

**METHODOLOGY FOR CIVIL PROJECT MANAGEMENT BASED ON THE PMBoK, ISO 21500 STANDARD AND THE PRINCE2 METHOD: CASE STUDY ANTOQUIA, COLOMBIA**  
**METODOLOGÍA PARA LA GESTIÓN DE PROYECTOS CIVILES BASADA EN EL PMBOK, LA NORMA ISO 21500 Y EL MÉTODO PRINCE2: CASO DE ESTUDIO ANTIOQUIA, COLOMBIA**

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**ABSTRACT**

**Keywords:**

management, civil projects,  
management standards,  
methodology, processes.

Project management contributes to the improvements of an organization, implementing actions that meet its requirements. In the management of civil works, analyzed for this study, it was determined that there is no consensus on the management model, appreciating that: some entities apply standards, without an adequate relationship; the participation of specialized managers with particular contributions and, finally, the development of goods aligned with international standards. Therefore, literature of methodologies that lack the inclusion of areas of social, environmental, archaeological and accounting management was analyzed. It was noted that economic and growth indicators of the sector have been created, but not specific to project management. In this work, a methodology applicable to all types of works was developed, based on the ISO 25000, PMBoK and PRINCE2 standards. The proposed methodology manages the necessary and sufficient information for timely decision-making. For its development, 26 different construction and auditing projects were studied, in 25 companies in Antioquia, and applied to 4 of them, resulting in a methodology that provides multiple technical contributions, better clarity in the definition of roles, more effective planning and more efficient execution of projects. In the cases applied, the management of time, resources and the satisfaction of stakeholders were improved. The scope and costs were stabilized and the possibility of adding budget was improved, without delays in the execution time,

	benefiting the management of civil projects in the companies studied.
	<b>Resumen</b>
<b>Palabras clave:</b> gestión, proyectos civiles, estándares de administración, metodología.	<p>La gestión de proyectos contribuye a las mejoras de una organización, implementando acciones que satisfagan sus requisitos. En la gestión de obras civiles, analizadas para este estudio, se determinó que no existe un consenso de modelo de gestión, apreciando que: algunas entidades aplican estándares, sin una relación adecuada; la participación de gerentes especializados con aportes particulares y, por último, el desarrollo de bienes alineados a estándares internacionales. Por lo anterior, se analizó literatura de metodologías que carecen de inclusión de áreas de gestión social, ambiental, arqueológica y contable. Se observó que se han creado indicadores de orden económico y crecimiento del sector, pero no específicos de gestión del proyecto. En este trabajo se desarrolló una metodología aplicable a todo tipo de obras, con base en los estándares ISO 25000, PMBoK y PRINCE2. La metodología propuesta gestiona la información necesaria y suficiente para la toma oportuna de decisiones. Para su desarrollo se estudiaron 26 proyectos diferentes de construcción e interventoría, en 25 empresas de Antioquia, y se aplicó sobre 4 de ellos, resultando una metodología que brinda múltiples aportes técnicos, mejor claridad en la definición de roles, planificación más efectiva y ejecución más eficiente de proyectos. En los casos aplicados se mejoró la gestión de tiempos, recursos y la satisfacción de interesados. El alcance y los costos se estabilizaron y mejoraron la posibilidad de adicionar presupuesto, sin presentarse atrasos en el tiempo de ejecución, beneficiando la gestión de proyectos civiles en las empresas estudiadas.</p>

## Introduction

It is common to find the indiscriminate use of the words administration, management, management, development, control, direction, and project management, giving rise to what is known as the jungle of administrative theory (Krezner, 2022). Some authors agree that the terms administration, direction, and management are accepted as having a common essence, (Alanis, 2021) as they refer to the same activities of planning, organizing, directing, evaluating, and controlling, in a specific way and with the purpose of delivering the consolidated or objective of a project. Project management has the double connotation of serving companies as the basis for their economic development (profits for the fiscal year) and as the basis for the development of their own work functions (fulfillment of their social function), and civil projects are the ones that most closely approximate the forms of current management.

Initially only the Objective-Cost-Time triad prevailed, with time values such as Scope-Quality were incorporated; now elements such as human resource, social, environmental and archeological management are added; all of them making a substantive part of a current project.

