



## Technical Audit and Unethical Practices in the Construction Industry

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### Abstract

This study presents the dark side of "unethical practices" in construction projects in Egypt, which impact the construction industry's development. It also identifies the project parties' unethical practices in funded projects and the Technical Audit's role in fighting them. A mixed methodology was used for collecting and analyzing quantitative and qualitative data. The study results indicated the owner's and bidder's unethical practices were Disclaim liability for nominated subcontractor mistakes and submitting an unbalanced bid, respectively. Also, the procedure militating against the practices was adopting and applying the technical audit concept to governmental projects. Separate analyses revealed differing viewpoints among consultants, owners, and contractors. The study contributes to the creation of honest competition to develop the construction industry, reducing public money losses, and evaluating competitors on a stable and sound basis. Also, building awareness and sensitizing our community to the construction project's dark side is necessary for getting a legally sustainable solution in future tender law formulation.

**Keywords:** Egyptian Construction Industry; Project Dark Side; Corruption; Technical Audit; Unethical Practices; Funded Project Failure.

### 1. Introduction

Construction is a significant global industry, accounting for a sizeable proportion of most countries' Gross Domestic Product (GDP) and Gross National Product (GNP). It is a very complex sector. Therefore, the ability to control and communicate with various stages, processes, and parties to meet the project objectives is not an easy job, and these responsibilities are on the organization professional [1]. Project studies must understand practices engaged in practitioners' actualities and languages to produce relevant and pragmatic findings. Therefore, the research must have strong roots in theoretical understanding within and beyond management and organization studies [2]. The dark side (unethical or illegal practices) is wicked, ambiguous, and elusive. The dark side of construction projects' "unethical practices" has an inverse impact on the project's performance and human lives on our planet [3]. Besides that, professionals are also facing crises and dilemmas as ethical professionals [4]. The construction sector is one of Egypt's largest and most valuable industries due to its assistance to the economy, averaging 4.8 percent of the GDP in 2015 [5]. The growth trends in the construction sector can also be visualized by the amount of investment capital, which tripled in the financial year 2015/2016 to reach 11.7 billion Egyptian pounds, compared to 3.7 billion Egyptian pounds in the financial year 2014/2015 [6, 7]. In addition, the construction industry offers a vast range of job opportunities for millions of Egyptians [8].

In the past few years, Egypt has witnessed massive development in the construction industry, especially mega projects such as the New Administrative Capital, Suez Canal Economic Zone, Ain Sokhna Port, New Al Alamain City,

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AL Galala City and Tourist Compound, Damietta Furniture City, The Golden Triangle, The Grand Egyptian Museum, and many other publicly funded mega projects. The construction industry is a crucial part of the Egyptian economy, behind the agriculture and oil industries [9, 10]. The Egyptian Centre for Economic Studies estimates that the construction sector and real estate activities accounted for 16.6 percent of total investments in 2016–2017. The public sector carried out about 14 percent of these investments, while the private sector executed 86 percent [11]. The construction sector witnessed a real growth rate of 8.5 percent by the end of the third quarter of 2016–2017, driven by the implementation of several mega-national projects. It is believed that Egypt is encountering a new development era in construction. With this rapid increase in the number of publicly funded construction projects and their differences in terms of geographical nature, method of contracting, budgets, etc. Many economic crimes have entered the construction industry, such as bribery, fraud, collusion, and many other forms of corruption.

Good ethics don't depend only on the professional but also on rules and regulations. The unethical practices happen during the project stages, but the more negative effect is the pre-contract stage, which involves the inception, design, planning, and tendering process [12]. The global infrastructure anti-corruption center (GIACC) summarized the unethical practices that happened during the pre-contract stage of the construction project as follows [13].

- The contractor's false documents submit to win the bid.
- Owner employees ask the preferred contractor to add an extra percentage to the contract
- The consultant preset the prequalification criteria, which are suitable to a specific bidder.
- Bid price leaking to a specific contractor to submit a lower bid.
- Contractors submit high-price bids to ensure particular contractors win the bid (bid rigging or collusion).

Corruption was estimated to be worth \$340 milliard worldwide in construction costs annually. The construction industry ranked consistently the most corrupt: extra payments to win or alter contracts and get around regulations are common [14-16]. The Corruption Perception Index (CPI) is the most widely used global corruption ranking. According to experts and business people, it measures how corrupt each country's public sector is perceived. In 2022, Egypt's CPI scale was 30 [17], which means that corruption is very high in all sectors. This level of corruption leads to a slow rate of economic development and reduces the government's efforts in the fight against poverty. Public construction projects in Egypt face poor quality of work, financial fraud, corruption, and lousy procurement practices. The most corrupt projects were public sector projects involving roadworks, groundworks, and infrastructure [18]. A construction project can be considered two stages, with contract signing as a dividing point. The main motive for this study is to disseminate technical auditing in the Egyptian construction industry, especially government projects. Although technical construction audit studies have been carried out in several countries, there is a lack of application of technical audits in the Egyptian construction sector, and published research on the subject matter is quite limited. So, this study will focus on the unethical practices at the pre-contract stage, which includes planning and design, prequalification, and tender process, and how we could use technical audits towards unethical practices prevention or reduction as well as enhancing ethics in the construction sector. This study uses a questionnaire survey of site engineers, consulting firms, cost managers, quantity surveyors, executive directors, project managers, and contractors regarding their perspectives and experiences on unethical matters related to project activities and the role of technical audit mechanisms in reducing unethical practices.

Limited research has addressed the prevalence of unethical practices, their implications as a dark side of the Egyptian construction project, and how to confront these practices. The study contributes to the gap in this area, especially in publicly funded projects, by extending the awareness of project stakeholders and society about unethical practices and their impacts. Also, suggested technical audits were applied in the Egyptian construction industry at the pre-contract stage to minimize unethical practices. The study has discussed the unethical practices related to the owner and the contractors at the pre-contract stage of construction projects. Also, study the reformist role of technical auditing in developing and raising the efficiency of the Egyptian construction industry and invite others to carry out further research and field studies, including the unethical practices during the project procurement, execution, and post-construction phases of governmental projects, especially in developing countries like Egypt.

## **2. Literature Review**

### **2.1. Causes of Unethical Conducts**

This section reviews some studies that discuss the causes of the unethical practices of the construction industry in different regions. They showed that the most influencing factors are underbidding, bid cutting, bid shopping, bid rigging, overbilling, collusion, coercion, change order games, initiation of complex projects [19], manipulation of prequalification, unfair conduct, cover pricing, withdrawal of tender, and compensation of tendering costs [20-22]. There are also political and economic factors such as economic downturn, political and financial constraints, political influence in tender awarding, monopoly of bigger firms over smaller emerging construction firms [23, 24], barriers to entry into

the market, portraying a bad image of the construction industry, poor value for money, high political connections, organization's practices, vested interests of stakeholders, and military incursions into politics [25, 26]. Social behaviours were identified as causes of unethical practices such as greed, personal culture, family firms, fear of the unknown, the culture of impunity, lack of a reward system, absence of ethical training programmes, lack of consequences when caught, diminished environment, absence of ethics systems, poor education, unethical leader roles, cultural differences, close relationships among contracting parties, perceived behavioural control, and attitude [27-29]. Some of the other causes of unethical practices, such as the overriding of the audit process over the contracting process, unfair behaviours, strict rules, unrealistic estimates/targets, negligence, non-disclosure of financial status, fraudulent qualifications, international pressure on the bidding process, the relationship between the owner and one of the bidders, insufficient sanctions, insufficient compliance with the audit report for design work, contract inspection difficulties, and the use of substandard materials and services, were discussed in studies by Githui [30] and Alani & Mahjoob [31]. Project stakeholders in Ghana's perceptions of unethical practices in the construction industry identified corruption, bribery, political interference, and kickbacks as the most prevalent behaviors. The result found differences in perceptions among different groupings [32].

