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RESEARCH ARTICLE

A novel consensus-based likert evaluation of public building dissatisfaction levels and quality recommendations

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Abstract

Quality issues are a major concern for building projects and continue unabated. Therefore, this research aims to investigate quality problems in Turkish public buildings and to recommend quality improvements to improve construction quality for successful construction in both public and private projects. Survey data were analyzed using frequency indices (*FIs*) and consensus frequency indices (*CFIs*) to rank dissatisfaction levels, in-complete or defective works, and suggestions to improve construction quality. According to the results of the survey, the *FI* of poor quality or non-standard work on the completed public buildings was 0.75, and the project duration estimated by the owners was the major cause (3.92 ± 1.16). The most stated recommendation for improving the quality of building work and materials was to increase sanctions on responsible personnel (4.28 ± 0.71) with a *CFI* of 0.64. Quality issues are a major concern for building projects. Literature has documented that there are a variety of challenges faced by construction projects, such as unforeseen structural issues and budget overruns. There are several types of quality control issues, including improper installation, defective materials, and deviations from approved plans. Having insufficiently qualified workers can result in delays, increased costs, and poor quality. Regulation violations can lead to fines, project delays, and reputational damage. This study aims to investigate Turkish public building quality issues from both the perspectives of contractors and control officers to ensure successful project outcomes. The findings of this study will provide valuable insights for the public and private construction sectors into improving construction quality to ensure successful building projects.

1. Introduction

The construction industry is a key player in the economy in terms of employment and wealth [1, 2], which accounts for around 10% of the EU's gross domestic product (GDP) and provides around 13 million direct jobs in Europe [3]. However, many projects experience extensive delays, exceeding initial time and cost estimates. Delays, cost overruns [4] and low-quality standards [5] are common problems in the construction industries of many countries. Costs, time and quality are interrelated constraints of success; therefore, the success of a construction project is measured by whether there is a balance between cost, time and quality. If both time and money are constrained, quality is likely to suffer [1]. The completed

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product quality especially in the field of construction is lower than in other sectors [6]. Mashwama et al. [1] stated that stakeholders' quality standard perceptions in the building construction industry are different, which negatively affects quality standards in the industry. Project quality is sometimes overlooked and this can be seen as one of the many causes of poor quality in construction projects [1, 7]; poor quality can cause delays, low productivity and cost overruns [8]. In addition, rectifying or repairing poor quality work costs tremendous amounts of money; there is not only the cost of repairing the defective work but also the additional costs that are often caused by the delay of the project. The cost of poor quality is higher than the total earnings of construction companies in the industry [2]. Poor quality work may be due to various factors, such as greedy contractors, quackery, insufficient budget allocation, inadequate regulatory framework, and inadequate quality control laboratories or personnel [9].

Building defects are one of the main aspects of building problems that need careful consideration. Various research papers indicated that quality issues are a major concern for building projects and continue unabated [2, 6, 8, 10, 11]. Poor quality can increase the cost of a building by more than 50% and delay a project by up to 50%, and poor quality occurs in more than 80% of completed construction projects [2]. The study by Oz [11] indicates that dissatisfaction with residential construction is largely due to the high profits expected by contractors. In addition, the lack of qualified workers, the lack of competence among contractors, and the incompetence and ineffectiveness of site managers and chiefs are also significant factors contributing to dissatisfaction [11]. Errors occur frequently on construction sites and can be costly for contractors and owners. Rectifying poor quality work detected during maintenance can be between 5% and 15% of the total project costs [1, 9, 12]. To reduce poor quality in public buildings, the Minister of Environment, Urbanisation and Climate Change in Türkiye has defined technical specifications and quality standards, and many public authorities and institutions utilize these in their projects. The literature contains many studies on construction quality issues [1, 2, 6, 8, 12] with some limitations. According to Olanrewaju and Lee [2, 6], a small sample size and a limited number of variables were limitations of their study, and they suggested future research with a larger sample size and more variables. There were several limitations highlighted in the study [8], including the need for a larger database to develop a more accurate and applicable model, the lengthy data preparation process, which can be shortened by using different methods, and the fact that the developed model has not been implemented in construction projects.

Construction projects face a variety of challenges, including unforeseen structural problems and budget overruns: Improper installation, defective materials, and deviations from approved plans are common quality control issues; having a shortage of skilled workers can cause project delays, higher labor costs, and compromised quality; regulation violations can lead to fines, project delays, and reputational damage. Managing these kinds of construction issues is crucial to minimising risks and ensuring project success. The scope of this study is to investigate public building construction issues from the perspectives of contractors and control officers to ensure successful project outcomes. The survey questions were developed after extensive literature reviews and face-to-face interviews with building construction experts. Quantitative analysis was used to assess public building quality issues. An in-depth understanding of the level of dissatisfaction with Turkish public buildings as well as incomplete or defective work will be provided in this study, and recommendations for improving building construction and material quality will also be included.

