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Theme: Project engineering, BIM technologies, experiences and applications

La adjudicación en el proceso de control de las inversiones aplicando la tecnología BIM

The award in the investment control process applying BIM technology

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Abstract:
The development of the investment process requires an award procedure, which allows timely deliberation in favor of one of the parties in litigation, involved in the contract, in the investment processes, where decision-making requires the analysis of the information, which characterizes the problem, attending to the regulations defined in the protocol, which characterizes the Building Information Modeling technology, (hereinafter BIM). The construction process, due to its diversity of multidisciplinary actions and requirements in the fulfillment of quality in BIM, generates conflicts between the parties to the contract, which require agile and precise solutions, through an award process, that guarantee the control and monitoring of production, both physically and in cut values. The objective of this work is the development of a procedure to control the execution of the investment, applying the method of the three cuts and the method of earned value, with the use of the indicators provided by computer tools such as Project, Gespro and Primavera, to provide timely and transparent solutions to problems, through an efficient adjudication process, which provides the necessary support for the application of BIM technology. In the content of the topic, the theoretical framework, the execution control, the adjudication process and the study of a case in the Prado Hotel in Havana City are developed.
Keywords: award, control, investments, technology BIM

Introduction

The development of the investment control process, with the application of the BIM technology methodology, is characterized by having a multidisciplinary participation, better organization and discipline, with greater demands on quality, cost and time, which stimulate the The emergence of problems between the integral parts of the contract, typical of the development in the application of new technologies and for their identification and solution, requires agile adjudication processes, which guarantee the continuity of the investment control processes, with the objective of achieving the results, within the established timeframe, within the framework of the budget and with the quality required by the client and stakeholders.

The objective of the work is the development of a procedure to control the execution of the investment, to identify the conflicts between the integral parts of the contract and provide their solution, applying an efficient adjudication process, based on the information provided by the method of the three cuts and the earned value method, with the use of cost, time and quality indicators, in order to provide timely, robust and transparent solutions to the problems between the parties to the contract, with the use of the new technologies, as a means of guaranteeing the application of BIM technology, with the computer support provided by systems such as Project, Gespro and Primavera, in the control of investment execution.

The problems in the investment process are numerous and diverse. With the development of new technologies, solutions to new problems require new analysis processes in search of efficient solutions. The award is the process of assigning a right, by a certified and authorized organization, to one of the parties to the contract in dispute, through the analysis of technical and economic information, provided by the status reports of the investment project by courts , from the beginning to the current state of the investment, to support the decision-making, in favor of the right of one of the parties in litigation, with its corresponding opinion, in the application of BIM technology.

BIM technology is the 3D virtual model oriented to objects, parameters, elements and components, for the representation of documents, graphics and writings, with physical and functional characteristics, for mature

organizations with comprehensive programs, which has its beginning in a protocol, that regulates its operation through an integrated, strategic, unique, multidisciplinary, collaborative, transparent and multidimensional information system, defined from the beginning to its demolition, with significant computer support, which guarantees the quality management of projects and decision-making throughout their life cycle, in an integrated management system.

The BIM protocol provides a legal conceptual framework for the organization, within the legal framework that establishes the contractual commitments between the interested parties. It is the unit that generates the contracting system where the obligations of the parties are established based on the client's requirements. It stimulates the methods of integration of the project teams with the interested parties, within the adoption of the common standards that regulate the key processes through the legal documentation that governs the award process.

The regulatory framework for project management, RIIPRO project engineering, BIM and the investment process has been regulated by the Project Management Body of Knowledge (PMBOK) VI 2017, Decree 327 of 2013, which regulates the investment process in Cuba, the ISO 9001, 10006 of 2003, 21500 of 2008 and 19650 standards, which with their integration in the BIM protocol, define an information system, which provide guidelines and regulations to specialists, who participate in the investment process, both in planning and control by cuts, through effective management, based on the identification of indicators.