The most unethical practices during the pre-contract stage in the Saudi construction industry were conducted by professionals. Some factors that encouraged these practices were illogical demands, taking bribes from the contractors, and a lack of supervision and monitoring [12]. According to Al-Sweity [27], the unethical behaviors that ranked highest in the procurement phase in the construction industry in the Gaza Strip conducted by the contractor were bid shopping, underbidding, overbilling, and bid rigging. While the owner's unethical behaviors are top ranking, the contract office tends to leak vital information on pricing to companies where they have interest, leaking information about the project budget, and designers restrict the bid with closed commercial specifications. The ethical issues in the procurement stage of Malaysian construction projects were affecting project outcomes such as lower quality, procurement management problems, negative effects on project phase completions, posing a risk to the project's possibility of completion. Also, the factors that contribute to unethical practices in project procurement are: economic downturn, national objectives, leadership, a non-transparent selection process, ineffective process evaluation, and the ineffectiveness of professional ethics and policy in procurement [33]. Corruption evidence at all levels, including proprietary rights infringements, drawings stealing during the design stage, collusive bidding during the tendering stage, cash inducements (bribery) for work performed overvaluing during the site operations, negligence in the form of poor-quality document production, and fraudulent conduct, such as covering up poor workmanship during site operations, all of these were mentioned in the study by Vee & Skitmore [34]. From the literature reviews, it was found that unethical practices are more popular in the pre-contract stage than the post-contract stage and that the most prevalent unethical behaviors are under-bidding, bid cutting, bid shopping, bid rigging, overbilling, changer order games, collusion, fraudulent contractor qualifications, cover pricing, and tender withdrawal without any reason. Also, other factors contribute to unethical practices in the construction industry, such as the economic downturn, lack of public awareness, political and financial constraints, the absence of strict contractual laws, greed, poverty, lack of use of internal auditing, a missing ethical compass, a lack of commitment and skills, personal culture and behavior, weak levels of supervision, cash flow problems, onerous conditions of contracts, and the absence of a reward system.

## **2.2. Unethical Practices Impact on Projects Delivery**

Project studies must understand practices engaged in practitioners' actualities and languages to produce relevant and pragmatic findings. Therefore, the research must have strong roots in theoretical understanding within and beyond management and organization studies [2]. The unethical professional practices effects on Nigerian construction projects were high construction and maintenance costs and poor aesthetic value, which are major impacts besides economic depreciation, project abandonment, and environmental deterioration [35]. Locatelli et al. [36] investigate the corrupt context's impact on public megaprojects (Italian high-speed railways) with two questions: Which project characteristics favor corruption? How does corrupt context affect project performance? They noted that, in answer to the first question, megaprojects share all the characteristics that increase the project's exposure to corruption, including project size, uniqueness, significant government engagement, and technical and organizational complexity. In answer to the second question, through an in-depth analysis of the Italian high-speed railway system, Corruption is harmful to project management and success in the construction and operation phases. In the project construction phase, the infrastructure project suffers from extra costs and remarkable delays in the schedule. Also, during the project operation phase, the project failed to achieve its purpose, leading to public resource waste. Maseko identifies the most dominant unethical practices and their impact on the construction of projects concerning emerging economies as the South African situation within comprehensive literature from 2011 to 2017. Unethical practices are harmful to the project and the stakeholders, resulting in huge losses such as loss of lives, financial and redirection of resources, and other factors such as economic damage, intimidation, criminal prosecutions, fines, and blacklisting. Also, unethical practices have negative impacts on construction project performance, like abandonment, building collapse, clashes, lawsuits, poor workmanship, underutilization of resources, and regular maintenance [37]. In analyzing, the causes of corruption in the Malaysian construction sector, which has an emerging economy, The study shows that all eighteen factors caused by corruption were significant, with the most critical being personal greed towards money, relationships between parties, a lack of

ethical standards, an intense competitive nature, and the involvement of a large amount of money [38]. Also, the most prevalent types of unethical practices among professionals in the Malaysian construction industry are still common and persistent, such as rate overpricing, bid cutting, delays, short payments, bribes for projects, nepotism, and tender manipulation [39]. Unethical issues in Malaysia's construction industry negatively impact the industry's development and project success. Major negative effects include project delays, cost overruns, defective works, public and worker safety risks, underdevelopment, client loss, project failure, and abandonment. These issues also contribute to the loss of trust and satisfaction in the industry [40]. The Ghanaian construction industry is experiencing significant cost overruns, abandonment, and time overruns due to unethical practices, leading to severe consequences [41].

### 2.3. Technical Auditing in the Construction Industry

As Egypt is considered an African country, this section discusses the concept of technical audits in the construction sector in other African countries like Ghana, Zambia, and Ethiopia. The effect of technical audits on construction project performance was investigated in district assemblies in Ghana, conducted on all publicly funded projects from 2010 until 2015. It was found that financial audits can serve as a control mechanism for overpayments for work done and the payments for upcoming works as well, and technical auditing is effective in the project management process because it identifies weaknesses and provides solutions to ensure the achievement of project objectives [42].

Bondinuba et al. assessed construction audit (CA) practice in Ghana, dividing it into five categories: finance and budgetary, procurement process, project management, technical, and legislative. CA practice stages were benchmarking, monitoring, and evaluation. Benchmarking guides the quality improvement of the technical auditor's work and provides a history for checking construction data. Monitoring focuses on observing project information and identifying undesirable conditions. The evaluation aims to find and fix vulnerabilities to avoid most project deviations and ensure compliance with funding requirements, project needs, environmental sensitivity, and local by-laws [43]. Sichombo et al. studied the benefits of technical auditing in Zambia's construction industry, finding unethical practices more prevalent in the pre-contract than the post-contract stage. The highest-ranked benefits of technical auditing include client confidence, enhanced accountability, reduced project costs, and disputes [20].

The internal audit of Design and Supervision was conducted in Ethiopia, revealing that the activities of the internal audit department are independent of the management of the Ethiopian Construction Design and Supervision Company, adding value to the main objective of the company. Also, the author recommends that for a more appropriate and effective internal audit function, the quality assurance program in the company's internal audit department should be strengthened [44]. A project audit conducted by an independent party is required for any publicly or privately funded construction projects. The audit reviews the management processes and project cost/schedule controls and compares those processes with construction industry best practices. Thus, Nalewaik [45] considered the audit function an essential project control tool. The construction audit aims to reduce the owner's costs, capture and recover over/under billings, detect fraudulent behavior, and increase future projects' accuracy and efficiency.

### 2.4. Ethical Issues and Risks in Egyptian Constructions Sector

Based on a study by Azzab & Badawi [46], it was found that the Egyptian construction industry has some ethical issues facing contractors who carry out mega projects, which resulted in serious dilemmas, including related problems to corruption, bribery, conflict of interest, nepotism, collusion, fraud, disloyalty, immoral behavior, and hypocrisy. According to Ibrahim et al. [18], the most corrupt actions during the tendering stage in Egyptian construction projects were bribery, conflict of interest, collusion, favoritism, nepotism, and bid rigging. A research paper conducted by EL-Matbaegy et al. [47] discussed some potential risks in construction projects during the recession period in Egypt according to owners' and contractors' perspectives: bribes on project delivery, lack of management thought, cronyism and corruption in awarding tenders, burn bid prices during tenders, and corruption and bribery of government officials. A report on Egypt's public procurement practices was published in 2013 by the European Bank for Reconstruction and Development (EBRD). The report stated that companies in Egypt are at high risk because of the procurement process's burdensome bureaucracy, lack of transparency, inefficient monitoring and review systems, and unethical public procurement officials [48]. Unethical practices must be resolved sustainably, as suggested in the study of the impact factors on the subcontractor's cash flow, such as the general contractor's deliberately delayed payments to the subcontractor (as unethical conduct). The study proposed the addition of a subsection to the Egyptian Executive Regulation of Tender Law 182 of 2018 to prevent and minimize this phenomenon [49].