In Colombia, civil project management basically focuses on three aspects: costs, time, and human resources, without methodologies that integrate the other areas. However, despite all the methodologies adapted for civil project management, we found deficiencies, weaknesses, inadequacies, or unnecessary complexities in their development. That is why the formation of a unique body of knowledge in the common language and management among professionals and specialties is so important and representative. There are several methodologies that aim to unify projects, but there are few applied to the civil sector. In addition, it has to be specific to Colombia, there is none.

In order to solve the problem, the research takes the information without previous alterations and interpretations by the interviewees (Yuni, 2021), focusing on projects that promote regional development and guarantee the efficient investment of resources in infrastructure projects (Simonaitis A. D., 2023). In addition, the management process groups, knowledge areas (EAE Bussines School, 2020) and the new PMBOK approach were analyzed (Project Management Institute, 2021), as well as the contributions of ISO 21500 (ISO, 2021) and the PRINCE2 method generating improvements in terms of timely delivery, cost control and stakeholder satisfaction. Their comparison made it possible to identify their advantages and challenges (Rueda Urrea, 2023), addressing in a more comprehensive manner the specific challenges faced by civil projects in this region (Tamayo Monsalve, 2022). Applying a single methodology for the search for differences and similarities between them so that the elements (variables, processes, etc.) that really apply to a generic civil project can be identified and developed in such a way that any work group under similar circumstances can obtain the same or better results in its execution (Nossa, 2021).

The objective of the project focused on the importance of critically evaluating updates of methodologies for continuous improvement (Herrera Sanabria, 2019), adapting them to local needs for more successful infrastructure outcomes. (Andrade Quintero, 2022). The implementation of this methodology in construction projects in Colombia will represent a significant competitive advantage, allowing compliance with quality standards, time, resource optimization and improved risk management (Alarcón C., 2020).

In Colombia, specific methodological approaches from the PMBoK have been used in major infrastructure projects such as the development of mass transit systems in cities

like Bogotá and Medellín (Simonaitis, Daukšys, & Mockienė, 2023); from (Faraji, Rashidi, Perera, & Samali, 2022) PRINCE2 in the urban expansion project in Cartagena; and from ISO 21500 in the urban renewal project in downtown Cali. Approaches that ensured compliance with regulations and the achievement of sustainable development and social responsibility objectives, while respecting the cultural and environmental diversity of the area (Camargo Sierra, 2020). Effectively managing frequent changes in project requirements and logistical challenges, resulting in more efficient execution of resources (Fobiri, Musonda, & Muleya, 2022).

The implementation of management methodologies in the construction sector faces significant challenges and requires cultural adaptation to align them with local practices and the local environment (de Almeida Barbosa Franco, Domingues, de Almeida Africano, Deus, & Battistelle, 2022). The challenges presented by the adaptation of these methodologies also offer opportunities for innovation in project management (Departamento Nacional de Planeación, 2023).

## Methodology

### *Project Management (civil)*

Project management methodologies have been developed with very different and distant approaches, moments and spaces, creating fundamental tools for the successful planning and execution of civil infrastructure projects (Management I. J., 2018).

Since the Second World War, entities have been created to rationalize the practice of project management, creating guidelines and standards with their own techniques, methodologies, tools and programs that are still in use today. They contribute international standardized knowledge to constantly changing projects (Cicmil, 2006), and are applied with different dimension and depth to civil projects.

**Table 1**

*Summary of some project management standards*

YEAR	METHODOLOGY	COUNTRY	APPROACH	BENEFIT - SCOPE
1953	APM BoK	UK - India	Projects	Practical improvement for project management in a variety of industries and sectors.
1960	BS 6079	England	Projects	He guides various aspects of project management (planning, execution, control) in a variety of industries.
1965	IPMA Competence	Switzerland - Netherlands	Projects - People	Focuses on the competence and skills of professionals.
1987	PMBoK	USA	Projects	It focuses on key areas such as scope, time, cost and quality, among others.
1989	PRINCE2	UK	Organization	Focuses on achieving project performance goals (profit, cost, time, quality, scope, sustainability, risk, and others) Seeks ongoing business justification.
1991	ECITB	UK	Persons	It focuses on developing skills in the construction and engineering industry.
1996	NCSPM	Australia	Persons	Defines skills and knowledge necessary for project management in a variety of industries and sectors.