The ISO 21500 standard was developed since 2008 with the purpose of achieving a guide for project management The same part of the fundamental effort of three nations: United States, United Kingdom and Germany, through three very recognized associations such as the Project Management Institute (PMI, 2009); Projects in Controlled Enviroments (PRINCE2, 2009) and The International Project Management Association (IPMA, 2012). They propose its development in five phases in a similar way to the PMBOK, with its cost systems. This International Standard places projects in the context of programs and project portfolios. But it does not provide detailed guidance on the management of programs and project portfolios, with its execution strategy, based on its priorities, with the aim of optimizing financing. [3]

In the international framework, the antecedents of the subject are limited and yet the problem is in force in a large number of investments, which deal with problems with quality, logistics and financial economic management, both with national, foreign or mixed resources. [1]

The content of the topic shows the adjudication process, the investment control system and the study of a case in the Prado Hotel in Havana City.

Materials and Method

The execution control process

It is the process that allows to measure the progress of the project by systematic cuts, taking into account the performance of a set of variables, indices and indicators, which govern the development of the project, based on the planning of tasks, resources, cost, time and quality, applying the method of the three cuts and the method of earned value, in an integrated management process, supported by an information and communication system to the parties interested in the project.

The three-cut method

The method of the three cuts is the process of controlling the execution of the schedule of the key processes of the investment life cycle, providing the necessary information to develop strategic decision-making, making use of the indicators provided by the method of earned value and financial economic management, in the integrated management process.

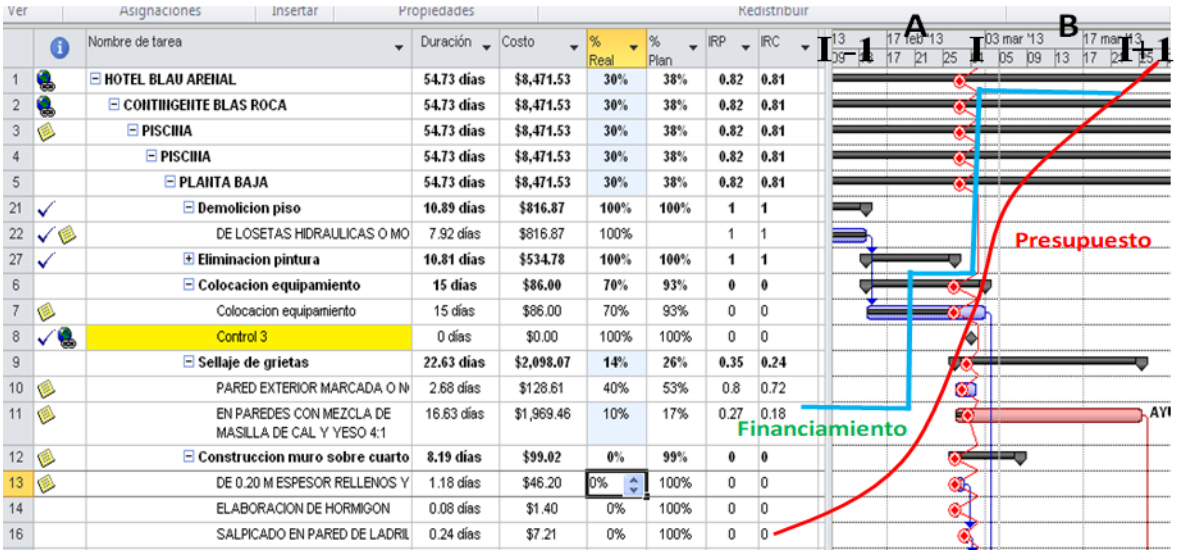
The method is applicable in the control and monitoring of the schedules that are developed in the key processes of the investment life cycle and especially in the key construction process, where it is most effective and where there are major problems related to the contents of the compliances reflected in the contracts and that require a differentiated treatment through an award process.

The objective of the process is to provide a procedure for project control. Apply the outage control method in the project execution schedule

Develop the earned value method and indicators. Develop decision-making, with the following distribution of its contents:

- Prepare the schedule for the project outage control Baseline, progress line, outage tracking
- Control the agreements in I-1 Goals for interval A
- Qualitative evaluation of the project in interval A Identification of conflicts. Strategy. Indicators Possible solutions. Behaviour
- Quantitative evaluation of the project in I. Diagnosis Budget and financing control. Accounting. Cash flow.
- Prepare interval B. Forecast. Profit management. Deliverable financial balance. Quality
- Decision making in court I.
- Update the information and communication system. Contract. Status report. Inform stakeholders

In order to illustrate the application of the method, the project control of the Hotel Blau Arenal on the Santa María beach in Havana is developed.



