# FACTORS INFLUENCING THE CHOICE OF COST ESTIMATES TYPES AND THE ACCURACY OF ESTIMATES FOR CONSTRUCTION PROJECTS

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**ABSTRACT**

*In this paper were analyzed, based on a research methodology, relations between the factors that determine what types of cost estimates of construction projects and approaches used in making cost estimates. The analysis made led to the confirmation of two research hypotheses: a strong positive correlation between the professional experience of project managers and the use of top-down approaches in the cost estimates of construction projects; a strong positive correlation between time and resources allocated for estimation and using parametric estimates. A second analysis is performed to estimate the relationship between the type of estimates used and accuracy of the estimate, confirmed for the three types of estimates: analogous, parametric and definitive. It has not been confirmed a significant relationship between the level of education of project managers and using bottom-up approaches, cost estimates of construction projects.*

**KEYWORDS:** *project, cost, management, construction.*

**JEL CLASSIFICATION:** *M19, M20*

## 1. INTRODUCTION

The cost of construction projects is one of the fundamental elements that organizations are taken into account in deciding whether to accept involvement in the execution of their Project cost management includes four basic steps: resource planning, cost estimating, cost budgeting and cost control.

The initial estimate of the costs involves making an initial cost calculations based on the resources identified in the resource planning stage. Apart from resources, the starting point in the cost estimates is the WBS. Considering the WBS there may be two major approaches to estimating costs: bottom-up and top-down approach. In the bottom-up approach costs are estimated for each level of the WBS starting from the last level to the first level of the WBS. A variant of the bottom-up estimates are definitive estimates.

Top-down approach involves estimating the costs at project level and their allocation to each level of the WBS. The top-down category estimates includes analogous and parametric estimates. Analogous estimates are those that use the cost of previous projects as the basis for estimating future projects, when the projects are very similar. Parametric estimates are those that use a mathematical model based on several parameters to determine the total project cost.

In estimating the cost of construction projects all three types of estimates are used although not to the same extent and not with the same results. From the perspective of project managers and managers for organization-wide each approach to estimating costs has advantages and disadvantages in terms of accuracy estimates made. Accuracy of the estimates is best viewed by comparing the cost of the project at completion with initial cost estimates.

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Given the long duration of the completion of construction projects accuracy of initial estimates is very important because they can be affected by a number of factors occurring during the execution of works: changes in prices and tariffs during the execution, changing the competitive position of suppliers / subcontractors the emergence of new materials, techniques and procedures of implementation, new tax regulations etc.

## 2. LITERATURE REVIEW

In literature there are several studies on methods used to estimate costs, data used to estimate the cost and accuracy of cost estimates. Of these the most important are those made by Page (1996), Humphreys (2004), Towler and Sinnott (2008). Towler and Sinnot (2008) showed that the accuracy of cost estimates is positively correlated with the volume of human resources allocated for the cost estimate.

Over time several studies have been conducted regarding the accuracy of cost estimates for projects outside CHAOS reports. Oberlander and Trost (2001) conducted a study on the factors that determine accurate cost estimates. Bertinsen and Davies (2008) conducted a cost analysis for a number of 63 international mining and smelting projects and assessed the accuracy of cost estimates. They concluded that the initial estimates of costs incurred in the feasibility studies have been overcome by an average of 14% and that for a project of thirteen completion costs are higher by 100% compared to the initial estimates. Contrary to most studies in the literature Bertinsen and Davies have shown that "smaller projects have less estimation accuracy than large projects", hypothesis supported by Odec's research (2004). However most studies in the literature support the hypothesis of a positive correlation between the increase in project size and project cost overruns rise compared to initial estimates (Roy and Christenfeld, 2008; Yang et. al, 2008).

Young and Markley (2008) consider that the approaches of the "top-down", as analogous and parametric estimates are below the "bottom-up" in terms of the accuracy of the estimates. They support the hypothesis that bottom-up estimates are more accurate because they are based on cost estimates for each component of the WBS and their totals at the project level.

Aibinu and Pasco (2008) conducted a study on the accuracy of cost estimates for 56 construction projects from 102 companies in Australia and goes to confirm the hypothesis that forecast accuracy is affected in a significant manner by the size of projects, thus confirming the results of studies in literature specialty mentioned above.

Jørgensen, Halkjelsvik and Kitchenham (2012) argue that "empirical studies differ in what they report as the underlying relation between project size and percent cost overrun. As a consequence, the studies also differ in their project management recommendations". They concluded that "are reasons to expect an increase in cost overrun with increased actual project size even when rational estimation strategies are applied".

Ishii, Takano and Muraki (2014) showed that the accuracy of cost estimates is essential in selecting profitable projects as contractor because any project price is determined before accepting contracts for execution of projects.

## 3. RESEARCH METHODOLOGY

Based on analysis of literature and the results achieved so far for this research were established the following objectives:
- determining the factors influencing the choice of estimation type for construction projects costs;
- the study of relations between the factors influencing the choice of cost estimate types and estimates types used by project managers in the Bucharest-Ilfov region;

- the study of relations between types of estimation and accuracy of estimates used for construction projects.