This study's highlights can be summarized as follows:

- Most performance problems are caused by poor quality or non-standard work.
- Quality problems often result from errors or deficiencies in construction drawings.

- Construction quality can be improved by increasing sanctions.
- A tenderer's past performance can be used to predict future performance.
- For a project to be of the highest value, non-price factors must be considered.

2. Material and Methods

A literature review and a survey questionnaire were used in this study. An online-based survey was considered to deliver the survey to the sample and collect their responses. The respondents were selected according to convenience sampling and data was collected through survey questionnaires. Bhardwaj [13] stated that convenience sampling needs a very short duration of time to collect data, is very easy to implement, inexpensive to create samples, and the members of a sample are selected in such a way that the researcher can easily access them.

Participants were selected based on their organizational types. The organizational categories were then subdivided into construction company owners, technical personnel working in construction companies, and government control officers. A number of domain experts on construction projects from public authorities and construction companies evaluated this questionnaire. Based on their suggestions, the questions were then refined to 29 inquiries. The first eight questions relate to the demographic characteristics of the participants, while the remaining 21 are about construction quality problems, their causes, and recommendations to improve them. Mostly closed-ended questions were used; one was open-ended to get participants' suggestions regarding non-price factors along with the price factor, four questions were multiple-choice, and the other 16 were rating scale questions. The questionnaire can be found in Appendix A.

Closed-ended questions are easier to use online [14] and can be easily analyzed for quantitative data [15]; however, participants write their responses in open-ended questions, which are also used in many areas of the behavioral sciences [14]. The questionnaires were administered online to control officers, contractors and technical personnel working at the contractor company. The survey is divided into four main sections: (1) the demographic characteristics of respondents, (2) the construction quality problems, (3) the causes of poor quality, and (4) recommendations for improving construction quality. Zonguldak Bulent Ecevit University, Human Research Ethics Committee approval was obtained under protocol 80 on February 24, 2022. On the first page of the online survey form, participants were required to agree to a consent form explaining the study's purpose and confidentiality. The study's research process is illustrated in Fig. 1.

The data were measured using both nominal scales like demographic characteristics of the respondents, and ordinal scales like construction performance ratings. These two simple data measurements to categorize different types of variables are appropriate for answering survey questions [15, 16]. The respondents were questioned about the rate of occurrence of construction performance/quality problems and causes on a five-point Likert scale based on agreement, frequency, and likelihood. Validity and reliability tests were conducted to evaluate the accuracy and consistency of the questionnaire. Reliability and validity are two key concepts used in the evaluation of any measurement tool to test the quality of research [17]. While validity is about the accuracy of a measurement, reliability is about the consistency of a measurement [18]. Validity describes how well the collected data covers the real research area [19]. Reality is the stability or consistency of a measure over time under the same conditions and using the same methods [18, 20]. Although reliability is important for a study, it also needs to be valid [20]. The questionnaire was validated by discussing it with the experts and revised with recommendations. Cronbach's Alpha was used to measure the internal reliability of the questionnaire in this study. The Cronbach Alpha coefficient is the most widely used internal consistency measure [20] and most people agree that the minimum internal consistency coefficient is 0.70 [22].

