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Application of Cost Engineering as a Tool For Budgetary Forecasting and Control in Municipal Public Works: (Case Study, Municipal Administration of Cacuaco 2023-2026)

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ABSTRACT

This research analyzes the application of Cost Engineering as a tool for forecasting and budgetary control in municipal public works, using the Municipal Administration of Cacuaco as a case study between 2023 and 2026. The study aimed to understand how Cost Engineering contributes to financial efficiency, mitigation of budget deviations, and improvement of transparency in municipal public management. The research is framed within the pragmatic paradigm, adopting a mixed-methods approach (qualitative and quantitative) with descriptive and explanatory characteristics. Data collection was conducted through document analysis, semi-structured interviews, and participatory observation, involving a sample of 30 participants composed of managers, financial technicians, and officials responsible for planning and executing public works. Quantitative data were analyzed using descriptive statistics, while qualitative data were treated through thematic content analysis. The findings reveal that 90% of participants acknowledge the application of Cost Engineering within the Municipal Administration of Cacuaco, while 97% consider this tool relevant for forecasting and budgetary control in public works. The main benefits identified include financial risk mitigation, accurate cost estimation, improved budget planning, and reinforcement of administrative efficiency. The results further demonstrate that Cost Engineering contributes to reducing waste, improving decision-making, and strengthening accountability in municipal management. The study concludes that Cost Engineering is a strategic instrument for the modernization of municipal public administration, promoting better resource allocation, financial sustainability, and transparency in public works execution. However, challenges remain regarding technical staff training, digitalization of control systems, and consolidation of institutional monitoring practices.

Keywords: Cost Engineering, budget control, public works, municipal management, Cacuaco.

INTRODUCTION

Efficient management of public works is one of the fundamental pillars for the sustainable development of municipalities and for improving the quality of life of the population. In Angola, this challenge takes on particularly complex dimensions due to accelerated urban growth, financial limitations, and the need to ensure greater transparency and accountability in the use of public resources (Mendes & Caldeira, 2023). In this context, Cost Engineering stands out as a strategic tool capable of supporting the forecasting, monitoring, and control of costs throughout the entire life cycle of public projects. Cost Engineering comprises a set of technical and scientific methods aimed at the estimation, planning, and financial control of projects, allowing for the reduction of budget deviations, optimization of resources, and support for decision-making (Kerzner, 2017). However, in many Angolan municipalities, including Cacuaco, the application of these methodologies is still limited, contributing to delays in the execution of works, cost overruns, and difficulties in accountability (Dias & Gomes, 2021).

Between 2023 and 2026, the Municipality of Cacuaco registered a significant increase in investments in public infrastructure, such as road paving, school construction, health centers, and water supply systems (N'Zinga &

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Pereira, 2022). Despite these advances, the lack of robust budgetary control mechanisms continues to generate discrepancies between planned and actual costs, compromising financial efficiency and the quality of works. Given this reality, this research seeks to analyze the application of Cost Engineering as a tool for forecasting and budgetary control in municipal public works, taking the Municipal Administration of Cacuaco as a case study. The study aims to identify the main existing challenges, understand current financial management practices, and propose recommendations that contribute to improving administrative efficiency, financial sustainability, and transparency in the execution of public projects.

The relevance of this research lies in its scientific and practical contribution to strengthening municipal public management in Angola. Beyond broadening the academic debate on cost management and public administration, the study offers technical support that can assist municipal managers in optimizing public resources, reducing waste, and strengthening institutional accountability (Oliveira et al., 2020). Therefore, it is hoped that the results obtained can serve as a reference for other Angolan municipalities facing similar challenges in the management of public works.

Problem Contextualization

The execution of public works in Angola, particularly at the municipal level, faces challenges associated with insufficient financial resources, technical limitations, and weaknesses in budgetary control mechanisms. Municipalities in the Luanda Metropolitan Region, such as Cacuaco, have received significant investments in public infrastructure; however, many projects continue to be marked by delays, financial deviations, and low efficiency in the application of public resources (N'Zinga & Pereira, 2022). One of the main factors associated with this problem lies in the limited use of structured cost engineering methodologies in the planning and monitoring of public works. In many cases, budgets are prepared based on inaccurate estimates, without adequate updating of material costs, labor, and financial contingencies, which contributes to significant differences between the planned and actual costs (Mendes & Caldeira, 2023).

Furthermore, the absence of efficient monitoring and control mechanisms favors cost overruns, waste, and difficulties in accountability, affecting public trust in local institutions (Dias & Gomes, 2021). Internal reports from the Cacuaco Municipal Administration indicate that several works carried out between 2023 and 2025 exceeded initial budgets by considerable percentages, highlighting weaknesses in the financial management process. In this sense, it becomes fundamental to understand how the structured application of Cost Engineering can contribute to reducing financial deviations, improving the quality of work execution, and strengthening the efficiency and transparency of the municipal administration. Thus, the central problem of this research is to analyze how Cost Engineering can be used as a strategic instrument for forecasting and budgetary control in municipal public works in the Municipality of Cacuaco.

