

## AN ANALYSIS OF PROJECT SELECTION AND ASSIGNMENT CRITERIA OF DANISH TENDERS IN EUROPE

Jesper Kranker Larsen, Department of Mechanical and Manufacturing Engineering, Denmark  
Lene Faber Ussing, Department of Mechanical and Manufacturing Engineering, Denmark  
Thomas Ditlev Brunø, Department of Mechanical and Manufacturing Engineering, Denmark

### ABSTRACT

*Public construction agencies are one of the largest developers within the Danish construction industry, where such agencies own and develop new public construction projects. Most of these projects are put out in European tender. This study analyses the selection and assignment criteria employed by these agencies in different types of public sector projects. Some of the objectives pursued by the study include the determination of 1/ the selection and assignment criteria mostly used in Danish public tenders 2/ how different types of projects use selection and assignment criteria in the bidding process, and 3/ any significant difference between the use of selection and assignment criteria in Danish public construction projects. The study uses a quantitative research approach where 157 Danish public tender cases were selected from the European Tenders Electronic Daily database between the period: January 2010 to March 2013. Fisher's Exact Test was conducted to determine if there was any significant use of some selection and assignment criteria. The findings of the study showed that invited tenders with pre-qualification and lowest price in 69.8% of the tenders are the most used selection and assignment criteria, with little regard to project type.*

**KEYWORDS:** Assignment Criteria, Construction Project Management, Public Construction Projects, Selection Criteria.

### INTRODUCTION

Most of all public and private financed construction projects go through a bidding round before the construction of a project starts, where different selection criteria are used to secure the projects (Mercer & Russell, 1969; Seydel, 2003). These selection criteria are further supported by assignment criteria to determine which construction partner has made the best offer in line with the projects' selection and assignment criteria (Easton & Moodie, 1999; Saen, 2007). The different combinations of bid and selection criteria are 'Invited Tender' with a pre-qualification process, 'Open Procedure Tender' and 'Public-Private Partnership'. The use of the three selection options are based on the projects economy, user demands and project strategic plan from the owner and project manager (Friedman, 1956; Yu & Wang, 2011). Two selection criteria are predominant in the Danish construction industry: lowest price and most economically advantageous offer. The most economically advantageous bid uses planned percentages weighting of parameters used to find the best offer, these parameters could be price, architecture and functionality but also education levels, personal skills and level of quality management system could be used as parameters (Deshmukh & Chaudhari, 2011; Weber & Current, 1993).

Systematic tendering is facilitated by electronic tendering software. Yan (2002) explains that electronic tendering software such as Integrated Construction Management System (ICMS), with subcontractor pre-qualification and online purchasing can streamline the daily tendering process. The way public construction projects is put out to tender has been studied by Kuprenas and Nasr (2007) who analyse cost trade-off across procurement methods such as: Traditional Design, Bid and Build and In-house Construction of projects. They found that the percentages of total cost on construction projects is nearly the same for Traditional Design, Bid and Build and In-house Construction, but find that the Traditional Design, Bid and Build model cost approximately 10% more related to changes. Project scope changes at the construction stage is further found to increase cost according to Creedy, Skitmore, and Wong (2010) and Fidan, Dikmen, Tanyer, and Birgonul (2011), where the success rate of a project is determined by the project manager's ability to manage such negative factors (Ahadzie, Proverbs, & Olomolaiye, 2008; Sun & Meng, 2009). The influence of these scope changes and potential reworks in construction projects have been studied by P. E. Love (2002) who find that the amount of cost related to rework does not differ relative to project type or the used tendering method, but found scope changes and rework estimated to 6.40 to 6.85% in direct cost, and 5.50 to 7.36% in indirect cost of a contract value (Lopez & Love, 2011; P. Love, Holt, Shen, Li, & Irani, 2002).

A potential solution to the described complication is cooperative tendering where Eriksson and Westerberg (2011) suggest that cooperative tendering should include joint specification, soft parameters in bid evaluation, joint subcontractor selection, incentive based payment, collaborative tools, and contractor self-control. These are further supported by Bhargava, Anastasopoulos, Labi, Sinha, and Mannering (2010) and Son and Rojas (2010) who find that lowest price bidding can stimulate cost and time increases, where on the other hand more effort spent on planning before construction stage is found associated to a better cost performance of a project (Gibson Jr, Wang, Cho, & Pappas, 2006). Another approach is prefabrication, which is found possible to maximize the tendering methods and gain benefits by the prefabricated construction in different project types (Tam, Tam, & Ng, 2007). The owner and project manager must therefore select an appropriate tendering method which stimulates an effective project organization in combination with price, design, build ability and management (Osipova & Eriksson, 2011).