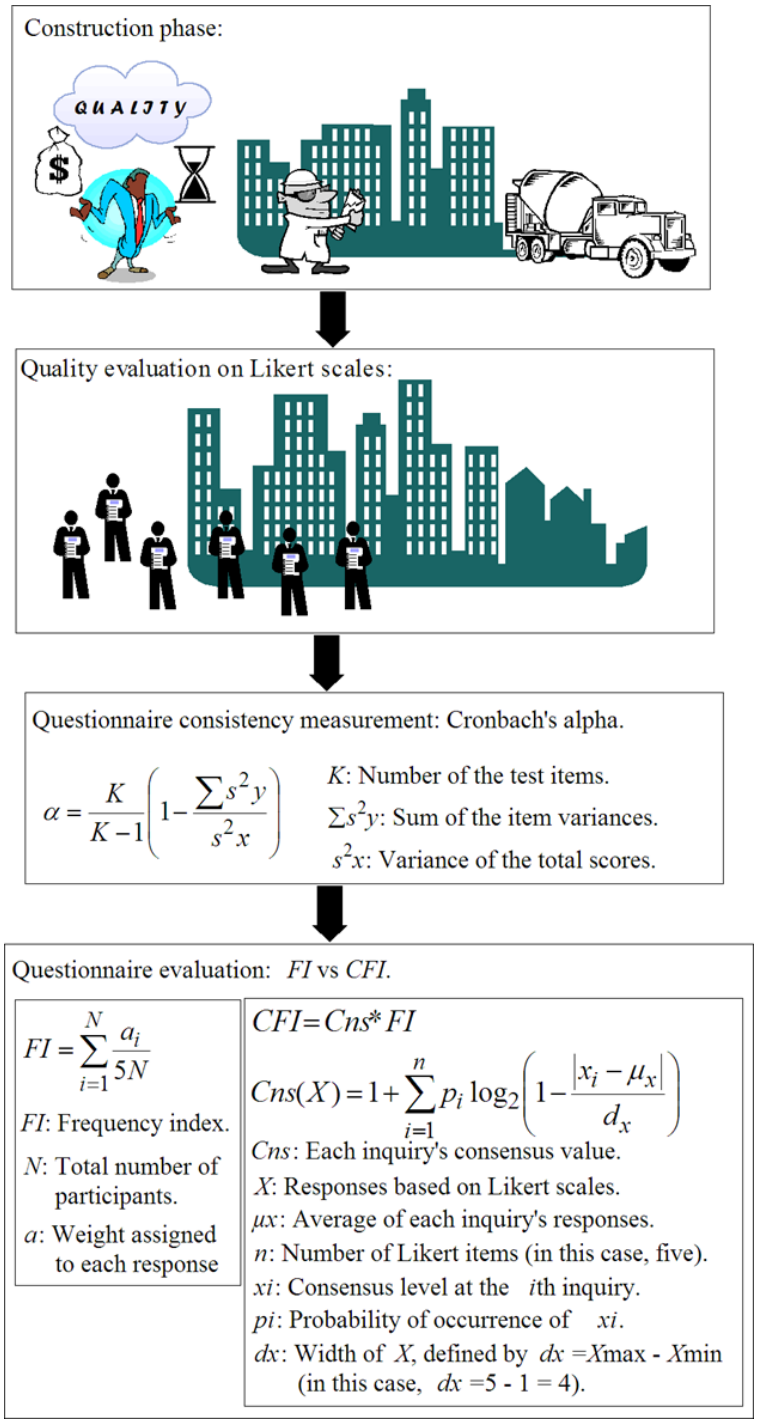

Fig. 1. An overview of the study's workflow

The data obtained from the survey (multiple-answer and single-answer responses) were analyzed using frequency indexes (*FIs*). We will use Eq. 1 [15] for single-answer questions (on a 5-point Likert scale), and Eq. 2 for multiple-answer questions.

$$FI = \sum_{i=0}^{5} \frac{a_i n_i}{5N} \quad (1)$$

$$FI = \frac{n}{N} \quad (2)$$

We then compute the consensus frequency index (*CFI*) based on the consensus value using the following equation.

$$CFI = Cns * \sum_{i=1}^{N} \frac{a_i}{5N} \quad (3)$$

If all members of a sample group agree on a declarative statement, it is said that they are in consensus [23]. This definition explains that there is no consensus if an equal number of participants choose their responses in the two extreme categories on a Likert scale, i.e., strongly disagree and strongly agree; however, if all participants choose the same category on the Likert scale, this group shows full consensus. Accordingly, the consensus degree differs from zero to one for all combinations of response patterns. According to Tastle & Wierman [23], consensus provides a comparison of different Likert distributions and matches human intuition, and they propose calculating the consensus degree as follows:

$$Cns(X) = 1 + \sum_{i=1}^{n} p_i log_2 \left(1 - \frac{|x_i - \mu_x|}{d_x}\right) \quad (4)$$

As indicated, using Likert scales with consensus values can help eliminate human bias. For example, the consensus value is one if two experts are in full agreement (5 and 5), but zero if they are in total disagreement (1 and 5 or vice versa). This value changes from zero to one for partial agreements. For each inquiry, frequency indexes (*FI*s) based on consensus values will be calculated using Equations 1 and 2, and consensus degrees will be calculated using Equations 3 and 4. After that, comparisons will be made between *FI*s and *CFI*s.

2.1. Data analysis

A number of survey data analysis tools are available with both advantages and disadvantages. MS Excel is a common data analysis tool due to its ease of use. However, it comes with some limitations and drawbacks, especially when it comes to complex formulas, multiple worksheets, and manual entry of data. As it is easy to use and allows a deeper understanding of survey results, this study analyzes survey data using Excel to calculate Cronbach's Alpha, median, standard deviation, and *FI*s and *CFI*s.

3. Results

Participation in the questionnaire was restricted to public construction officials, contractors, and technical personnel with experience in public building projects. They were invited to participate in the survey by e-mail. In total, 53 responses were received, with an approximate response rate of 3 out of 4. The internal consistency of the survey was measured with Cronbach's Alpha. Sixteen test items (or variables) were evaluated because they were suitable for a five-point Likert scale. The internal consistency reliability value was found as 0.71 (Fig. 2) using Eq. 5, which is interpreted as acceptable [22]. The findings are presented and discussed in the following sections.

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum s^2 y}{s^2 x}\right) \quad (5)$$

Where α is the internal consistency, K is the number of the test items, $\Sigma s^2 y$ is the sum of the item variances, and $s^2 x$ is the variance of the total scores.

