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BEHAVIOR IN TERMS OF DELAYS AND COST OVERRUN OF THE CONSTRUCTION OF PUBLIC INFRASTRUCTURE IN COLOMBIA

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ABSTRACT

Delays and cost overruns in the construction of public infrastructure in Colombia is well documented in the literature. However, the information used in the studies is usually supported by subjective perceptions and not by reliable data. For this reason, it is important to conduct a detailed execution analysis of construction contracts in Colombian public infrastructure to confirm the existence of cost overruns and delays. For this analysis, cost values and contractual deadlines were obtained from not currently running contracts made by state agencies in Colombian infrastructure construction. These data were compared with the real final results to establish consistent percentage delays and cost overruns. Consistent differences along time since 2011 were found depending on the type of contract, revealing the weaknesses of the selection process. Additionally, the analysis shows that cost overruns are less significant than time delays. The results obtained from this analysis will be used to identify the magnitude of the problem in order to create new strategies to develop more efficient selection criteria for public contracts in Colombia.

Keywords: *Public Infrastructure, Contracts, Delays, Cost Overruns, Colombian Infrastructure.*

RESUMEN

Las demoras y sobrecostos en construcción de infraestructura pública en Colombia están bien documentados en la literatura. Sin embargo, la información usada en los estudios esta usualmente soportada por percepciones subjetivas y no por datos confiables. Por esta razón, es importante realizar un detallado análisis de datos sobre la ejecución de contratos de construcción de infraestructura pública en Colombia para confirmar la existencia de problemas en términos de sobrecostos y demoras. Para este análisis, valores de costos y plazos contractuales fueron obtenidos de contratos realizados por agencias estatales de Colombia que se desenvuelven en construcción y que no se están ejecutando actualmente. Estos datos fueron comparados con resultados reales finales para establecer índices consistentes de demoras y sobrecostos. Diferencias consistentes a través del tiempo desde el año 2011 fueron encontradas dependiendo del tipo de contrato, revelando las deficiencias del proceso de selección. Adicionalmente, el análisis demuestra que los sobrecostos son menos significantes que los retrasos. Los resultados obtenidos del análisis van a ser usados para identificar la magnitud del problema con el fin de crear nuevas estrategias para desarrollar criterios de selección más eficientes para los contratos públicos en Colombia.

Palabras clave: Infraestructura Pública, Contratos, Demoras, Sobrecostos, Infraestructura Colombiana.

1 INTRODUCTION

The presence of problems in planning and tendering of public infrastructure contracts occur in implementation and are reflected in delays, cost overruns and the loss of money. The first sign that a contract was poorly planned or bid is the increase in execution time without a strongly justified explanation. Additionally, poor beginnings of a project also increase the initial budget because of items that were not taken into account when planning produce cost overruns. Finally, the sum of these problems generate loss of public money in the execution of contracts because private companies cannot pay the extra money needed to cover the materialization of threats produced by the bad initial planning of contracts. In conclusion, the main effects that arise from poor planning and improper bid can be explained in delays, cost overruns and loss of public money.

The first significant cause comes from preliminary studies by the contracting entity that are reflected in obtaining the correct scope, budget and duration of a contract. The scope is the first step to consider defining the type of deliverables. In other words, the scope will be the guide upon which the proper execution is going to be evaluated. Similarly and linked to the scope is the budget that the entity has for a contractor to perform the required work. Finally, the duration of execution of the contract will be obtained, which must be consistent with the needs and the real possibilities of contractors. In conclusion, not having a correct implementation of the previous studies in scope, budget and duration is the main reason for not having a proper roadmap to follow in the execution of contracts.

Similarly, another cause of future problems in the execution of contracts is the structuring of the contractual specifications such as enabling requirements, additional requirements and rating methodologies. Within the enabling requirements there are those minimum requirements that the contracting entity believes should have any bidder to ensure contract compliance. Similarly, in order to create competition there are also additional requirements which seek to differentiate bidders. However, these requirements are not always adequate for proper selection since they are obtained in many cases in different contracts. Finally, with the presence of several contractors bidding contracting entities carrying out diverse methodologies to select the best contractor. However, in many cases the methods used do not generate the expected result because they were not really designed to select the best option. In conclusion, poor structuring of enabling requirements, additional requirements, and rating methodologies that will generate significant problems in the execution of contracts.

