Research Article

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Analysis of tender procedure phases parameters for railroad construction works

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Abstract: The beginning of each construction investment is preceded by proper preparation. In the case of public procurement, this usually involves conducting a tender procedure to select a contractor for the works. Railway construction works require this rigor. This article will provide an overview of railway construction investments planned to be implemented in the current EU financial perspective. The key elements of the tender process related to individual stages of the tender will be analyzed.

Keywords: tender procedure, railroad works, public procurement

1 Introduction

Appropriate preparation of a construction project is one of the guarantors of completing the planned investment in the assumed time and with the given budget. An element of the construction process that requires special attention is the transition from the pre-project (design) phase to the investment implementation phase. This usually involves the investor conducting a tender procedure selecting the works contractor. In the traditional form of performance of a construction project, the design-bid-build system, the design must be contracted first and then, following its completion, construction works are contracted. In the case of investments implemented in the design and build formula, a single contractor is entrusted both design works and implementation [1, 11].

For public investors, which include the Polish national rail network administrator, in the case of a tender procedure, the rigor of the Public Procurement Law (PPL) is bind-

ing [2]. According to its content, the contracting authority is imposed a number of restrictions and the manner of proceeding when preparing contractual documents or dates of individual stages of the tender. Complex administrative activities resulting from the content of PPL in connection with the currently implemented, the largest railway investment program 'National Railway Program until 2020 with a perspective up to 2023' (NRP) [3], require from the investor more intensified actions in the scrupulous preparation of subsequent tender procedures.

The above generates a number of potential risks, which in consequence may affect the proper preparation and, in the longer term, the completion of the investment in accordance with the terms of the contract. Various methods and tools are being sought and successively developed providing a comprehensive risk assessment. Selected tools for risk assessment in construction project were presented in [4, 6, 7]. The analyzes of tender documentation carried out so far indicate that this problem affects both the conducted and ongoing proceedings [9, 10]. The quality of the tender documentation is indicated as the main factor causing disruption of the procedure [11, 12]. There are also opinions describing the other elements of the tender (content of the contract, method of managing the preparation of the tender procedure, etc.) as equally important reasons for incorrect implementation of the PPL procedure [11, 13].

The PPL procedure also requires tenderers to increase the amount of work and time required to prepare a correct offer. Like contracting parties, potential contractors find themselves in this situation differently, often encountering problems. Their sources are different, but all of them lead to analyzes on participation in subsequent tender procedures. The work [14] lists a number of potential problems determining the submission of an offer in the procedure. Even in the event of participation in a tender, tenderers must construct their offers in a way that ensures the best possible chances of obtaining the contract. Various techniques are used. Their review and characteristics are the current subject of research [15].

The study of railway construction investments was also explored by the authors of the article. The work [5] presents a case study with particular emphasis on the risk of additional works that may occur during railway con-

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struction projects. On the other hand, work [8] discusses the tendering procedures from the earlier period, focusing on the analysis of the bidding factors. The authors' own research served as a contribution to further, extensive considerations.

This article will attempt to confront the approaches presented in the preparation of the tender process of construction projects with completed rail construction investments. The authors will characterize selected orders and describe the most important features and dates of announced orders for projects or works.

Then, the acquired data will be subject to statistical analysis. The obtained results will be commented on and supplemented with conclusions from the research.

2 Bidding procedure – theoretical outline

Conducting the tender procedure according to the Public Procurement Law requires compliance with certain specific conditions [2]. The course of the procedure is preceded by the preparation of proper documentation, according to which an offer can be made explicitly and completely. Most often, the documentation appears as SETO (Specification of Essential Terms of the Order), and it includes, among others the following studies:

- Description of the Order (containing: name of the order, procedure, etc.);
- FUP - Functional and Utility Program;
- TC - Terms and Conditions;
- IW - Instructions for Contractors;
- TSoPACW - Technical Specifications of Performance and Acceptance of Construction Works;
- Design Guidelines;
- Investor's internal regulations.

In addition to the documents listed in the content of the Act, any study not contradicting other legal acts may be an attachment to the tender procedure. Orders ordered by Polish national rail network administrator often include a number of internal instructions of the contracting authority or OPB (Offer Price Breakdown) in the tender content, constituting a proposal for the settlement of individual pre-order items of the order.

The rigor of the Public Procurement Law also provides for regulations regarding individual stages of the tender procedure and their time periods. The complexity of the provisions of the Act in this regard is large, so for a better

understanding of the subject of the article some simplifications have been made.

The most frequently appearing phases of the tender procedure in the case of railway construction investments are:

- Contract notice;
- Opening envelopes;
- Information about the selection of the best offer;
- Signing a contract.