By looking at the selection and assignment criteria and the combination of these in the construction industry, the objective of this study therefore are, to determine: 1/ which selection and assignment criteria are mostly used in public construction projects put out in European tender, 2/ how different types of construction projects are use selection and assignment criteria in the bidding process and finally 3/ if there are any significant difference between the selection and assignment methods used in Danish public construction projects.

## **MATERIALS AND METHODS**

The research method for the study is based on a quantitative research approach involving three main stages to secure a systematic research process. The first 'input stage' identifies data, followed by a 'processing stage' which analyses the data and finally an 'output stage' where the results are argued for its significance. The study was early in the process limited to Danish public construction projects based on authorities are required to put projects out in European tender if the total cost exceeds the Europeans Union's minimum permissible value.

The 'input stage' was conducted as a literature review in line with Levy and Ellis (2006) and adjusted to support the input stage according to Kumar, Gattoufi, and Reisman (2007) and Pittaway, Robertson, Munir, Denyer, and Neely (2004) where the authors initiated their research process by identifying which public agencies manage, develop and supervise public construction projects. In the current study, four different agencies were identified, which hereafter were converted to seven search strings by adding 'AND', 'AU' and 'CY' for example CY=[DK] AND AU=[Agency no. 1] AND AU=[Agency no. 2] etc., the seven basic search strings were subsequently tested in the European Tenders Electronic Daily database to determine which of the seven search strings identified most applicable tender cases. Table 1 shows the search string result during the input stage.

**Table 1: Search string results for the input stage**

No.	Search Sting description	Result
01	CY=[DK] AND AU=[Agency no. 1]	3701
02	CY=[DK] AND AU=[Agency no. 2]	3511
03	CY=[DK] AND AU=[Agency no. 1] AND AU=[Agency no. 2]	3511
04	CY=[DK] AND AU=[Agency no. 3] AND AU=[Agency no. 4]	258
05	CY=[DK] AND AU=[Agency no. 1] AND AU=[Agency no. 2] AND AU=[Agency no. 3] AND AU=[Agency no. 4]	157
06	CY=[DK] AND AU=[Agency no. 1] AND AU=[Agency no. 3] AND AU=[Agency no. 4]	157
07	CY=[DK] AND AU=[Agency no. 2] AND AU=[Agency no. 3] AND AU=[Agency no. 4]	157

The results of the search strings was hereafter reviewed by one of the involved agencies to confirm if there were any missing in the search stings which could support the research. However no further adjustments were made to the 'main string' which was decided to be string number four. The main search string was hereafter used in the European Tenders Electronic Daily database to conduct the data for the next 'processing stage' where 258 tenders were identified, and by the following data process reduced to 157 cases, based on tender documents which did not contain correct data. Thus search string number five was confirmed which contain all four agencies, but also search string number six and seven, see Table 1.

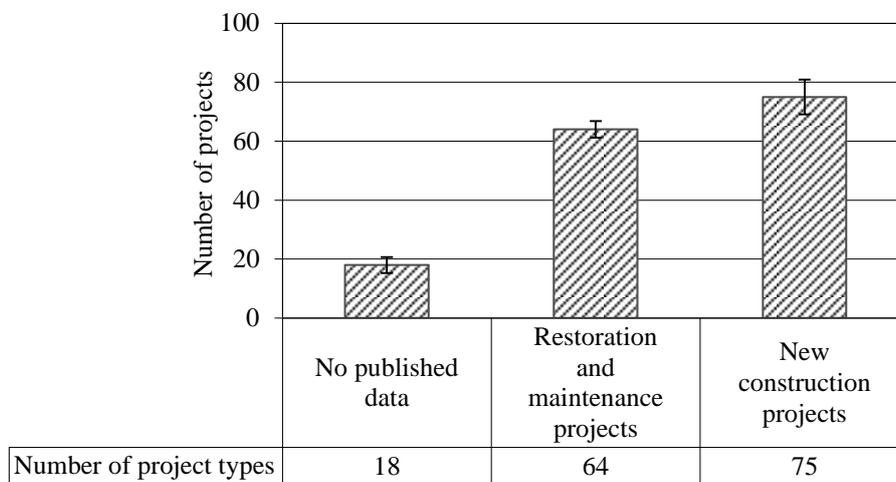
In the 'processing stage' was the quantity of data according to the researcher's time resources limited to analyze data from January 2010 to the month of March 2013, 157 tender cases were converted to numerical data in a local database, to allow statistical analysis of the tenders. The data analysis was conducted using Microsoft Excel, where the data was first presented by column charts with the total number of involved cases and standard error. Thereafter a Fisher's Exact Test of independence was conducted to determine if there was any significant use between project types selection and assignment criteria, the significance level was decided to be 0.05 (Fellows & Liu, 2009). Fisher's Exact Test was used in the analysis instead of a Chi-square test, because some of the cell's in the data contains less than five observations (Fellows & Liu, 2009). Within Fisher's Exact Test are the numbers of tender cases lower than the 157 identified tenders, because some of the cases did not contain the full data which was demanded.

