

# Comparative Analysis of the Financial Behavior of Structural Systems

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**Abstract**— *The focus of this study is quantitative, of a non-experimental type, since it is intended to study the financial behavior in a social housing construction of up to six floors, with the aim of analyzing the financial data issued by the company, without modifying, manipulate or intervene directly on the information obtained.*

*The methodological design is descriptive cross-sectional since the data will be obtained in a single moment, to be analyzed in a case study, where the purpose is to describe the financial behavior of the structural systems of load-bearing walls and structural masonry, reaching the comparison financial with the identification of the differences and similarities, in which the structural system with the best viability is determined.*

**Keywords**— *Structural system, load-bearing walls, structural masonry.*

## I. INTRODUCTION

In our country Colombia, family housing of social interest has become an opportunity for families who want to have decent housing, the national government has created multiple strategies to protect the well-being of the most disadvantaged families in the nation, changing and transforming environments where the Society is the center of this great work framed in Colombian legislation [1].

In turn, generating healthy spaces and controlling the variable of city expansion, guaranteeing that human settlements develop in a more organized manner, certifying the provision of basic services and generating people who acquire this type of low-cost housing, stability and protection [2].

In this type of development, the national administration led by our president of the republic intervened in a special way, along with the private companies that execute projects, these companies working together with the national government present endless offers in the market. Housing units that supply the needs, where the client can avail of various financing systems for the acquisition of real estate [3].

Despite the fact that this type of housing is low cost VIS. It must comply with parameters so that they are habitable and under the control of the corresponding entities regulate compliance, under design standards, quality, execution of construction processes, urban and architectural design, whatever adjusts to the need and coverage of services. Public. Its maximum market value is one hundred and thirty-five monthly legal minimum wages in force (135 SMLM) [3].

Taking into account the average cost and the ceiling established by the national government, the construction of

affordable housing adopted two of the most used structural systems in this type of housing which are, structural masonry and the load-bearing wall system [4]. Both types of structural systems are in an industrialization stage, where the requirement in mass production to meet demand and the speed of their processes require a comprehensive analysis to determine which type of structural system should be used, linking the variables of utility, profitability, cost benefit, a better decision-making can be financially analyzed by senior management and conclude as an investor how profitable it can be to invest in these types of projects [2].

## II. THEORETICAL FRAMEWORK

### *Social Interest Housing*

Low-income housing is defined as housing developed to guarantee the right to housing of lower-income households [4]. In each National Development Plan, the National Government will establish the type and maximum price of solutions for these households, taking into account, among other aspects, the characteristics of the housing deficit, the possibilities of access to credit by households, the conditions of supply, the amount of credit resources available from the financial sector and the sum of State funds allocated to housing programs [5]. In any case, the money or in-kind resources allocated by the National Government, in development of legal obligations, to promote low-income housing will be directed primarily to serving the country's poorest population.

### *Load-bearing Walls*

According to NSR 10, load-bearing walls are walls that, in addition to their own weight, carry other vertical loads from the mezzanine and the roof. These walls must be tied to the diaphragm and must have vertical continuity [3].

### *Procedure Regarding Placement of Concrete*

The concrete in the foundation mesh should be placed starting from the axes of the load-bearing walls and continuing with the transverse axes in continuous sweep, in the casting process if any suspension occurs, they must be treated under vertical joints in the axes of the stiffness walls transverse to load-bearing [6].

### *Structural Masonry*

The resistant earthquake standard applied for the Colombian territory sets the scope of structural masonry as structures comparable to structures in other types of materials.

Classified as follows: Reinforced cavity masonry, reinforced masonry, partially reinforced masonry, unreinforced masonry, confined wall masonry, diaphragm wall masonry, and externally reinforced masonry [1]. The use of this type of structural system depends directly on the seismic hazard zone and type and use of the building [7].