Relevance and formulation of the problem

The scientific relevance of this study lies in the need to deepen the understanding of the application of Cost Engineering in the context of municipal public works in Angola, particularly in a scenario characterized by technical limitations, financial challenges, and increasing demands for transparency and administrative efficiency. Although several international studies exist on budgetary control and project management (Kerzner, 2017; Smith, 2018), the Angolan reality presents institutional, economic, and administrative specificities that require contextualized approaches adapted to local dynamics. In the Angolan municipal context, the management of public works continues to be marked by weaknesses in planning, monitoring, and financial oversight processes, frequently resulting in delays, budget deviations, and inefficient use of public resources (Mendes & Caldeira, 2023). Thus, this research assumes scientific importance by analyzing the application of Cost Engineering as a strategic instrument for forecasting and budgetary control in the Municipal Administration of Cacuaco, contributing to the strengthening of public management practices.

From an academic point of view, the study contributes to the production of contextualized knowledge on public financial management and cost engineering in Angola, offering a well-founded analysis of the institutional, technical, and administrative conditions that influence the execution of municipal public works (N'Zinga & Pereira, 2022). Furthermore, the research provides theoretical and methodological support that can aid the

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implementation of modern budgetary control mechanisms, which are still underexplored in Angolan municipalities (Oliveira et al., 2020).

The research also presents scientific relevance by strengthening the integration between theory and practice, articulating concepts of Cost Engineering, project management and public administration. This articulation contributes to the professionalization of municipal management, promoting greater efficiency, rationalization of resources and improvement in the quality of public works (Kerzner, 2017; Mendes & Caldeira, 2023).

Additionally, the study constitutes a benchmark for future research on municipal financial management, budgetary control, and the sustainability of public investments in Angola, and can serve as a comparative model for other municipalities with similar characteristics (Dias & Gomes, 2021). Thus, the research contributes to reducing the existing scientific gap regarding the systematic application of Cost Engineering in municipal public works in the Angolan context, reinforcing the academic rigor and practical relevance of the topic studied.

Research subject

This study aims to investigate the application of Cost Engineering as a tool for forecasting and controlling budgets in municipal public works, taking as a reference the Municipal Administration of Cacuaco, in the period between 2023 and 2026. The choice of this subject is based on the need to understand, in depth, how the technical and methodological mechanisms of Cost Engineering can influence financial efficiency, the quality of work execution, and the strengthening of transparency in the management of public projects at the municipal level.

The object of study proves relevant because it allows for the analysis of the relationship between the systematic application of Cost Engineering and the financial performance of public works, providing relevant evidence for decision-making, optimization of the use of public resources, and improvement of planning and budgetary control processes.

In this sense, the research contributes to the advancement of scientific knowledge and the development of practical tools applicable to municipal management in Angola. Thus, the study focuses on Cost Engineering applied to forecasting and budget control in municipal works, constituting an essential instrument for strengthening financial management, the sustainability of public works, and improving administrative efficiency in the context of the Cacuaco Municipal Administration.

General Objective

To analyze the application of Cost Engineering as a tool for forecasting and budgetary control in municipal public works, using the Municipal Administration of Cacuaco as a reference, for the period between 2023 and 2026.

Specific Objectives

To achieve the overall objective, the following specific objectives were defined, guiding the research in a structured and systematic way:

1. To identify the current mechanisms for forecasting and controlling costs in municipal public works in Cacuaco, analyzing the procedures, practices, and instruments used in budget preparation and execution.
2. To evaluate the effectiveness of applying Cost Engineering to the financial management of public projects, considering the impact on meeting deadlines, the quality of works, and the control of budget deviations.
3. To diagnose the main gaps and limitations in cost management processes for municipal works, including technical, organizational, and institutional weaknesses that compromise the efficiency of public management.
4. To propose practical and methodological recommendations for optimizing the planning, forecasting, and budgetary control of public works, adapted to the administrative and socioeconomic reality of the Municipality of Cacuaco.

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LITERATURE REVIEW

A review of the literature on cost engineering and budget control in public works shows that this area has been gaining increasing relevance in project management, especially in the public sector, where efficiency in the use of resources is a governance imperative.

Authors such as Kerzner (2017) and Smith (2018) highlight that cost engineering has evolved from a purely accounting practice to a strategic approach to planning, monitoring and decision-making, allowing for greater rigor in the financial management of projects.

In the context of public management, the literature shows that infrastructure projects are frequently subject to budget deviations, delays, and inefficiencies, especially when there is no structured cost control system. Flyvbjerg (2014) states that large public projects tend to exceed initial budgets due to planning failures and underestimation of risks, a reality also observed in developing countries.

In Africa, and particularly in Angola, studies such as those by Mendes and Caldeira (2023) and N'Zinga and Pereira (2022) indicate that the application of cost engineering is still limited due to a shortage of qualified technical staff, fragile administrative systems, and weak digitization of public management processes. These factors compromise the accuracy of estimates and the effectiveness of budgetary control, which requires a prior analysis of public works planning, as shown in the following figure:



Figure 1. Analysis and Planning of Municipal Public Works

Source: Image retrieved from Google, 2026

Figure 1 illustrates the technical planning process for public works, where engineers and technicians analyze maps, projects, and execution data. This process is directly linked to the pre-budgetary control phase, being essential to guarantee the technical and financial viability of the projects. Cost Engineering contributes to the definition of priorities, resource estimation, and optimization of public investments. The figure reinforces the importance of integrated planning as the basis for efficiency in municipal management.

Cost Engineering and Budget Control Process

This presents a conceptual model of the Cost Engineering process applied to the management of public works, including the planning, execution, and control phases. This diagram demonstrates the interconnection between the different stages of the project lifecycle, highlighting the role of continuous feedback in improving management. The figure summarizes the functioning of Cost Engineering as an integrated decision support system, reinforcing efficiency, transparency, and sustainability in municipal administration.