	Nombre de tarea	Duración	Costo	% Real	% Plan	IRP	IRC
1	HOTEL BLAU ARENAL	54.73 días	$8,471.53	30%	38%	0.82	0.81
2	CONTINGENTE BLAS ROCA	54.73 días	$8,471.53	30%	38%	0.82	0.81
3	PISCINA	54.73 días	$8,471.53	30%	38%	0.82	0.81
4	PISCINA	54.73 días	$8,471.53	30%	38%	0.82	0.81
5	PLANTA BAJA	54.73 días	$8,471.53	30%	38%	0.82	0.81
21	Demolicion piso	10.89 días	$816.87	100%	100%	1	1
22	DE LOSETAS HIDRAULICAS O MO	7.92 días	$816.87	100%		1	1
27	Eliminacion pintura	10.81 días	$534.78	100%	100%	1	1
6	Colocacion equipamiento	15 días	$86.00	70%	93%	0	0
7	Colocacion equipamiento	15 días	$86.00	70%	93%	0	0
8	Control 3	0 días	$0.00	100%	100%	0	0
9	Sellaje de grietas	22.63 días	$2,098.07	14%	26%	0.35	0.24
10	PARED EXTERIOR MARCADA O N	2.68 días	$128.61	40%	53%	0.8	0.72
11	EN PAREDES CON MEZCLA DE MASILLA DE CAL Y YESO 4:1	16.63 días	$1,969.46	10%	17%	0.27	0.18
12	Construccion muro sobre cuarto	8.19 días	$99.02	0%	99%	0	0
13	DE 0.20 M ESPESOR RELLENOS Y	1.18 días	$46.20	0%	100%	0	0
14	ELABORACION DE HORMIGON	0.08 días	$1.40	0%	100%	0	0
16	SALPICADO EN PARED DE LADRIL	0.24 días	$7.21	0%	100%	0	0

Figure No 1. Section I in the Hotel Blau project

The method generates three cuts I-1, I, I + 1 with the intervals A and B of figure No. 1. with the information provided in the cut (I - 1), the update in the interval A, the accumulated evaluation in (I), the forecast in B and the goals for (I + 1), allowing to develop the continuous process by cuts, where all the members and interested parties intervene

updating the information in the interval A, processing and interpreting the results according to the development of its functions, to prepare the status report in section I. The graph shows the intervals A and B close to section (I).

Project agreements in the previous cut I - 1

The first step is the identification of the agreements made in the previous cut, where the main problems that should have been solved in interval A of this cut I are reflected.

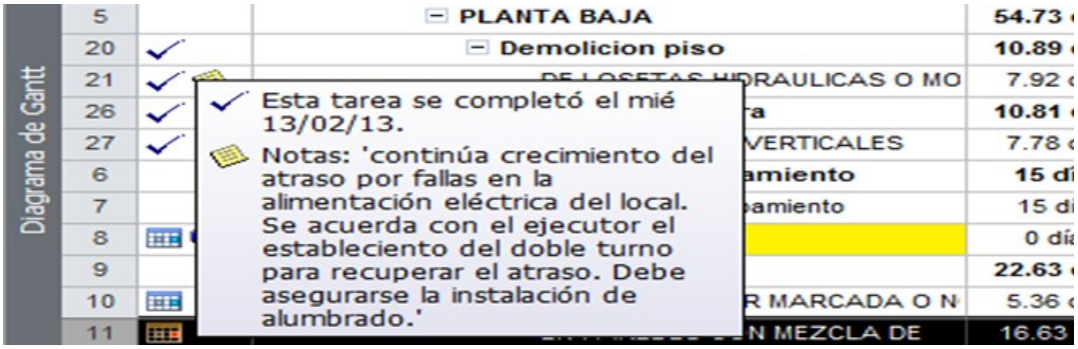


Figure No. 2. Reference of the agreements to the tasks in the schedul

Figure No. 2 shows how to represent the agreements associated with the tasks in the schedule using the notes. The agreements are ordered according to their priorities according to the impact on the project. The agreements are kept in the schedule notes as evidence and as part of the status report, where the important agreements that affect the project are reflected and must be known to the functional structure and managers from the BIM information system.

