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Recommendations for Directing the Success of Roads Projects Management, Analysis of Triple Restriction

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Abstract. The present Project is developed in Ecuador, Morona Santiago Province as a response to prior research that determined the failure of projects execution is due to the poor management of restrictions set by the director project. This research constitutes a contribution to Scientific knowledge about Project Management, primary factors influencing the failure of projects and recommendations for the achievement of success on roads construction projects. In order to get the established objective in this study, it was necessary the analysis of the conditions on which roads projects were executed and completed over the years 2018, 2019, and 2020 by the Decentralized Autonomous Government of Morona Santiago on the modality of procurement, and it was also important to establish the causes that contributed to a particular outcome on projects. The approach of the analysis is focused on the management of restrictions of costs, time, and scope (triple restriction) of projects in study. The technique that was used is the analysis of the content that was applied to contractual records of 81 hired projects by selection of minor amount, price, bid, reverse auction, and contingency plan according to the Ecuadorian legislation for public works procurement. For the record and further data analysis, the information was encoded identifying in contractual files the causes that directly or indirectly led to categories of costs management, time and scope of projects. The results achieved show the causes that contributed to the failure of projects and the state in which they were finished in terms of initially established costs, time and scope. The obtained information was the basis to come up with recommendations referring the good practices on projects management that will work people in charge of projects management of roads constructions in order to obtain success on future projects.

1. Introduction

A project is defined as the temporal effort performed in order to create a product, service or unique result [1]. It is the Director of the Project who implements practices of projects management so that it can be finished within the expected parameters and satisfied the needs of the client. In this context the management is a the most important tool to implement a project.



A meaningful part of any country resources, especially developing countries, is dedicated to civil and infrastructure projects. World Bank figures show that between the 3% and the 8% GDP of developing countries is dedicated to construction industry [2]. These projects have to be performed and delivered under certain restrictions or limitations, the main ones traditionally are scope, time, and costs [3]. Even though humanity has conducted an endless number of projects from long ago, the applied techniques for the management of projects until now have not marked the turning point to achieve the intended success on projects completion [4]. This reality is expressed in the research project developed by Almeida Abarca, in which he concludes that only the 31% of construction projects in the last three years were completed within a range of deviation of 10% regarding the initial budget and the 25% within the initial schedules with a tolerance of deviation of 10% [5], likewise, on a study developed in the year 2010, determined that from 40 construction projects just one of them hardly finished within the scheduled time [6]. Another investigation argues the main problems on traditional approaches for projects delivery have been delays on planned schedules, cost overruns, significant quality problems and an increase on the number of complaints and litigations related to construction [14]. In the year 2011 it is concluded that the main factors affecting costs, times and quality in the construction field are the poor planning and programming, fraudulent practices, and kickbacks [16]. It has also been identified that projects execution has problems with the management of resources, modifications of characteristics that have been previously established or changes on some requirements by the contracting party [5]. In conclusion, there is little evidence of a successful project in which the three parameters of it have been balanced and the necessity of time management, cost and quality persist [15]. Consequently, it is evident there are parameters that have to be studied and influence the management of projects.

One of the most frequently used tools to measure success in projects management, is the triple restriction conformed by the costs, time and scope parameters [7]. The three restrictions are regularly known as the Project Management Triangle or as the Triple Restriction, where each side of the triangle represents a restriction, then, one side of the triangle cannot change without affecting the others. But the triple restriction is also one of the least neglected foundations on projects management [8], since not all projects are really achieved in time, cost and expected quality. Most of the time, breakdowns are the result of unexpected problems, deviations from the original plan during the execution of the project [3].

At the moment of running a project we are necessarily working with the triple restriction and this is the most important concept in history of project management [9] and is about a form of representation of the most basic criteria by which project success is measured [8]. Time, cost and quality are the main feasible objectives for the client on any building construction project [10]. Failure on one restriction will probably generate a negative pressure over one or the two other restrictions, it means a bad interpretation of triple restriction can lead us to project failure in spite of the efficient role of the other aspects in a project [11]. It has been discovered that efficient management of triple restriction is essential for the success of a project [12].