The literature also highlights the importance of instruments such as baseline budgeting, variance control, and financial performance indicators, namely the CPI (Cost Performance Index) and the SPI (Schedule Performance

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Index), as fundamental tools for evaluating project efficiency (Oliveira et al., 2020; Kerzner, 2017). These indicators allow for real-time performance monitoring and support corrective decisions. Another central theme in the literature is the role of digital technologies in modernizing cost engineering.

Tools such as MS Project, Primavera P6, and BIM have been widely recognized for increasing the accuracy of budget forecasting and improving integrated cost, time, and quality control (Silva & Martins, 2022). Finally, the literature emphasizes that the effectiveness of cost engineering in the public sector depends not only on technical tools but also on institutional factors such as transparency, accountability, and management capacity.

In contexts like Angola, these elements are crucial for ensuring good governance and the sustainability of public works. However, existing studies converge on the idea that cost engineering is an essential tool for improving the efficiency, transparency, and sustainability of public works, although its application in Angola still faces significant structural and operational challenges.

Table 1 – Literature Review Matrix on Cost Engineering and Budget Control

Author(s)	Year	Central Theme	Main Contributions	Relevance to the Study
Kerzner	2017	Project management and cost engineering	Defines cost engineering as a tool for planning, estimating, and controlling throughout the project lifecycle.	It lays the foundation for the basic concept of cost engineering applied to public works.
Smith	2018	Cost control and project performance	It introduces the evolution of cost engineering towards an integrated approach with risk analysis and performance indicators.	It supports the importance of indicators such as CPI and SPI.
Flyvbjerg	2014	Risks in large public projects	This demonstrates that large projects tend to exceed budgets and deadlines due to planning failures.	It justifies the need for strict budgetary control.
Mendes & Caldeira	2023	Public works management in Angola	They highlight institutional, technical, and financial weaknesses in cost management in Angola.	It contextualizes the challenges of cost engineering in Angola.
N'Zinga & Pereira	2022	Infrastructure and municipal management in Angola	They point to limitations in technical training and in the application of modern management tools.	It reinforces the need for training and technological modernization.
Oliveira et al.	2020	Project management tools	They highlight the use of software, indicators, and integrated cost control systems.	It supports the importance of digitization and real-time monitoring.
Silva & Martins	2022	Technologies to support project management	They highlight the role of BIM, MS Project, and other tools in the efficiency of budget control.	It supports the technological modernization of cost engineering.
Dias & Gomes	2021	Accountability in public administration	They emphasize transparency and accountability as essential elements of public administration.	It links cost engineering with transparency and public trust.

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Matos & Carvalho	2022	Budget management in Angola	They identify structural challenges in budget forecasting and control.	It reinforces the problematic nature of the study in the Angolan context.
World Bank	2020	Institutional capacity building	It highlights the importance of technical qualifications for efficient public management.	It argues for the need to train municipal staff.

Source: Author's own elaboration, based on the 2025 studies.

Brief characterization of the study area

The Municipality of Cacuaco, located in the province of Luanda, is one of the main urban expansion zones of the Angolan capital. Its origins date back to the 16th century, having evolved from an old fishing village into a formally established administrative unit in 1965. Its geostrategic position, close to important industrial and residential corridors, gives it high economic and social relevance, but also significant challenges in urban planning and the provision of public services.

From a demographic point of view, Cacuaco is experiencing rapid population growth, driven by internal migration and the expansion of Luanda's urban area (INE Angola, 2022). This growth puts significant pressure on municipal services, requiring greater investment in basic infrastructure such as housing, sanitation, education, and health, which directly impacts budget management.

In socioeconomic terms, the municipality has a mixed economy, predominantly comprised of the informal sector, commerce, and small industrial activities. However, challenges such as youth unemployment, social inequalities, and weak local revenue generation capacity persist, limiting municipal financial autonomy.

In the area of infrastructure, Cacuaco has been the target of investments in roads, schools, health units, and drainage systems. However, the execution of these works faces recurring problems of delays, cost overruns, and insufficient technical control, highlighting weaknesses in project management and the application of cost engineering tools.

At an institutional level, the Municipal Administration of Cacuaco follows the model of local state administration, performing functions of planning, execution of public policies and management of works. Despite modernization efforts, limitations persist related to the scarcity of specialized technical staff, weak digitization of processes and insufficient integrated management systems.

The organizational structure of the administration includes management bodies, technical services, and decentralized executive services responsible for areas such as education, health, infrastructure, environment, and economic development. Finally, it is worth highlighting that the application of cost engineering in the municipality constitutes a strategic tool to improve forecasting, budgetary control, and transparency in the execution of public works. Its adoption can contribute to reducing waste, optimizing resources, and strengthening institutional accountability, especially in a context of strong urban pressure and limited financial resources.

MATERIALS AND METHODS

Paradigm and Type of Study

This research falls within the pragmatic paradigm, which prioritizes the resolution of concrete problems through the combination of quantitative and qualitative methods (Morgan, 2014).

The choice of the pragmatic paradigm is justified by the need to obtain a comprehensive and integrated understanding of the phenomena of forecasting and budgetary control in the Angolan municipal context, reconciling objective data with the subjective perspectives of the actors involved.

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The study is characterized as descriptive and explanatory research, focusing on a case study of the Cacuaco Municipal Administration. This strategy allows for an in-depth analysis of administrative practices, financial impacts, and specific technical challenges, based on empirical data and perceptions of the main actors involved (Yin, 2018).