In the final 'output stage', the result from the 'processing stage' was presented for review and discussions. The results which were found in the Fisher's Exact Test of independence were

checked for factors or perspective that have been overlooked in the ‘processing stage’, but no further adjustments were made to the results. After the final result review, was arguments constructed according to results from the data analysis and results from previous literature.

## RESULTS AND DISCUSSION

The results from the “output stage” are presented in this section to show how the quantitative approach answers the research questions. The results shows the selection and assignment criteria according to specific project types, and then the selection and assignment criteria is analysed to determine their significant usage. Data on the project types covered by this study are presented in Figure 1. The ‘no published data’ segment refers to tenders which contain data of the used selection or assignment criteria but do not have information about the type of project. The ‘no published data’ was found to include 18 (11.5%) of the 157 cases.

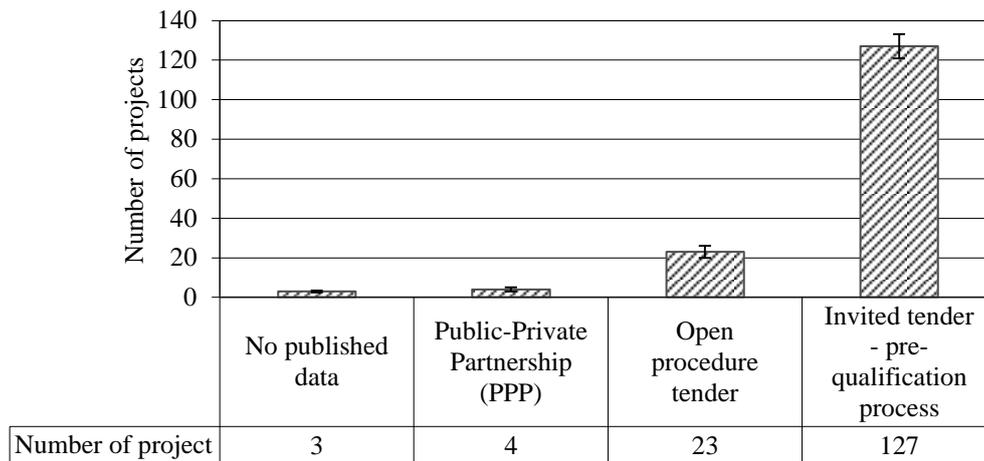


**Figure 1: Project types for all 157 cases in the database, with standard error**

The segment on restoration and maintenance projects involves 64 (40.8%) of the 157 cases and comprise construction projects on older buildings where user requirements, or usage purpose has changed so a restoration of the building is required. The remaining part of this segment involves projects such as part replacements of windows, roofs and other facility management operations of smaller volume which still demand a European tender. New construction projects account for 75 (47.8%) of the 157 cases and comprise construction works for new buildings, such as public offices, university buildings etc.

### Selection Criteria

Data on the selection criteria applied for the projects are presented in Figure 2. On observation, the most used criteria regardless of project type is invited tender with pre-qualification process in 127 (80.9%) of the 157 cases. The advantage of invited tenders is that the project manager and owner are assured that tenderers have the right resources (human capital, financial stability etc.), and that the offered tender fulfills the requirements with an invited pre-qualification process before the following offer process is started. The invited pre-qualification process acts as a barrier for the rest of the market, based on the requirements the owners set up to limit the amount of biddings. This also ensures that incoming bids come from tenderers that have the right balance of skills and experience.



