

## FACTORS INFLUENCING THE VARIATION OF CONSTRUCTION COSTS IN ECUADOR

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### Abstract

An important factor to consider in assessing the development of a country is the construction of infrastructure works, housing, and buildings for commercial and industrial purposes that contribute to improving people's quality of life. All those involved in the construction process, before starting a project, must know in detail the costs of the process, both the design and the construction of the work, therefore, in this research, the objective is to determine the factors that influence the variation of costs of construction projects in Ecuador and a possible minimization of the impact of the factors analyzed in the cost of construction projects. To this end, the following research questions are posed: What are the factors involved in the variation of construction costs in Ecuador?, How to minimize the negative impact of the actors involved in the variation of construction costs in Ecuador? A survey validated by experts is applied and has a reliability of 0.8 measured with the Alpha coefficient of Cronbach, as a result of its application 782 responses were obtained. Fraudulent practices are determined as the most influential factors in the variation of costs in 37%, 16% the non-compliance of subcontractors, 11% the timely availability of machinery or equipment, 9% the governmental environment, 8% the non-compliance of the source of financing, 6% inadequate budget planning, a 4% oversights in monitoring the execution of the project, 3% the failure of workers to meet goals, 2% in changes in designs, 2% the interaction between those involved, and 2% the planning of inadequate chronograms. Finally, the study identifies possible actions to minimize the impact of the factors analyzed on the cost of construction. In this way, the research questions raised are answered favorably.

**Keywords:** Construction costs, construction cost factors, cost variation

## 1. Introduction

The influence on employment rates related to the construction sector is one of the most important factors in a country's economy, development, and economic growth. Precisely, the execution of civil works projects, including roads and roads, medical and educational centers, housing, and civil works for public and private benefit, among others, directly influence the well-being of the population. These construction projects are in high demand in all public and private areas, nationally and internationally, and are required permanently, which motivates to know both the contractor and the contractor-builder components, models, materials, and methods involved in the various works, to carry out adequate risk prevention and management, specifically in the analysis and determination of costs (García & Casalilla, 2019).

## 2. Contextualization

The construction sector accounts for 7.31% of the country's companies. Guayas is the province that has the largest number of companies engaged in construction, with around 1,700 companies. Pichincha is in second place, with more than 1,200 companies (Aval, 2019). In Ecuador, the construction sector is one of the sectors that contribute greatly to the economy. By 2018, around four thousand companies that are dedicated to construction in its various branches will be registered(Aval, 2019).

### 2.1 Construction costs

All those involved in the construction process, before starting the project, must know in detail the costs of the process, both design and construction of work, therefore, currently, companies request complete and timely information on costs, and, on the rate of profitability for a successful and strategic decision making; Additionally, this information is a fundamental input, used at the executive level of the company to define actions that maximize performance and guarantee compliance with the objectives set. The non-availability of this information limits the company's knowledge about the processes and controls to determine an efficient cost accounting mechanism. This mechanism is a priority for adequate management and distribution of material and human resources, an effective strategy of accumulation and allocation of construction costs, and finally tends to increase profitability<sup>1</sup>(Vazquez, 2022).

The main objective of cost control is to achieve a result with the expected quality optimizing expenditures, in addition, competitiveness can be raised with a more attractive and economical offer to the potential market (Morales and Pazmiño, 2022).

The proper estimation and cost management of a construction project is essential for the contractor since it will allow the development of a competitive offer and an effective forecast of contingencies and thus an efficient management of the factors that influence the variation of costs (Mendoza, 2015; Cabezas et. al., 2021).

Performing an empirical process of calculation in the estimation of costs, without technical, scientific, and methodological basis, will cause failures in the logical and effective determination of the results and the mechanisms of accumulation of costs, especially in

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<sup>1</sup> This information is requested for analyzer the rate of return of completed projects, and how the variation in construction costs influences during the execution of projects, thereby making decisions on new projects.

industrial works or government contracts where the permanent measurement of the costs incurred is mandatory. Without an appropriate information system, companies are in serious difficulties in making decisions regarding products that generate losses or gains not contemplated, it would be impossible to study to minimize the causes for which unforeseen losses or gains are generated (Agurto et al., 2022;Julca, 2022;Lazarus, 2022;Paucar-León et. al.,2022).