Type of Research Approach

This research adopts a mixed methodological approach (qualitative and quantitative), structured under a pragmatic and applied paradigm. This choice stems from the complexity of the object of study – cost engineering and budgetary control in the Angolan municipal context – which simultaneously involves technical, institutional, and human dimensions.

The quantitative approach allows for the examination of objective data, such as budget execution, financial deviations, contract deadlines, and cost variations. In turn, the qualitative approach makes it possible to understand perceptions, administrative practices, institutional limitations, and decision-making processes that cannot be captured exclusively by numerical indicators (Tashakkori & Teddlie, 2010).

In the Angolan context, where public information systems still face structural challenges, the integration of methods proves particularly appropriate, as it allows for compensating statistical limitations with well-founded interpretive analysis (Creswell & Plano Clark, 2018).

Research Procedures

The procedures adopted were structured in three main phases:

Exploratory phase:A literature review and theoretical framework on cost engineering, municipal management, and budget control;

Empirical data collection phase: Obtaining documentary data and conducting interviews;

Analytical phase: Statistical treatment of quantitative data and thematic analysis of qualitative information.

This methodological sequence ensures coherence between theoretical foundation and empirical evidence, allowing for an integrated reading of municipal reality (Gil, 2019).

Indirect Documentation

Indirect documentation consisted of the analysis of secondary sources, including: National legislation on public finances and local administration; General State Budget reports; Court of Auditors reports; Academic studies and international reports on municipal governance.

The use of indirect documentation is essential to contextualize the research and establish a consistent interpretive framework (Marconi & Lakatos, 2017). In the Angolan case, recent institutional reports highlight the need to strengthen internal control mechanisms and municipal financial planning, which justifies the relevance of this study (Angolan Court of Auditors, 2023).

Direct Documentation

The direct documentation involved primary data collected in the Municipality of Cacuaco, namely: Internal budget execution reports; Measurement maps and work assignment records;

Annual activity and investment plans;

Semi-structured interviews with managers and technicians. Direct data collection allows capturing the concrete reality of municipal management, overcoming abstract generalizations and providing contextualized empirical evidence (Quivy & Campenhoudt, 2017).

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Data Analysis and Triangulation

The analysis of quantitative data was performed using descriptive statistics, allowing the identification of means, standard deviations, budget execution rates, and percentage cost variations. Qualitative data were treated through thematic content analysis, with coding of interviews and categorization of responses according to previously defined dimensions (Krippendorff, 2018). Methodological triangulation consisted of comparing: Official documentary data; Statistical results; Perceptions of institutional actors. This procedure reinforces the internal validity of the research and reduces the risk of interpretive bias (Flick, 2018).

Data Collection Techniques

The following data collection techniques were used:

Document analysis: Budget execution reports; Public works plans; Contracts and cost revisions; Municipal audit reports;

Semi-structured interviews: Conducted with municipal managers, planning technicians, and construction supervisors; they allowed for the collection of qualitative insights into cost forecasting and control practices;

Participatory observation: Assistance in planning and evaluation meetings for public works; allowed observation of administrative practices and interaction between technical units. These techniques ensure data triangulation, strengthening the validity and reliability of the conclusions (Denzin, 2017).

Data Analysis

The analysis of quantitative data was based on descriptive statistics, allowing the identification of budget execution patterns, magnitude of deviations, and frequency of cost revisions. Qualitative data resulted from a thematic content analysis, which involves coding interview transcripts and documents to identify emerging categories related to practices, barriers, and opportunities in the application of cost engineering (Bardin, 2016).

The research process observed methodological rigor and fundamental ethical principles, including: Informed consent from participants; Guarantee of anonymity and confidentiality; Ethical use of data for exclusively academic purposes; Respect for scientific codes of conduct (Israel & Hay, 2006). The ethical approach is particularly relevant when analyzing administrative practices and sensitive financial data, ensuring that the research contributes to knowledge without compromising the rights or reputations of those involved.

Development of Variables

The study variables were structured into two main groups:

1. **Independent Variables:**Budget planning; Technical training of staff; Existence of internal control systems; Use of technological tools.
2. **Dependent Variables:**Degree of budget execution; Occurrence of financial deviations; Compliance with contractual deadlines; Level of administrative transparency.

The operationalization of these variables was carried out based on measurable indicators, such as percentage of financial execution, number of contract revisions, and frequency of internal audits. The clear definition of the variables contributes to the analytical consistency and comparability of the results (Field, 2018).

Population and Sample

The target population of the investigation comprises: Municipal technicians responsible for budget preparation; Financial and public works managers; Heads of planning and engineering units; Representatives of internal audit and control bodies. The sample was selected using non-probabilistic criteria of convenience and intentionality, in order to ensure that participants have direct experience with the subject matter under study and can provide relevant and substantiated information for the analysis (Patton, 2015). Considering the limited size of the

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institutional universe, a non-probabilistic intentional sampling was chosen, selecting participants with direct experience in the object of study (Etikan, Musa, & Alkassim, 2016).

Sample Size and Justification

The sample size was determined taking into account: The size of the municipal technical staff; The need for functional representativeness; The operational feasibility of data collection;

- The principle of theoretical saturation in qualitative interviews.

In small-scale organizational studies, qualitative data saturation is often achieved between 12 and 20 expert interviews (Guest, Namey, & Mitchell, 2013).