YEAR	METHODOLOGY	COUNTRY	APPROACH	BENEFIT - SCOPE
1997	ISO 10006	Switzerland	Projects	Provides guidelines for quality management in projects.
1997	SAQA	South Africa	Persons	It establishes the necessary standards to guarantee management competence.
1998	OGC PMMM	UK	Organization	Evaluates the maturity of project management in government entities: Provides standards to improve project management in the public sector.
2001	P2M	Japan	Projects	It focuses on integrated project and program management, approaching management holistically and maximizing the value delivered.
2002	PMI® PM CDF	USA	Persons	Focuses on the development of project management competency. Provides detailed guidance to improve the skills and knowledge required for management.
2002	OPM3™	USA	Organization	Focuses on improving project management at the organizational level.
2012	ISO21500	Switzerland	Projects	Provides guidance for project management. Designed for a variety of industries and sectors. It offers a framework aligned with other international standards.

However, it lacks specific application for civil projects in Colombia and therefore in the achievement of objectives and scopes, as desired in practice.

### ***Development of the Unified Methodology***

The proposed methodology was developed based on the three predominant project methodologies in Colombia, but specifically oriented to the civil infrastructure sector (Management I. J., 2018). The integration of these three methodologies offers a holistic approach, combining the flexibility of PMBoK, the structure of PRINCE2 and the international standards of ISO 21500 (Prebanić, 2017) and is thought of the appropriate applicative (Lozares, 2012):

***Table 2***

Comparative summary of the methodologies studied and proposal.

METHODOLOGY	SUMMARY OF THE IDEOLOGY - STRUCTURE
PMBoK	<p>Comprehensive approach that establishes standards and best practices for project management; it is a comprehensive guide detailing best practices in project management.</p> <p>The PMBoK, 5th - 6th edition, distributes this knowledge in 5 process groups, 10 management areas and 49 management processes. The proposal for the 7th edition (2021) emphasizes 12 Principles and Domains (Cagua, 2021), seeking flexibility, adaptability and the achievement of results, without being contrary to the process approach of previous editions. They do not cover particular topics as the areas do, but allow autonomy in choosing best practices, tools and techniques</p>

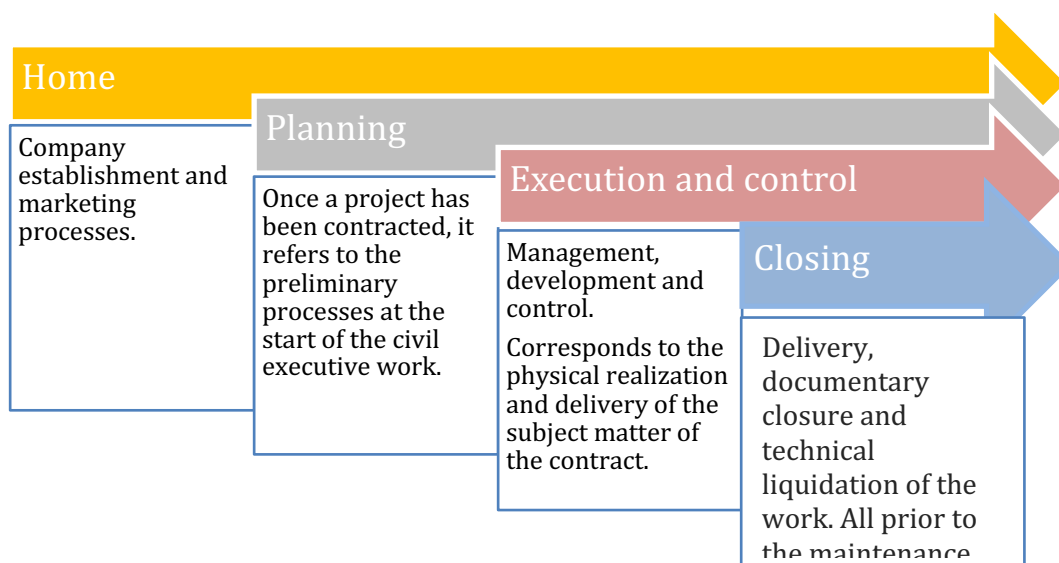
METHODOLOGY	SUMMARY OF THE IDEOLOGY - STRUCTURE
PRINCE2	<p>Adaptable and controlling through clear stages and roles, relevant in large civil projects (Management I. J., 2018). It is detailed and specific, adhering to defined standards, templates and roles.</p> <p>It is characterized by being pragmatic and focused, not on knowledge, but on the success of the project. PRINCE2 seeks to convert uncertainty and variability into controlled environments, by means of themes, justified in the feasibility study of a case (Business Case) permanently reviewed in the project life cycle.</p> <p>PRINCE2 is based on 7 management principles of recognized effectiveness, describes 7 management processes (groups of processes or phases) and 7 themes (knowledge areas),</p>
ISO 21500	<p>Provides an international framework, aligning with PMBoK and PRINCE2.</p> <p>It does not define tools or techniques, it only defines the project life cycle. It is a simpler and friendlier version. It does not plan risk management.</p> <p>It is a highly detailed version, which distributes this knowledge in 5 process groups, 10 management areas and 39 management processes.</p> <p>It is presented for the project execution cycle, connecting 4 dimensions:</p> <ul style="list-style-type: none"> <li>• 4 Phases: it relates the times within the execution of the project.</li> <li>• 15 Areas: relates sets of analogous knowledge.</li> <li>• 43 (Groups of) Processes: relates processes within an area or between them.</li> <li>• 265 Records (System inputs and outputs): relates data demand and information output under process management.</li> </ul> <p>Thus, the body of knowledge is unified, with the necessary and sufficient processes for the management of civil works.</p>
Proposed Methodology	