**Figure 2: Selection criteria for all 157 cases in the database, with standard error**

The second most used selection criterion is the open procedure tender which accounts for 23 (14.6%) of the 157 cases. This selection criterion has the advantage of opening up opportunities for a wider range of tenderers that could impact on total price (keener prices as a result of competition). Although with the open procedure, there is chance for frivolous project partners to increase which potentially complicates projects later on. Consequently cost and planning activities increases, so also is customer dissatisfaction and financial issues. The open procedure has the advantage of using market forces to secure the lowest price, but the weakness of unlimited offers. Open procedure should then only be used in projects where the consequence is limited to the general process of a project.

The third most used selection criterion in public construction projects is the public-private partnership which counts for 4 (2.5%) of the 157 cases in the analysis. This selection criterion can therefore be argued to be a ‘niche model’ compared to the use of open procedure and invited tender with pre-qualification. Public-private partnership will therefore not be further analyzed based on their limited usage in public construction projects.

Looking at project types and the use of selection methods, it was found that both restoration and maintenance projects in 57 (43.2%) of the 132 cases and new construction projects in 63 (47.7%) of the 132 cases, use invited tender process, whereas the open procedure was mainly used for new construction projects in 11 (8.3%) of 132 cases. One (0.8%) out of 132 cases of the open procedure was restoration and maintenance project, see Table 2.

To be able to demonstrate and make any significant conclusions on the use of either open procedure or invited tenders with a pre-qualification process between the two project types, a Fisher’s Exact Test is conducted. The tested null hypothesis is that both selection criteria’s are used equally between the two described project types. Although by looking at the percentage distribution of cases on Table 2, it would seem there is a focus on using invited tenders with a pre-qualification process for both project types.

**Table 2: Fisher's Exact Test for selection criteria compared to project types, at 5% significance level**

Null hypotheses $H_0: \mu_1 = \mu_2$ : Open procedure tender and invited tender are used equally between restoration and new construction projects?			
	Open procedure tender	Invited tender, pre-qualification process	Total
Restoration and maintenance projects	1 (0.8%)	57 (43.2%)	58
New construction projects	11 (8.3%)	63 (47.7%)	74
Total	12	120	$n = 132$
Fisher's Exact Test results			
Hyper geometric probability	$H_A: \mu_1 \neq \mu_2: 0.0070$		
Two sided p-value	0.0121		
Probability $a < 1$	0.0076		
Probability $a > 1$	0.9994		

The result of the Fisher's Exact Test presented in Table 2, indicate that the null hypothesis could be rejected as  $0.0070 \neq 0.05$ . This shows that the two selection criteria, open procedure tenders and invited tender with pre-qualification process, are not used equally between the two project types.

### Assignment Criteria

Further interrogation of the data obtained from the study, yields the assignment criteria for the projects. Therefore regardless of the project type and selection criteria, two assignment criteria were predominant: lowest price and the most economically advantageous offer. The information obtained is presented in Figure 3. Of these criteria, the most used, 'lowest price' accounts for 118 (75.2%) of the 157 cases. The lowest price criterion has the advantage of using the market force to secure the lowest price from incoming bids, but as described in the selection criteria section, a combination of open procedure and lowest price usually result in complications. The criterion should therefore only be used in tasks where the consequence is limited to the general process of a project.

The second most used criterion is the 'most economically advantageous offer' and was used in 30 (19.1%) of the 157 cases, see Figure 3. The benefits of using the most economically advantageous offer are: the project manager and owner can specify planned percentages weighting of parameters used to find the best offer, such as price, architecture and functionality, but also education levels and level of quality system can be used to review incoming bids etc. Most economically advantageous offer has therefore the benefit that it gives the opportunity to find the best offer according to some planned weighting, but also acts as a barrier for offers that do not fulfil these weighted parameters.

Further analysis of the project types' use of assignment methods, found that both restoration and maintenance projects account for 45 (34.6%) of the 130 cases, and new construction projects account for 55 (42.3%) of the 130 cases that used lowest price as the assignment criterion. Further, it was found that the 'most economically advantageous offer' criterion was less used by both project types, thus for new construction projects, only in 14 (10.8 %) of 130 cases, and for restoration and maintenance projects, only in 16 (12.3%) of 130 cases. This data is presented in Table 3.