Sample Size Calculation

For the quantitative component, the sample size calculation for finite populations was used, according to the formula:

Figure 1: Mathematical formula for calculating sample size.

Where: n = sample size; N = population size; Z = confidence level (1.96 for 95%); p = estimated proportion (0.5 when unknown); ee = margin of error (5%). This procedure ensures statistical rigor and technical basis in defining the sample (Israel, 1992). However, given the restricted institutional nature of the municipality, the study prioritized the inclusion of the largest possible number of directly involved technicians, approaching a census sampling whenever feasible. We will perform the calculation rigorously, assuming:

- **N = 32**
- **Z = 1.96**(95% confidence level)
- **p = 0.5**(maximum variability)
- **e = 0.05**(5% margin of error)

The formula for finite populations is used:

$$Z^2 = (1,96)^2 = 3,8416$$

$$p(1-p) = 0,5 \times 0,5 = 0,25$$

$$Z^2 \cdot p(1-p) = 3,8416 \times 0,25 = 0,9604$$

$$e^2 = (0,05)^2 = 0,0025$$

Source: Python

For a population of 32 individuals, with 95% confidence and a 5% margin of error, the required sample size is approximately 30 participants. This means that the study covers approximately: 30/32 × 100 ≈ 93.75% of the total population, practically configuring itself as a census study, which: Substantially reduces sampling error; Increases the precision of the estimates; Reinforces the internal validity of the research; and Minimizes the risk of statistical bias. Considering a universe composed of 32 elements, the application of the formula for finite populations, assuming a confidence level of 95% and a margin of error of 5%, resulted in a sample size of 29.61, rounded to 30 participants. Thus, the study approaches a survey with high statistical representativeness and methodological robustness for the advancement of research.

Analysis, Interpretation, and Discussion of Results

The analysis and interpretation of the results is a central moment, as it allowed us to transform the collected data into scientific knowledge capable of supporting valid conclusions and consistent recommendations. More than just presenting numbers, this process sought to understand the underlying social dynamics and assess how these relate to the objectives set out in the study.

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Socio-demographic characterization of respondents

Table 1. Gender of Respondents

Gender	Frequency	Percentage (%)
Masculine	21	70
Feminine	9	30
Total	**30**	**100**

Source: Prepared by the author based on the data collected, 2026

The data reveals that, of the total of 30 participants, 70% (n=21) are male and 30% (n=9) are female, highlighting a male predominance in the analyzed universe. This asymmetry may reflect the historical underrepresentation of women in technical and administrative sectors linked to the management of public infrastructures, a phenomenon widely discussed in the literature on gender and public administration (Acker, 1990; Guy & Newman, 2004). Although a significant female presence is observed, the results suggest the need to strengthen institutional policies promoting gender equality and professional inclusion, in line with the principles advocated by international organizations such as the United Nations (2020).

Table 2. Age range

Age range	**Frequency**	**Percentage (%)**
18-25 years old	8	27
26-35 years old	10	33
36-45 years old	3	10
46-60 years old	6	20
More than 60 years	3	10
Total sample	**30**	**100**

Source: Prepared by the author based on the data collected, 2026

The age distribution of participants shows a predominance of individuals between 26–35 years (33%) and 18–25 years (27%), revealing a markedly young institutional body. However, the 46–60 age group (20%) and those over 60 years (10%) ensure the presence of accumulated experience, essential for organizational stability. This configuration suggests an intergenerational balance potentially favorable to innovation and knowledge transfer, as advocated by theories on human capital and organizational learning (Becker, 1993; Argote, 2013). In public management contexts, age diversity can strengthen institutional adaptability and the quality of decision-making, in line with recommendations from the Organization for Economic Co-operation and Development (2019).

Table 3. Level of Education

Level of Education	**Frequency**	**Percentage (%)**
Primary Education		
High School	13	43
Licensed	11	37
Teacher	6	20
Total	**30**	**100**

Source: Prepared by the author based on the data collected, 2026

The analysis of educational attainment presented in the graph above shows that 43% of respondents have completed secondary education, 37% hold a bachelor's degree, and 20% have a master's degree; no participants have only completed primary education. This profile highlights a predominantly qualified human capital, although there is room for strengthening advanced higher education. In theoretical terms, academic qualification

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is a determining factor for administrative efficiency and the quality of public decision-making (Denhardt & Denhardt, 2015; Schultz, 1961). In a municipal management context, as is the case with the municipal administration of Cacuaco, the emphasis on continuous training aligns with the guidelines of the United Nations Educational, Scientific and Cultural Organization (2021), which underlines the importance of investing in skills for sustainable institutional development.

Knowledge and understanding of cost engineering

Regarding the perception of cost engineering, the results in the following graph indicate that 77% of participants claim to have knowledge of it, while 17% declare they do not, and 7% express uncertainty. This predominance suggests a considerable level of familiarity with planning, estimation, and budgetary control practices, fundamental to efficiency in the management of public projects. The literature supports the idea that technical mastery of cost control methodologies positively influences financial predictability and risk mitigation (Kerzner, 2017; Flyvbjerg, 2014). However, the existence of a minority without consolidated knowledge shows the need for continuous training and institutional capacity building. In public administration contexts, strengthening these skills aligns with the best practices promoted by the Project Management Institute (2021), which emphasizes the integration of cost, schedule, and performance as pillars of project sustainability.

Table 4. Knowledge and perception about cost engineering.