Pursuant to the Act (PPL), each of the above-mentioned stages must be disclosed to the public, which allows easy acquisition of data necessary for analysis. Therefore, only 4 phases of the tender procedure will be mentioned later in the work.

3 Sampling

The research will include a review of public procurement for design or construction works commissioned by PKP PLK S.A. (a Polish Railway Company – National Administrator of Railroad in Poland). Orders published within the period from 1 September 2018 will be analyzed, until 30.08.2019, which will include the design or construction of any railway building facilities with a budget of at least PLN 1,000,000.00 net. The date of the tender settlement will not matter. In order to obtain the data, the company's internal purchasing platform was used [16], and in the event of insufficient information, supplementation was made on the basis of the Supplement to the Official Journal of the European Union [17].

The application of the assumed criteria allowed the selection of 54 tender procedures that could have been further analyzed. However, at the data acquisition stage there were problems with some orders (lack of complete information, ongoing proceedings, unclear / partial orders, etc.) and the final sample for which the authors have a full set of data is 47 tenders.

Contract documents were obtained for the selected orders (Terms of Reference, Information on opening envelopes, protocols, etc.) allowing for complete information. For the purposes of the study, the following data were collected:

- contract deadlines according to PPL (order announcement, opening envelopes, signing the contract, etc.);
- estimated investment budget;
- changes in the time of contract periods;
- contract award date;

- number of bidders;
- the number of electronic auctions carried out;
- the number of appeals submitted during the tender;
- the number of cancellations of tender procedures and the reasons for their occurrence.

The information is the basis that was used for further considerations, discussed in the order of the stages of the tender adopted. To describe the data from each phase of the procedure, basic statistical measures will be used, such as: statistical mean, variance, standard deviation. Average is one of the first measures used when viewing data. It gives you the opportunity to quickly find out what their tendency is. However, possible outliers in the data set render it useless. Therefore, statistics are generated that describe the dispersion of the results around the mean. The standard deviation is a measure of the spread of the data. A high value indicates a large deviation of the data from the mean, and a low value indicates that the data is close to it. Variance and standard deviation are closely related and provide information about how large the variation in the results in a given data set is. The authors will also build histograms, which, as one of the most popular statistical charts, are used to present the amount of data in the given intervals of the studied variable. A fixed number of intervals of 10 [18] was assumed for the purposes of building histograms. The adopted method of information preparation will allow easy comparison of the results obtained.

4 Contract notice and submission of bids

The first stage of the tender considered will be the period between the publication of a contract notice and the submission of tenders, more commonly known as “envelope opening”. During this time, based on the available tender documentation, the bidder should develop a technical and price proposal for the implementation of the contract in question. The period between the announcement of the tender procedure and the opening of envelopes should be as long as possible, enabling the preparation of the best

Table 1: Statistical measures for "Offer preparation".

Period Name	Average [days]	Variance [days]	Standard deviat. [days]
Offer preparation	53.96	369.43	19.22

Figure 1: Histogram for "Offer preparation".

offer. Therefore, the authors decided to refer to this stage as the “Offer Preparation” period.

An analysis was made of the time from announcement of the order to the date of the offer for the assumed sample. In accordance with the adopted methodology, basic statistical measures were determined and presented in Table 1. Figure 1 presents the histogram for the examined period.

Based on the results obtained, it can be concluded that for 39 tenders the envelopes will be opened no later than 69 days from the date of the announcement. This corresponds to over 82% of the sample studied.

The investor specifies a range of information in the tender documentation, including the envelope opening date. In accordance with applicable regulations, the date of submission of the offer may be moved due to certain circumstances (errors in the announcement, adding new tender documentation, etc.). Such situations have been observed in the analyzed tender procedures. The period associated with the postponement of the submission date was called “the extension of the envelope opening date”. Table 2 contains statistical measures for this period.

An analysis of the extension of the envelope opening date showed that for 24 tenders, which represents more than 51% of the examined tenders, the date of submission of the offer was very small (0-9 days). It can also be seen that the extension of the envelope opening time for 43 or

Table 2: Statistical measures for "Extension of envelope opening date".

Period Name	Average [days]	Variance [days]	Standard deviat. [days]
Extension of envelope opening date	14.23	321.18	1.92

Figure 2: Histogram for “Extending the envelope opening date”.

ders was less than 34 days. This corresponds to over 91% of the sample tested. Figure 2 presents the histogram of the examined period.

It should be emphasized that the term “preparation of bids” was understood as the actual date of receipt of the bidders’ proposals as part of the tender procedure. Determining the extension of the offer deadline refers to the initially assumed dates specified in the first version of each of the analyzed orders. Information about these dates was not included directly in the content of this work.

Based on the information obtained from the “opening of envelopes”, the number of bidders participating in the tender procedure was compiled and the estimated amount of the contract was taken. These data is analyzed later in the article.