### Relationship in the Phases of a Civil Project

The first knowledge and documentary dimension relates groups of processes applied over time, whether independent or not:

**Figure 1**

*Phases of a civil project*



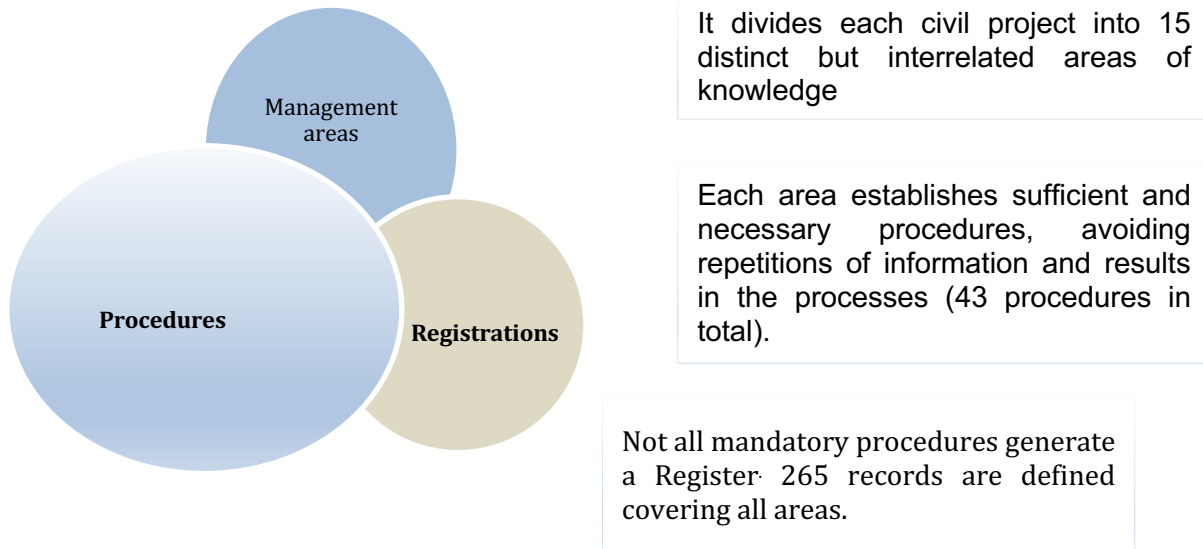
### Relationship in Areas, Procedures and Records

The second knowledge and documentary dimension relates specific topics of knowledge, developed by personnel specialized in each topic and necessary for the overall

sum of the project, making available through this methodology sufficient, necessary, timely and coherent information for the identification of problems and decision making:

**Figure 2**

*Relationship in areas, procedures and records*



The defined areas of knowledge are:

- (1). Objective and scope.
- (2). Business organization.
- (3). Marketing and service improvement.
- (4). Costs and budgets.
- (5). Timing and scheduling.
- (6). Human resources.
- (7). OSH Occupational health and safety.
- (8). Communications.
- (9). Suppliers and warehouse.
- (10). Quality control.
- (11). Project management (administrative technician).
- (12). Social and stakeholder management.
- (13). Environmental and archaeological management.
- (14). Risk management.
- (15). Accounting.