Reactions	Frequency	Percentage (%)
Yes	23	77
No	5	17
Maybe	2	7
Total	**30**	**100**

Source: Prepared by the author based on the data collected, 2026

The following results demonstrate that 90% of respondents state that Cost Engineering is applied in the Municipal Administration of Cacuaco, while 10% indicate that its use occurs only in certain cases. This majority perception suggests the progressive institutionalization of planning and budgetary control practices, considered essential for the rationalization of public spending and for efficiency in project execution (Horngren et al., 2014; Meredith & Mantel, 2017).

However, the reference to partial application reveals possible weaknesses in methodological standardization and the consolidation of technical procedures. In the context of public administration, consistency in the application of financial control instruments is a determining factor for transparency and accountability (Hood, 2010). Thus, the data indicates relevant progress, but also the need for institutional and training reinforcement to ensure a systematic and sustainable implementation of Cost Engineering practices.

Table 5. Application of cost engineering in Administration

Reactions	Frequency	Percentage (%)
Yes	27	90
No		
In some cases	3	10
Total	**30**	**100**

Source: Prepared by the author based on the data collected, 2026

Table 6.Relevance of applying Cost Engineering to Budget Forecasting and Control in Public Works

Reactions	Frequency	Percentage (%)
I agree	17	57
I completely agree.	12	40

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I disagree.	1	3
I completely disagree.		
Total	**30**	**100**

Source: Prepared by the author based on the data collected, 2026

The data shows a strong consensus regarding the relevance of Cost Engineering in the forecasting and budgetary control of municipal public works: 57% of respondents agree and 40% strongly agree with this statement, while only 3% disagree. This result reveals a broadly favorable institutional perception of the use of technical methodologies for estimation, monitoring, and financial control, recognized as essential instruments for mitigating budget deviations and contractual delays.

Specialized literature supports the view that the systematic application of cost control techniques improves financial predictability and enhances efficiency in the management of public projects (Flyvbjerg, 2014; Kerzner, 2017). In municipal environments, characterized by budgetary constraints and high social pressure for results, the integration of planning, execution, and control constitutes a pillar of good financial governance (Schick, 2013). The near unanimity observed suggests that, within the context of the Cacuaco Municipal Administration, there is technical awareness of the strategic importance of Cost Engineering. This institutional alignment is consistent with international project management guidelines promoted by the Project Management Institute (2021), which advocates the rigorous integration of cost, schedule, and performance as a condition for the sustainability of public interventions.

Application and benefits of cost engineering

The application of Cost Engineering in the forecasting and budgetary control of municipal public works constitutes a strategic instrument for rationalizing expenditure and improving institutional performance. By allowing for more rigorous estimates, economic feasibility analysis, and continuous monitoring of deviations, this approach significantly reduces the risk of cost overruns and delays, recurring problems in public projects internationally (Flyvbjerg, 2014).

Among the main benefits, the reinforcement of financial predictability stands out, ensuring greater alignment between planning and execution. The literature demonstrates that structured cost control systems favor evidence-based decisions, promoting greater efficiency in the allocation of scarce resources (Drury, 2018). In a municipal context, where social pressures are high and budgets are limited, such predictability becomes essential to guarantee the continuity of public services. Another relevant benefit lies in strengthening transparency and accountability.

The adoption of technical financial control methodologies contributes to greater clarity in the processes of contracting, execution, and supervision of works, reducing margins for inefficiencies and improper practices (Hood, 2010). This aspect is particularly important in local administrations, such as the Municipality of Cacuaco, where the proximity between public power and citizens demands greater responsibility in the management of collective resources. Additionally, Cost Engineering promotes a results-oriented organizational culture, encouraging the integration of cost, time, and quality—central elements in modern project management (Meredith & Mantel, 2017).

By consolidating technical planning and control practices, municipal administration strengthens the sustainability of its interventions and contributes to more robust financial governance oriented towards local development.

Table 7.Benefits of Cost Engineering

Reactions	Frequency	Percentage (%)
Cost estimate	9	30
Budgetary planning	3	10
Economic feasibility analysis	6	20

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Transparency and accountability	1	3
Financial risk mitigation	11	37
Total	**30**	**100**

Source: Prepared by the author based on the data collected, 2026

The analysis of the benefits associated with the application of Cost Engineering reveals multiple dimensions that directly impact the efficiency and effectiveness of municipal public works management. It is observed that the mitigation of financial risks emerges as the most prominent benefit, with 37% of the sample highlighting its importance, demonstrating the relevance of this tool in preventing cost overruns and ensuring the budgetary sustainability of projects (Kerzner, 2022; Flyvbjerg, 2014). Cost estimation constitutes another central benefit, representing 30% of the responses, and reflects the ability of Cost Engineering to provide more accurate financial forecasts, allowing for more informed decisions and a more efficient allocation of resources (Drury, 2018).

Economic feasibility analysis, mentioned by 20% of participants, reinforces the methodology's role in the prior evaluation of projects, promoting the selection of works with greater social and economic returns (Meredith & Mantel, 2017). Although less frequently mentioned, the importance of budgetary planning (10%) and transparency and accountability (3%) highlights how Cost Engineering contributes to results-oriented public management, encouraging accountability practices and institutional trust (Hood, 2010). However, the results indicate that Cost Engineering not only optimizes financial resources but also strengthens municipal governance, reducing uncertainties and promoting a more technical, responsible, and strategic management culture (Matos et al., 2021). This context highlights the need to systematically integrate this tool into municipal administrative processes as a way to enhance efficiency, reduce risks, and ensure that public investments generate real and sustainable benefits for the local community.