The effects that must be resolved by the executor in his direct interaction with the investor, designer and supplier, are defined in the schedule specifying the effect, causes, possible solutions, the person responsible and the date with reference to the provisions of the contract. When it involves a delay, it is necessary to include the Arrears Adjudication Act with Fixed Cost Increases, hyperlinked to the affected task, defining the person responsible.

Project update at current interval A

The updating of tasks in interval A starts with the% completion of the tasks, based on the volume of work executed, in relation to the planned, the actual duration, the actual resources and the adjustment of the rates. Overdue tasks are reflected by the system and causes are reflected in notes with possible hyperlinks if necessary.

Interval A identifies the tasks that present delays with their causes reflected, as evidence in their notes or hyperlinks and it is necessary to evaluate it by estimating the evaluations according to visual information, or following the criteria of the scorecard of good, fair or bad according to the result of its indicators.

Applying a filter as shown in figure No. 3, it is possible to obtain only the tasks with delays, on which it is necessary to develop corrective actions taking into account the causes and their effects on the project, taking into account the slack and their given priorities. down the critical path

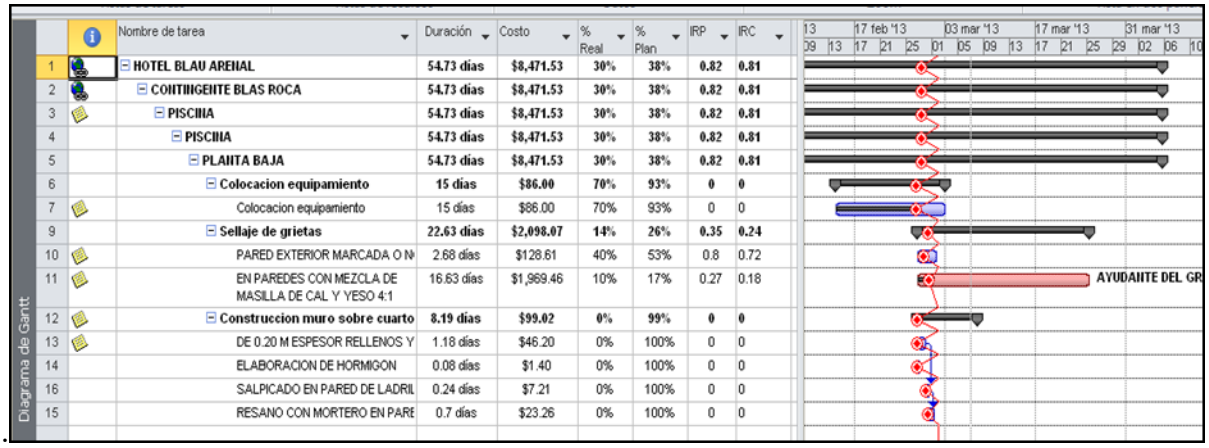


Figure No. 3. Filter with the tasks that present delays in the project

After applying the filter, the selected tasks are evaluated using the IRP and IRC indicators of the schedule and cost. Each project has different characteristics and responds to indicators that are dependent on its objective function, so that both cost, time, quality, logistics and performance can have different weights depending on the type of project. [two]

The system calculates the indices of the planned cost of the planned work, CPTP, the planned cost of the actual work, CPTR and the actual cost of the actual work, CRTR, for the calculation of the indicators, IRP = CPTR / CPTP and the

IRC = CPTR / CRTR, cost and time, applying the method of earned value and the physical progress and in values of the project. The quality, logistics and performance, qualitatively and their weighting, allow to obtain the evaluation of the tasks, to proceed to the qualitative evaluation of the current cut A.

Results and Discussion

Cumulative evaluation of the project in cut I

After updating the project with the% of progress of the tasks in interval A, we proceed to the evaluation in cut I, cumulatively from the beginning with the baseline, the progress line and the cost center of the project. During the execution of the control process, it is carried out first in the interval in A and then in I.

The evaluation of the current interval A, may be different from the evaluation accumulated from the origin in I. This is an important concept that the project manager and the investor should have when evaluating the investment in the cut. In the cut of figure No. 1, the project is at 30% and should be at 38%, as of the project update. It presents a deviation of 8% due to the tasks with arrears and use of the budget, according to the values of the IRP = 0.82 <1 and the IRC = 0.81 <1 indicators of the project and the indicators of the IRP and IRC tasks with problems, whose Evidence of compliance with the technical standards and planned tolerances were collected in the notes of the tasks and reflected in the corresponding filter.