## 3. Research Methodology

The study methodology uses qualitative and quantitative approaches, as shown in Figure 1. This mixed research methodology involves collecting and analyzing data to understand research issues. The quantitative method collects numerical data that can be statistically analyzed, such as closed-ended questions and questions with scale scoring in the questionnaire. This data is referred to as "hard" data. The qualitative method involves analyzing data through techniques like finding common themes in open-ended and essay questions in the questionnaire. Using mixed methodology is more effective in better comprehension of research issues than using just one approach.

### 3.1. Research Population and Sample Size

This research targeted two different parties: the first party is construction project owners and their representatives, including consultants, and the second party represents the contractors' companies. There is no official list of the owners and contractors of publicly funded construction projects in Egypt in which the research was concerned; such rareness of the data reflects the margin of error. To calculate the sample size for the unknown population and the estimated population mean, the Cochran Equation 1 was used [50].

$$n = \frac{\sigma^2 z^2}{e^2} \tag{1}$$

where  $n$  = sample size,  $\sigma$  = standard deviation of the sample,  $e$  = acceptable sampling error,  $z$  =  $z$  value at reliability level or significance level.

From 30 random samples, the standard deviation ( $\sigma$ ) has been calculated to equal 1.33 at reliability level 95% or significance level 0.05;  $z = 1.96$ . The error margin is assumed to be  $e = 0.20$ . By substituting these values into the above equation, the minimum sample size has been calculated as 170 to achieve a 95% confidence level.

Figure 1, shows the flowchart of the research methodology through which the objectives of this study were achieved.

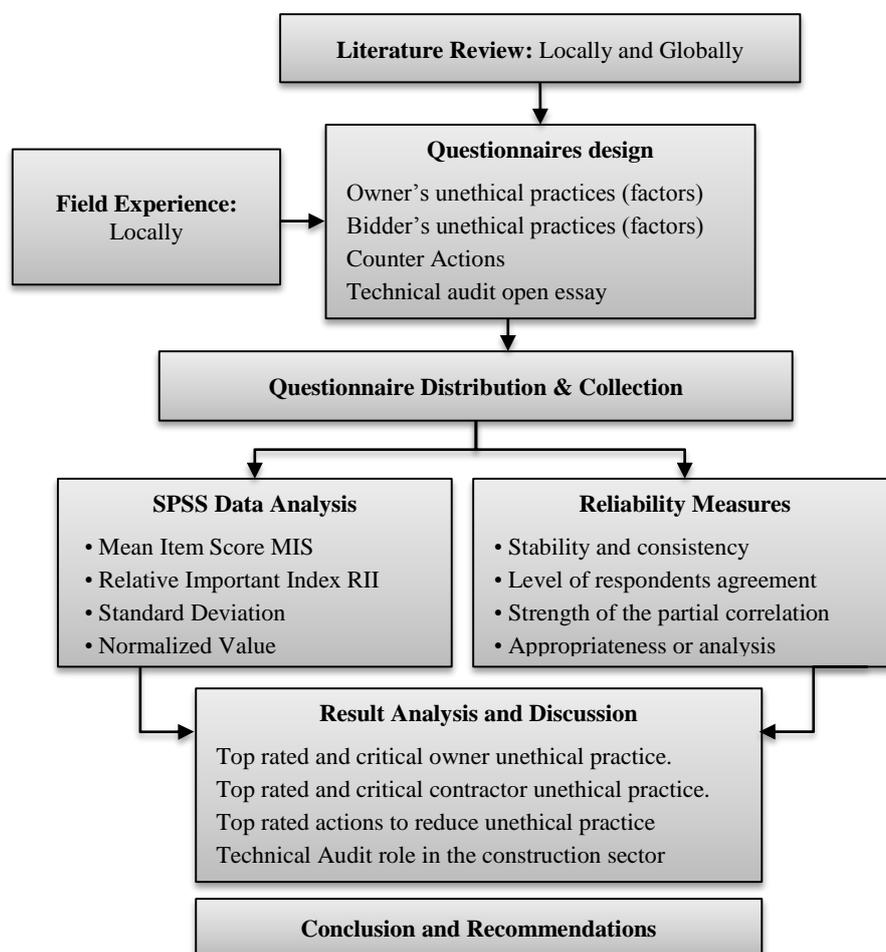


Figure 1. Flowchart for mixed methodology approach

### 3.2. Questionnaire Design

The questionnaire design depended on the literature review and the researcher's practical experience in the field. The preliminary questionnaire was prepared in Arabic to ensure that all respondents understood the meaning of the questionnaire clauses. The Arabic version of the survey was discussed with ten experienced experts with more than 15 years of experience in different construction bodies to ensure that the critical variables related to unethical practices in the Egyptian construction sector were not ignored. The final formulation was prepared in Arabic and English. The questionnaire contained three parts: the first part, study purposes; the second part, term definition; and the third part, explaining the method of questionnaire filling out. The questionnaire core was divided into three categories: 1st for personal data, 2nd for ordinal data, and the third category contains multiple choices about owner and contractor's

unethical practices scale scoring. Also, there was a section to discuss the possible actions to reduce unethical practices and the concept of technical audit in the Egyptian construction industry; at the end of the questionnaire, there are open essay questions followed by multiple-choice questions for each project party.

### 3.3. Personal and Ordinal data

The first category of the questionnaire's core contains nominal data such as name, current position in the organization, academic qualification, category, experience years, technical audit knowledge, project type and approximate number of projects. The second category of the questionnaire's core contains clauses that were scored using the five-point Likert scale, with responses being 1 = strongly disagree/very rare, 2 = disagree/rare, 3 = moderately agree/do not know, 4 = agree/common, 5 = strongly agree/very common. To analyze clause scoring by SPSS package software, from the literature review, the ordinal data of owner, bidder, and actions to reduce unethical practices were coded as shown in Tables 1 to 3.

**Table 1. Owner unethical practices**

Code	Clause
O <sub>1</sub>	Projects announcing with complex designs, only one contractor can implement it.
O <sub>2</sub>	Preparing bid technical evaluation criteria compatible with a particular contractor
O <sub>3</sub>	Tender cancellation after envelopes opening for an unknown reason
O <sub>4</sub>	Re-announcing of the project with the same Bid Package
O <sub>5</sub>	Leakage lowest expected bid price to a specific contractor
O <sub>6</sub>	An unannounced relationship between one of the owner's employees and one of the bidders
O <sub>7</sub>	A quick and clear response to inquiries of one bidder without others
O <sub>8</sub>	Announcing the project despite owner's financial incapability
O <sub>9</sub>	Prepare one or more project items specification using the brand (close) specifications.
O <sub>10</sub>	Refusal to compensate the Contractor when the project is re-announced with the same bid package.
O <sub>11</sub>	Disclaim liability for Nominated Subcontractor mistakes

**Table 2. Bidder's unethical practices**

Code	Clause
C <sub>1</sub>	Unbalanced bid submits due to project items quantities errors
C <sub>2</sub>	Low bid price submits due to his expectation of issuing change orders games
C <sub>3</sub>	Bidders' collusion by submitting a high bid price to ensure specific bidder win
C <sub>4</sub>	The reluctance of the bidders to submit bids despite an invitation in return for money from other bidders or any other purpose.
C <sub>5</sub>	The contractor withdraws his bid without justification.
C <sub>6</sub>	Manipulation of pre-qualification criteria and submitting false documents to win the bid.
C <sub>7</sub>	Provide a project scheduling with manipulation of the owner's activities (the owner's activities on the Critical Path).