DISCUSSION OF RESULTS

The discussion of the results obtained in this investigation allows us to establish clear relationships between the application of Cost Engineering and the improvement of efficiency in the planning, execution, and budgetary control of municipal public works in the Municipality of Cacuaco. The data analysis indicates that the majority of participants recognize the relevance of this tool for cost forecasting, mitigating financial risks, and ensuring transparency in public management, corroborating studies that point to Cost Engineering as a central element in the rationalization of resources and the strengthening of accountability (Kerzner, 2022; Flyvbjerg, 2014). The predominance of favorable responses to the use of Cost Engineering (90%) shows that municipal technicians perceive it as a strategic methodology capable of reducing cost overruns and delays, allowing for more informed decisions and more sustainable investments (Drury, 2018). In parallel, the identification of benefits such as accurate cost estimates and economic feasibility analysis reinforces the role of this tool not only as a technical instrument, but also as a strategic planning mechanism that guides the prioritization of projects with greater social and economic impact (Meredith & Mantel, 2017).

Although the percentage of participants who associated Cost Engineering with transparency and accountability was lower, this result highlights the need to deepen the culture of accountability within municipal administration, consolidating practices that promote civil society's trust in the execution of public works (Hood, 2010; Matos et al., 2021). Furthermore, the analysis of the age distribution, education level, and experience of the respondents indicates that the effective adoption of Cost Engineering strongly depends on the technical training of staff and the integration of digital monitoring systems, as suggested in studies on municipal governance and public financial management (Creswell & Plano Clark, 2018). The results reinforce that Cost Engineering constitutes a strategic instrument for the management of public works, allowing for the optimization of resources, reduction of uncertainties, and strengthening of administrative efficiency, contributing to municipal investments generating concrete and sustainable positive impacts for the population.

The analysis and discussion of the results show that the phenomenon under study manifests itself as a multifaceted reality, influenced by structural, institutional, and sociocultural factors that interact dynamically in the Angolan context. Empirical data confirms that the effectiveness of the policies and strategies analyzed depends not only on their formal design, but above all on the quality of implementation, institutional capacity,

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and the involvement of local actors, corroborating the perspective that sustainable development requires inclusive and adaptive governance (Fukuyama, 2013; North, 1990). It is also observed that the articulation between strategic planning, continuous monitoring, and evidence-based evaluation constitutes a determining element for the production of socially relevant results (OECD, 2019; Sen, 1999). Thus, the findings of this chapter reinforce the need for integrated approaches, supported by principles of public accountability, citizen participation, and administrative efficiency, as essential pillars for consolidating lasting impacts on collective well-being.

Summary

This research analyzes the application of Cost Engineering as a tool for forecasting and budgetary control in municipal public works, using the Municipal Administration of Cacuaco as a case study for the period 2023 to 2026. The objective of the study was to understand how Cost Engineering contributes to financial efficiency, mitigation of budgetary deviations, and improvement of transparency in municipal public management. The research falls within the pragmatic paradigm, adopting a mixed methodological approach (qualitative and quantitative), of a descriptive and explanatory nature. Data collection was carried out through document analysis, semi-structured interviews, and participant observation, involving a sample of 30 participants composed of managers, financial technicians, and those responsible for the planning and execution of public works. Quantitative data were treated using descriptive statistics, while qualitative data were analyzed using thematic content analysis. The results demonstrate that 90% of participants recognize the application of Cost Engineering in the Municipal Administration of Cacuaco, and 97% consider this tool relevant for the forecasting and budgetary control of public works. Among the main benefits identified are the mitigation of financial risks, accurate cost estimation, improved budgetary planning, and strengthened administrative efficiency. The results also show that Cost Engineering contributes to the reduction of waste, improved decision-making, and increased accountability in municipal management. It is concluded that Cost Engineering constitutes a strategic instrument for the modernization of municipal public administration, promoting greater rationalization of resources, financial sustainability, and transparency in the execution of public works. However, challenges persist related to the technical training of staff, the digitization of control systems, and the consolidation of institutional practices for continuous monitoring.

CONCLUSION

The analysis developed throughout this investigation allowed us to conclude that the application of Cost Engineering in the Municipal Administration of Cacuaco plays a strategic role in the forecasting and budgetary control of public works, contributing significantly to the efficiency in the use of public resources and to the financial sustainability of projects (Kerzner, 2022; Drury, 2018).

It was observed that most municipal technicians possess sufficient knowledge about this tool, recognizing its relevance in cost estimation, economic feasibility analysis, and mitigation of financial risks, which demonstrates the institutional maturity to implement more rigorous planning practices (Meredith & Mantel, 2017).

The research also demonstrates that, although there is a high level of adherence to Cost Engineering, a significant gap persists in the use of this methodology as an instrument of transparency and accountability, suggesting the need to strengthen the culture of accountability and the integration of digital monitoring mechanisms (Hood, 2010; Matos et al., 2021).

Furthermore, the effectiveness of applying Cost Engineering depends heavily on the technical qualifications of the staff and the availability of technological systems that allow for continuous monitoring of budget execution (Creswell & Plano Clark, 2018).

Overall, the research confirms that Cost Engineering is not just a technical instrument for financial calculation, but a strategic planning tool that allows for prioritizing investments with greater social impact, reducing waste and delays, and ensuring the sustainability of municipal public projects.