That is, it could not be determined whether the problem is due to a marketing situation of the product or a problem somewhere in its cost structure, nor could the cost structure of the products be evaluated about pricing. From the established costs and fixed prices, it will compete with other bidders and the award may be won or lost, even with an inefficient mechanism of determination of costs can cause economic losses in the execution of the work. It is not possible to establish **an accurate budget for construction if there is no clarity on the costs of a civil works project** (Arroyave, 2022;Granda, 2022).

## 2.2 Direct and indirect costs

In the proposal of the construction project, the project budget must be determined with an estimate at the level of detail (Caro & Guerrero, 2022), in which indirect costs intervene - payments for designs, permits, lawyer payments, etc.- (Hinope & Ocejo, 2022) and direct costs -acquisition of the site, construction of the building, other infrastructure- (Castel et al., 2021). The higher the level of detail and the more realistic the **cost calculation, the more realistic the probability of risks and unforeseen events for the execution of the project** (Barreda, 2022). This preliminary estimate of expenditure is the basis for committing government funds or coordinating preliminary financing.

Direct costs are those items that are directly related to the construction work. Direct costs are considered the costs of construction materials, land acquisition, and services, including sanitary and storm sewer, water, gas and electrical lines, site leveling, erosion and sedimentation control, street pavement, curbs, ditches, and sidewalks, etc. (Rojas & Meza, 2022; Mazón-fierro et. al.,2023)

Indirect costs are the general items that allow the execution of the works that concern the civil works project (Muñoz & Asanza, 2018). Indirect costs are considered to be the expenses of administration, technical direction, organization, surveillance, transport of machinery, contingencies, construction equipment, construction of general facilities, advertising investment, etc. To the indicated are added the operating costs, among which we can mention the expenses of consumer items, be these: lubricants, fuels, copies, cleaning supplies, etc., technical and administrative positions whether fees, accountants, executive salaries, etc. Indirect costs of the construction office are also made, among which we can mention: field charges, taxes, and financing, among others. As for office expenses, these generally affect the expenses of the tender, stationery and stationery, copies and duplicates, mail, telephones, radio, electricity, gas, and other consumption, etc. (Collatupa, 2022; Cross, 2022; Molina-Recalde,2023).

The cost estimate and budget must be carefully developed, this depends on the correct execution of the work, the sustainability of the company, and present and future strategic actions. To this end, the following should be considered: a) carry out the costing of updated inputs and with the forecast of variation, with a record of the incidents that may affect the value; b) determine the conditions of taxes and withholdings, the form of payment, transportation, and loading and unloading personnel included in the cost or are additional values; c) determine if the delivery time is appropriate and if the units of measurement are correct and necessary according to the work (Castro-Fierro, 2022; Cardona & Valencia, 2021; Molina-Granja et.al.,2020).

In Ecuador, in the case of government procurement, there is a mechanism to control price variations and thus regulation of compensatory adjustments. This mechanism called: Construction Price Index -IPCO, is an economic indicator that allows us to measure the evolution of the prices of construction inputs. The mechanism contemplates the application of the index in the polynomial formulas of the price readjustments in the contracts of the Public Works, following the provisions of Art. 83 of the Organic Law of the National Public Procurement System(SNCP, 2021; Molina-Granja et. al.,2015).

Polynomial formulas are mathematical formulas that appear in the contracts for the execution of works concluded by the State or public sector entities, with which the readjustment of prices is carried out when there have been variations in the costs of the components of the unit prices stipulated in the contracts. These costs are readjusted, for payment of the advance and the work execution sheets, from the date of variation. The IPCO investigates the prices at the producer and importer level of materials, equipment, and construction machinery with their respective technical and market specifications, which are constantly updated due to technological changes in the manufacture of products (INEC, 2021; Santillán-Lima et. al., 2021).