**Table 3. Actions to reducing unethical practices**

Code	Clause
A <sub>1</sub>	Adopting and applying the technical audit concept in the governmental construction industry.
A <sub>2</sub>	Formulate the standard contract to include technical audit in the contract terms and conditions.
A <sub>3</sub>	Quantify and confirm renewals of a blacklist for bidders and consultants involved in unethical practices
A <sub>4</sub>	Blacklisted (contractors, consultants, etc.) should be banned from public funded projects participation for a sufficient period.
A <sub>5</sub>	Public sector employees training on the technical audit program
A <sub>6</sub>	Including ethical practices as one of the bid technical evaluation criteria
A <sub>7</sub>	Legislation to link ethical practices to promotion
A <sub>8</sub>	Contract clauses should contain monetary penalty for unethical practices, called immoral practice fine
A <sub>9</sub>	Enforce the owner to inform the rest of the government agencies about contractors, and consultants involved in unethical practices and the type of manipulation
A <sub>10</sub>	Create Value Engineering division in the owner structure.
A <sub>11</sub>	Adopting the Anti-Corruption System (PACS) in construction projects
A <sub>12</sub>	Appointment of independent technical auditors in the pre-contract stages
A <sub>13</sub>	De-registration of consulting firms that have proven to be involved in unethical practices

### 3.4. Multiple Choice and Essay Questions

The third category of the questionnaire's core was a multi-choice question: who should pay the technical audit fees, which of the project stages should be technically audited, what is the most common category responsible for unethical practices, and should the owner be obligated to carry out a technical audit? In addition, essay questions were asked to know the vision and suggestions of the respondents, such as the importance of having a technical audit in the project execution phase and the importance of this study or similar studies in introducing the concept of a technical audit into the Egyptian construction industry.

### 3.5. Data Collection and Analysis

The questionnaire was distributed through manual distribution and an online framework along with site engineers, consultants, contractors, manufacturers, suppliers, and clients from different governmental and non-governmental organizations in Egypt. Fifty hard copies and 200 online forms were distributed to different construction professionals. The number of hard copies returned was 39, and the answers in online forms were 141. The total response rate was 72%. Responses to each question have been listed and arranged in the form of a Microsoft Excel spreadsheet. Then statistical software called SPSS was used to analyze the data.

Before the data analysis, the questionnaire's reliability was tested using stability and consistency measures of scores across raters, the level of respondent agreement, the strength of the partial correlation between the clauses, and the appropriateness of the clauses for analysis. Using Cronbach's Alpha coefficient test, Kendall's coefficient of concordance ( $w$ ) test, Kaiser-Meyer-Olkin (KMO) test, and Bartlett's test of sphericity, respectively. Cronbach's Alpha coefficient test was used to measure the stability and consistency of scores, which ranged between 0 and 1. According to George and Mallery [51], the Alpha coefficient values follow the rules in Table 4. The closer Cronbach's alpha coefficient is to 1, the greater the internal consistency of the items in the scale. As shown in Table 5, Cronbach's alpha coefficients for questionnaire fields were more than 0.7. So, internal consistency is accepted, which means all questionnaire fields are reliable, and analysis can be carried out.

**Table 4. Cronbach's Alpha coefficient ranges**

Cronbach's coefficient	
Value	Condition
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

**Table 5. Cronbach's Alpha, Kendall's coefficient ( $w$ ), KMO, and Sphericity coefficient values**

Field	Clauses No.	Cronbach's Alpha	Kendall's Coefficient ( $w$ )	KMO Value	Sphericity		
					Approx. chi-square	Sig.	Df.
Owner, Unethical practices	11	0.778	0.103	0.685	157.240	0.000	55
Bidder, Unethical practices	7	0.806	0.238	0.747	101.450	0.000	21
Actions, Unethical practices reducing	13	0.893	0.523	0.725	286.371	0.000	78

Kendall's coefficient of concordance ( $w$ ) test was conducted to determine the level of respondent agreement. It ranges from 0 to 1. Zero is no agreement between respondents, while 1 is perfect agreement [52]. For the first and second fields of the questionnaire, ( $w$ ) was 0.103 and 0.238, respectively, which means there is a low agreement between raters, and ( $w$ ) for the third field of the questionnaire was 0.523, which means there is a moderate agreement between different raters, as shown in Table 5. To examine the strength of the partial correlation between the clauses, the Kaiser-Meyer-Olkin (KMO) test was conducted [53]. KMO values closer to 1 are considered ideal and suitable for factor analysis, while values less than 0.5 are unacceptable, as shown in Table 6. The KMO values for the three questionnaire fields were more than 0.5, which means all the questionnaire fields are suitable for factor analysis, as shown in Table 5. Bartlett's test of sphericity was used to check the redundancy between variables [54]. As shown in Table 5, all the significance levels for Bartlett's test are below 0.05, suggesting a substantial correlation in the data [55]. Normalization values determine the influencing factor by using the following Equation 2: Factors with a normalized value  $\geq 0.50$  are considered critical [56].

$$\text{Normalized value} = \frac{\text{mean} - \text{min.mean}}{\text{max.mean} - \text{min.mean}} \tag{2}$$

**Table 6. Level of acceptance of the Kaiser-Meyer-Olkin (KMO)**

Kaiser-Meyer-Olkin (KMO)	
Value	Level of acceptance
> 0.9	Superb
0.8-0.9	Great
0.5 – 0.7	Mediocre
< 0.5	Unacceptable

## 4. Results and Discussion

### 4.1. Demographic Information

The general profile of the respondents to the survey was summarized and categorized. The participants in the survey were from governmental and non-governmental organizations with different job descriptions: site engineers, project managers, consultants, cost managers, quantity surveyors, executive directors, and contractors. The majority of the respondents belonged to the consultant profession (34.4%), owner (30%), and contractors (27.2%), and the minority of respondents were from other professions: quantity surveyor, cost manager, auditors (5.6%), and suppliers (2.8%). More than two-thirds of the respondents have bachelor's degrees, holders of master's degrees (18.3%), Ph.D. (6.7%), and (5%) of respondents have other qualifications like diplomas. The experience years of the participants range from 1-year experience to more than 15 years, with most respondents having 5-10 years of experience. More than 71.7% of the respondents reported that they have previous knowledge of technical audits in the pre-contracting phase of construction projects. Respondents required in the study are occupied with various positions, academic qualifications, organizations, experience, and types of participating projects, as summarized in Table 7. In this table, most of the participants in the survey were executive directors of various construction projects with sufficient experience to answer the questions in the questionnaire. Although most of the participants hold a bachelor's degree in engineering, a smaller number hold a master's degree, which qualifies them to answer questions with high efficiency. As for the practical experience, most participants have experience ranging from six to ten years, a sufficient period that makes them qualified to answer questions based on what they encountered.