2 STATE OF THE ART

The fact that exists delays and cost overruns in the construction of public infrastructure is based only in perspectives of the users, which have been constructed by an ambient of dissatisfaction, delays in the infrastructure of cities and the reality of low productivity, reflecting the correlation between public investment in infrastructure and productivity as causes of economic competitiveness (Wold Economic Forum, 2012). Across the time, there is an interest to try to give an explanation to the problem, usually for both the project owner and the project contractor; however, the delays may be caused by the owner (compensable delay) (Rosenfeld, 2014), by the contractor (no excusable delay), by acts of god, or a third party (excusable delay), meaning that it is often difficult to analyze the ultimate liability in delay claims Because of the many sources and causes of construction delays (Kraiem & Diekmann, 1987).

The problem of cost overrun, especially in the construction industry, is a worldwide phenomenon, and its ripples are normally a source of friction between clients and contractors on the issue of price variation (Akpan & Igwe, 2001), but this construction failure can be avoided by employing better engineering practices in design and construction, such as checking and reviews of designs and construction procedures (Haydl & Nikiel, 2000). Rework has become an endemic feature of the procurement process in construction that invariably leads to time and cost overruns in projects (Josephson, Larsson, & Li, 2002), two indicators of cost deviation are used for quantify these costs: cost overrun to the owner and the cost of rework to the contractor (Attalla & Hegazy, 2003), however in most instances quantify the last one is very difficult because the contractor needs to show that the owner or the owner's agent caused active hindrance or the owner demonstrated bad faith toward the contractor (Thomas & Messner, 2003).

Since the beginning of the new century, there has been an interest to explain the potential causes of the delays (Oliveros & Fayek, 2005) and cost overrun, and in the assessment of causation and allocation of liability (Farrow, 2007); focusing on actions and inactions of project participants and external factors (Aibinu & Odeyinka, 2006). Many professionals thought that these were associated with the treatment of exceptionally adverse weather, dealing with early completion schedules, quantification of the prolongation costs associated with an approved extension of time and concurrent delays (Scott & Harris, 2004). This interest evolved to the point of achieve proactive project control based on better prediction of project performance at different time horizons (Li, Moselhi, & Alkass, 2006) using time series analysis techniques with integrated historical productivity data and on-going field productivity (Hwang & Liu, 2005).

Previous research studies have provided insight into the factors that affect overruns; however the findings may have been limited because they do not explicitly consider the simultaneous relationship between cost and time overruns, these for the different project types can generally differ due to the inherent construction practices and planning processes associated with each project type (Bhargava, Anastasopoulos, Labi, Sinha, & Mannering, 2010). Despite the previous, changes are the main causes of delays and cost overruns in construction projects (Zhao, Lv, Zuo, & Zillante, 2010), for example analytical results reveal that "changes in client's requirement" are the main causes of delays in both planning and design phases (Yang & Wei, 2010) and these changes are usually issued to cover variations in scope of work, material quantities, design errors, and unit rate changes (Alnuaimi, Taha, Al Mohsin, & Al-Hart, 2010).

In the second decade of the century XIX, the idea arose that cost overrun depends on causal relations between various risk sources (namely, risk paths) and sources of vulnerability that interfere with these paths (Fidan, Dikmen, Tanyer, & Birgonul, 2011). Also, the dependencies generated by the progress of construction are not adequately considered during construction scheduling. For this reason, it may cause conflicts at the construction site, resulting in incalculable delays and extra costs, for what the used of building information models (BIM) can be used to support construction scheduling (Marx & König, 2011). As a consequence the greater control of the time and costs due to planning and scheduling deficiencies have the highest impact on cost performance from clients, consultants, and contractors' perspectives (Doloi, 2013).

3 METHODOLOGY

It was initially raised a review of the state of the art on cost overruns and delays in construction of public infrastructure in the world. This review was performed in order to know existing research and data worldwide on problems encountered in construction, also to know the principal causes of the problems in different type of projects. Once the theoretical basis of cost overruns and delays was established, we sought to establish similarities with the Colombian case.