The application of the indicators, as a way of evaluating the control and monitoring of the planned goals, guarantee the uniformity of the evaluation of the projects, making use of a uniform methodology, in order to achieve the trend in a set of evaluations by cuts, to develop decision making.

The IRC indicator and the final expected cost, CEF = CPF x IRC and the trend, allow evaluating the possible results at the end of the project.

Preparation and prognosis in the next interval B

The preparation of interval B of the project, represents the proactive position in the control process, is the strategic action of the management system, where solutions are provided to the problems identified in interval A to solve them in interval B or until the end of the project, taking into account the expected results in it and the problems already identified in B. It is the preparation of the project to continue its execution, in the next interval B with the cut-off I +1, where the executor's work plan is specified in B, with obtaining the results in physics and values**.**

En el intervalo B, es necesario prepararse para asumir las tareas bajo las condiciones imperantes en el momento de la toma de decisiones, que pueden ser diferentes a las condiciones del escenario inicial cuando fueron planificadas, donde el recurso humano, la calidad, costo, suministro y tiempo, con sus respectivos riesgos, en las condiciones reales actuales de ejecución del proyecto y la gestión del cambio.

Decision making

Decision making is defined as the selection of an alternative among a set of solutions based on the evaluation of the weighted indicators applying the knowledge system provided by Operations Research. Decision-making is part of a process in which the decision is only one step and its quality depends on the level of preparation of the information provided by the system and the man's experience in making good use of the information in making decisions. decisions.

Decision-making in I is developed on the basis of the discussions in the fulfillment of the agreements made in the previous cut I-1, the evaluation in the current interval A, the accumulated evaluation in the cut I, the preparation of the next interval B and its problems and the trend of the indicators in the previous cuts, taking the agreements that will be controlled in the next I + 1 cut, developing a continuous process by planned cuts. [3]

The control process making use of the three cuts method and the earned value method and its indicators, provides the necessary information to proceed with the adjudication process, when there is no agreement between the parties and provide a technical, economic and social solution. , to the identified problem. [8]

Award procedure

The adjudication is a transversal process to the investments and can be presented at the moment in which the problem arises between the parties, previous contractual document that specifies the contracted commitments. In general, the contract integrates a schedule, resources, costs, financing, cash flow, accounting and tables provided by the parties, in a planning process, to control the indicators according to the method of the Earned Value, the PMBoK, ISO Standards and Decree 327, to manage the process, in order to identify the causes that originate the problem and provide an opinion on how to solve it. [7]

The award occurs in different forms of the investment process, where the most significant is related to the differences in the development of the budget and financing, when the project is left with insufficient cash flow to continue the project, with non-compliance with the contents of the updated initial investment contract. Other forms of awarding the

investment are presented from the bidding process and the logistics processes established in the organization's BIM protocol.

The contradictions between the parties interested in the contract during the execution of the investment, arise as a need for development and an objective reality, which must be resolved in a timely manner by cuts in the schedule, taking into account the provisions of the contract, its supplements, the budget, financing, cash flow, balance sheet and accounting system. At times when problems cannot be resolved normally between the parties, the presence of uncommitted agents is necessary to provide effective responses and avoid delinquent decisions that complicate problems.

Therefore, in the investment process, the presence of the adjudicator at key moments is a necessity, in order to avoid the dilation of problems, which complicate decision-making.

For this reason, this process requires the participation of a team made up of advisers representing the parties and a main specialist, who may be a teacher not committed to the parties. The team can be made up of three specialists or five depending on the scope of the problem to be solved.

The participation of the adjudicator may be requested at the time of a conflict during the execution of the investment, in a continuous process of monthly control to avoid greater evils or at the time of specifying the results of a tender where the investment is awarded to an organization. In all processes, the content of the current protocol is an important basis for the development of the award.

The main actions to be carried out are the following:

- Claim by one of the parties for breach of the investment contract
- Request for award to an authorized organization
- Award team
- Information on the parties. Identification of the problem. Hypothesis of the parties
- Request for investment information to the parties

✓ Initial contract and adjustments
✓ Schedules for monthly cuts from the beginning in the Ms Project
✓ Monthly production status reports from the beginning
✓ Financial balances. Changes
✓ Partial award report. Analysis with the parties

- Final award report

Work program for the development of the award

The work program is the basis for the development of the award, which will be approved by the parties requesting it, under a contract that regulates the process following the proposed procedure, adjusted to the characteristics of the investment and the current regulations included in the BIM protocol.