Starting from the research objectives of the study and research methods previously used in the literature was developed the research methodology used in this study that is shown in figure no. 1.
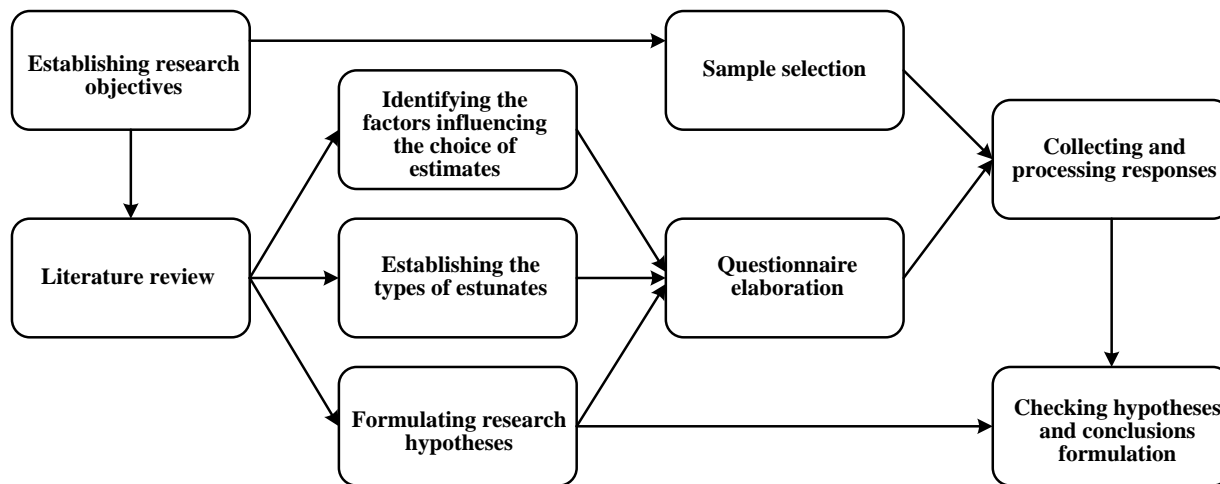


**Figure 1. Research methodology**

Given the research objectives, results and conclusions of previous research literature were identified the main variables influencing the choice of cost estimates and a questionnaire was developed consisting of three sections:

- an introductory section with three questions concerning the characteristics of the firms selected for this research;
- the second section with eight questions concerning factors influencing the choice of project costs estimation type;
- the third section with four questions about the types of estimates used and their accuracy.

Characteristics of selected organizations for this research in the introductory section covers: organization size (micro, SME, large enterprise); length of the organization; main activity according to NACE code.

Were considered eight factors influencing the choice of estimation type used for construction projects analyzed: project value, the number of activities of the project, the age of project manager, seniority in the organization of the project manager, work experience of the project manager, level of the project manager studies, the time allocated for cost estimates, allocated resources for cost estimates (considered as a man - hours).

The types of estimates used were analogous and parametric estimates for the top-down approach and the definitive estimates for the bottom-up approach. As a measure of the estimates accuracy have been chosen three types of deviations from the initial estimated cost: less than 10%, between 10 and 20% and over 30%.

Based on data provided by the Trade Registry and the top of the construction companies in the region Bucharest-Ilfov was elected a representative sample of 50 firms that were contacted by email to communicate the name of a project manager to answer the questionnaire . Of the 50 companies contacted 30 release name a project manager, equivalent to a response rate of 60%. Of the 30 project managers communicate by construction companies one refused to answer the questionnaire and two incomplete answers were formulated at second and third sections of the questionnaire giving a final response rate of 54%. After receiving the questionnaire responses was performed statistical data processing, analyzing correlations between factors influencing the choice of

estimation and types of estimates used, confirmation / rejection of the assumptions research and formulate conclusions.

## 4. RESEARCH HYPOTHESES

For this research were established following hypotheses:

H1. There is a strong positive correlation between the professional experience of project managers and the use of top-down approaches in cost estimates of construction projects.

H.2 There is a strong positive correlation between project managers age and using top-down approaches in cost estimates of construction projects.

H3. There is a significant positive correlation between education level project managers and the use of bottom-up approaches, cost estimates of construction projects.

H4. There is a strong positive correlation between the time and the resources allocated for the estimation and using of the parametric estimates.

Hi5. There is a significant relationship between the estimation type and deviation size of the final cost for construction projects.

## 5. RESULTS AND FINDINGS

After processing the results of questionnaires was realized an analysis of correlations between factors influencing the choice of cost estimation types and cost estimation types. The results of this analysis are shown in Table no.1.