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The results obtained reinforce the importance of institutionalizing the practice of this methodology and investing in continuous training of professionals, ensuring that the management of public works is efficient, transparent, and oriented towards concrete and lasting results for the population of Cacuaco (Flyvbjerg, 2014; Drury, 2018; Meredith & Mantel, 2017).

RECOMMENDATIONS

Based on the results obtained and the detailed analysis of the application of Cost Engineering in the Municipal Administration of Cacuaco, recommendations are presented below aimed at strengthening the effectiveness, transparency, and sustainability of public works, contributing to more rigorous and efficient budgetary planning:

1. **Continuous technical training**Invest in training municipal staff in cost engineering, financial management, and project control, in order to reduce budget deviations and improve resource allocation;

2. **Implementation of integrated digital systems**Adopting construction management and budget control software allows for real-time monitoring of physical and financial progress, increasing administrative efficiency and transparency.

3. **Regular internal and external audits**Institutionalize auditing practices with clear and measurable performance indicators, reinforcing accountability and mitigating risks of corruption or mismanagement;

4. **Citizen participation and stakeholder engagement**To promote the inclusion of the community and other relevant stakeholders in the planning and evaluation of projects, strengthening collaborative management adapted to local needs;

5. **Development of ongoing studies**To conduct periodic research on the application of Cost Engineering and the effectiveness of implemented strategies, allowing for the identification of best practices and the adjustment of public policies to the social, economic, and urban dynamics of the municipality.

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Research Questionnaire

Dear respondent:

The purpose of this questionnaire is to gather information for the final compilation of my dissertation on the topic: Application of Cost Engineering in the Forecasting and Budgetary Control of Public Works in the Municipality of Cacuaco. The questionnaire targets economic agents and employees of the Cacuaco municipal administration, and the data will be used for analysis, interpretation, and the issuance of recommendations.

Part I – Respondent Characterization

1. Gender:

   - ☐ Masculine
   - ☐ Feminine

2. Age range:

   - ☐ 18-25 years old
   - ☐ 26-35 years old
   - ☐ 36-45 years old
   - ☐ 46-60 years old
   - ☐ More than 60 years

3. Level of education:

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- ☐ Primary Education
- ☐ High School
- ☐ Bachelor's degree
- ☐ Master's degree

Part II – Knowledge and Application of Cost Engineering

4. Do you have knowledge of Cost Engineering?

- ☐ Yes
- ☐ Node
- ☐ Perhaps

5. Is Cost Engineering applied in your work area at the Municipal Administration of Cacuaco?

- ☐ Yes
- ☐ Node
- ☐ Only in some cases

6. Do you consider cost engineering to be relevant for forecasting and controlling the budget in municipal public works?

- ☐ I completely agree.
- ☐ I agree
- ☐ I disagree.
- ☐ I completely disagree.

Part III – Benefits of Cost Engineering

7. In your opinion, what are the main benefits of Cost Engineering? (Check all that apply)

- ☐ Cost Estimate
- ☐ Budgetary Planning
- ☐ Economic Feasibility Analysis
- ☐ Transparency and Accountability
- ☐ Financial Risk Mitigation

8. Which of these aspects do you consider most relevant for improving budget execution in public works?

- ☐ Technical training of staff
- ☐ Implementation of integrated digital systems
- ☐ Regular audits and performance indicators
- ☐ Citizen participation

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- Ongoing studies of best practices

Part IV – Perception and Recommendations

9. In your opinion, what are the biggest challenges in applying Cost Engineering in Cacuaco?
10. What suggestions do you propose for optimizing forecasting and budget control in municipal public works?

Thank you so much for everything.

Author:

Pascoal Josimar Domingos Santana

Quantification of the data collected in tables, SPSS-Excel

Table No. 1. Gender

Gender	Frequency	Percentage (%)
Masculine	21	70
Feminine	9	30
Total	30	100

Source: Prepared by the author based on the data collected, 2026

Table No. 2. Age Range

Age range	Frequency	Percentage (%)
18-25 years old	8	27
26-35 years old	10	33
36-45 years old	3	10
46-60 years old	6	20
More than 60 years	3	10
Total sample	30	100

Source: Prepared by the author based on the data collected, 2026

Table no.03 Level of Education

Level of Education	Frequency	Percentage (%)
Primary Education		
High School	13	43
Licensed	11	37
Teacher	6	20
Total	30	100

Source: Prepared by the author based on the data collected, 2026

Table no.04 Knowledge and Perception about cost Engineering

Reactions	Frequency	Percentage (%)
Yes	23	77
Node	5	17
Maybe	2	7
Total	30	100

Source: Prepared by the author based on the data collected, 2026

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Table no.05Application of Cost Engineering in Management

Reactions	Frequency	Percentage (%)
Yes	27	90
Node		
In some cases	3	10
Total	30	100

Source: Prepared by the author based on the data collected, 2026

Table #6The Application of Cost Engineering is Relevant in Budget Forecasting and Control in Municipal Public Works

Reactions	Frequency	Percentage (%)
I agree	17	57
I completely agree.	12	40
I disagree.	1	3
I completely disagree.		
Total	30	100

Source: Prepared by the author based on the data collected, 2025

TableNO. 7Benefits of Cost Engineering

Reactions	Frequency	Percentage (%)
Cost estimate	9	30
Budgetary planning	3	10
Economic feasibility analysis	6	20
Transparency and accountability	1	3
Financial risk mitigation	11	37
Total	30	100

Source: Prepared by the author based on the data collected, 2026