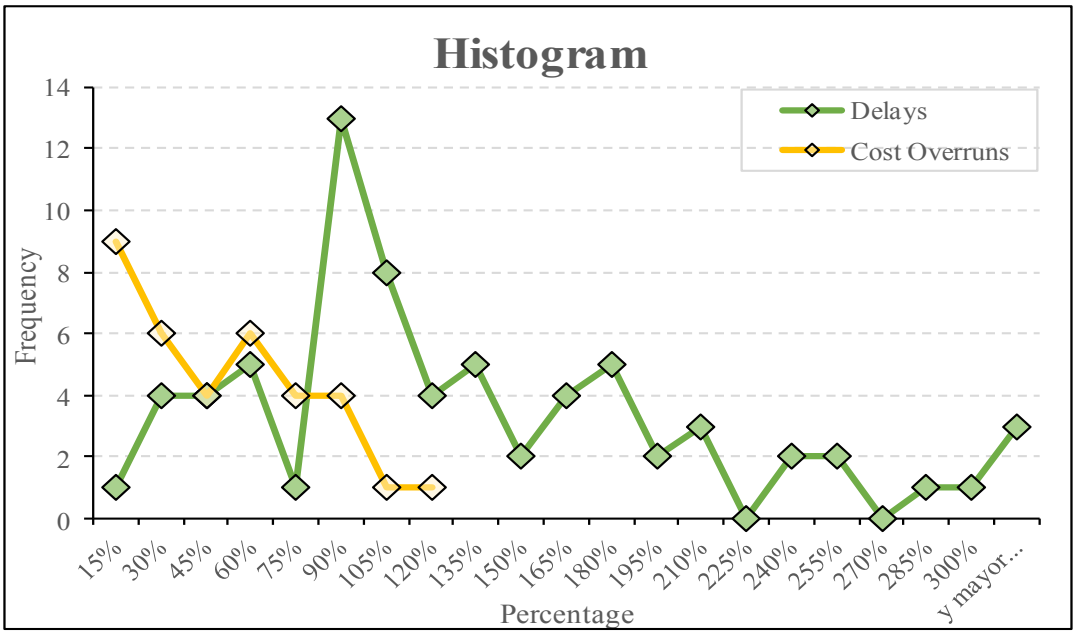
Once the theoretical basis of this research is established, information relating to contracts are collected in different entities of the Colombian public sector. The data was obtained from "*SECOP - Sistema Electrónico para la Contratación Pública*", that is an electronic system that allows state entities to comply with the disclosure requirements of the different acts issued in contractual processes. Some of the information required for analysing data is the length and the initial cost of the contract. Likewise, in order to generate a comparison of performance, information on the duration and actual cost at the end of the contract as well as other variables that may be used for other statistical analysis was obtained.

From above data, delays and cost overruns present in the actual execution of public infrastructure contracts were found. This information is presented equally by year and by type of contract.

4 DATA ANALYSIS

For data analysis, we conducted a review of 109 contracts for construction of public infrastructure in Colombian public entities throughout the years 2011, 2012 and 2013. On this, it should be emphasized that mainly analyzed works, supervision and designs contracts. From the results the information presented in the image 1 was obtained with descriptive statistics that are shown on table 1.

Image 1 – Delays and Cost Overruns in Colombian Public Entities



Source: Own Development (2014)