### **2.3 Influence of factors**

Frequently, construction projects are in difficult situations concerning cost variations defined in the baseline established in the project plan it is complex to maintain control of the performance of civil works precisely because of the management of multiple variables involved, it is necessary to know the factors that are most frequently present in the variation of costs so that managers can make timely decisions, and establish a set of actions focused on reducing the risks and negative impacts that could generate a variation in costs. It is therefore essential to analyze the factors that generate cost overruns, strengthening research in this field. (Enshassi et al., 2009; Jimenez et al., 2020;Gonzalez et al., 2014; Lozada et. al., 2018)

Globally, it is very common to determine cost deviations in construction projects, even in underdeveloped or highly developed countries. Information on cost overruns is available in Egypt, Saudi Arabia (Muianga et al., 2014; Abd et al., 2008; Assaf & Al-Hejji, 2006), India, Turkey, and Malaysia, in some cases even exceeding 50% of the original cost of the project

(Memon & Rahman, 2014; Doloi et al., 2012; Gündüz et al., 2013; Shehu et al., 2014). It is determined that the factors that represented delays and impacts on the costs of construction projects are mainly caused by changes in designs, low labor productivity (Tarhini et al., 2015; Lopez & Love, 2012), inadequate planning (Olawale & Sun, 2010) and resource shortages. Additionally, countries such as the United Kingdom, (Alinaitwe et al., 2013) considered very advanced in project control techniques, even with state-of-the-art software tools, have problems managing costs in many projects (Arevalo & Soto, 2022). A higher frequency of deviations in the cost baseline is evident in developing countries (Arias, 2021).

Currently, both public and private institutions have a greater demand to increase competitiveness and, with it, establish better work standards, and obtain a service and/or product of higher quality, with well-defined costs and in the planned time. The disadvantages to meeting the aspects required by customers are precisely the factors that are involved in the construction process and influence the cost of the work, such as changes in the contractual scope of the construction project (change orders), engineering changes, delay in procedures, soil conditions different from those established in the contract, The emergence of changes and additional work, additionally, includes the possible impacts generated by events not identified promptly in the formulation of the proposal, disruptions, stoppages, impacts from unforeseen risk events and climate variability. These factors affect the adequate fulfillment of the cost baselines, thus generating deviations and causing cost overruns in the final deliverables of the execution of the construction project (Arias, 2021).

Specifically variations in the estimation of costs in the planning stage, to the value invested until the final phase of delivery of the projects, several factors significantly influence. Some correspond to factors related to the organization and internal management of projects, and others to factors related to the sociocultural environment (Aldana-Bernal & Bernal-Torres, 2019), that is, the economic, technological, and political environment within which organizations operate (Lozano et al., 2018).

### **3. Methodology**

The type of research is descriptive because it allows us to describe reality as it is observed. The approach is quantitative since it tries to identify general laws that affect the study, and through surveys, information is collected and statistical analysis is carried out. The research method is inductive-deductive because particular cases of factors that affect the variation of construction costs are analyzed and general conclusions are drawn, in the same way, from a general problem such as the variation of construction costs, particularities of the study problem are determined. A data collection instrument is developed and validated. It is determined as units of analysis specific to the companies dedicated to construction in Ecuador, defining a population of approximately 4.000 companies. With a confidence level of 95% and a margin of error of 5%, the sample of 351 companies surveyed is determined, however, 782 responses were obtained (Aval, 2019) The information collection technique used was the survey, which was applied online through the Google Forms tool. To know the factors that influence the variation of

construction costs, a questionnaire of closed questions was designed that was validated by 8 experts: two mathematicians, one expert in linguistics, four experts in construction, and one expert in the legal field; was validated by the Delphi Expert Judgment method. Thus, the fidelity of the instrument obtained a Cronbach's alpha of 0.83. Once the instrument was applied to the calculated sample, the factors that influence the variation of construction costs were analyzed. Finally, through comparative statistics, the information collected was processed in search of answers to the proposed objective.

