answers	[%]
ORA	27	75.0
E-marketplace	3	8.3
B2B	1	2.8
E-shop	1	2.8
own software	1	2.8
ORA + commodity exchange	3	8.3
Total	36	100.0

Table 4. Survey results: number of respondents using ORA with respect to stakeholder types on construction projects

ORA use	Client	Contractor	Total
Yes	26	21	47
No	19	36	55
Total	45	57	102

Table 5. Analysis of responding companies with respect to number of employees and type of stakeholders in construction projects

Number of employees	Company size	Total number	[%]	No. of clients	No. of contractors
1–50	small	35	34.3	5	30
51–250	medium-sized	50	49.0	30	20
250 and above	large	17	16.7	10	7
Total		102	100.0	45	57

Table 6. Number of responding companies using ORA tools with respect to their size

Usage of e-commerce tools	No. of employees 1–50	No. of employees 51–250	No. of employees above 250	Total
Yes	11 (31.4 %)	27 (54 %)	9 (52.9 %)	47
No	24 (68.6 %)	23 (46 %)	8 (47.1 %)	55
Total	35	50	17	102

5.3. Hypotheses testing

Hypothesis H.1 claims that the role of the company within the construction project (client vs contractor) has an influence on the frequency of ORA use.

Results aggregated in Table 4 show that clients are more likely to use ORA than contractors; 57.7 % (26 out of 45) of clients claim that they use ORA, as opposed to 36.8 % of contracting companies. Hypothesis H.1 has thus been confirmed.

A discrepancy between the results given in Table 3 and Table 4 can be observed: 30 companies claim the use of ORA when answering the question regarding e-commerce tools, while 47 respondents claim the use of ORA in their company. This difference can be related to different understanding of participation in an auction event.

Hypothesis H.2 claims that company size influences the company's attitude towards ORA and its use. The number of employees was selected as a measure of company size. Three categories that correspond to the simplified definition of an SME [32] were established to describe the size of the company. Distribution of size within the sample of responding companies is presented in Table 5. The majority (almost a half) of the companies taking part in the survey employ 51 to 250 employees. They can therefore be classified as mid-size enterprises. 45 out of 102 respondents claim that they act as clients within the procurement process, while the remaining ones take part in this process as contractors.

Table 6 shows the number of companies using ORA with respect to the size of the enterprise (measured in number of employees). Only 11 out of 35 (31.4 %) small companies use ORA. The use of ORA in medium-sized and large companies is 54.0 %, and 52.9 %, respectively. There is no considerable difference in the frequency of ORA use between large and medium-sized companies. However, the use of ORA is much less frequent in the category of small companies. It can therefore be postulated that mid-size and large companies have similar viewpoints regarding successful use of ORA, as opposed to small companies.

Hypothesis H.2 has therefore been confirmed; as the obtained results (Table 6) clearly show that mid-size and large companies tend to use the ERA process more often than the small ones.

Hypothesis H.3 states that the stakeholder type (client vs contractor) influences the perception of advantages and barriers related to ORA.

The questionnaire contained a question related to the perception of advantages and barriers. The respondents were asked to rank the list of advantages and barriers (Table 7). The conducted research was aimed at recording perceptions of both clients and contractors. The respondents were asked to rank

Table 7. Importance of advantages and barriers in the implementation of ORA as perceived by investors and contractors (average values; 1 = most important, 5 = least important)

Importance of advantages		Investor	Contractor
Benefits	Decrease in bid price	1.42	2.19
	Transparency	1.64	2.56
	Savings in time	2.48	2.56
	Elimination of geographic and language barriers	3.48	3.37
Impediments	Unwillingness of suppliers	2.52	2.31
	Acquisition costs	2.87	2.37
	Unsuitable product	3.06	3.31
	Hardware and software (HW/SW) requirements	3.45	3.69

individual barriers/advantages on the Likert scale from 1 to 5, one being the most important and five the least important barrier, or driver, respectively. Grade averages, obtained as described above, for all identified ORA-related advantages and barriers are presented in Table 7.

Overall results presented in Table 7 show that investors perceive advantages as having more influence, compared to the perception expressed by contractors. The largest difference can be observed for the decrease in bid price and transparency that are strongly perceived by the clients (average grades given by the clients and contractors are 1.42 and 1.64, respectively). On the other hand, savings in time and elimination of geographical and language barriers have comparable importance within the sample. Geographic and language barriers are considered as the least important barrier.

Respondents have also indicated that the unwillingness of suppliers is the most significant barrier (2.52 and 2.31 for investors and contractors, respectively), which is followed by acquisition costs (2.87 and 2.37, respectively). The remaining two barriers, unsuitable product and HW/SW requirements have an average rating above 3, and can thus be considered as less important. Overall, the lowest significance was attributed to the barrier related to hardware and software (HW/SW) requirements from the contractor's point of view (3.69).