In the year 2018 the first investigation in Ecuador about achieved performance on public projects was done, using as a reference the information recorded by institutions in the GPR (*Gobierno por Resultados* / Government by Results) and contrasting such information with components of the triple restriction. Results show fulfillment of efficiency on performances; however, these results are only superficial due to the fact that the origin of data comes from a digital platform in which it is not possible to know what causes these results in depth.

The data gathered in this investigation show the average of projects duration is 4.8 years, with a budgetary execution that reaches the 98% of what was planned and a physical advance corresponding to 67%. Research suggests doing a standardized study of assessment parameters, separate information by type of projects or group projects with similar characteristics; as well as deepen on obtained results in prior research projects [17].

Currently it is difficult to evidence research projects in Ecuador that deepen their studies on factors that include the triple restriction on building construction projects with similar characteristics, nor even diagnosis motivated by a reality in which construction projects finished and because of their validity and trustworthiness contribute to the improvement of practices for directing project to achieve the desired success within the parameters of cost, time and scope. Therefore, to determine the main reasons that impede the fulfillment of the three restrictions in construction projects is a radical factor to propound actions that guide us to get better results, especially on paramount components of evaluation of a project as they are cost, time, and scope. To obtain these parameters the present study is conducted in which the subject study is focused on roads construction projects in the Province of Morona Santiago in Ecuador.

In the Province of Morona Santiago, the most important entity that has jurisdiction on the management of rural roads is the Provincial Autonomous Government of Morona Santiago. In the projects this entity executes on the procurement modality, trivially many factors that impede the normal development of the contractual execution have been discovered, and they include repercussions in the term, cost, and scope of a project, and this in turn is reflected on a deficit in the management of local development of the land in general.

In order to identify the causes, the problem was addressed by means of an analysis of the contractual records, to which a research technique called content analysis was applied. The units of analysis are the management of cost, time, and scope of projects at matter, study population comprehends roads construction projects executed by contract on the modality of lower amount, reverse auction, quotation and bidding of public works in the years 2018, 2019 and 2020 by the Provincial DAG of Morona Santiago. The data has been prioritized by categories and subcategories and from there, general guidelines will be established to be considered at the moment of executing roads projects. These guidelines constitute recommendations that contribute to the improvement of practices referring projects management with the aim of achieving success on roads projects management in Morona Santiago. Having similar application scopes to building construction in general, this research will offer standards that will function as a basis for the planning of future specific investigations for each sector and its components.

2. Methodology

The present investigation was performed in the Province of Morona Santiago, Ecuador, and focused on roads projects the governorate of Morona Santiago has executed as a government entity with provincial administrative jurisdiction. Annually, this entity in average assigns about 8 million dollars for roads management in the region. The governorate area in charge of the administration of roads management, the assigned resources and the execution of provincial projects is the Public Work Direction, Connectivity and Multimodal Transport (*DOOPPCTM* / *PWDCMT*). All projects performed and executed by the *PWDCMT* consider works of construction of bridges and roads on levels: 1) pavements 2) ballast 3) maintenance and 4) opening of roads. Projects susceptible to analysis consider roads projects over a period of time between the years 2018 and 2020, that means the execution of the contract started in the year 2018 and finished in the year 2020.

This research Project was held in two parts: 1) qualitative analysis through content analysis made to identify the status of fulfillment of cost, time, and scope factors in projects at matter; 2) quantitative analysis through descriptive statistics made to obtain the percentage of fulfillment of initial conditions of the project in relationship with cost, time, and contractual object. With this information it is easy to obtain the percentage of projects that were successfully completed or not. Descriptive statistics was also used to measure the seven factors that influenced on projects until they fail.