5 Selection of the offer and ordering

Submitted offers are subject to substantive verification and evaluation due to the tender criteria applied. The purpose of the assessment is to select the best offer and to sign the contract with the Contractor who presented it. Therefore, the period between the actual opening of the envelopes (after taking into account the possible extension) and the selection of the best proposal was called “Offer selection”.

During the analysis of the proposals received by the contracting authority, various possibilities arise that affect the correct procedure of the prepared contract. There are errors in the offers submitted, failure to meet the contract requirements, or other procedures that cause the tender procedure to be repeated or, in extreme cases, to cancel the procedure. The phenomena that were observed in the sample are presented in the next chapter.

As a result of incorrect events, the research sample was reduced by tenders, which for various reasons were not settled. In view of the above, the number of orders subject to further analysis is 36. The selection of the offer takes place after the tender committee unequivocally determines the best evaluation using the assumed tender criteria. The time between the actual opening of the envelopes and the selection of the offer was determined for the examined sample. In the case of tender procedures containing multiple information about the selection of the most advantageous proposal, the date of the last (binding) selection was chosen for further analysis, namely one whose bidder was the same as the subsequent contractor. Selected orders were described using statistical measures (Table 3).

Table 3: Statistical measures for “Offer selection”.

Period Name	Average [days]	Variance [days]	Standard deviat. [days]
Offer selection	96.06	1998.68	44.71

The comparison of the time of “Offer selection” for individual orders reveals that for 10 tender procedures (over 27% of the sample) the selection of the offer takes place between 102 and 120 days from the opening of envelopes. There is no significant difference in quantity in the remaining time intervals of the histogram, as they are very similar (procedures 1-5), as seen in Figure 3 showing the histogram for “Offer selection”.

Figure 3: Histogram for “Offer selection”.

The crowning stage of the tender procedure is the moment of signing the contract with the Contractor. This usually occurs after all appeal procedures have been exhausted and after considering potential complaints. The time period from the moment of selecting the offer to the

date of signing the contract is presented as “Signing the contract”.

The analyzed orders were not completed at this stage, therefore 36 orders were still examined. Selected tenders were described using statistical measures, as illustrated in Table 4.

Table 4: Statistical measures for “Contract signing”.

Period Name	Average [days]	Variance [days]	Standard deviat. [days]
Contract signing	60.64	16.25	4.03

Based on the data obtained from the analysis, it can be seen that 28 proceedings are concluded with a contract within 72 days at the latest. This corresponds to over 77% of the sample studied. In addition, the time of signing the contract of one of the analyzed tenders significantly differs from the others, amounting to 132 days.

Figure 4: Histogram for “Contract signing”.

Signing the contract with the Contractor basically completes the tender process and allows the Contractor to design or implement the works. It also completes the statistical analysis of individual stages of the contract in accordance with PPL. However, when collecting information on tenders, additional data was obtained that complement the present analysis.

6 Global analysis of tender procedures

As suggested in the study [8], the market of railway industry entrepreneurs is saturating and the number of bid-

ders participating in subsequent tender procedures involving the construction of railway lines announced by the national railway network manager is gradually decreasing. For the contracts discussed in this article, no similar analysis was performed, as the tenders under examination relate to various buildings, not just railway lines. Only the basic statistical measures (for sample 47 according to item 3 of the article) were included in Table 5.

Table 5: Statistical measures for starting bidders.

Subject of Study	Average	Variance	Standard deviat.
Number of Bidders	4.38	6.94	2.63

The derivative effect of a smaller number of bidders and the resulting supply is the expected increase in the prices of submitted offers. An additional element affecting cost factors was the systematic increase in materials, as well as the work of people and construction equipment. The above translated into the costs of submitted bids, which were noticeable when comparing the investor's assumptions with the proposals of the tender participants. Some submitted offers exceeded the investor's cost estimate more than twice. Similar behaviors were already indicated during the analysis of tender procedures at the beginning of the implementation of the tasks of the NRP [8].

In the event of significant budget overruns, the awarding entity used the solution provided for in the PPL, namely an electronic auction. The auction was aimed at reducing the cost of the planned investment as much as possible, which was always the most important tender criterion. All contractors who submitted a bid that met formal requirements were invited to participate. The auction was used for 27 tenders (over 57% of the sample) for which envelopes were opened. This shows the scale of the problem. Despite the bidding, 3 orders out of 27 were canceled due to a significantly higher price than the investor's budget assumed by the contracting authority.

Between the envelope opening stage and the selection of the offer, 11 out of 47 tender procedures were annulled. This number represents over 23% of the sample, which may further affect the implementation of the railway investment program. The following justifications have been distinguished for annulled tender procedures:

- exceeding the estimated budget too much - 9 orders;
- error impossible to remove by the ordering party - 1 order;
- no offers submitted - 1 order.