#### *Financial Statements*

It is that financial information that provides reliable elements of judgment that allow both internal and external users to evaluate aspects such as: economic and financial behavior of the organization, its stability and vulnerability, as well as its efficiency in meeting its goals [3]. The organization's ability to maintain and generate added value to its resources, obtain adequate financing and evaluate the viability of the organization, its growth and business value. Consequently, the financial statements of an organization must provide the user with elements of judgment depending on solvency, operating efficiency, financial risk and profitability [8].

External opportunities. Where solvency serves to examine whether the organization manages its financial resources and its future vision and ability to meet its commitments as an organization in the short and long term, and its obligations for clarity of those who invest in it [9]. Strategic liquidity enables the organization to meet its cash commitments at the required time. Operational efficiency, generates value by working at production levels aligned with its installed capacity on demand, avoiding idle assets and with the strategist mind. Knowing the financial risk allows organizations to evaluate the possibility of managing it to prevent an external loss that in the future changes the current or expected financial situation,

#### *Financial Analysis*

Financial analysis is a tool that all organizations need. The analysis activity involves the study of the knowledge of each of its components. It is an examination of the reality, principles and properties and functions of the organization. For this, data from different sources and resources, and in a particular context, information is generated, which in turn can be transformed into a decision-making factor. Every non-profit organization, without them, requires knowing elementary aspects of their financial performance, the economic, social and political situation they have, the expectations they generate, and the fulfillment of their objectives [10].

#### *Analysis of the Financial Structure*

Financial statements constitute the structure of an organization's financial situation and financial performance. The objective of the financial statements is to provide real information on the organization's statements, returns and cash flow, which in turn is useful for making economic decisions. The financial statements provide results based on the following statements [11].

Assets, liabilities, equity, income and expenses or the statement of profit and loss; within these also this change in net worth, cash flow. This compilation of information together

with the financial statements will help management to predict future cash flows, the distribution of resources and the degree of uncertainty of them [12].

#### *Horizontal Analysis*

There are several methods to analyze financial statements, depending on what is required to analyze proposes a particular method. Among them is the horizontal method which is based on various procedures such as the increase and decrease procedure. Which consists of comparing the homogeneous concepts of the financial statements to two different dates, obtaining from the compared figure and the base figure a positive, negative or neutral difference [7].

In this research project the legal aspects for its approach and development will be considered, taking into account the legislation based on the fact that Colombia is a state of law where all laws must be clearly known to the population, for which reason the government administrations are in the obligation to enact them, clearly and with easy access to society [13]. What is known among society about social interest policies is minimal, compared to the great effort of the state to provide communities with the right to decent housing [14].

Social interest housing is defined as a project that is aimed at guaranteeing the right to housing, focused on households that generate lower incomes, promoting a decent space to inhabit. Framed for Colombia in the political constitution since 1991 and recorded in article 51, where it indicates that. Every Colombian citizen has the right to decent housing. The state will establish the necessary conditions to give effect to this right and will promote adequate plans and systems for long-term financing", within the framework of social, economic and cultural rights [15].

According to the Law of 3 of 1991 it establishes that "by which the national system of social interest housing is created, the family housing subsidy is established, the territorial credit institute, ICT, is reformed and other provisions are issued." In its 1st article. Establishes the creation of the national system of social interest housing, linking the private and public sector, in the process of financing construction, improvement, relocation, authorization and legalization of housing titles. Everything will be done according to the plans of the government administration. In its article 6 it establishes that the state will make a contribution in money, this only once, of course the applicant complies with the provisions of the law [3].

Law 388 of 1997 aims to establish mandatory parameters with respect to the location where the low-income housing must be built, and the provision of basic home public services must be guaranteed [9].

Decree number 2080 of 2010, delimits the form of promotion and offer of housing projects of social interest by the compensation funds according to the management of resources and compliance with the different provisions of the law [16].

Law 842 of 2003 is the code of professional engineering ethics, which sets the guidelines by which engineering professionals in Colombia must abide [17].

III. METHODOLOGY

The methodology will be descriptive, qualitative and quantitative, based on the information collected, with the judgment of professionals with experience in the housing construction sector, who contributed through their knowledge, their perception of the viability in the preparation is known of this type of projects, the typology of the sample to know their perception had as a requirement to have worked in the sector directing or managing the development of this type of social interest housing projects and its conception in the types of structural systems, for this housing low cost [18].