#### 4. Results

From the literature analyzed, it is determined that the main factors influencing the costs of construction projects are: a) government conditions; b) availability of funds by the contractor (Alinaitwe et al., 2013) (Memon & Rahman, 2014); c) inadequate supervision and direction of the project; (Torres-Medina, 2018) (d) adequate budget planning (Macias, 2019); e) low worker productivity (García & Sierra, 2020); (f) non-compliance by subcontractors (Rosemary, 2021); (g) changes in designs (Prieto et al.); h) lack of communication between stakeholders (Bravo & Mendoza, 2019); (i) changes in the scope of the contract (Gomez, 2022); (j) fraudulent practices. (Ramos, 2020)

When starting with the project design, designers estimate the cost per area based on the client's total budget (in case you know it) or the client's needs (in size, complexity, and finishes) for the project. Sometimes, the needs of the project and the total budget do not match. In these cases, the professional suggests modifications of any of the variables mentioned in the previous paragraph to adjust a functional and pleasant design with a viable budget. Thus, other factors that influence the cost are:

##### **Cost per square meter**

Usually, there is an estimated average value under normal conditions of the cost per square meter, a value that is even regulated by government control authorities, in this cost, there are variables such as:

- a) The **location**, **considering** the geographical area, the climate and environment, the accessibility, altitude, seismicity index, culture, and society of the sector.
- b) The procurement, which has to attend to logistical issues, suppliers, technical specifications, and specific characteristics that require equipment, services, and specific personnel.
- c) Construction, which is responsible for ensuring storage warehouses, handling and maintenance of equipment, provision of temporary services, basic services, sanitation, accommodation space, and medical services, among others.
- d) Labour, which includes an analysis of the economic situation of the sector, availability of skilled labor, direct recruitment or subcontracting Community interactions and regulations.
- e) The programming of the work, which defines a schedule with control milestones and deliverables, and determines the speed of progress.
- f) The larger the size, the larger the cost per square meter, since it requires electrical, mechanical, and structural structures more complex than those of a small project.
- g) The complexity of the project, in the aspect of the architectural, structural, or electromechanical design is directly proportional to the cost of the project.

h) The construction system has a significant influence on cost, e.g., prefabricated systems. When the construction system is chosen according to the material supply of the context, costs can vary. For example, in a very remote rural area, it may be cheaper to build on wood that is obtained from the area than by bringing materials from the nearest city.

i) Finish is a factor that always influences the cost of construction, depends on veneers, the cost of fixed furniture (such as kitchens and closets), electrical accessories (lamps, bulbs, switches), mechanics (sinks, catchers and others), and availability in the sector.

### **Cost of personnel**

In some countries, construction personnel set their fees as a percentage of the cost of the work, in other cases a fixed value per day, per week, or per month, and in other cases, a value is fixed for the work, which can be subcontracted to a natural or legal enterprise.

### **Institutional costs**

A budget for a construction project should consider payments to institutions involved in the process, payments of forms, approval of plans, factory lines, and other municipal and government procedures in general.

### **Contingency costs and special cases**

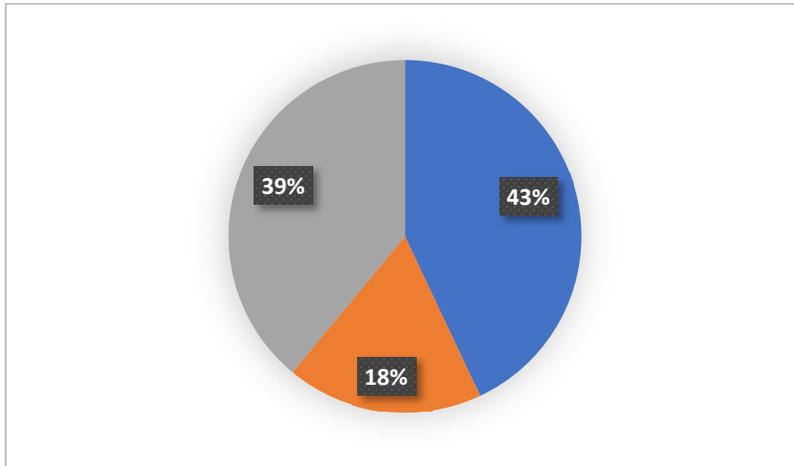
Each construction project should be considered as a different project, and in each case, costs are determined that may not be determined in other cases, for example, the soil study, which may vary according to the particular conditions of the terrain; contour lines or topographic survey; special studies or consultancies; and unforeseen events, for which a percentage must be considered based on experience and the existing risk.