Number of items on a 5-point Likert scale:	$K =$	16
The sum of item variance:	$\Sigma s^2 y =$	15.247
Variance of total score:	$s^2 x =$	44.940
Internal consistency:	$\alpha =$	0.705

Fig. 2. Cronbach's Alpha (α) internal consistency reliability statistics

Statistical significance measures for questionnaires are also presented in Table 1. A consensus among controllers and contractors was to increase sanctions against those who are responsible for incomplete, defective or poor quality construction (4.28 ± 0.71), while the lowest dissatisfaction appears to be in the completion of building projects at contract prices (2.40 ± 1.12).

Table 1. Statistics on the questionnaire

#	9	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	$M_{avg.}$
M	3.208	3.340	3.132	2.792	2.906	3.962	4.038	3.925	3.811	3.774	4.283	4.113	3.887	3.943	2.736	2.396	3.515
s^2	0.429	1.092	1.209	1.183	0.953	0.716	0.904	1.353	1.172	1.269	0.505	0.515	0.780	0.619	1.289	1.258	0.953
SD	0.655	1.045	1.100	1.088	0.976	0.846	0.951	1.163	1.083	1.127	0.710	0.718	0.883	0.787	1.135	1.122	0.962

#: Questions on a 5-point Likert scale; *M*: Mean; s^2: Variance; *SD*: Standard deviation. Minimum and maximum mean values are indicated by darker shading.

Also, a consensus exists that all types of equipment and materials should be defined more clearly in contract documents and that contracts should not be awarded below the limit value (abnormally low bids) in construction work (4.038 ± 0.951).

3.1. The respondents' profiles

The age range of construction control officers was between 29 and 64, while the age range of the contractor's technical personnel was between 27 and 41. Eighty-three percent of respondents were men, and seventeen percent were women. Table 2 depicts the results of respondents' profiles. Close to 17% of the respondents were company owners, about 13% of them worked for the contractors as technical personnel, and 70% of them worked for the public contracting authorities as construction control officers. More than 44% of company owners had a bachelor's degree or higher, and about 56% of them had been in their current business for 10 to 20 years. Approximately 57% of the technical personnel in the company worked as engineers, and about 48% worked as site chiefs. Nearly 46% of control officers stated that they had worked in their current job for more than 10 years.

A survey was conducted among respondents working in the Department of Construction and Technical Affairs in the Municipalities, the Local Governments, and the University in the city of Zonguldak since these departments specialize in public building construction.

Table 2. Profile statistics of the respondents

Profile		N	%	Profile	N	%	Profile		N	%
Organisational type				*Current position*			*Year in current position*			
Company owners		9	17	Contractor: owner	9	17	For contractors and technical personnel	0-5	3	6
Technical personnel of the company		7	13	Company: engineer	4	8		6-10	6	11
Government control officers		37	70	Company: site chief	3	6		11-20	6	11
Year of working experience in construction industry				Head of control officers	3	6		>20	1	2
For contractors and technical personnel	0-5	1	2	Control supervisor	5	9	For government control officers	0-5	9	17
	6-10	5	9	Control officer	29	55		6-10	11	21
	11-20	8	15					11-20	7	13
	>20	2	4					>20	10	19
For government control officers	0-5	0	0							
	6-10	14	26							
	11-20	9	17							
	>20	14	26							

N: Respondents.

Table 3 shows that of the respondents, 20 of whom work in the Municipalities, 20 of whom work in the Local Governments, and 13 of whom work at the University.

3.2. Public building quality dissatisfaction levels

Building quality problems were questioned based on the perceptions of the control officers, the contractors, and the technical personnel involved in building contracts. Respondents were allowed to select multiple-choice questions to determine the causes of poor quality or non-standard work, and disputes. Forty respondents out of 53 stated that "poor quality or non-standard works" was the most important performance problem, while "not execution of works by the standards or technical specifications", "not execution of works by the drawings", and "lack of competence of the building contractors" were the top-ranked impacts, respectively. As can be seen in Table 4, the most frequent performance problems in the ranking stemmed from contractors. However, 28 of the respondents stated that "deficiencies or errors in construction drawings and technical specifications" cause quality problems. "Prolongation of project owner approval processes", or "dissatisfaction with project changes during the construction of the work" was not seen as much of a performance problem.

3.3. Incomplete or defective works

The nature of the incomplete or defective building works was questioned based on the construction works and the installation works. Table 5 indicates that while 40 out of 53 respondents stated that the finishing work was the most frequently detected incomplete or defective building construction works, 39 out of 53 people stated that the wastewater system was the most frequently detected incomplete or defective building installation works. These two are at the top with about 0.75. "Poor quality building materials", "waterproofing", "elevator or escalator", and "heating or ventilating" also ranked high with more than 0.50.

3.4. Recommendations for improving the quality of work

Public control officers and contractors were asked 10 questions to rank their recommendations for improving the quality of work and materials. Rankings based on *FI* and *CFI* differ slightly. Table 6 shows that the *FIs* of the recommendations are quite high with over 0.50, as compared to a *CFI* of 0.35.