**Table 7. Demographic Information**

Respondent's	Frequency	Percentage (%)	Cumulative (%)	
Category	Site engineer	42	23.3	23.3
	Project manager	30	16.7	40
	Cost manager	15	8.33	48.33
	Quantity surveyor	6	3.33	51.66
	Consultants Engineer	15	8.33	59.99
	Executive director	52	28.9	88.89
	Contractor	15	8.33	97.22
	Supplier	5	2.8	100
Academic Qualification	Bachelor Degree	126	70	70
	Master Degree	33	18.3	88.3
	PhD	12	6.7	95
	Other qualifications	9	5	100
Organization	Consultant	62	34.4	34.4
	Owner	54	30	64.4
	Contractor	49	27.2	91.6
	Other professions	10	5.6	97.2
	Suppliers	5	2.8	100
Experience	1-5 years	12	6.7	6.7
	6-10 years	63	35	41.7
	11-15 years	45	25	66.7
	> 15 years	60	33.3	100
Experience with different types of projects	Residential buildings	66	36.7	36.7
	Public buildings	58	32.2	68.9
	Infrastructure	56	31.1	100

## 4.2. Owner Unethical practices

Based on the data analysis outputs, the factors related to the owner's unethical practices at the pre-contract stage in the Egyptian construction public-funded projects were identified and ranked according to Mean Item Score MIS, Relative Important Index RII, Standard Deviation with rank (I), and by Normalized value ranked with rank (II), as shown in Table 8. Unethical practice related to the owner with highest rank were; disclaims liability for the Nominated Subcontractor mistakes with MIS 3.60, refusal owner to compensates contractor when the project is re-announced with the same bid package with MIS 3.43, prepare one or more project items specification using brand specification with MIS 3.33, an unannounced a relationship between one of the owner employee and one of the bidders with MIS 3.32, bid price leak to a specific contractor to submit an offer at a lower price 3.10, The owner is re-offering of the same Bid Package 3.00, The owner put forward the project despite knowing that he is financially unable or that the project will face financial difficulties 2.87, the owners' consultant prepares the technical evaluation criteria for the bids to be in agreement with a particular contractor or company (2.85), Responding to inquiries for a specific contractor and delaying a response or not responding to another contractor (disclosing information about the tender to one contractor and concealing important information about another contractor) (2.80). The lowest-ranked two unethical practices related to the owner or his representative were the cancellation of the tender after opening the envelopes to re-issue them for an unknown reason with MIS 2.42 and the owner putting forward projects with complex designs only a specific contractor or company can implement with MIS 2.33. The calculated normalization values identified six owners' unethical practices as critical (normalization values  $\geq 0.50$ ).

In Table 8, there are six critical unethical practices related to the owner at the pre-contract stage, which are a disclaiming liability for Nominated Subcontractor mistakes (O11), Refusal to compensate the Contractor when the project is re-announced with the same bid package (O10), preparing one or more project items specification using the brand (close) specifications (fake costs) (O9), An unannounced relationship between one of the owner's employees and one of the bidders (O6), Leakage lowest expected bid price to a specific contractor (O5) and finally re-announcing of the project with the same Bid Package (O4). The study results were compared with studies conducted in multiple countries, such as Zambia [20], South Africa [57], Pakistan [58], China [59], and Nigeria [60], revealing a significant level of agreement.

**Table 8. Overall Owner's Unethical Practices Ranking**

Factor code	MIS	Std. Deviation	RII	Rank I	Normalized value	Criticality Ranking II
O <sub>1</sub>	2.33	2.07	0.467	11	0	-
O <sub>2</sub>	2.85	2.62	0.57	8	0.41	-
O <sub>3</sub>	2.42	2.27	0.483	10	0.07	-
O <sub>4</sub>	3	2.76	0.6	6	0.53	6
O <sub>5</sub>	3.1	2.9	0.62	5	0.61	5
O <sub>6</sub>	3.32	3.05	0.663	4	0.78	4
O <sub>7</sub>	2.8	2.58	0.56	9	0.37	-
O <sub>8</sub>	2.87	2.68	0.573	7	0.43	-
O <sub>9</sub>	3.33	3.02	0.667	3	0.79	3
O <sub>10</sub>	3.43	3.13	0.687	2	0.87	2
O <sub>11</sub>	3.6	3.33	0.72	1	1	1

### 4.2.1. Classified Ranking of Owner Unethical Practices

By conducting separate analyses of the consultants' perspective evaluations, owners, and contractors to determine the item's order according to each category's opinion rank (I) and rank (II) and to see if there is a discrepancy in the overall ranking, As shown in Table 9, which summarized in Table 10. The results show that the most unethical practice related to the owner, according to consultants' opinions, was (an unannounced relationship between one of the owner's employees and one of the bidder's O6) and, according to the owner's opinion, was (disclaim liability for nominated subcontractor mistakes (O11)), according to the contractor's opinion, it was (refusal to compensate the contractor when the project is re-announced with the same bid package O10).

**Table 9. Parties' Perspective on Owner's Unethical Practices Ranking**

Parties' perspective	Factor Code	MIS	Std. Deviation	RII	Rank I	Normalized Value	Criticality Rank II
Consultant's	O <sub>1</sub>	2.59	2.38	0.518	11	0.00	-
	O <sub>2</sub>	2.94	2.70	0.588	7	0.31	-
	O <sub>3</sub>	2.71	2.45	0.541	10	0.10	-
	O <sub>4</sub>	2.88	2.59	0.576	8	0.26	-
	O <sub>5</sub>	3.06	2.85	0.612	6	0.42	-
	O <sub>6</sub>	3.71	3.29	0.741	1	1.00	1
	O <sub>7</sub>	2.76	2.57	0.553	9	0.16	-
	O <sub>8</sub>	3.35	3.03	0.671	5	0.68	3
	O <sub>9</sub>	3.35	2.95	0.671	4	0.68	3
	O <sub>10</sub>	3.65	3.25	0.729	2	0.94	2
	O <sub>11</sub>	3.65	3.34	0.729	3	0.94	2
Owner's	O <sub>1</sub>	2.13	1.73	0.425	10	0.12	-
	O <sub>2</sub>	2.81	2.57	0.563	4	0.56	4
	O <sub>3</sub>	1.94	1.84	0.388	11	0.00	-
	O <sub>4</sub>	3.13	2.85	0.625	3	0.76	3
	O <sub>5</sub>	2.50	2.32	0.500	7	0.36	-
	O <sub>6</sub>	2.81	2.60	0.563	6	0.56	4
	O <sub>7</sub>	2.25	1.94	0.450	9	0.20	-
	O <sub>8</sub>	2.31	2.21	0.463	7	0.24	-
	O <sub>9</sub>	3.31	3.06	0.663	2	0.88	2
	O <sub>10</sub>	2.81	2.60	0.563	5	0.56	4
	O <sub>11</sub>	3.50	3.28	0.700	1	1.00	1
Contractor's	O <sub>1</sub>	2.71	2.39	0.543	11	0.00	-
	O <sub>2</sub>	3.14	2.85	0.629	10	0.35	-
	O <sub>3</sub>	3.21	2.95	0.643	9	0.41	-
	O <sub>4</sub>	3.36	3.09	0.671	7	0.53	6
	O <sub>5</sub>	3.93	3.63	0.786	2	1.00	1
	O <sub>6</sub>	3.79	3.48	0.757	3	0.88	2
	O <sub>7</sub>	3.29	3.00	0.657	8	0.47	-
	O <sub>8</sub>	3.50	3.18	0.700	6	0.65	5
	O <sub>9</sub>	3.57	3.23	0.714	5	0.71	6
	O <sub>10</sub>	3.93	3.53	0.786	1	1.00	1
	O <sub>11</sub>	3.71	3.44	0.743	4	0.82	3