In addition to the surveys carried out, information was identified for the body of development and the basis of justification, with an analysis of the construction sector in recent years, its development in the city of Bogotá, the determination of demand in the capital city and in the Sabana, the advantages and disadvantages that private companies have in the conception of this type of housing projects of social interest (VIS), the execution, development of schedule and budgets, the analysis of financial variables that allow determining the viability of projects executed in structural systems load-bearing walls and structural masonry [15].

Instruments or Tools Used

Among the tools that will be used will be surveys of professionals in engineering and architecture who are managing housing projects, who have knowledge about construction systems and processes and who, through the judgment of experts, allow to know the perception of viability in the development of housing projects, in this case social interest housing (VIS), where precise aspects were investigated to know their position vis-à-vis knowledge and perception of financial behavior through experience. Along with this, financial formulas were used to determine each of the financial variables used such as, internal rate of return, current net value, and benefit-cost ratio, and the Excel tool for the calculation and tabulation of the indicators [8].

Population and Sample

The population corresponds to the personnel involved in the case study, especially the senior management that is in charge of making financial decisions. In this order of ideas, a population of 10 professionals is estimated whose representative sample with a 95% confidence factor is 21 professionals, 14 from civil engineers and 7 from surveyed architects, with experience in project management and development. of housing, knowledge of construction systems, budget, execution of work, profiles that refer to positions of directors and project coordinators [5].

Scope and Limitations

The scope of this investigation is to identify the demand for limited social interest housing only in Bogotá and the savanna, analyzing the advantages and disadvantages from the budgetary side, making a financial analysis to compare the structural systems of load-bearing walls versus structural masonry, identifying the financial behavior and determine the most profitable structural system. The case study applied to 6-story buildings with shallow foundations, in low-income

housing 24 housing units. The investigation will not contemplate aspects of qualitative order, it will not be taken into account as many variables that influence quality or other aspects. In addition, it starts from a base where the land and price per square meter of land is compared with respect to prices in the delimited area [13].

The inclusion criteria:

- Social interest housing construction project
- Buildings with up to six floors
- Structural system of load-bearing walls
- Structural masonry system

Exclusion criteria:

- Construction project different from social interest housing
- Buildings greater than six floors
- Use of a structural system other than load-bearing walls or structural masonry
- Projects with more than 5 years of construction

IV. RESULTS

The evaluation from the managerial part will be outlined through a DOFA matrix. Identifying for this chapter each of the variables that will allow the information to be condensed, and to extract from a managerial vision the contribution of the budget comparison presented for each of the structural systems, load-bearing walls and structural masonry.

TABLE 1. DOFA Matrix Project Basil.

	Strengths	Weaknesses
DOFA MATRIX LOADING WALLS SYSTEM	1 Process agility. 2 Short-term profitability 3 Easy exit to the market due to abundant demand.	1 Limitations on urban land. 2 Skilled labor 3 to develop this construction process. 3 Waste in materials
Opportunities  1 Increase in the quality of the process. 2 Optimization in times and yields. 3 Generate negotiations for high consumption of materials used in the process.	<b>Strategy FO</b>  <b>O1F1.</b> Implement technologies that allow faster processes and with higher quality <b>O3F2.</b> Make contacts with large input suppliers without intermediaries and obtain considerable savings.	<b>DO strategy</b>  <b>O1D1.</b> Entering a market outside the city or neighboring municipalities, seeking the need of the applicant. <b>O2D2.</b> Train personnel who have been continuously for more than 1 year. <b>O3D3.</b> Estimate the flow of purchases and their delivery to work, to minimize waste and cost overruns.
Threats  1 The shortage of supplies to execute. 2 Increase the TRM. 3 Increase in market prices.	<b>FA strategy</b>  <b>A1F2.</b> Expand list of possible suppliers. <b>A3F3.</b> Generate input purchases in foreign markets only when necessary, depending on the TRM and its fluctuation.	<b>DA Strategy</b>  <b>A3D3.</b> Generate warehouses for general consumption inputs. <b>A1D3.</b> Offer in the housing market, various options to have demand for perception.