As a way to show the application of the procedure, an adjudication case study is developed at the Prado Hotel in Havana, executed by a team from the International Center of Havana (CIH

Claim by one of the parties for breach of contract

The investment has an initial contract, in which during its initial process it has a good performance and in the middle of the execution, there is a problem of lack of financing to continue the investment, raised by the builder and the investor who do not agree With the builder, he submits the claim to the CIH adjudicating organization, not committed to the parties, prior agreement with the builder organization, seeking a case study and an enlightening opinion on the problem.

At the request of the parties through a contract with the CIH, a work team is created made up of a specialist from each of the parties from the Ministry of Construction (MICONS) and the Ministry of Tourism (MINTUR), with a professor specialist in the subject of project execution control applying the Integrated Project Management, not committed to the investment and two CIH activists, for the organization of the information, proceed to develop the award.

Identification of the problem. Hypothesis of the parties

The work team asks the parties for the information necessary to carry out the award, which is reviewed by each of the specialists who are members of the team and organized by the activists, according to the content of the procedure.

The content of the requested information is the initial investment contract with supplements and changes, the monthly cuts made in the Project schedule, from the beginning of the investment to the current cut-off date, the status reports for cuts with the indicators, IRP and IRC product of the management process, of the three cuts method, applying the earned value method, in order to evaluate the causes, the effect, the decisions and the agreements made during the

project change management. As complementary documentation of the investment, the feasibility study, budget, financing, cash flow, permits, negotiation, risks and the quality system**.**

The investment project in its life cycle, goes through the controls for weekly tactical and monthly strategic cuts reconciled with the cost center, for the development of decision-making within the framework of the integrated management system.

The initial information is organized sequentially and shared in the work team, as a unique means of information, against which the hypotheses and formulation of the parties are compared, in search of the solution to the problem, through the initial study of the schedules to identify the causes that originate it.

Monthly production status reports from inception

The monthly strategic production status reports will be delivered, based on the weekly tactical cuts, made in the Project, with the indicators provided in the PMBoK earned value method, in order to reflect the two versions of the parties specifying the problem as shown in figure No 4, where the budget curve up to the current date F1 is represented, the investment stoppage due to lack of financing F2-F1 and financing according to the hypotheses of the parties and the fixed cost increase stop product.