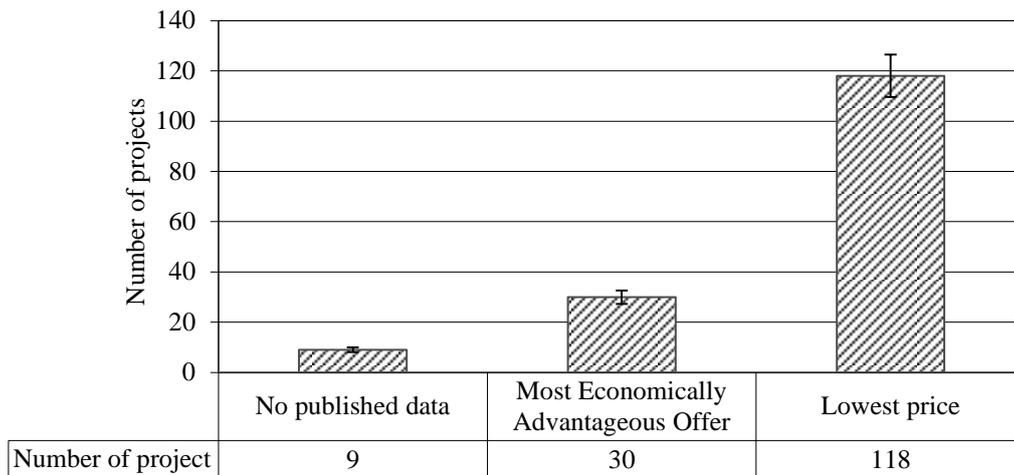


Figure 3: Assignment criteria for all 157 cases in the database, with standard error

To demonstrate and make any significant conclusion on the use of either the most economically advantageous offer or the lowest price criterion, between the two project types, a Fisher's Exact Test is conducted. The tested null hypothesis is that both assignment criteria are used equally between the two described project types. By looking at the percentage distribution of cases presented at Table 3 it would seem that there is a focus on using lowest price as the assignment criterion for both project types.

Table 3: Fisher's Exact Test for most economically advantageous offer and lowest price compared to project type, 5% significance level

Null hypotheses $H_0: \mu_1 = \mu_2$ : Most economically advantageous offer and lowest price are used equally between restoration and new construction projects?			
	Most economically advantageous offer	Lowest price	Total
Restoration and maintenance projects	16 (12.3%)	45 (34.6%)	61
New construction projects	14 (10.8%)	55 (42.3%)	69
Total	30	100	$n = 130$
Fisher's Exact Test results			
Hyper geometric probability	$H_0: \mu_1 = \mu_2: 0.1200$		
Two sided p-value	0.5321		
Probability $a < = 16$	0.8439		
Probability $a > = 16$	0.2761		

To test the null hypothesis, Fisher's Exact Test confirms the hypothesis. This result shows that the two assignment criteria are used non-significant equal between the two project types. Though there is an indication that lowest price criterion is preferred for both project types due to the percentages distribution but this is not significant.

## Selection and Assignment Criteria

By comparing the two most used selection and assignment criteria it is possible to determine how the different criteria are used in public construction projects, it is also possible to analyse if there is any significant use of some combinations.

As stated previously, the percentage most used selection criterion regardless of project type is invited tender with a pre-qualification process, while the percentages most used assignment criterion regardless of project type are lowest price which further is supported by Table 4, where it is found that the combination of these two criteria are mostly used in 88 (69.8 %) of the 126 tender cases. The advantages of combining these two criteria are: the invited tender with a pre-qualification process gives the owner and project manager the opportunity to invite project participants and evaluate their ability to fulfill the expected requirements. Pre-qualification act as barriers for the rest of the market by limiting the amount of bids and to ensure that the bids only come from tenderer having the right balance according to requirements. Hereafter using the lowest price as assignment criterion for the approved tenderer, market forces help to secure the lowest price between the approved incoming offers having the right balance between the requirements and the lowest price.

**Table 4: Fisher's Exact Test for most economically advantageous offer and lowest price compared to open- and invited tenders, 5% significance level**

Null hypotheses $H_0: \mu_1 = \mu_2$ : Most economically advantageous offer and lowest price are equally used between open procedure tender and invited tender process?			
	Most economically advantageous offer	Lowest price	Total
Open procedure tender	0 (0.0%)	12 (9.6%)	12
Invited tender, pre-qualification process	26 (20.6%)	88 (69.8%)	114
<b>Total</b>	<b>26</b>	<b>100</b>	<b>n = 126</b>
Fisher's Exact Test results			
<b>Hyper geometric probability</b>	$H_A: \mu_1 = \mu_2: 0.0540$		
<b>Two sided p-value</b>	0.0709		
<b>Probability a &lt;= 0</b>	0.0540		
<b>Probability a &gt;= 0</b>	1.0000		