From the above discussion and the results presented in Table 7, it can be concluded that the overall perception of the importance of advantages and barriers of ORA adoption is similar for the investors when compared to the opinion expressed by contractors. The results presented in Table 7 indicate that the ranking (with respect to the perceived importance) is practically the same regardless of the stakeholder type. It should be noted, however, that the judgment of investors is more clearly expressed (i.e. larger differences in average grade for individual grades are recorded for the investor group). Hypothesis H.3 can therefore be partially confirmed.

5.4. Discussion

The results obtained show that Czech construction industry is using ORA quite extensively; 46.1 % of the respondents confirm

that they use ORA in their operations. Overall, the results obtained lead to the conclusion that the advantages are more important for this industry than the barriers. We attribute this phenomenon to the fact that some barriers can be removed or they appear only in specific buying situations. Any client aiming at consistent and successful use of ORA at a large scale should consider implementing actions that are based on the list of advantages justified and compiled in this work. Above all, the potential decrease in purchase prices has to be matched with the related costs in order to evaluate the real savings potential. Previous research

[13] shows that buyers are obtaining significant short-term price reductions, while the benefits to suppliers are less obvious. The results presented in Table 7 confirm this finding.

A significant difference in the perception of the process transparency is certainly worth noting. From the investor's perspective, this is considered to be an important benefit, which is justified by the fact that the corruption is substantially present in the field of public works in the Czech Republic [33]. Therefore, for public authorities, it is desirable to carry out public tenders in a clear and transparent way with ORA as a support tool. Nevertheless, on the side of suppliers, the transparency is rated as significantly less important. The low rating of transparency may occur due to various facts, e.g. inadequate selection of the order-winning criteria [13]. The authors therefore recommend using only criteria that are logical, reasonable and clearly justified. In case of doubt about suitability of the criteria, it is better to choose the winner on the basis of the lowest bid price. Although savings in time are not negligible, their potential for the construction sector is reduced due to the fact that each project is unique and requires its own project documentation, and therefore a particular tender structure differs from other tenders.

Elimination of geographical and language barriers should be of particular interest especially in border regions, where foreign suppliers can deliver cheaper materials or services, whether due to different taxation or cheaper labour. From this perspective, an ORA system supporting various languages should be encouraged.

The analysis of survey results shows that the unwillingness of suppliers to take part in ORA is perceived as the most significant barrier for both clients and contractors, followed by the (high) acquisition costs. If clients using ORA wish to attract more bidders, they should consider promoting this procurement route in the field of construction using various tools, such as presentations in professional publications and at gatherings, public presentations, and preparation of printed/online guidelines explaining the benefits and drawbacks of ORA, targeted specifically to construction industry. Considering the

potential for significant price savings, the barrier of acquisition costs cannot be perceived as significant for the investor (therefore it rated lower than the advantages of a decrease in bid price, transparency, and even time savings). The least significant barriers are unsuitable character of the product (which corresponds to the fact that the selection of contractor or material supplier can be successfully and correctly implemented using ORA) and HW/SW requirements, since investors generally use this system as a web application through remote access. In addition, no special training is required for the IT personnel, thanks to availability of simple software solutions with user-friendly interfaces.

As participation of suppliers/contractors in ORA is free of charge, it is surprising to observe that contractors rate the barrier of acquisition costs as more important than the investors. This can be attributed to the fact that the majority of construction contracting companies are small, and therefore they perceive the costs of acquiring HW and SW as quite significant.

The present research confirms that larger companies tend to use the ORA process more frequently than smaller ones, which supports the findings obtained in previous research [18].

In construction, one of the largest shortcomings of online reverse auctions is the fact that no permanent business links can be established among construction project partners if ORA is used as procurement method. Lack of trust, poor communication and misunderstanding among partners that may appear on such projects may lead to delay of project execution and inadequate quality of works. Therefore, clients should make a special effort to create a proper team atmosphere in the initial phase of the project if the project goals are to be achieved as initially specified.

6. Conclusions

ORA is a place where supply and demand meet. The buyer tries to ensure a bargain purchase by maximising the level of competition in the tender, while the suppliers submit bids that will bring them the best value, considering the estimated costs, the risks of the project, and the situation on the market. This procurement tool is also gaining significance in construction sector.