**Table 10. Owner's Unethical Practices Overall and Categorized Ranking**

Unethical Practices Code	Overall Ranking I	Categorized Ranking I			Overall Ranking II	Categorized Ranking II		
		Consultants	Owner	Contractors		Consultants	Owner	Contractors
O <sub>1</sub>	11	11	10	11	-	-	-	-
O <sub>2</sub>	8	7	4	10	-	-	4	-
O <sub>3</sub>	10	10	11	9	-	-	-	-
O <sub>4</sub>	6	8	3	7	6	-	3	6
O <sub>5</sub>	5	6	7	2	5	-	-	1
O <sub>6</sub>	4	1	6	3	4	1	4	2
O <sub>7</sub>	9	9	9	8	-	-	-	-
O <sub>8</sub>	7	5	7	6	-	3	-	5
O <sub>9</sub>	3	4	2	5	3	3	2	6
O <sub>10</sub>	2	2	5	1	2	2	4	1
O <sub>11</sub>	1	3	1	4	1	2	1	3

By comparing rank (I) based on RII with rank (II) based on Normalized value, there is a good agreement in the factors of the highest order, such as O11, which is top-rated according to overall ranking I, rated 3<sup>rd</sup>, 1<sup>st</sup>, and 4<sup>th</sup> according to consultants', owners', and contractors' opinions respectively. Also, O11 is top-rated according to overall ranking II, rated 2<sup>nd</sup>, 1<sup>st</sup>, and 3<sup>rd</sup> according to the consultants, owners, and contractors' opinions. As for the factors in the lowest order, there is a slight variation in their importance and degree of criticality, such as for (O1), which has the lowest rank according to overall ranking I, consultants' and contractors' opinions, and penultimate according to the owner's perspective. According to Rank II, this factor was not critical at all.

### 4.3. Bidder Unethical Practices

The parties' perspective overall analysis rank I and rank II shown in Table 11, which show that the highest ranked bidders' unethical practices was submitting an unbalanced bid due to his knowledge of project item quantities errors with MIS (3.82), followed by manipulation of pre-qualification documents where the bidder submits false documents regarding equipment, labor, and company qualifications to win the bid with MIS (3.67), Submit a low price bid in the expectation of issuing change orders during execution with MIS (3.65), provide a project timeline with manipulation of the owner's activities (unnecessarily placing some of the owner's activities on the critical path) with MIS (3.50), Bidders agree with each other to submit a high financial bid to ensure the victory of a particular contractor/company (collusion) with MIS (3.42).

The lowest ranked two unethical practices related to the bidder or his representative were the contractor's refusal to submit the bid despite his invitation in return for money or any other purpose with MIS (2.93) and the contractor withdrawing his tender without justification with MIS (2.48). Based on the normalization values calculation, critical bidder's unethical practices were identified (normalization values  $\geq 0.50$ ). Table 11 shows five unethical practices contractors-related at the pre-contract stage are critical. These are submission of an Unbalanced bid (C1), change orders games (C6), collusion between bidders (C2), Manipulation of pre-qualification criteria (C7) and Manipulation of the owner's activities on the critical path (C3). The earlier findings from previous studies in countries such as the USA [19], Pakistan [21], Malaysia [22], and Iraq [61] support this study's results. However, these studies included other factors that ranked highly as payment games, number of contractual links, and negligence, which don't happen much in the Egyptian construction sector according to expert opinions during their discussion of the preliminary questionnaire.

**Table 11. Overall Bidder's Unethical Practices Ranking**

Factor code	MIS	Std. Deviation	RII	Rank I	Normalized Value	Criticality Rank II
C <sub>1</sub>	3.82	3.48	0.763	1	1	1
C <sub>2</sub>	3.65	3.37	0.73	3	0.87	3
C <sub>3</sub>	3.42	3.13	0.683	5	0.7	5
C <sub>4</sub>	2.93	2.65	0.587	6	0.34	-
C <sub>5</sub>	2.48	2.26	0.497	7	0	-
C <sub>6</sub>	3.67	3.36	0.733	2	0.89	2
C <sub>7</sub>	3.5	3.16	0.7	4	0.76	4

#### 4.3.1. Classified Ranking of Contractor Unethical Practices

The analysis of the ranking of unethical practices (I) and (II) based on the opinions of different parties is presented in Table 12. Table 13 provides a comparison between the overall rank (I), overall rank (II), and the categorized ranking. Consultants and the owner agreed that the most unethical practice by the contractor was submitting a low bid price with the expectation of issuing change orders (C2). However, according to the contractors, the most unethical practice was submitting an unbalanced bid due to errors in project item quantity (C1). The overall ranking (I) for the top-rated factors (C1, C6, C2, C7, and C3) was the same as the overall ranking (II). On the other hand, the last two factors in overall ranking (I) (C4 and C5) were not considered critical in overall ranking (II) by the owner, consultant, and contractor.

**Table 12. Parties' Perspective on Bidder's Unethical Practices Ranking**

Parties' perspective	Factor code	MIS	Std. Deviation	RII	Rank I	Normalization Value	Criticality Rank II
Consultant's	C <sub>1</sub>	4.24	3.74	0.847	2	0.97	2
	C <sub>2</sub>	4.29	3.83	0.859	1	1.00	1
	C <sub>3</sub>	3.59	3.24	0.718	4	0.56	3
	C <sub>4</sub>	3.12	2.72	0.624	6	0.26	-
	C <sub>5</sub>	2.71	2.47	0.541	7	0.00	-
	C <sub>6</sub>	3.59	3.20	0.718	3	0.56	3
	C <sub>7</sub>	3.47	3.03	0.694	5	0.48	-

Owner's	C <sub>1</sub>	3.38	3.22	0.675	4	0.65	4
	C <sub>2</sub>	4.00	3.62	0.800	1	1.00	1
	C <sub>3</sub>	3.19	2.98	0.638	5	0.55	5
	C <sub>4</sub>	2.63	2.42	0.525	6	0.24	-
	C <sub>5</sub>	2.19	2.03	0.438	7	0.00	-
	C <sub>6</sub>	3.63	3.41	0.725	3	0.79	3
	C <sub>7</sub>	3.69	3.37	0.738	2	0.83	2
Contractor's	C <sub>1</sub>	4.14	3.74	0.829	1	1.00	1
	C <sub>2</sub>	3.36	3.07	0.671	4	0.50	4
	C <sub>3</sub>	3.86	3.55	0.771	3	0.82	3
	C <sub>4</sub>	3.29	3.05	0.657	5	0.46	-
	C <sub>5</sub>	2.57	2.36	0.514	7	0.00	-
	C <sub>6</sub>	4.00	3.64	0.800	2	0.91	2
	C <sub>7</sub>	3.29	3.07	0.657	6	0.46	-

**Table 13. Bidder's unethical practices overall and categorized ranking**

Factor Code	Overall Ranking I	Categorized Ranking I			Overall Ranking II	Categorized Ranking II		
		Consultants	Owner	Contractors		Consultants	Owner	Contractors
C <sub>1</sub>	1	2	4	1	1	2	4	1
C <sub>2</sub>	3	1	1	4	3	1	1	4
C <sub>3</sub>	5	4	5	3	5	3	5	3
C <sub>4</sub>	6	6	6	5	-	-	-	-
C <sub>5</sub>	7	7	7	7	-	-	-	-
C <sub>6</sub>	2	3	3	2	2	3	3	2
C <sub>7</sub>	4	5	2	6	4	-	2	-

#### 4.4. Reducing Unethical Practices Actions

As shown in Table 14, the highest-ranked action that can reduce unethical practices is adopting, and applying the technical audit concept in the governmental construction industry with MIS 4.55, followed by reviewing standard contract forms and reformulating them to include technical audit as part of the contract terms and conditions with MIS 4.53, and banning the blacklisted contractors and consultants from participating in public-funded projects for a sufficient period with MIS 4.48, Preparing training plans for public sector employees on the technical audit program for government projects. In the fifth rank were Confine and Make Black lists, including contractors and consultants involved in unethical practices (4.45) SD (3.98), followed by The Egyptian authorities responsible for publicly funded projects should adopt the Anti-Corruption System (PACS) developed by Transparency International for use in construction projects (4.38) SD (3.91), assigning the owner to inform the rest of the government agencies on behalf of contractors and consultants involved in unethical practices and the type of manipulation (4.38) and SD (3.96), Linking the criteria for rewards and promotions to the performance side of the owner's employee and his practice of unethical behavior in the profession (4.33), introducing a clause in the contract imposing a monetary penalty for unethical practice (immoral practice fine) (4.32).