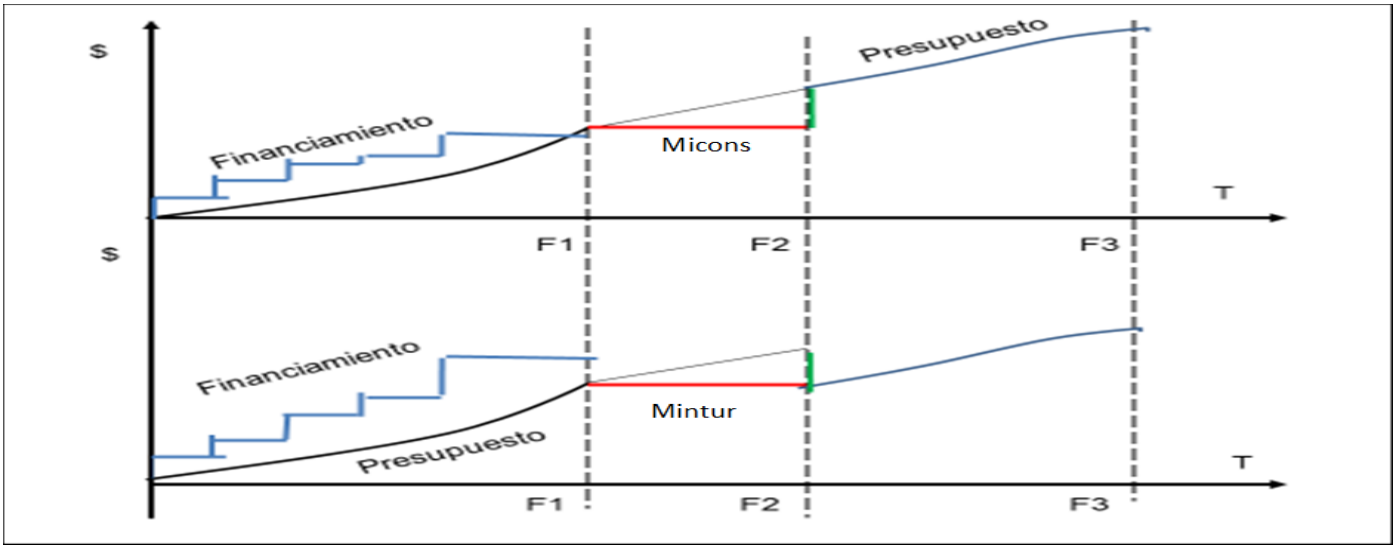


Figure No.4. Hypothesis of the parties, Micons and Mintur

The builder of the Micons claims from the Mintur investor, an increase in financing on the F1 date, to guarantee the continuity of the work and the investor responds that the sum of the advance and the financings delivered up to the F1 date, guarantee the cash flow for the continuity of the work. The non-agreement between the parties during the time interval F2 - F1 generates an increase in fixed costs that are claimed by the construction.The Project provides the accumulated values such as indices, CPTP, CPTR and CRTR, for the calculation of the indicators, IRP = CPTR / CPTP and IRC = CPTR / CRTR, from the beginning of the work, with the programming, production and the financing, in order to demonstrate through its curves, the behavior of financing and its relationship with the indices, as shown in figure No.4