According to the IPCO, monthly there is a variation in costs and issues a monthly price index for construction materials, equipment, and machinery, whose variation is considered in the work budgets.

With this background, with the support of the construction chamber of Ecuador and associated associations, a survey is applied to the actors of the construction projects (the owner or sponsor, the designer or consultant, the builder or contractor – including directors, site residents-, quality control entities, testing laboratories and suppliers. ), is carried out at the country level, virtually obtaining 782 responses and, through trend analysis, the following is determined:

The survey was applied to construction professionals working in construction companies, and it is determined that 72% of respondents are between 28-42 years old, 57% are male, 43% are located in the provinces of Guayas and Pichincha, obtaining 18% of respondents located in the provinces of Azuay and Tungurahua, and 39% distributed in the other provinces.

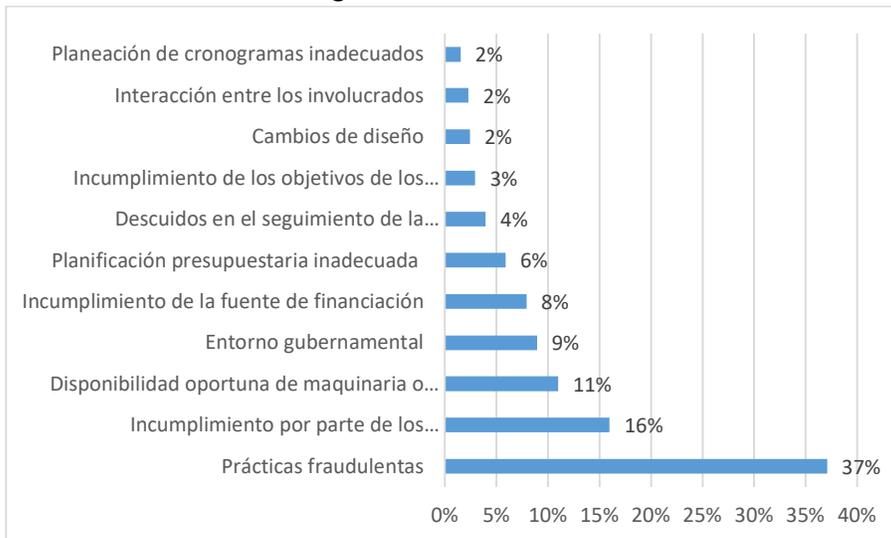
Figure 1: Location of the companies surveyed



Note: This Figure 1 shows the location of the companies.

The most influential factors in the variation of costs in 37% are determined by fraudulent practices, 16% non-compliance of subcontractors, 11% timely availability of machinery or equipment, 9% government environment, 8% non-compliance with the source of financing, 19% between inadequate budget planning, carelessness in monitoring the execution of the project, failure to meet worker goals, design changes, interaction among those involved, planning inadequate schedules

Figure 2:  
Influence of factors affecting the variation of construction costs



Note: This Figure 2 shows the influence of factors affecting construction cost variation.