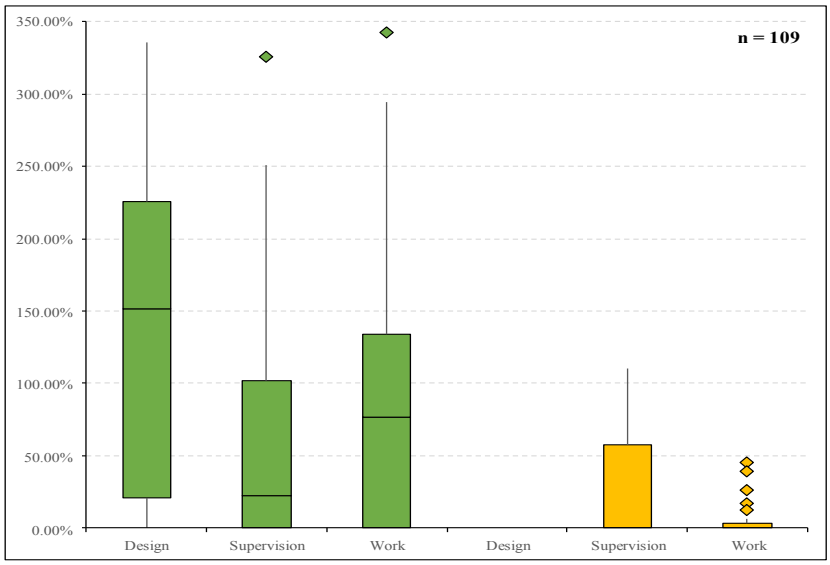
Table 1 - Descriptive Statistics of Delays and Cost Overruns

TOTAL	Total Count	Average	St. Deviation	Minimum	Q1	Median	Q3	Maximum	IQR
Delays	109	80.52%	87.66%	0.00%	0.00%	76.03%	133.88%	342.27%	133.88%
Cost Overruns	109	13.48%	26.34%	0.00%	0.00%	0.00%	12.64%	110.52%	12.64%

Source: Own Development (2014)

Similarly, analysis of cost overruns and delays by type (Image2 and Table 2) and by year (Image 3 and Table 3).

Image 2 – Delays and Cost Overruns by type



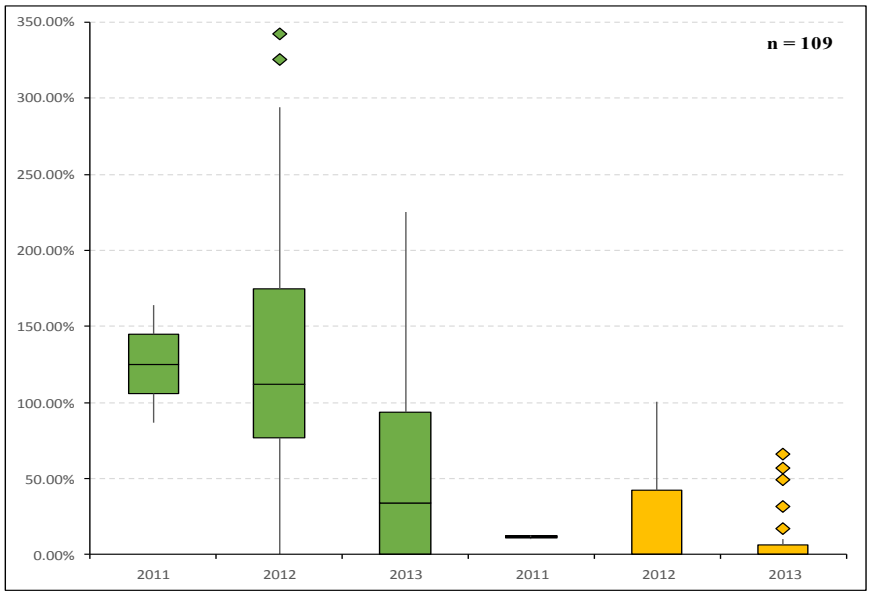
Source: Own Development (2014)

Table 2 - Descriptive Statistics by type

DELAYS	Total Count	Average	St. Deviation	Min.	Q1	Median	Q3	Max.	IQR
Design	10	142.46%	119.27%	0.00%	20.90%	151.90%	225.41%	335.56%	204.51%
Superv.	43	65.06%	82.67%	0.00%	0.00%	22.22%	101.54%	325.49%	101.54%
Work	56	81.33%	81.59%	0.00%	0.00%	76.54%	133.88%	342.27%	133.88%
COST O.	**Total Count**	**Average**	**St. Deviation**	**Min.**	**Q1**	**Median**	**Q3**	**Max.**	**IQR**
Design	10	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Superv.	43	28.87%	35.55%	0.00%	0.00%	0.00%	57.31%	110.52%	57.31%
Work	56	4.07%	9.43%	0.00%	0.00%	0.00%	0.82%	45.64%	0.82%