**Table 14. Overall Actions, Unethical Practices Reducing Ranking**

Action Code	MIS	Std. Deviation	RII	Rank I	Normalized Value	Criticality Rank II
A <sub>1</sub>	4.55	4.06	0.91	1	1	1
A <sub>2</sub>	4.53	4.07	0.907	2	0.96	2
A <sub>3</sub>	4.45	3.98	0.89	5	0.72	5
A <sub>4</sub>	4.48	4.02	0.897	3	0.85	3
A <sub>5</sub>	4.45	3.97	0.89	4	0.79	4
A <sub>6</sub>	4.18	3.76	0.837	11	0.21	-
A <sub>7</sub>	4.33	3.89	0.867	8	0.53	7
A <sub>8</sub>	4.32	3.88	0.863	9	0.51	8
A <sub>9</sub>	4.38	3.96	0.877	7	0.64	6
A <sub>10</sub>	4.27	3.8	0.853	10	0.4	-
A <sub>11</sub>	4.38	3.91	0.877	6	0.64	6
A <sub>12</sub>	4.17	3.72	0.833	12	0.19	-
A <sub>13</sub>	4.08	3.67	0.817	13	0	-

The tenth rank was the approval of the Value Engineering Department for the administrative structure of the owner (4.27), followed by adopting ethical practices as one of the criteria for the technical evaluation of bids (4.18). The lowest-ranked two measures that can minimize unethical practices in the pre-contract stage are the appointment of independent technical auditors in the pre-contract stages of the project, which must be a requirement (4.17), and the de-registration of consulting firms that are proven to be involved in unethical practices and banning them from participating in publicly funded projects (4.08). The calculated normalization values identified nine actions to reduce unethical practices as critical (normalization values  $\geq 0.50$ ).

The study revealed that Egyptian governmental organizations should take some steps to combat unethical acts in the public construction sector, especially at the pre-contract stage, such as adopting the technical audit concept in the construction sector (A1), reformulating contract forms to include technical audit as part of the contract terms and conditions (A2), blacklisting contractors and consultants involved in unethical issues (A4), and training public sector employees on the technical audit programs (A5). These procedures are mainly consistent with the study conducted by Ibrahim et al. [62] that discussed the mechanism of minimizing and preventing unethical practices in the construction industry in different countries such as Kenya, Pakistan, Malaysia, China, Australia, and the United Kingdom.

**4.4.1. Classified Ranking of Actions Taken to Reduce Unethical Practices**

The ratings of the consultants, owner, and contractors were used to determine the ranking of factors. Table 15 shows the opinions of each group and whether there were differences in the overall assessment. Table 16 reveals that the consultants and owner agreed that adopting and applying the technical audit concept in the governmental construction industry (A1) is the most effective action to reduce unethical practices. On the other hand, the contractors believed that banning blacklisted contractors and consultants from public-funded projects for a sufficient period (A4) is the best approach. The overall ranking (I) in Table 16 matches the top-rated factors from (A1) to (A5) in the same order. Factors (A7) to (A9) have a similar arrangement with slight resemblance. However, factors (A10) and (A6), which ranked 9th and 10th in overall ranking (I), were not considered critical factors in overall ranking (II), but were mentioned as critical in the consultants' and owners' categorized rank (II). The last two rated factors (A12) and (A13) in overall ranking (I) were not mentioned as critical factors in either the overall ranking (II) or categorized ranking (II).

**Table 15. Parties' Perspectives on Unethical Practices Reducing Actions Ranking**

Parties	Factor code	MIS	Std. Deviation	RII	Rank I	Normalization Value	Criticality Rank II
Consultant's	A <sub>1</sub>	4.53	4.029	0.906	1	1.00	1
	A <sub>2</sub>	4.35	3.881	0.871	5	0.83	2
	A <sub>3</sub>	4.24	3.773	0.847	9	0.72	4
	A <sub>4</sub>	4.24	3.757	0.847	8	0.72	4
	A <sub>5</sub>	4.41	3.926	0.882	2	0.89	2
	A <sub>6</sub>	4.06	3.597	0.812	11	0.56	5
	A <sub>7</sub>	4.24	3.789	0.847	10	0.72	4
	A <sub>8</sub>	4.35	3.865	0.871	3	0.83	2
	A <sub>9</sub>	4.29	3.835	0.859	7	0.78	3
	A <sub>10</sub>	4.35	3.881	0.871	6	0.83	2
	A <sub>11</sub>	4.35	3.865	0.871	4	0.83	2
	A <sub>12</sub>	3.71	3.361	0.741	12	0.22	-
	A <sub>13</sub>	3.47	3.181	0.694	13	0.00	-
Owner's	A <sub>1</sub>	4.44	3.969	0.888	1	1.00	1
	A <sub>2</sub>	4.44	4.031	0.888	3	1.00	1
	A <sub>3</sub>	4.44	3.984	0.888	2	1.00	1
	A <sub>4</sub>	4.31	3.905	0.863	5	0.83	2
	A <sub>5</sub>	4.31	3.857	0.863	4	0.83	2
	A <sub>6</sub>	4.06	3.708	0.813	11	0.50	6
	A <sub>7</sub>	4.19	3.824	0.838	9	0.66	4
	A <sub>8</sub>	4.19	3.775	0.838	8	0.66	4
	A <sub>9</sub>	4.13	3.775	0.825	10	0.58	5
	A <sub>10</sub>	4.19	3.742	0.838	7	0.66	4
	A <sub>11</sub>	4.25	3.824	0.850	6	0.75	3
	A <sub>12</sub>	3.88	3.464	0.775	12	0.25	-
	A <sub>13</sub>	3.69	3.354	0.738	13	0.00	-

	A <sub>1</sub>	4.50	4.018	0.900	6	0.69	4
	A <sub>2</sub>	4.64	4.140	0.929	2	0.84	2
	A <sub>3</sub>	4.50	4.018	0.900	5	0.69	4
	A <sub>4</sub>	4.79	4.276	0.957	1	1.00	1
	A <sub>5</sub>	4.57	4.088	0.914	3	0.77	3
	A <sub>6</sub>	4.21	3.817	0.843	10	0.39	-
Contractor's	A <sub>7</sub>	4.43	3.946	0.886	8	0.62	5
	A <sub>8</sub>	4.07	3.703	0.814	11	0.24	-
	A <sub>9</sub>	4.50	4.071	0.900	7	0.69	4
	A <sub>10</sub>	4.29	3.836	0.857	9	0.46	-
	A <sub>11</sub>	4.57	4.088	0.914	4	0.77	3
	A <sub>12</sub>	3.86	3.464	0.771	12	0.01	-
	A <sub>13</sub>	3.85	3.464	0.769	13	0.00	-