Table 3. Cross-tabulation between the current position and public authorities

Current position	Public authorities			Total (*N*)
	Municipalities	Universities	Local governments	
Contractor: owner	0	2	7	9
Company: engineer	1	1	2	4
Company: site chief	0	1	2	3
Head of construction control officers	2	1	0	3
Construction control supervisor	5	0	0	5
Construction control officer	9	7	5	21
Construction control engineer	3	1	4	8
Total (N)	20	13	20	53

Table 4. Dissatisfaction perceptions ranked by controllers and contractors

Dissatisfaction descriptions	*n*	*FI*	Rank
Poor quality or non-standard work	40	0.75	1
Not execution of work by the standards or technical specifications	34	0.64	2
Not execution of work by the drawings	31	0.58	3
Lack of competence of the building contractors	30	0.57	4
Deficiencies or errors in the construction drawings and technical specifications	28	0.53	5
Unforeseen circumstances during the execution of the construction	25	0.47	6
Change of client's decision	25	0.47	6
Building contractors' target of reaching the desired quality	24	0.45	7
Disputes delaying work and increasing indirect cost	23	0.43	8
Insufficient funds	23	0.43	8
Projects' scheduled date of completion	22	0.42	9
Project and construction control officers' experience, competence and effectiveness	19	0.36	10
Delay in the delivery of the worksite to the contractor	19	0.36	10
Deficiencies, errors, vagueness or ambiguity in the contract documents	17	0.32	11
Failure to deliver the work to the project owner on time	17	0.32	11
The additional cost of project owner decision change	16	0.30	12
Progress payments later than the time specified in the contract	16	0.30	12
Prolongation of project owner approval processes	12	0.23	13
Dissatisfaction with the project changes during the execution of buildings	11	0.21	14

Table 5. Ranking of incomplete or defective works in public building projects

Incomplete or defective works	*n*	*FI*	Rank	Incomplete or defective works	*n*	*FI*	Rank
Building construction works				*Building installation works*			
Finishing works	40	0.75	1	Sewage water system	39	0.74	1
Poor quality building materials	36	0.68	2	Elevator or escalator	31	0.58	2
Waterproofing	33	0.62	3	Heating or ventilating,	29	0.55	3
Non-quality building materials	25	0.47	4	Air conditioning	17	0.32	4
Formwork, reinforcement, concrete and rough works	24	0.45	5	Water supply system	16	0.30	5
Heat insulating	11	0.21	6	Fire-extinguishing system	15	0.28	6
Roofing	8	0.15	7	Uninterrupted power supply	10	0.19	7
Construction surveying mistakes	8	0.15	7	Power compensation	9	0.17	8
Doors and windows	5	0.9	8	Lighting equipment	7	0.13	9
				Electric generator	5	0.9	10
				Transformer	2	0.4	11

Table 6. Ranking of recommendations for improving project quality

i	Recommendations	*X:* Likert scale					Statistics				Ranking				
		5	4	3	2	1	μ	s^2	*SD*	*FI*	R	*Cns*	R	*CFI*	R
23	Increase the sanctions against those responsible for incomplete, defective or poor quality work	23	22	8	0	0	4.283	0.505	0.710	0.86	1	0.75	3	0.64	1
24	Specify the quality and standart definitions of all kinds of equipment and materials more clearly in the contract documents	17	25	11	0	0	4.113	0.515	0.718	0.82	2	0.77	1	0.63	2
19	Sign a contract with the tenderer whose price offer above the limit value, not defined as abnormally low tender	22	14	14	3	0	4.038	0.904	0.951	0.81	3	0.66	6	0.53	6
18	Be more selective qualification criteria in the evaluation of tenders in building work	15	24	11	3	0	3.962	0.716	0.846	0.79	4	0.73	4	0.58	4
26	Consider non-price factors along with the price in the evaluation of the tenders of the building work	12	28	12	0	1	3.943	0.619	0.787	0.79	5	0.76	2	0.60	3
25	Specify the brands of all kinds of equipment and materials in the contract documents	14	22	15	1	1	3.887	0.780	0.883	0.78	6	0.70	5	0.54	5
21	Require a repair insurance for possible defective work for a certain period after final acceptance	17	17	13	4	2	3.811	1.172	1.083	0.76	7	0.60	8	0.46	7
22	Require a periodic maintenance and repair insurance for mechanical installation and electrical work for a certain period after final acceptance	17	16	14	3	3	3.774	1.269	1.127	0.75	8	0.58	9	0.44	8
17	Evaluate the outputs of the satisfaction surveys as a tender qualification criterion	3	8	29	7	6	2.906	0.953	0.976	0.58	9	0.70	5	0.41	9
16	Conduct a satisfaction survey and evaluate the outputs in the performance measurement of the building contractor	4	7	24	10	8	2.792	1.183	1.088	0.56	10	0.62	7	0.35	10

#: Questions on a 5-point Likert scale; μ: Mean; s^2: Variance; *SD*: Standard deviation; *FI*: Frequency Index; *Cns*: Consensus degree; *CFI*: Consensus frequency index; R: Rank.