TABLE 2. Matrix DOFA XY project

<p><b>DOFA MATRIX STRUCTURAL MASONRY SYSTEM</b></p>	<p><b>Strengths</b></p> <p>1 Process agility. 2 Short-term profitability 3 Easy exit to the market due to abundant demand.</p>	<p><b>Weaknesses</b></p> <p>1 On-site mixing control for the voussoirs and masonry glue. 2 Control of construction processes. 3 Waste in materials. 4. Number of floors.</p>
<p><b>Opportunities</b></p> <p>1 Increase in the quality of the process. 2 Optimization in times and yields. 3 Generate negotiations for high consumption of materials used in the process.</p>	<p><b>Strategy FO</b></p> <p><b>O1F1.</b>Implement technologies that allow faster processes and with higher quality <b>O3F2.</b>Make contacts with large input suppliers without intermediaries and obtain considerable savings.</p>	<p><b>DO strategy</b></p> <p><b>O1D1.</b>Entering a market outside the city or neighboring municipalities, seeking the need of the applicant. <b>O2D2.</b>Train personnel who have been continuously for more than 1 year. <b>O3D3.</b>Estimate the flow of purchases and their delivery to work, to minimize waste and cost overruns.</p>
<p><b>Threats</b></p> <p>1 The shortage of supplies to execute. 2 Increase the TRM. 3 Increase in market prices.</p>	<p><b>FA strategy</b></p> <p><b>A1F2.</b>Expand list of possible suppliers. <b>A3F3.</b>Generate input purchases in foreign markets only when necessary, depending on the TRM and its fluctuation.</p>	<p><b>DA Strategy</b></p> <p><b>A3D3.</b>Generate warehouses for general consumption inputs. <b>A1D3.</b>Offer in the housing market, various options to have demand for perception.</p>

*Analysis of the Financial Variables Applied to the Basil Case Study and the XY Contrast Case Project.*

In the chapter under development, the financial evaluation of the basil project will be expanded, developed in the structural system of load-bearing walls and the project in contrast in another different structural system, structural masonry, each one having specific characteristics, regarding the development of the execution schedule. This will be the first of three scenarios with the aim of ensuring the viability of the project and legibility of investment.

For the Basil and XY projects, financial indicators such as Internal Rate of Return (IRR), Net Present Value (NPV) and the Benefit / Cost Ratio (B / C) will be taken, in each of the projects the same variables will be evaluated and real and probable scenarios will be presented where their financial indicators will vary, with variables such as time and investment flow.

For this second scenario, it is proposed to link other types of variables, which will allow evaluating projects from points of view where financial indicators will be decisive in managerial decision-making.

This second scenario will have a different projection of income, where the income from property sales will be articulated as follows, an initial fee of 30% of the total value of the property, estimated as follows, 10% of the total value of the property as separation, 20% of the total value of the property, distributed in fixed installments for a maximum

period of (6) six months, after the month of separation. And after the last installment to complete the initial installment, the payment of 70% of the total value of the property, this 70% is generally disbursed through a financial entity.

The execution of the project will be carried out in the estimated period from the start in (6) six months for the structural system of load-bearing walls and for the structural system of masonry in (8) eight months respectively, both projects will be financed with a rate interest rate 0.8195% EM, financing requested through the construction loan, it must be specified that for this type of credit the financial institution proposes the maximum term for the total payment of the debt six months after the end of the schedule, for this In this scenario, the total payment of the debt will be made as the amortization periods pass.

The evaluation of the systems through their budget comparison and behavior in determining variables at the time of making a managerial decision, determines and answers the research question that, first knowing the project from the development of its calendar, tools of financing and investment capital, the budgetary stage will allow knowing the cost of the project, based on this information, giving an answer through the analysis of financial variables, variables that will allow the manager to approach and give a report depending on the analysis and a project with its profitability.