Content analysis was applied to contractual records; this technique was considered the most suitable for the investigation since data was not obtained during the real time it happened [18], but the source was comprised by written records from contracts between the years 2018 and 2020. Existing different types of written documents, the type of documents that were analyzed in this investigation were classified according to their nature as institutional documents [19] and are those filed on the contractual records of executed projects on the procurement modality by the General Direction of Public Work, Transport, and Multimodal Communication PWDCMT of the Governorate of Morona Santiago during the period of 2018 – 2020. These contractual records show all the legal, technical and administrative events occurred during the construction of roads works. Validation of documentation to be analyzed was done through contrast of information with the files from the General Direction of Inspection (*DGF/GDI*) of the governorate of Morona Santiago. This validation action permitted the acquisition of files with complete information regarding the befallen events during the contractual execution and the performed actions by the Contractor, Inspection, and Management of contract, both Directions have a record that contain the contractual files of executed projects on the modality of procurement in either cases of lower number of projects, price of projects, bidding of projects, reverse auction of projects and emergency executed projects. Lower amount is a procedure that is used for the procurement of projects whet the amount of the contract is lower to 0,000007 coefficient of the initial budget of the state, quotation processes are the ones that are used for the procurement of projects when the amount of the contract is higher to a lower amount but lower to 0,00003 coefficient from the initial budget of the state, reverse bidding processes are the ones used to contract services when the amount of the contract is higher to 0,000002 coefficient from the initial budget of the state with the condition that participants struggle on a reverse bid the opponent's price [20] and an emergency procedure I used to assist emergency situations, these are performed on a direct way with providers from the state and the economic amount to be hired does not have limit but its objective is to overcome the emergency [21], see Table 1.

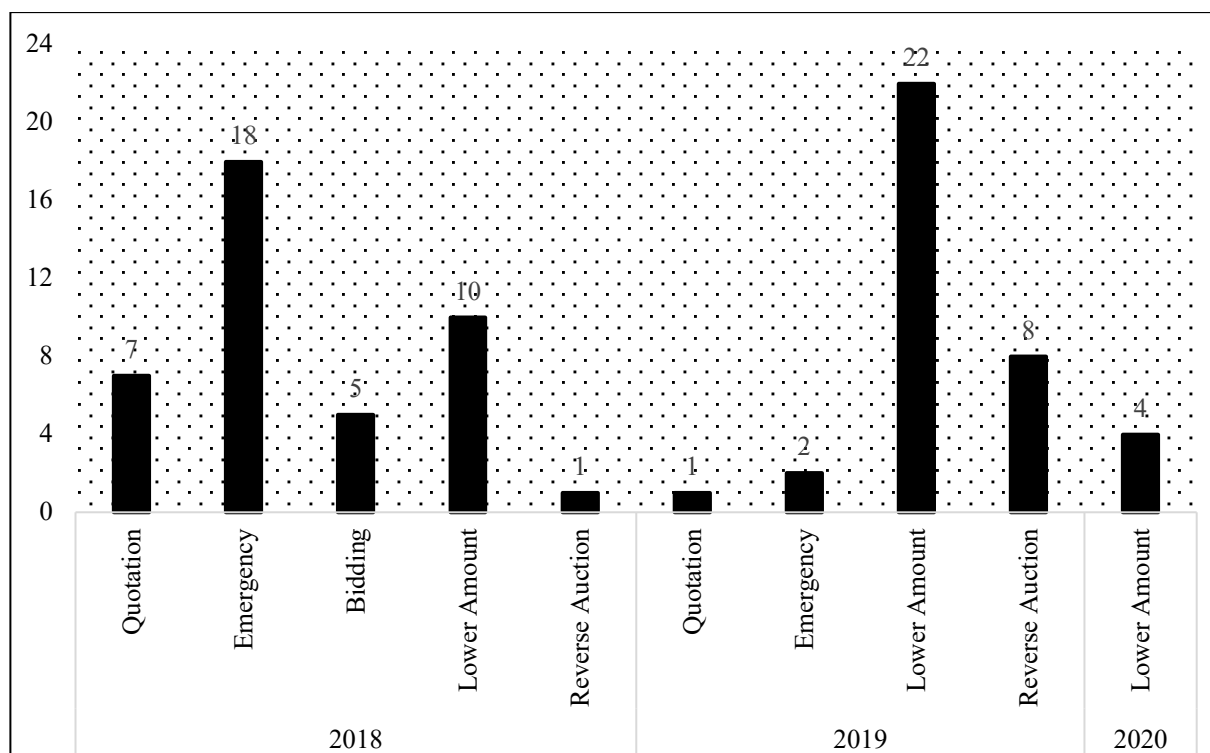
Table 1. Procurement modality and economic amounts for the years 2018, 2019 y 2020.