The research reported in this paper is aimed at investigating the extent of the use of ORA in the Czech construction industry, along with barriers and advantages perceived by participating parties (the contractor and the client). The results of the online survey used in the investigation, addressed to a sample of stakeholders in the Czech construction industry, show that

ORA use is well established in this particular sector of industry. Furthermore, it was confirmed that construction works represent a type of product suitable for auctioning via ORA. Motivation to use ORA is stronger on the side of investors, who perceive higher transparency of the process as an important driver, in addition to price savings. On the other hand, the unwillingness of suppliers to participate in ORA was indicated as the most important barrier to successful implementation. Both investors and contractors agree that ORA systems are not demanding from the perspective of HW and SW requirements. Consistent with the findings presented in [18], this study confirms that the company size influences the company's attitude towards ORA and its use in a positive manner: larger companies tend to use this procurement route more often. Overall, ORA represents the most often-used type of e-commerce tool employed in the Czech construction sector and the potential for decreasing the bidding price is a major motivator for the participants.

The use of ORA in construction sector can also contribute to automation of the buying process, especially in the case of regularly repeated purchases, such as purchase of strategic raw materials or purchases for building maintenance. If the adoption of ORA is approved, it is advisable to compare several computer-supported auction systems. In addition to basic requirements (such as system stability, user support, training, language localization, multi-criteria evaluation, a black box or customization options), the selected system should also satisfy specific needs formulated by the investor.

Just like in other procurement routes, it has been observed that a comprehensive and concise specification of the product (service) that the client demands is a fundamental requirement for the successful use of ORA. In the case of construction works, this requires, above all, preparation of a high-quality project documentation. Both the bill of quantities and the drawings need to be carefully prepared, as the contenders will use these documents as the basis for preparing their offers. Only then can it be expected that both contracting parties will consider the project successful, and thus be willing to engage in ORA again.

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Appendix 1

Content of the web-based survey

PART 1: GENERAL

1. In the construction project, your company usually acts as
 - Private investor/client
 - Public investor
 - General contractor
 - Sub-contractor
 - Supplier of special equipment/services

2. Your position in the company is
 - Project manager
 - Responsible for procurement
 - Member of management board
 - Other (_____)

3. The size of your company/institution is
 - 1 – 50 employees
 - 51 – 250 employees
 - More than 250 employees

PART 2: ELECTRONIC COMMERCE – GENERALO

4. Are you familiar with electronic commerce?
 - YES
 - NO

5. Do you use electronic commerce in your company?
 - YES
 - NO

6. Which types of electronic commerce do you use at your work?
 - (comment: open question)

PART 3: ORA

7. Does your company use electronic auctions?
 - YES
 - NO
 if YES, go to question No. 9
 if NE, go to question No. 8

8. Do you plan to use e-auctions in the near future?
 - YES
 - NO
 if YES, go to question No. 9
 if NO, go to the end of the survey.

9. What is the role of your company when you use ORA?
 - Mostly client
 - Mostly contractor

10. Please state approximate number of tenders : a) being issued by your company annually, or b) answered by your company annually
 - 1 to 5
 - 6 to 20
 - More than 20

11. What kind of advantages do you perceive when you use e-auctions. Please rank the listed advantages/advantages with respect to importance (for your company); 1 = most important, 5 = least important.

- Decrease in bid prices 1 2 3 4 5
- Savings in time 1 2 3 4 5
- Transparency 1 2 3 4 5
- Elimination of geographical and language barriers 1 2 3 4 5
- Other – please specify 1 2 3 4 5

Decrease in bid prices: use of ERA results in price savings and thus increase cost efficiency of the company

Savings in time: repeated use of ERA can bring significant savings in transaction times, furthermore, a lot of tasks can be done automatically

Transparency: ERA can serve as an important rule for eradication of corruption

Elimination of geographical and language barriers: ERA enables greater participation of bidders from other countries

12. What kind of barriers do you perceive when you use e-auctions. Please rank the listed barriers with respect to importance (for your company); 1 = most important, 5 = least important.

- High acquisition costs 1 2 3 4 5
- Unwillingness of suppliers to participate 1 2 3 4 5
- Unsuitable nature of the product 1 2 3 4 5
- HW and SW requirements 1 2 3 4 5
- Other – please specify 1 2 3 4 5

Acquisition costs: purchase of ERA system is expensive for our institution
Unwillingness of suppliers to participate: unwillingness results from a fear of losing the contract or keeping the contract at terms which are less advantageous for the supplier

Unsuitable nature of the product: it is very difficult/impossible to describe the demanded product precisely and define and quantify the supplier selection criteria

HW and SW requirements: the use of ERA systems is conditioned by demanding HW and SW requirements

13. Do you agree with the statement that ERA advantages overweight ERA barriers?
 - 1 = strongly agree, 5 = strongly disagree
 - 1 2 3 4 5

14. Do you agree with the statement that ERA enables automation of purchasing process in your company?
 - 1 = strongly agree, 5 = strongly disagree
 - 1 2 3 4 5
 (Question only for clients)

Thank you for your time and feedback. If you wish to receive the results of the survey, please tick YES.

- YES

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