In this way, concluding that the type of structural system is more profitable, which for the proposed work turns out to be the basil project, where the structural system of the building in load-bearing walls was proposed.

The project in general and the variables contemplated allow senior management to carry out an analysis of the variables that can be involved, to provide a basis for support not only for low-income housing, but also to provide new areas of study in other types of structural systems. and the expansion of relevant variables in the analyzes, promoting and encouraging the comparison and analysis of financial variables, contributing to timely management decision-making, generating reliability, will help private companies and investors to have financial estimates, opening the way for foreign capital.

Making this tool a social benefit of economic contribution to the nation's commerce and economy, the generation of new jobs, new technologies, more efficient processes, more stringent evaluations in decision-making, knowledge of financial tools in the comprehensive evaluation of construction projects.

V. CONCLUSION

Taking into account the research carried out, comparatively analyzing the financial behavior of structural systems, the following conclusions are presented:

- Knowing the demand for housing in the homes of the city of Bogotá and the northern, southern savannah, allows management to have a knowledge of the business and its behavior, taking as an opportunity, the variable expansion of the city, the need of households to acquire housing. , together with the multiple tools that the national government such as subsidies and facilities by financial

entities.

- The urban re-densification and the development of low-income housing allow to give quality of life to thousands of homes, which makes this a tool that allows to give dignity to Colombian homes.
- The acquisition of housing is an asset for new families who, through this type of low-cost housing, see their dreams come true and in turn allow their assets to be valued in the future due to the expansion behavior.
- The changes in the land use plan (POT), for the capital city and for the surrounding municipalities, allow land owners within the city and surrounding municipalities, to see a business opportunity, on land that previously could only be used for single-family houses with 1 and 2 floors.
- Many of the tools provided by financial institutions allow investors and future investors to have peace of mind in the support of the entities and the national government.
- Business opportunities for micro and macro companies in the construction sector.
- The urban development and improvement of the conditions of the sectors, allows it to grow in an organized way.
- Knowing the projects in each one of their constructive stages and in the elaboration allows that in their planning financial indicators can be evaluated to determine a utility.
- Knowing the budget of the projects and the detail of the same allows evaluating the best alternative, as a business linking all the variables, makes the project have a lower risk in the conception.
- Knowing what advantages and disadvantages these types of building projects can have, makes management able to make increasingly sound decisions.

In the evaluation of the financial indicators, carried out from three scenarios, there are positive and negative results due to the variables that were taken into account, thus showing that it will depend on the scenario that you want to take to assess the viability of a project of these characteristics. The scenario to be evaluated in depth corresponds to scenario 2. Where the exercise can be taken to the most real topic.

- One of the present indicators to evaluate which type of structural system is more viable compared to the other is the net present value (NPV), in the case of both projects it must be made clear that the net present value for both cases in scenario 2 they are above zero, which means that both types of systems are profitable.
- It should be borne in mind that despite the fact that in both scenarios the values of the internal rate of return are in the range above 0, this indication gives us clarity that both projects are also viable, the difference is that one is more profitable than the other. .
- It should be clarified that the benefit-cost ratio is more favorable for the case in which it is decided to use the load-bearing wall system, compared to the structural masonry system, this in a difference of 3 points, but it should be clarified that in the year This difference can make between 100 to 200 million pesos that for a 6-story building in an estimated time of 145 months, it would become attractive for an investor.

- in the proposed exercise, the investor decides to use according to the comparison of both systems, where he uses an internal opportunity rate (TIO) of 8% ME Given in the load-bearing wall system with a net present value of where, Evidence that The most viable alternative is the load-bearing wall alternative, bearing in mind that if you select the XY project going to current net value, it would stop receiving (107, 993,404.21) million pesos.
- Making the evaluation of the variables, it must be determined that the most viable option is the one developed in the structural system of load-bearing walls and allows the business to be more attractive to the investor, it must also be made clear that this exercise designed for the construction in production of more than 10 to 15 buildings of these characteristics, will be decisive in managerial decision-making.

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