Procurement modality	Condition	Amounts year 2018	Amounts year 2019	Amounts year 2020
Lower Amount	Lower than	\$243.973,60	\$248.705,76	\$248.488,94
Quotation	Between	\$243.973,60 - 1.045.601,15	\$248.705,76 - \$1.065.881,83	\$248.488,94 - \$1.064.952,62
Bidding	Higher than	\$1.045.601,15	\$106.588.183,00	\$1.064.952,62
Reverse Auction	Higher than	6970,67	\$7.105,88	\$7.099,68

^a Table developed with data obtained from the official page of the National Service of Public Procurement of Ecuador.

With a record that has been completely validated on its content, the extracted information offered reliable data for the objectives of the investigation. The PWDCMT and DGF meet Administration and Contract Inspection duties respectively. Both directions have the control of the execution and works according to the functions assigned by the Organic Law of Public Procurement (LOSNC/OLPP) and the internal control policies of Ecuadorian Legislation.

The population in this study is comprised by all roads projects that were contracted and executed by the PWDCMT of the governorate of Morona Santiago through lower amount, quotation, bidding, reverse auction and emergency works, or those constructed within the years 2018 and 2020 see figure 1. Because of the quantity of gathered data, the taken sample was all population comprising roads construction contracts in the province of Morona Santiago, executed, competed, and received by the contracting entity between the years 2018 and 2020.