A further review of the tender procedures showed that 11 of the 47 tender procedures submitted appeals, representing more than 23% of the sample. Appeals were submitted at various stages of the tender procedure, and their nature and consequences were not covered by detailed analyzes. It was only stated that in 1 of 11 tender procedures under which appeals were lodged, the tender was annulled. However, the authors were not able to examine the possible link between these facts.

The authors attempted to examine the total duration of the tender procedure from the moment the contract was published to the day the contract was signed. This period was called “Duration of the tender procedure” and was subject to statistical analysis. The test was performed in accordance with point 5 items with 36 orders. The determined statistical measures are presented in Table 6.

Table 6: Statistical measures for the “Duration of the tender procedure”.

Period Name	Average [days]	Variance [days]	Standard deviat. [days]
Tender duration	212.64	5 544.41	74.46

The results obtained show that in 10 out of 36 orders (over 27% of the sample) the tender procedure lasts from 238 to 272 days. In addition, it is observed that for over 86% of orders up to 272 days after the tender announcement, a contract will be signed.

Figure 5: Histogram for “Tender duration”.

Another element of the analysis was to check the possible relationship between the duration of the tender procedure and the estimated value (size) of the contract. In order to determine the correlation the Pearson correlation coefficient “r” was used. The method of determining the

Pearson correlation coefficient is shown in formula 1 [18]:

$$r = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2} \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}} \quad (1)$$

where:

x, y – number of attempts (x, y have the same number of observations);

$\bar{x}, \bar{y}$ – average values of the samples;

i – sample size ($i = 1, 2, \dots, n$).

For the relationship studied, the correlation coefficient was 0,32. According to the interpretative assumptions of the method, the result is in the range (0; 0,5) which indicates a weak level of positive correlation. The chart showing the relationship between the value of the contract and the duration of the tender procedure is shown in Figure 6.

Figure 6: Relationship between the value of the contract and the duration of the tender procedure.

The last element of the analysis was a comparison of individual stages of the tender procedure with the total duration of the contract, that is, from the moment the contract is announced to the day the contract is signed by the selected contractor. To this end, the obtained average values from individual time periods were added up, referring to the average value of the duration of the tender procedure. The sum of average individual stages was 210,66 days, while the average duration of the tender procedure determined directly from the time from contract announcement to the signing of the contract reached 212,64 days. This slight difference resulted from the accepted mathematical procedures, however both results are comparable. 210,66 days is therefore used for comparative analysis as the duration of the tender procedure.

Calculations were performed for the reference point thus adopted. The obtained results were collected and are summarised in Table 7.

Table 7: Participation of individual stages of the tender procedure in the examined sample.

Period name	Average [days]	Participation in the tender procedure [%]
Offer preparation	53,96	25,61
Offer selection	96,06	45,60
Contract signing	60,64	28,79

7 Conclusions

The analysis allowed to observe a number of phenomena. As expected, [8] the procurement review showed a disproportion for the different phases of the tender procedure. The preparation of the offer which, due to its complexity, is more labor-intensive, was statistically similar to the time associated with waiting for signing the contract. In addition, the average time of the most important stages of the procedure was determined: offer preparation, offer selection and contract signing. Having sufficient data, it was also found that the duration of the offer was extended and its average time was estimated. The above complement the research into similar issues [12].

The authors sought relationships between the most important parameters describing tender procedures: duration and estimated value of the contract. The result obtained showed a weak correlation with an upward trend. The determined correlation should be checked and its character specified on the basis of further analysis of ongoing orders.

It should also be noted that a large number of tender procedures commissioned by the national rail network manager have an underestimated budget or the contracting authority's expectations regarding market offers are greatly underestimated. This state is affected by the current economic situation (higher costs of materials and machinery) as well as the saturation of the railway construction market [8]. Statistically, every second bid had to be supplemented with an electronic bidding aimed at minimizing the value of submitted bids. Despite these solutions, an average of 1 in 4 orders was canceled. Comparably, about 25% of tenders were appealed. The nature of the appeals could not be determined due to a lack of data.

Identified problems may result from reasons that are articulated in other studies [11]. Regardless of the reasons for their creation, the national rail network manager should take actions to minimize the occurrence of undesirable phenomena, such as: underestimation of investor budgets, annulment of tenders or extension of individual stages of the contract. The success of one of the largest rail

investment programs, the NRP, may depend on the effectiveness of countermeasures.

The authors' further research work is related to the observation of subsequent tenders for railway construction works. The obtained data will be used to develop a proprietary method of mitigating risks arising during the implementation of tenders.

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