Source: Own Development (2014)

Image 3 – Delays and Cost Overruns by year



Source: Own Development (2014)

Table 3 - Descriptive Statistics by year

DELAYS	Total Count	Average	St. Deviation	Min.	Q1	Median	Q3	Max.	IQR
2011	2	125.36%	54.55%	86.79%	106.08%	125.36%	144.65%	163.93%	38.57%
2012	51	131.96%	84.22%	0.00%	76.54%	112.45%	174.79%	342.27%	98.25%
2013	29	59.87%	74.08%	0.00%	0.00%	34.07%	93.96%	250.82%	93.96%
COST O.	**Total Count**	**Average**	**St. Deviation**	**Min.**	**Q1**	**Median**	**Q3**	**Max.**	**IQR**
2011	2	11.58%	1.70%	10.38%	10.98%	11.58%	12.18%	12.78%	1.20%
2012	51	22.18%	33.46%	0.00%	0.00%	0.00%	42.45%	110.52%	42.45%
2013	29	9.27%	18.73%	0.00%	0.00%	0.00%	6.36%	66.48%	6.36%

Source: Own Development (2014)

5 DISCUSSION

A clear difference between the percentage of delay and the percentage of cost overruns that occur in the construction of public infrastructure Colombian was observed. Firstly in image 1 and table 1 it is possible to see that measures of central tendency for delays shows that the arrears are around of 80% with a positive bias. However, in cost overruns arrears are around 13% with an unclear bias. This proportion could imply that a fixed overhead increase of 13% when a delay of 80% exists, indicating the propensity to extend or suspend contracts affecting in a small proportion of the initial budget. Similarly, this trend is observed constant over time where the percentage of cost overruns always is lower than delays in the works.

In order to deepen the basis of this problem found from the image 2 and table 2 that the largest arrears focuses on design and work contracts. Despite this, the supervision is not affected at the same proportion. For this reason, we can infer that many works and designs contracts are without supervisors or by otherwise signed contracts for supervisors have longer times compared to the contracts that are monitored for them.

On the side of cost overruns, it shows that contrary to what happened with arrears, the type of contract that is most affected is supervision. This can happen because the budget

for the auditing contract takes real effort from a team. This means that if an auditing contract is extended, the budget should be impacted since it is required additional payment of professionals for the time extended.

Similarly, design contracts have no overruns despite being tendered in the same way that supervision, that means by professionals. This may indicate that design contracts should handle other figures of procurement (deliverables) or simply that contractors responsible for carrying out the designs do not work with the stipulated team for the contract from the beginning of it.

In the case of works contracts it is understandable that cost overruns almost does not existed with some critical exceptions (Image 2). This is because even though the execution of construction contracts has arrears, these contracts are charged against amount of work performed initially at a fixed price (fixed unit prices).

Finally, observing the image 3 and the data of the table 3, the delays and the cost overruns has been decreasing in more than the 50 %. This fact is the consequence of the revolution of the industry in Colombia, which nowadays is looking to implement new technologies or methodologies of construction innovation for improve the effectiveness of the projects.

6 CONCLUSIONS AND RECOMMENDATIONS

The major finding is that delays and cost overruns has very large differences between them. Therefore it is concluded that there are problems when contracts were planned because delays extremely exceed the cost overruns. So, it is recommended to perform a check on project planning regarding the provisions of contractors, because it can be seen that the time is very short despite generate a slightly change on the initial budget.

Likewise it shows that design contracts have arrears without cost overruns. This indicates that there must be greater vigilance on design contractors since these contracts are awarded by consulting (working people). For this reason, the existence of delays but not cost overruns indicates a misuse of professional's resources, or simply not using of the professionals required.

In general, it is advisable to perform a more detailed analysis of the different contracts from the beginning of its planning. This is because generally not successful contracts were found, being compliance of contractual time the most problematic characteristic. Although in this paper an analysis of the estimated cost overruns for arrears was not developed, should be understood that arrears means also cost overruns on the population and the contracting entities.

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