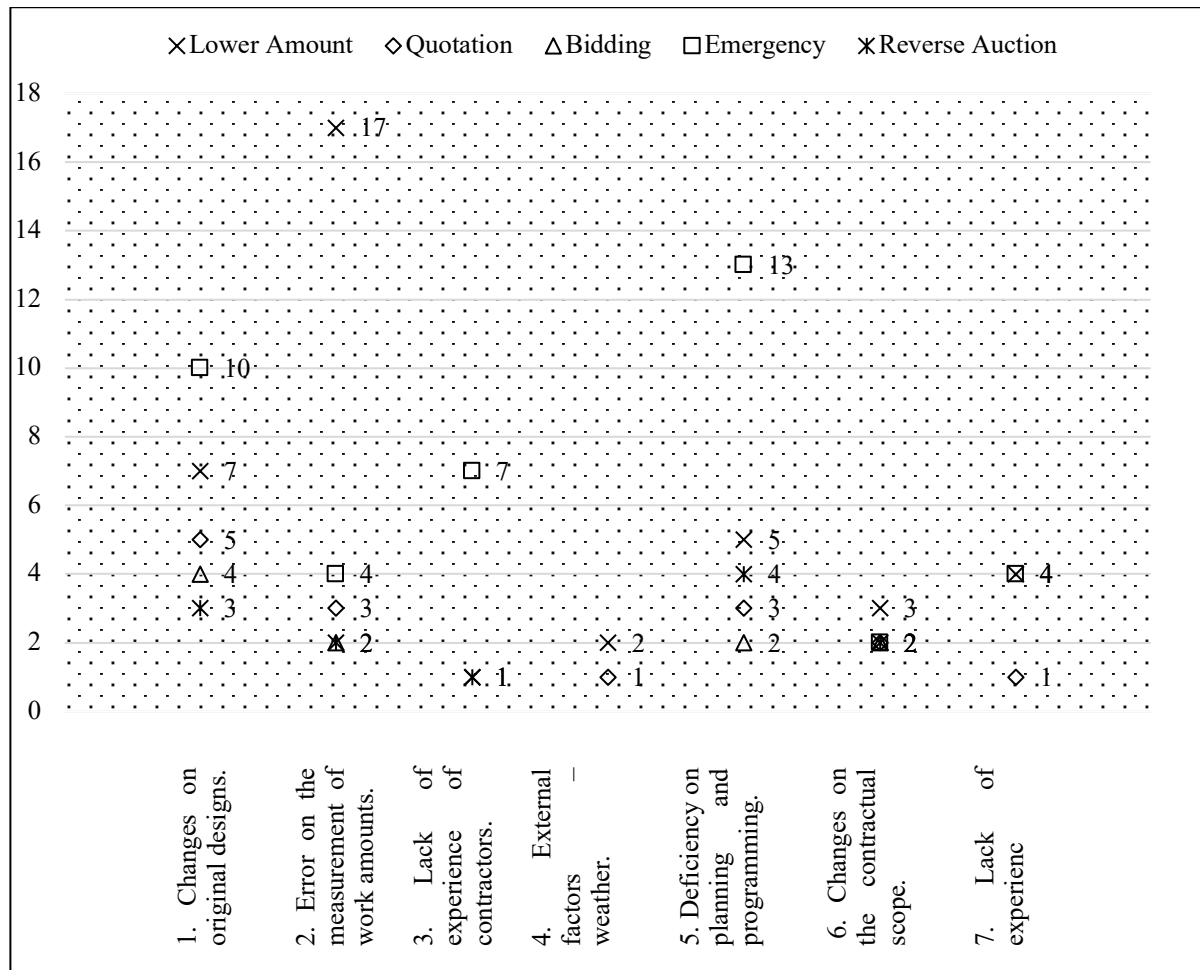
^a Projects comprising the population of study, consolidated in the subcategories formed by procurement modality, results on a total of 81 projects.

Figure 1. Amount of considered projects for the study, grouped according to procurement modality.

The analysis unit consists of words, directly or indirectly related with the management of the Roads Projects Direction whether it implicit or in some kind of identifiable way in the documentation of analyzed expedients. Context units are defined under textual criteria that form semantic relations with the analysis unit since they constitute their interpretative framework. They can be statements, paragraphs or documents. The information was organized in a digital record of projects, its characteristics and variables, this information was the basis for the information processing. For the analysis of the information some categories of analysis were raised, containing the variables of the hypotheses, from these categories what was analyzed was the fulfillment regarding the original conditions established in the contract. Thus, three categories were obtained: management of time, management of terms, and management of scope. With the purpose of establishing a homogeneous relationship among projects that share similar conditions, another subcategory was established regarding the procurement process: lower amount projects, quotation projects, bidding projects, reverse auction projects, and emergency projects.

To perform a qualitative analysis, it was required to propose a record that permits measure information for data analysis, to achieve this objective the information was coded identifying in the contractual documentation the causes that came into play directly or indirectly on the categories of costs, time, and scope management of projects. In total seven codification parameters were established on the design, planning and executions of projects stage, parameters that come from content analysis of the

contractual documents, and they are: 1. Changes on Original Designs, 2. Error in the estimates of work amount, 3. Contractor with lack of experience, 4. Weather external factors, 5. Deficiency on planning and programming, 6. Changes on contractual scope, 7. Lack of experience of engineers, to which the role of determining or not was given for each project and category. The results show in figure 2 the ponderation obtained for each procurement modality.



^a Reached ponderation for each influence not to achieve success for each procurement modality.