**Table 16. Actions of Reducing Unethical Practices Overall and Categorized Ranking**

Factor Code	Overall Ranking I	Categorized Ranking I			Overall Ranking II	Categorized Ranking II		
		Consultants	Owner	Contractors		Consultants	Owner	Contractors
A <sub>1</sub>	1	1	1	6	1	1	1	4
A <sub>2</sub>	2	5	3	2	2	2	1	2
A <sub>3</sub>	5	9	2	5	5	4	1	4
A <sub>4</sub>	3	8	5	1	3	4	2	1
A <sub>5</sub>	4	2	4	3	4	2	2	3
A <sub>6</sub>	11	11	11	10	-	5	6	-
A <sub>7</sub>	8	10	9	8	7	4	4	5
A <sub>8</sub>	9	3	8	11	8	2	4	-
A <sub>9</sub>	7	7	10	7	6	3	5	4
A <sub>10</sub>	10	6	7	9	-	2	4	-
A <sub>11</sub>	6	4	6	4	6	2	3	3
A <sub>12</sub>	12	12	12	12	-	-	-	-
A <sub>13</sub>	13	13	13	13	-	-	-	-

**4.5. Participants' Perspectives Analysis**

The authors posed six open essay questions regarding Technical Audits, ethics codes, contract awarding, organizations' unethical practices, unethical practices in project types, and responsibility for unethical practices. The analysis of the responses yielded the following key points:

- Incorporating Technical Audits into project management phases can help prevent errors, expedite project delivery, and improve quality while reducing costs.
- 55.3% of the respondents reported that their organizations do not have a code of ethics, while 44.7% have a personal ethical code based on religious beliefs.
- 63.8% of respondents stated that the construction phase begins before contract signing, while 36.2% disagreed, particularly in project tendering situations.
- 17% of respondents reported that their organizations have reported cases of unethical practices to authorities, resulting in a conviction rate of 44.4%. However, 83% of respondents denied this.
- The majority of respondents (37%) identified infrastructure projects as having the highest percentage of unethical practices, followed by public buildings projects (32%) and residential projects (31%).
- Regarding responsibility for unethical practices, 62.1% of participants believed that contractors bear more responsibility during the pre-contract stage, 27.9% attributed primary responsibility to the owner, and 10% believed it is shared between the contractor and the owner.

#### 4.6. Technical Audit: Obligation to Perform, Timing and Fees

In a survey on multi-choice clause analysis outputs, 91.7% of the respondents believe that the government should obligate the district owner to carry out the technical audits before signing contracts for publicly funded projects. The result is consistent with previous studies showing that unethical practices majority occur in the pre-contracting project phase [20]. Regarding technical audit fees, 90% of the respondents believe the owner should pay for them, while 10% believe the contractor should cover the costs. Regarding technical audit timing, 31.5% of respondents believe during the design stage, 25.8% of respondents believe during the bidding period, 16.7% of respondents believe during preliminary studies, 13% of respondents believe between contract signing and project execution, and 13% of respondents believe during the execution phase, as shown in Figure 2.

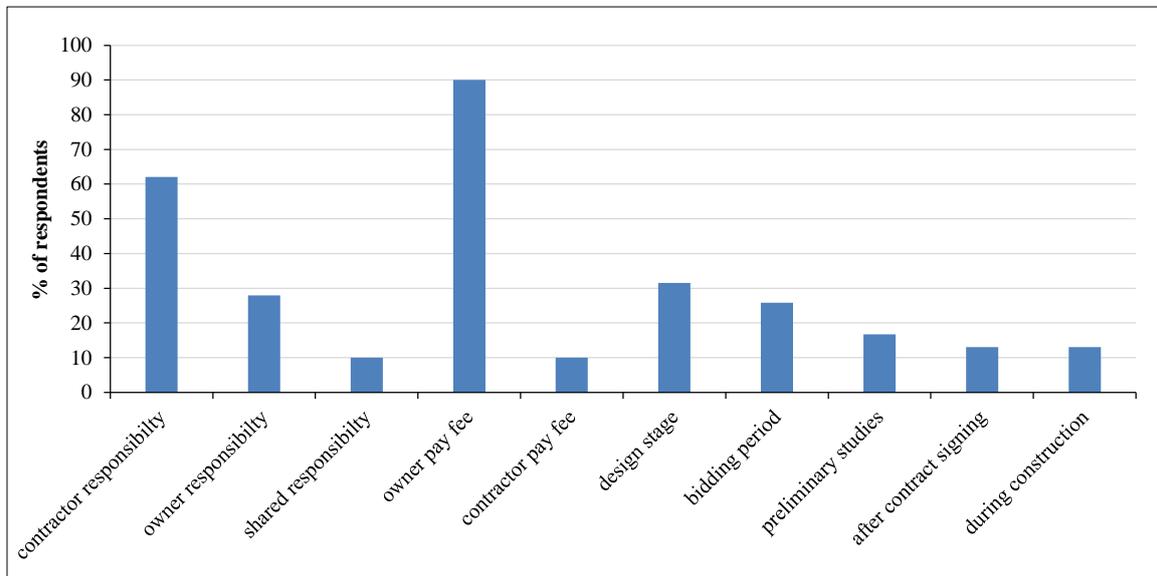


Figure 2. Unethical Practices Responsibility & Technical Audit Timing and fees

The study also found differing opinions between consultants, owners, and contractors regarding unethical practices related to the owner. Consultants believe that the most unethical practice is an undisclosed relationship between the owner's employees and a bidder, while owners disclaim liability for mistakes made by nominated subcontractors. On the other hand, contractors believe that the owner's refusal to compensate them when re-announcing a project with the same bid package is the most unethical practice. Consultants and owners agree that the most common contractors' unethical practice is submitting low-bid prices with the expectation of issuing change orders. The most effective action to reduce these practices is to adopt and implement the concept of technical audits in the governmental construction industry.

## 5. Conclusions

This study focuses on the most common unethical practices conducted by different construction professionals at the pre-contract stage for public-funded projects in the Egyptian construction industry. It also examines the role of technical auditing in fighting such practices, particularly at the pre-contract stage, and introduces measures to reduce the impact of those practices. The highest-ranked unethical practice by owners is disclaiming liability for the mistakes made by nominated subcontractors. The highest-ranked unethical practice by bidders is submitting an unbalanced bid due to their knowledge of errors in the bill of quantities.

The highest-ranked action that can combat unethical practices is the technical auditing concepts adopted in the construction industry for governmental projects. This study contributes to the development of the construction industry by promoting honest competition, reducing losses of public funds, evaluating competitors on a fair and reliable basis, and identifying reliable entities for project delivery.

The study recommends that Egyptian public-funded construction project organizations take steps to minimize or eliminate unethical practices. These steps include valuing whistleblowers, developing a code of ethics for construction companies, implementing a mechanism to reward and penalize compliance with the ethical code, and considering ethical practices when awarding contracts. It also involves appointing an independent technical auditor, including mandatory audit regulations in contracts, and conducting audits at least once during the project life cycle. To prevent unethical bidders from bidding on public works, the World Bank and Egyptian construction industry regulators should maintain a register of blacklisted companies. Furthermore, create construction audit units among national auditing bodies to enhance moral and financial control over construction projects.

Future research and studies on managerial issues are needed, such as e-tendering applications for public tenders, to improve efficiency, expedite contractual procedures, and reduce corruption rates.

## 6. Declarations

### 6.1. Author Contributions

Conceptualization, M.Y. and A.H.; methodology, M.Y., A.H., and R.A.; software, R.A.; validation, M.Y., A.H., and R.A.; formal analysis, M.Y., R.A.; investigation, A.H.; data curation, R.A. and M.Y.; writing—original draft preparation, M.Y. and R.A.; writing—review and editing, M.Y.; visualization, A.H. All authors have read and agreed to the published version of the manuscript.

### 6.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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### 6.5. Conflicts of Interest

The authors declare no conflict of interest.

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