The top three recommendations according to *FI* for improving the quality of public building work are (1) increasing the sanctions against responsible personnel, (2) specifying the quality and standard definitions of all kinds of equipment and materials more clearly, and (3) signing a contract with the tenderer whose price offer is above the limit value, while *CFI* suggests that the third place is evaluating tenders using both price and non-price factors. Other rankings of the recommendations are shown in Table 6.

3.5. Non-price factors together with the price offer

One open-ended question in the survey was asked about non-price factors (qualitative and/or quantitative) in determining the most economically advantageous tender. Forty respondents answered this question. Two answers were not taken into consideration because of meaningless, while semantic errors in other sentences were corrected and categorized. As can be seen in Table 7, contractors' past work performance was the most frequently proposed as a non-price factor. This was followed by qualification and an adequate number of technical personnel and workers.

Table 7. Ranking of proposals for non-price factors

Proposals for non-price factors	n
Past work performance measure based on quality, completion time, technical personnel, or subcontractors	27
Tenderer's qualification and a sufficient number of technical personnel and workers	8
Documents relating to facilities, machinery, devices and other equipment required for the fulfillment of the work	3
Similar work experiences	3
Tenderer's professional and technical qualifications	3
Feasibility of work at the offered price	2
Material brands	2
Guarantee letters	2
Subcontractors' qualifications	1
Implementation methods	1
Project duration offers	1
Quality certificate	1
Various types of materials in the constructor's stock required for the fulfillment of the work	1

Five respondents also made some recommendations for non-price factors. These are determining the estimated cost of work with current market prices, introducing a new formula to evaluate price offers not to award the contract to the abnormally low tender, fulfilling the legal requirements promptly in case of problems related to the work quality during the execution of the construction, and having common practices on non-price factors in tenders. It was also stated that the importance weight of the evaluation of contractors' past performance should be more than that of price offers.

3.6. Overall evaluation

According to the *FI* and *CFI* rankings, the first three places differ. The respondents stated (shown in Table 8) that the project duration estimated by the project owner can affect the expected quality. Time, cost, and quality are closely related to the success of a project, and a deviation from one of them can affect the others closely. Both inadequate time estimation and awarding the contract to the lowest price offer have serious consequences for any project, and overall satisfaction can fall. Speed affects the quality level of work due to poor execution, the percentage of waste in construction materials increases, or working overtime negatively affects workers' productivity and production quality [24]. Furthermore, detecting incomplete, defective, or faulty work between preliminary acceptance and final acceptance, or within five years after final acceptance of building work ranks high. In terms of achieving quality, the aim or goal of a contractor is average with the highest consensus (0.80). Many of the contractors had a high goal of achieving the quality specified in the contract for the work. Building projects were almost often completed within the time specified in the contract as well as at the contract price.

4. Discussion

A building's quality is crucial to the success of a construction project [8] but critical nonconformities are often detected during construction [25]. This situation has been documented in numerous studies. Based on Kazaz & Birgonul's study [10], the Turkish construction industry has a quality level close to average in terms of satisfaction. According to Oz [26], some owners are partially or fully dissatisfied with construction based on drawings, standards, or specifications.

Table 8. Overall evaluation of public building projects

i	Definition	*X:* Likert scale					Statistics			Ranking				
		5	4	3	2	1	μ	*s2*	*SD*	*FI*	R	*Cns*	R	*CFI*	R
20	The effect of the contract duration determined by the project owner on the expected quality specified in the contract documents	20	19	8	2	4	3.92	1.35	1.16	0.78	1	0.58	3	0.46	2
14	Meeting incomplete, defective, or faulty work between preliminary acceptance and final acceptance in building work	6	19	19	5	4	3.34	1.09	1.05	0.67	2	0.62	2	0.41	3
9	The aim or goal of a building contractor to achieve the quality specified in the contract of the work	1	14	34	3	1	3.21	0.43	0.65	0.64	3	0.80	1	0.51	1
15	Meeting incomplete, defective, or faulty work within five years after the final acceptance of building work	5	15	21	6	6	3.13	1.21	1.10	0.63	4	0.62	2	0.39	4
27	The building work completed within the time specified in the work contract	1	17	11	15	9	2.74	1.29	1.14	0.55	5	0.56	5	0.31	5
28	The building work completed at the contract price	1	11	9	19	13	2.40	1.26	1.12	0.48	6	0.57	4	0.27	6

#: Questions on a 5-point Likert scale; μ: Mean; $s^{2:}$ Variance; *SD*: Standard deviation; *FI*: Frequency Index; *Cns*: Consensus degree; *CFI*: Consensus frequency index; *R*: Rank.

Similarly, the data in the study by Oz [26] also revealed that poor quality or non-standard work, not execution of work according to standards, technical specifications, or drawings were prevalent performance problems in public building projects.