^b The assigned score to each factor of influence was done on the first stage of the qualitative analysis through content analysis of the contractual documents.

Figure 2. Influencing factors on projects not to achieve success and their ponderation for each procurement modality.

In this concept the analysis meets the condition of extensive categories in the sense all the population was analyzed and it embraces projects on all stages of roads construction, that means projects from roads openings to definitive level roads, are relevant since they adapt to the purposes of the present study, finally, they are mutually exclusive since the unit of analysis according to the amount of the contract will be placed in one subcategory and category. The results will be used to identify the state of management of time, cost, and scope of roads projects according to the procurement modality, that is lower amount, quotation, bidding, reverse auction or emergency, moreover it would be possible to identify the main causes that contribute the project not to be completed according to the expected in the pre-contractual stage. From these findings we can create guidelines that will help as a guide for main

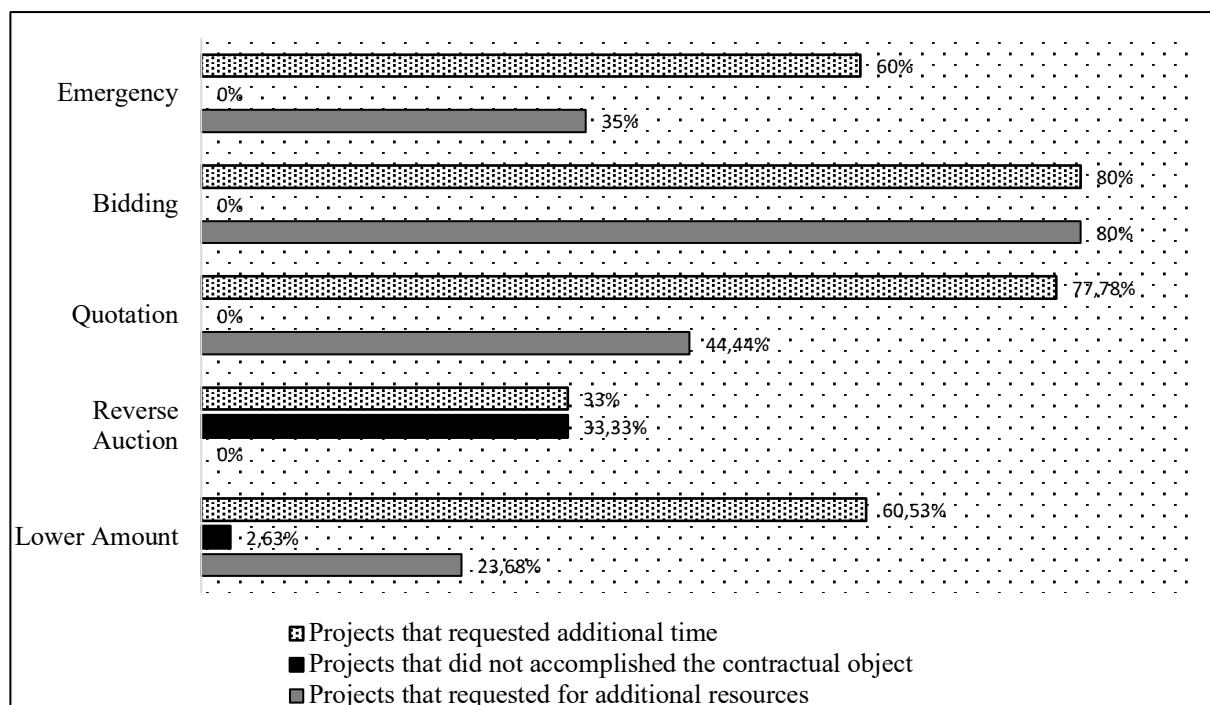
actors who are in charge of running and directing constructive roads projects in order to route the success when completing the project in terms of triple restriction.