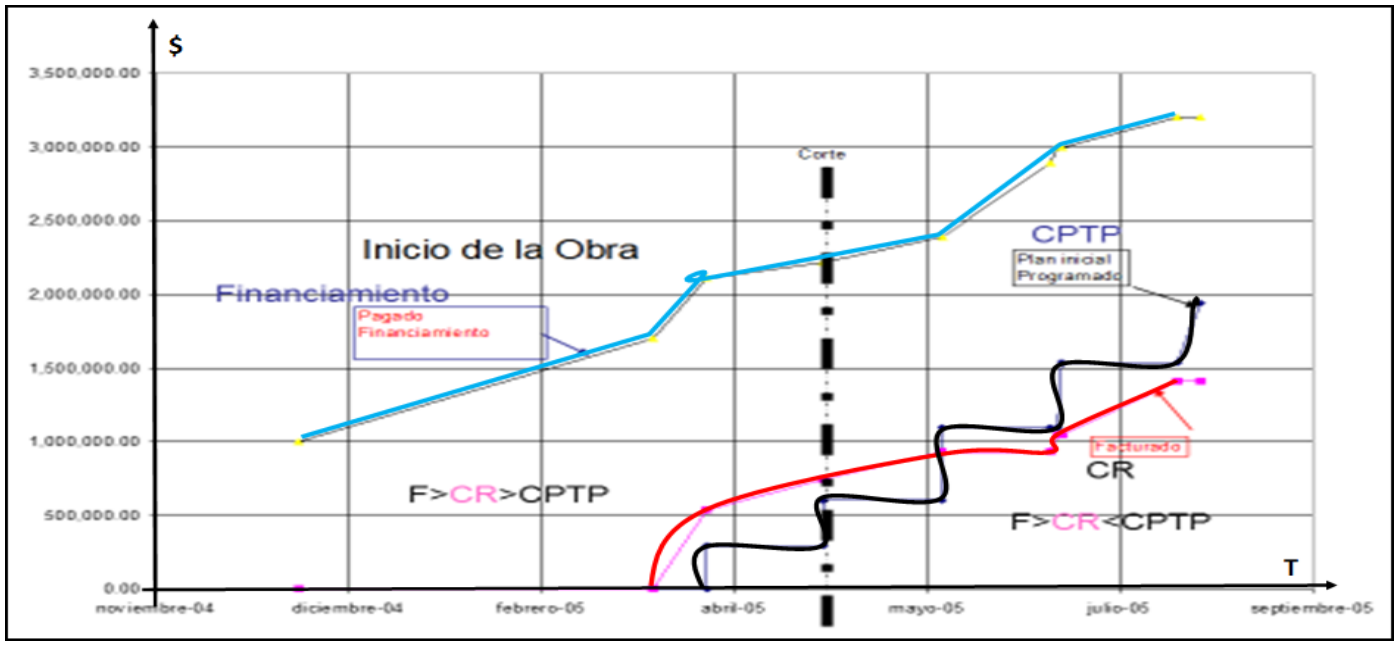


Figure No. 5. Behavior of the budget, financing and indices

From the analysis of figure No 5, it can be deduced that, at the beginning of the work, a good productivity is reached above the schedule, with real cost CR invoiced above the planned and IRC values> 1, values above the unit with a good performance of Financing> CR> CPTP, after June, low productivity prevailed, little certification, low use of the workforce, lack of a systematic control by cuts to make the appropriate decisions and lack of an effective control of the materials by reversing the process with Financing> CR <CPTP, in which the IRC takes values lower than the unit,

demonstrating that there was always the availability of financing above the expected, motivated by the excess of advances provided by the Investor, without an accurate certification of the deliverables.

Figure No 5 shows a cut, where the high level of planned financing, the CPTP and the real cost invoiced CR> CPTP can be seen. During the first months of February to May, financing is available well above the CPTP, so there were no problems, the value of the real certified CRTR production is above what was planned, IRC = CPTR / CRTR> 1 there are no problems and the CPTR until May with very good productivity IRP> 1.

In June the CRTR = CPTR = CRTR and the IRC = 1. In the following months until August, the value of the CRTR production remains below the planned CPTP, but with a parallel trend and close to what was initially planned.

In this case there is a delay in programming and Financing >>> CPTP> CPTR IRP <1 with excessive financing. In the period from May to June, there is an increase in financing much higher than that required by the initial programming of the project, reflected in the contract at a time when the production gradient decreases.

As of May, where there are already problems of low production, with a supply of sustained financing contingent on the value of CRTR production, with values below the planned CPTP, with unreliable cuts reflecting the changes and lack of requirement by the investor.

Final award report

The final award report determines a good start, with a good level of production, where it made good use of the financing, with the CPTP and the real cost invoiced CR> CPTP, with a good performance without problems. In June the IRC = 1.

As of June, the level of production decreases with delays in deliverables and a reduction in CR <CPTP, with IRC values = CPTR / CRTR <1, with CPTR values <CPTP and IRP values <1. Maintaining the planned financing provided by the investor.

As a result, it is concluded that the investor delivered the planned level of financing without a control of the builder's production level and therefore, the builder had the necessary cash flow to continue the work. The investor did not maintain economic and financial control of the production level and made financing deliveries without due certification. The fixed cost increment for the downtime is affected to the builder.

The final report prepared by the award team is presented to the authorities represented in the integral parts of the award contract requested from CIH, for their approval. Once the report is approved, it is presented to the competent courts, for their evaluation and opinion, which once it becomes final, it is carried out.

Conclusions

1. The investment execution control procedure, applying the method of the three cuts and the earned value method, with the use of indices and indicators provided by computer tools, allowing the evaluation of investments in the cuts, with the objective of identifying problems and their solutions, in an integrated management process.

2. BIM technology provides an integrated, strategic, unique, multidisciplinary, collaborative, transparent and multidimensional information system, with significant computer support and the application of the earned value method, to guarantee the monitoring and control of investments.

3. The adjudication process, supported by the process of controlling the execution of the proposed investments and the foundations provided by BIM technology, develops an agile and efficient procedure, which allows identifying the causes and effects of the problems, in order to proceed to delimit the responsibilities of the integral parts of the contract and dictate the way of solving the problems, based on the information provided by the courts and their status reports.

4. As new construction technologies are developed and the certified investor acquires this knowledge, the level of demand for quality and the rigor of contracts becomes more evident, the need to use award services becomes makes it more necessary.

5. The award process is transversal to the entire investment process, the use of the contract as daily work material and the demands of the quality of the new technologies by the interested parties, make the award process present, at the right time. in which there is no agreement between the parties interested in the contract.

6. Taking into account that, on occasions, there have been financial breaches; poor quality of works during construction and / or completion; As well as the non-compliance with the time of the stages of the construction process and others, expressed in the contract and that they have generated demands by the parties involved in the investment, it is necessary, in these situations, the solution of the dispute through a tribunal or arbitration commission, which analyzes and provides the pertinent solution to claims.

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