Working with inexperienced or inadequate contractors is another quality issue encountered on construction projects. Inappropriate contractors can lead to various problems such as poor quality of work, delays, and other issues [27], or a contractor under financial burden may skip work to earn some profit [15, 28]. A sustainable construction company requires a certain level of construction experience, expertise and training [29]. The lack of competence of building contractors also ranked high in this research, which could be one of the causes of performance problems. On the other hand, construction workers play a critical role in a project's execution. Unskilled labor and low productivity have a significant negative impact on project performance, resulting in low quality, high costs, and time overruns [30, 31]. Olanrewaju & Hui Jing Lee [2] stated that defective concrete floors, defective plasters, poor quality brick wall construction, poor workmanship and inadequate site investigations in the foundation, and poor quality roofing due to poor workmanship and substandard materials were common in construction projects. In another study, Forcada et al. [32] found that the most common defects during construction were related to the structure's rigidity and improper roof and facade assembly. These defects resulted from poor workmanship rather than material quality.

Deficiencies or errors in construction drawings and technical specifications can also lead to another performance problem because design-related factors contribute to poor quality [2]. Design defects are generally detected during project execution and lead to rework [33]. The problems associated with the designs are mainly: (1) generally incomplete and unclear design drawings, (2) lack of standards in the designs, and lack of suitability for existing technology, and (3) not defined details in the designs [33]. The respondents strongly stated the need to specify the quality and standard definitions of all kinds of equipment and materials more clearly in the contract document. Fifty-three percent of them also stated a similar statement about public buildings' performance problems. Working drawings and specifications are the primary documents used by contractors to

complete a project. Specifications describe the qualities of materials and installation methods, which should be comprehensive, accurate, and clear [34].

The survey of this study also indicated that poor quality or non-quality building materials were prevalent in building construction work. There is a direct correlation between the quality of the whole project and the materials used, and successful construction projects always utilize high-quality materials. Using high-quality materials ensures that the overall project meets quality standards and is durable, cost-effective, safe and sustainable; however, substandard materials lead to some problems causing functioning concerns, repairs and disruption [35]. Furthermore, Olanrewaju & Hui Jing Lee [2] found in their study that poor quality sewage pipes during the defect liability period were high. Additionally, finishing work in construction and sewage water systems in installation are among the highest-ranked incomplete or defective works in public buildings.

This survey asked recommendations for improving construction quality. The top three recommendations with an average of scores above four are (1) increasing the sanctions against those responsible for incomplete, defective or poor quality work, (2) specifying the quality and standard definitions of all kinds of equipment and materials more clearly in the contract documents, and (3) signing a contract with the tenderer whose price offer is above the limit value, not defined as an abnormally low tender. However, taking into account both price and non-price factors when evaluating building tenders ranks third with a consensus value of 0.76.

There are very serious sanctions on contracting parties specified in the Turkish Public Procurement Contracts Law. For example, prohibition temporarily or permanently from participating in public tenders, prosecution under criminal law, or completion and compensation for any damages and losses caused by any parties to have incurred. Contractors and sub-contractors in contracts shall be liable successively or severally for any loss or damage, not only from the date of commencement of construction to the date of final acceptance but also for fifteen years counting from the date of final acceptance. Furthermore, contracting officials shall also be liable successively or severally to the contractor for any loss or damage caused by deficient inspection and control, for fifteen years [36]. However, the survey respondents did not find the sanctions sufficient, or they did not know their prohibitions and liabilities.

Determine the most appropriate tender for a construction project is a major concern and a crucial process, especially for government authorities [37-39]. In other words, inadequate procurement systems are usually the cause of major problems in construction projects [40]. Based on this survey, it was strongly recommended to sign a contract with the tenderer whose price offer is above the limit value. In the current public tender evaluation practices in Türkiye, it can be considered that the lowest tenderer among pre-qualified tenderers is awarded a contract [27]; however, practices show that the lowest price is not the best option for contracting authorities [41] and may lead to a decrease in the performance of the construction project [15, 42].

Lastly, there was one open-ended question about non-price factors in tender evaluation. Respondents suggested 14 factors. Tenderers' past performance measures ranked at the top with a frequency of 27, and qualification and a sufficient number of technical personnel and workers took second place in the ranking with a frequency of eight. Tenderers' past performances and technical competencies influence construction performance [43]. In public projects, the traditional lowest-price method is still widely used and contracts are usually awarded at the lowest price [26]. However, there are many studies in the literature that consider non-price factors in addition to price in contractor selection. There has been a recent tendency to move away from the lowest price principle [26, 37, 38, 44-47].

5. Limitations and Future Studies

Convenience sampling is most commonly used because of its numerous advantages, but it has some

drawbacks as well. Among the major drawbacks are sampling bias, lack of variety of participants, systematic errors, limited external validity, and researcher bias [48]. It's likely that several articles will be published soon on a similar topic in different locations or populations to compare their results with those of this study, due to the drawbacks mentioned above. Furthermore, although the results of this study are statistically valid and consistent with prior similar studies, studies with a larger sample size may be better at analyzing the current state of building construction projects. Moreover, determining the most economically advantageous tender in public tenders only based on the price offer may disrupt the time-cost-quality balance of the project and lead to various disputes [26]. Therefore, future research should investigate non-price factors in the evaluation of tenders.