3. Results and discussions

From projects constructed through contract by quotation the 44,44% of projects were completed with higher resource from the assigned initially and the 77,78% of projects requested an additional term to the established initially. The main causes according to the incidence for this category are: 1. Changes on original designs, 2. Errors in the measurement of work amount, changes in the contractual object and deficiency on the planning and programming with similar incidence and 3. Changes in the scope of the contractual object.

From projects constructed through emergency contract the 35% of projects were completed with higher resource and the 60% of projects requested additional time. The main causes are: 1. Deficiency, planning and programming, 2. Changes on original designs, and 3. Lack of experience of the contractor.

From projects constructed through bidding contract the 80% of projects were completed with higher resource and the 80% of projects requested additional time. The main causes are: 1. Changes on original designs, 2. Errors on the measurement of work amounts, 3. Deficiency, planning and programming and 4. Changes in the contractual scope with similar incidence.

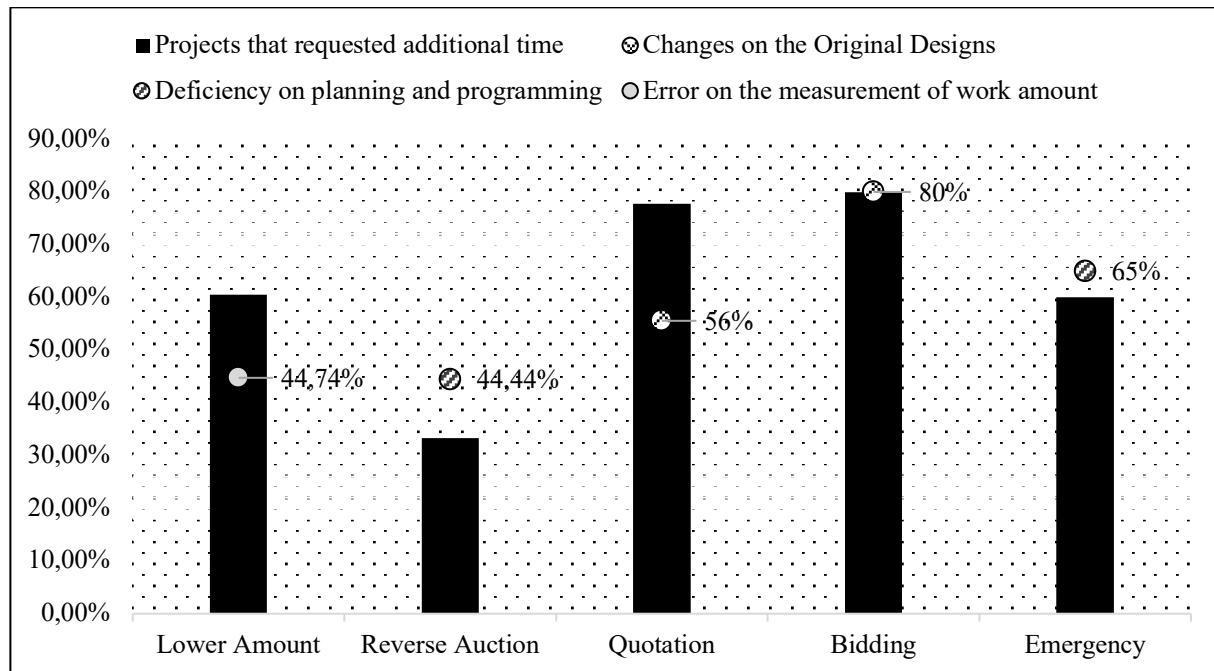


^a Percentage of projects that violated due date, cost, and contractual object, the results are shown for each procurement modality, the processed data correspond to 81 projects shown on figure 1.

Figure 3. Percentage of due date, time, and scope fulfillment of projects by categories.

From projects constructed through lower work amount contract the 23,68% of projects were completed with higher resource, the 2,63% did not fulfill the scope and the 60,53% of projects requested additional time. The main causes are: 1. Errors in the measurement of work amount, 2. Changes on the original designs and 3. Deficiency on planning and programming.