The second most used combination is found to be invited tenders with a pre-qualification process where the selection criterion is most economically advantageous offer in 26 (20.6 %) of the 126 tender cases. This is shown in Table 4. The use and advantages of invited tender with a pre-qualification process are the same as previously explained, but the different selection criterion will provide more advantages than lowest price, because the most economically advantageous offer criterion has the benefit of using a planned percentages weighting of parameters to secure the best offer. These parameters could be for example price 50%, architecture 25%, and functionality 25% but also educational level and level of quality system can be used as parameters to find the best bids.

The third selection and assignment combination accounts for 12 (9.6%) out of 126 tender cases is, open procedure tender with lowest price (see Table 4). The advantage of open procedure tender is that more offers can be received, but the procedure has more chances for frivolous project partners to be engaged. By using lowest price as the assignment criterion, the market forces helps to secure the lowest total price from the incoming offers. The combination of open procedure tenders and lowest price has therefore the advantage of using the market to secure more offers and low price. However because of the consequences resulting from unlimited offers, the procedure should therefore be used in project tasks where the impact is limited.

To be able to demonstrate and conclude any significant use of the selection and assignment criteria, a Fisher's Exact Test was similarly conducted. The null hypothesis tested is that the most economically advantageous offer and lowest price are used equally with open procedure tender and invited tender with a pre-qualification process. The results (the percentage distribution of cases on Table 4) indicate an unequal use between these criteria.

Fisher's Exact Test confirms the null hypothesis which means that there is no significant use of some combinations regardless of project type, though it was found that invited tenders with pre-qualification and the lowest price is the mostly used combination in Table 4.

## CONCLUSION

The objective of this paper was to study which selection and assignment criteria was mostly used in public construction projects put out in European tenders. Data from 157 Danish public tender cases were obtained and through a quantitative research approach it was found, that invited tenders with a pre-qualification process was the most used selection criterion in 127 (80.9%) of the 157 cases. Fisher Exact Test on the study data confirms the significant use of invited tenders regardless of project type by rejecting the null hypothesis at  $0.0070 \neq 0.05$ .

Further the study analysed information on project type's use of selection methods and found that both restoration and maintenance projects (57 of 132 cases) and new construction projects (63 of 132 cases) used invited tender process with pre-qualification. The significant use of invited tenders with a pre-qualification process was anticipated by the authors, based on the inherent advantages of invited tenders with a pre-qualification process. The process ensures that the tendering partners have the right qualification to fulfil clients' expectations before tendering.

The study also found that the most used assignment criterion was the lowest price which was used in 118 of 157 tender cases regardless of project type. This assignment criterion was used on restoration and maintenance projects (45 of 130 cases) and new construction projects (55 of 130 cases). On the other hand, the 'most economically advantageous offer' criterion was used on restoration and maintenance projects in 16 of 130 cases, and on new construction projects in 14 of 130 cases. On observation, assignment criteria were broadly used than the selection criteria. Fisher's Exact Test on the data, shows that there is no significant use of the lowest price in public construction projects. The broader use of assignment criterion was not expected from authors compared to the significant use of invited tender with pre-qualification where a significant use of lowest price could have been expected. The authors are therefore convinced that there could be other parameters such as complexity, type and price etc., which

are considered by project managers and owners when the assignment criteria are selected according to project type.

By studying if there is a significant use of the combination of invited tender with a pre-qualification process and lowest price, the study found 88 out of 126 tenders. Fisher's Exact Test confirms that the selection and assignment criteria are distributed equally between the obtained cases regardless of project type. The results from the data analysis shows a significant use of the invited tender with pre-qualification process as the selection criterion, while assignment criteria was not found to be significantly used in public construction projects, although there is indication that the lowest price is preferred.

The study has implications for both the construction industry and future research within the field of construction selection and assignment criteria. The results could indicate to contractors and developers that intend to enter and capture new market shares in Danish public construction projects, the trend in tendering strategies used by public agencies and their project managers. Consequently the bidding strategy adopted by contractors should reflect the tendering strategies so that it increases their chances for successful bids for Danish public construction projects.

Further research within the field is encouraged and the authors suggest that future studies could cover all European countries' public construction agencies. This could be compared with the current results.

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