6. Conclusion

The quality levels of public building construction and recommendations for improving the quality of building work and materials were investigated in this research. A survey was administered to all parties (contractors and government control officers/inspectors) involved in public building contracts. The survey indicated the most frequent quality problem was "poor quality or non-standard works". Among the issues relating to the contractors' performance were "not the execution of works by the standards or technical specifications", "not the execution of works by the drawings", and "lack of competence of the building contractors". Regarding construction works and installation works, incomplete or defective building works were questioned. According to the respondents, the finishing works and the wastewater system were the most frequently detected incomplete or defective works. Furthermore, the respondents ranked recommendations for improving public building quality. High-ranked recommendations were "increasing the sanctions against responsible personnel", "specifying the quality and standard definitions of all kinds of equipment and materials more clearly", "considering non-price factors along with the price in the evaluation of tenders for building work", "signing a contract with the tenderer whose price offer is above the limit value", and "being more selective about qualification criteria in the evaluation of tenders for building work".

One open-ended question in the survey was asked about non-price factors. Contractors' past work performance and qualifications, and an adequate number of technical personnel and workers were the most frequently proposed non-price factors.

In the overall evaluation of the survey, it was stated that the estimated time frame by the project owner can affect the expected quality. Inadequate time estimation has serious consequences for any project. In other words, speed affects work quality due to poor execution. Completion of construction projects within the contract period is essential for the project's success [49, 50]. Furthermore, detecting incomplete, defective or faulty work between preliminary acceptance and final acceptance, or within five years after final acceptance was ranked among the top priorities. Contractors' quality perception, however, received the highest consensus value (0.80). Accordingly, the aim or goal of a building contractor for achieving the quality specified in the contract for the work is average, which is the highest ranking. Consequently, this research provides fresh knowledge to legal authorities and contractors in public building projects for the successful delivery of building projects to owners or clients. Furthermore, the findings provide recommendations for improving public building quality. In addition, about 75% of respondents stated the importance of non-price factors in addition to price in selecting the most suitable contractor for public building construction.

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Author Contributions

B. Oz: Conceptualization, Methodology, Resources, Data Curation, Writing-Original draft, Writing- Review & Editing.

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Data Availability Statement

No new data were created or analysed in this study.

Ethics Committee Permission

Zonguldak Bulent Ecevit University, Human Research Ethics Committee approval was obtained under protocol 80 on February 24, 2022.

Conflict of Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Appendix A

An overview of the study's questionnaire.

#	Questions	#	Questions
1	Please indicate your age.	16	Do you think conducting a satisfaction survey and evaluating the outputs in the performance measurement of building contractors?
2	Please specify your gender.	17	Will measuring satisfaction survey outputs as a tender qualification criterion generally improve quality?
3	Please specify the public entity you work for.	18	Would construction contractors' perception of quality be improved by more selective qualification criteria when evaluating bids for building projects?
4	Please specify your profession.	19	Does the contract price below the limit value (an abnormally low tender) in building construction projects negatively affect the quality perception of construction contractors?
5	Please specify your current position.	20	Could the urgency of delivering building construction projects be one of the factors contributing to a reduced level of quality?
6	Please specify your education.	21	Are you of the opinion that requiring repair insurance for possible defective works after final acceptance will enhance contractors' perception of quality?
7	How many years have you been working in the construction industry?	22	Do you think that the requirement of periodic maintenance and repair insurance for mechanical installation and electrical work for a certain period after final acceptance will enhance contractors' perception of quality?
8	How many years are you in your current position?	23	Is it possible that increasing penalties against those responsible for incomplete, defective, or poor quality will improve the effectiveness of inspections and work?
9	To achieve the quality specified in the contract, what are the goals of contractors who make commitments to public buildings?	24	Do you believe that specifying the quality and standard definitions of all kinds of equipment and materials more clearly in the contract documents will increase the expected quality and reduce disputes?
10	Which of the following are the most likely reasons for not achieving the quality specified in the contract for building projects (you may choose more than one option)?	25	Do you believe that specifying the brands of all kinds of equipment and materials in the contract documents will increase the expected quality?
11	Generally, which of the following are defective and incomplete building construction works (more than one option can be selected)?	26	In the evaluation of building tenders, does the inclusion of non-price factors increase quality?
12	Generally, which of the following are defective and incomplete building installation works (more than one option can be selected)?	27	Is it common for building projects to be completed within the contract deadline?
13	Which of the following factors leads to disputes between building contractors and owners/clients (more than one option can be selected)?	28	Is it common for building projects to be completed at the contract price?

Cont'd: An overview of the study's questionnaire.

14	Generally, how often do you encounter incomplete, defective, or faulty work between preliminary acceptance and final acceptance in building works?	29	In determining the most economically advantageous tender, what non-price factors could be considered?
15	Generally, how often do you encounter incomplete, defective, or faulty work within five years after the final acceptance of building work?		