From projects constructed through reverse auction contract the 33,33% did not accomplish the expected scope and the 33,33% of projects requested more time. The main causes are: 1. Deficiency on planning and programming, 2. Changes on original designs with similar validation, 3. Errors on the measurement of amounts and changes on the scope of the Project.



^a Restriction of due date is the most violated in all types of contracts considered in this study, on figure 4 it is shown the percentage of projects that requested extra time, represented in bars and it is also shown the factor that influenced the most and its percentage in each procurement modality represented in circles.

Figure 4. Most violated restriction and factors that influenced on each type of contract.

On projects of lower amount, the due date is accomplished on a 60,53% of projects, the main cause is a failure in the measurement of work amount. On quotation the due date is accomplished on a 77,78% of the projects and the main cause is the changes on the original designs of the project. On Biddings the due date and the budget are accomplished on an 80% of the projects and the most influencing factor is the change on the original designs of the project. On reverse auction the due date and the scope are accomplished on a 33,33% of the projects, the main cause is the deficiency on planning and programming on the execution of the project. On emergency the due date is accomplished on a 60% of the projects and the most influencing factor is the deficiency on planning and programming on the execution of the project.

Analyzing the data on a global way from the 81 analyzed projects, 23 were completed successfully, which means accomplishing the due date, budget and scope initially assigned. On the 58 remaining projects, the factors influenced the following way: on 29 projects the original designs were modified, on 28 projects failed the measurement of work amounts, on 27 projects failed the planning and programming, on 11 projects changes were made to the contractual object, on 9 projects what influences was the lack of professional experience of designers and builders, finally on 3 projects the problem was caused by external factors as it is weather.

4. Conclusions

Regardless the procurement modality or contractual budget the present research project shows that when executing a road project there are many factors that generate complications on different stages so it is

considered important that professionals in charge of administration, management or direction of projects acquire competences in terms of project direction, good practices, techniques and tools. The implementation of these knowledge to processes that intervene on a project will influence the improvement of results of projects.

Results show that none of the completed products were executed on an organized way. Works have been executed in a disorganized way without defining the stages on projects. Therefore, it is recommended to consider that each project has a life span, which can be defined as the series of phases by which it goes through from its beginning until its closure, these are: 1) beginning of project, 2) organization and preparation, 3) work executions, 4) control and monitoring and 5) closure of project. An adequate management of these phases on a project and its constant feedback will substantially improve the control of expected results in a project.

Success on a Project starts from the adequate structuration and approach of its life span. That is why in this regard it is recommended to have five key documents for the planning and execution of the project, these will help with an effective direction: 1) Keep a record of constitution of the project in which all parties are identified, 2) Baseline of the scope of the structure of work unbundling, baseline of time or chronogram, baseline of costs or budget organized by terms and a matrix of responsibilities allocation.

Another important factor related to the no fulfillment of projects in terms of triple restriction is the change of the scope of the Project or the contractual object. The scope is the baseline of a project and has to be managed within the beginning phases of the project. The good practice at this point is to establish the scope with the gathering of all the requirements so that the project accomplishes its objective, it is also fundamental to improve the technical abilities of professionals that elaborate projects, it is necessary to establish that the department of planning be the ones in charge of revision and approval of projects. For the execution it is recommended to put into practice the elaboration of a structure of work disaggregation in which all deliverables of the project are defined on a sequential and organized way.

Keeping in mind that in most of the analyzed projects there have been changes on the original designs and a bad measurement of the work amounts, which has caused inconsistencies in the fulfillment of the activities, it is proposed to professionals in charge, the elaboration of a Project Management Plan, which includes Management Plans for each stage of the life span of the project, it must include the way to define how to execute each phase and how to control and monitor. Success of a project highly depends on establishing work according to the Project Management Plan and producing deliverables.

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