**Table 1. The analysis of correlations between factors influencing the choice of cost estimation types and cost estimation types (P<0,05)**

| No. | Factors influencing the choice of cost estimation types | Top – down approach | | Bottom – up approach |
|---|---|---|---|---|
| | | Analogous estimates | Parametric estimates | Definitive estimates |
| 1 | Project value | 0,05 | 0,42 | 0,07 |
| 2 | Number of activities of the project | 0,12 | 0,34 | -0,14 |
| 3 | The age of project manager | 0,76 | 0,24 | 0,11 |
| 4 | Seniority in the organization of the project manager | 0,11 | 0,27 | -0,12 |
| 5 | Work experience of the project manager | 0,75 | 0,81 | 0,27 |
| 6 | Level of the project manager studies | 0,14 | 0,44 | 0,22 |
| 7 | The time allocated for cost estimates | 0,27 | 0,72 | -0,06 |
| 8 | Allocated resources for cost estimates (man - hours). | 0,41 | 0,77 | 0,18 |

The first research hypothesis is the relationship between the project manager professional experience and top-down approaches use in cost estimates. H1 hypothesis is confirmed cause there are strong positive relationships for the analogous estimates (r = 0.75) and for the parametric estimates (r = 0.81). H.2 hypothesis is confirmed only in part because there is a strong positive correlation between project manager age and analogous estimates. Hypothesis H.2. is not confirmed

for parametric estimates. Validating the first two hypotheses was influenced by two factors: using mainly parametric estimates for large projects and small analogous estimates for civil engineering projects which are very similar.

The third hypothesis is not confirmed because there is not a strong significant correlation between level of education of project managers and bottom –up approaches in the cost estimates of construction projects. This result is affected by the fact that the definitive estimates are less common in Romania as reflected in the results of this research carried out in the Bucharest - Ilfov.

The fourth hypothesis is confirmed for parametric estimates, both in terms of time- parametric estimates correlation and in terms of the correlation between resources and parametric estimates. There is a weak positive correlation between the resources allocated to estimates and other estimation types used.

Another analysis was performed between types of estimates used and the accuracy determined as the size of deviations from initial estimates. This analysis is shown in Table number 2.

**Table 2. The analysis of correlations between types of estimates used and the accuracy (P<0,05)**

| Estimate types | Deviations from the initial estimate | | |
|---|---|---|---|
| | Less than 10%, | Between 10 and 20% | Over 30%. |
| Analogous | 0,06 | 0,07 | 0,72 |
| Parametric | 0,08 | 0,75 | 0,11 |
| Definitive | 0,76 | 0,07 | 0,11 |

The analysis conducted confirms the hypothesis H5 meaning that there is a relationship between the type of cost estimate used and deviations from the initial estimate. The review finds that there are strong positive correlations between:

- estimates analog and deviations over 30% from the original estimate;
- parametric estimates and deviations from the original estimate 10-20%;
- definitive estimates and deviations of less than 10% from the original estimate.

The following table contains a summary of the hypotheses that have marked the research and their confirmation.

**Table 3. Confirmation of research hypotheses**

| No. | Hypotheses | Result |
|---|---|---|
| 1 | H1. There is a strong positive correlation between the professional experience of project managers and the use of top-down approaches in cost estimates of construction projects. | Confirmed |
| 2 | H.2 There is a strong positive correlation between project managers age and using top-down approaches in cost estimates of construction projects. | Partially confirmed |
| 3 | H3. There is a significant positive correlation between education level project managers and the use of bottom-up approaches, cost estimates of construction projects. | Not confirmed. |
| 4 | H4. There is a strong positive correlation between the time and the resources allocated for the estimation and using of the parametric estimates. | Confirmed |
| 5 | H5. There is a significant relationship between the estimation type and deviation size of the final cost for construction projects. | Confirmed |

Research carried out in this study had some limitations of which the most important are:
- the sample size (number of construction companies and the number of project managers) compared to other surveys performed in the same field;
- reduced use of definitive estimates by project managers in the construction industry.

## 6. CONCLUSIONS

Methods for the project cost estimates and the accuracy of the initial costs of the projects have been the subject of several research carried out by specialists. Studies conducted so far have pursued the relationship between types of estimates used and the accuracy without the literature to reach a consensus on the results. There were, until this study, no research on correlations between factors influencing the choice of estimation and cost estimates used types.

This research had to two essential objectives: the analysis of correlations between factors influencing the choice of cost estimation types and cost estimation types followed by the analysis of correlations between types of estimates used and the accuracy. Three hypotheses were confirmed in this research. The first confirmed hypothesis is the strong positive correlation between the professional experience of the project managers and the use of top-down approaches in the cost estimates of construction projects. The second confirmed hypothesis is a positive correlation between the types of cost estimates and the accuracy of the estimates. A third confirmed hypothesis is the existence of a strong positive correlation between time and resources estimation and using parametric estimates. A partially confirmed hypothesis is the existence of a strong positive correlation between age and project managers and the use of top-down approaches in the cost estimates of construction projects. This hypothesis is confirmed only in the case of the analogous estimates.

The research conducted had some limitations of which the most important are the sample size and frequency of use definitive estimates construction projects in Bucharest-Ilfov region. In future research carried out in the same field will expand nationwide sample for correlation analysis between between factors influencing the choice of cost estimation types and cost estimation type. Estimates accuracy analysis will be extended to NACE code of construction companies and construction projects.

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