In the same way, from the bibliographic review and the result of the survey applied to construction professionals working in construction companies, the possible causes of the factors that influence construction costs are determined:

Table 1

Possible causes of factors influencing construction costs

<b>Influencing factors on cost variation</b>	<b>Possible causes</b>
Fraudulent practices	The political environment of the country, excessive control of markets Loopholes Overconfidence Non-compliance in process times Non-compliance with quality parameters Ignorance of current regulations (Bigio and Ramírez, 2017).
Non-compliance by subcontractors	Cost of goods and services to be outsourced Availability of goods and services to be outsourced underestimation of expected costs, loss of control over service providers Increased reliance on contractors' signatures. (Rosemary, 2021)
Timely availability of machinery or equipment.	Location of the work External factors (damages, legal limitations, environmental conditions) Short proper operating time
Non-Compliance with the Funding Source	Bureaucratic procedures Incidentals Improper planning
Government environment,	The political environment of the country Applicable laws and regulations
Improper budget planning	Inexperience Generalization of costs Inadequate analysis of specifications or customer specifications Inexperience Little risk forecast
Oversights in follow-up to the execution of the project	The inexperience of the actors Overconfidence Government procedures
Failure to meet Workers' goals,	Incorrect definition of contracts Worker inexperience Availability of materials and resources
Design changes	Planning failures Time availability for design New requirements
Interaction between those involved,	Lack of communication Differences of opinion between involved

	Unplanned follow-up Unspecified control milestones
Plan for Inadequate Schedules	Inexperience Little risk forecast The political instability of the government

Note: This table 1 shows the possible causes of factors influencing construction costs.

On the possible actions to minimize the impact of the factors on the cost, the following are mentioned:

Table 2

Possible actions to minimize the impact of factors on cost

<b>Influencing factors on cost variation</b>	<b>Possible Mitigation Actions</b>
Fraudulent practices	Transparency of internal institutional processes Establish Overseer Involvement Perform a Monitoring and Control on the Site Training of current regulations
Non-compliance of subcontractors,	Set costs of goods and services to be outsourced Check the availability of goods and services to be outsourced Develop contracts in greater detail
Timely availability of machinery or equipment.	Determine in detail the Location of the work and its characteristics Analyze External factors (damages, legal limitations, environmental conditions) Establish Preventive Maintenance Control and Manage Industrial Risks
Non-Compliance with the Funding Source	Foresee Bureaucratic Procedures Analyze and manage project risks in detail Plan expenses in detail
Government environment,	Establish a Country's Political Risk Forecast Follow Up on Relevant Laws and Regulations Training on a legal basis
Improper budget planning	Create work teams Specify detailed costs Establish collaborative mechanisms for the analysis of specifications or customer specifications Establish risk management plans
Oversights in follow-up to the execution of the project	Establish a monitoring and control plan Monitoring of activities and resources Document government procedures following current regulations.

Failure to meet Workers' goals,	Detailed definition of contracts Permanent training of the worker Timely forecasting of materials and resources
Design changes	Establish collaborative planning and forecasting of the work Set strict design controls Anticipate possible new requirements Consider possible conditions for design changes
Interaction between those involved,	Establish multiple media Generate a meeting and follow-up plan
Plan for Inadequate Schedules	Training for planners Check project history Perform risk analysis and management

Note: This table 2 shows possible actions to minimize the impact of factors on cost.

## 5. Conclusions

To answer the first research question, fraudulent practices are determined as the most influential factors in the variation of costs in construction projects, coinciding with what was mentioned by Ramos (2020), with a similar influence on the non-compliance of subcontractors considered by Romero (2021), with an important valuation also influences the timely availability of machinery or equipment, and the governmental environment as also mentioned by Alinaitwe (2013); with less influence is the non-compliance in the source of financing, the inadequate planning of the budget indicated by Macias (2019); similarly, what Torres-Medina (2018) expressed is confirmed, considering as a factor of affection to the oversights in monitoring the execution of the project, the failure of workers to meet goals also mentioned by García (2020), changes in designs, the interaction between those involved, and the completion of inadequate schedules.

To answer the second research question, it is determined that among the possible actions to mitigate the factors that affect the variation of construction costs, the study allows us to find that the internal institutional processes should be transparent, with strategies that allow the involvement of overseers and monitor and control all processes and in all phases of the construction project.

## 6. Future Jobs

Define models and methodologies of costs of construction projects parameterizable to the reality of each country, which allows for minimizing the variation of costs and having an adequate forecast of project costs.

Define models of parameterizable budgets with adjustable bands of variability, to achieve maximum efficiency in the execution of construction projects.

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