### ***Application of the Proposed Methodology***

To verify the performance of the proposed methodology, companies were selected that met the following criteria:

**Table 3**  
*Inclusion and exclusion criteria*

CRITERIA	INCLUSION	EXCLUSION
Infrastructure Project	Within the department of Antioquia	Outside the department of Antioquia
Type of Company	Public or Private	Mixed or foreign economy
Resource availability	Total shareholders' equity	Not self-financing by sales or developed in stages
Type of contract	Interventory or construction	Design or consulting
Type of selection	Open public bidding	Unique selection
Valuation of costs	Adjustable unit prices	Any other type (Turnkey, etc.)
Company Size	Median <sup>1</sup> : Staff of fifty (50) to two hundred (200) workers. Assets between 5,001 and 30,000 SMMLV <sup>2</sup>	Small or large company: Personnel and/or assets outside the defined margin.
Project Value	Between U\$A 50,000 and U\$A 10 million of dollars	Outside the specified range
Project duration	4 years or less	More than 4 years

The field study was conducted on a sample of 26 projects of various genres, with companies that met the above criteria. The projects studied are presented in Table 2:

Manuals, processes and records for the planning and development of civil projects were studied, identifying common models, in order to develop a single methodology and validate a complete information system. The selection of 26 companies, representing the average construction company and typical state contractor, under Law 80 - Colombia's state contracting law.

**Table 4**  
*Projects studied*

	CRITERIA	INCLUSION	EXCLUSION
1.	Commune 7	Urbanism	Auditors
2.	Home improvements	Housing	Auditors
3.	Path of Life	Urbanism	Auditors
4.	Metro Plus	Acu. Y Alc.	Construction
5.	Educational Centers	Buildings	Construction
6.	Envigado - V. S. Catalina	Acu. Y Alc.	Construction
7.	Vial Linares 2	Vias	Construction
8.	Las Mirlas Road Circuit	Vias	Construction
9.	Potrillo Village	Sewer	Auditors
10.	Urb. Niquia Village	Urbanism	Construction
11.	Decameron Rionegro	Urbanism	Construction
12.	Éxito Parking Lot - La Ceja	Urbanism	Construction
13.	Alc. Panorama	Urbanism	Construction
14.	Urb. Bracamonte	Urbanism	Construction
15.	Rionegro	Water and Sewerage	Construction

<sup>1</sup> In Colombia, Law 905 of August 2, 2004, amending Law 590 of 2000, promotes the formation of companies of different sizes (micro, small and medium), including family businesses and Simplified Joint Stock Companies, defining them as units of economic exploitation in any sector.

<sup>2</sup> SMMLV, acronym for Minimum Monthly Legal Minimum Wage in Force



	CRITERIA	INCLUSION	EXCLUSION
16.	Bridges	Maintenance	Construction
17.	Perpetuo Socorro Square	Park	Construction
18.	Robledo Diagnostic Center	Building	Construction
19.	La Estrella	Water and Sewerage	Auditors
20.	San Carlos	Sewer	Auditors
21.	Classrooms El Bagre	Building	Auditors
22.	Segovia Sports Unit	Coliseum	Construction
23.	Santander Park	Park	Construction
24.	Mine Sedimenters	Tanks	Construction
25.	Sandra K	Substation	Construction
26.	Commune 3	Platforms	Construction

The companies studied are located in the department of Antioquia (Medellín), Cundinamarca (Bogotá D.C.), Valle (Cali), the central or Andean zone of Caldas, Risaralda and Quindío (Manizales, Pereira and Armenia) and the Atlantic coast in Bolívar, Atlántico and Magdalena (Cartagena, Barranquilla, Santa Marta), areas that account for 70% of the country's infrastructure investment, and of these Antioquia alone accounts for at least 36%, surpassed only by Cundinamarca.

However, the research focuses on projects carried out in the so-called Metropolitan Area of the Aburrá Valley, which includes 10 municipalities in the department of Antioquia, with the city of Medellín as its capital. The projects are of medium cost and complexity, being those between US\$ 50,000 and US\$ 10 million, since this value covers most of the civil projects developed in the country, including the fourth generation roads, which represent the most expensive projects and which are normally developed in sections. In general, projects are developed in periods of less than four years, with an average duration of two years.

In addition, the methodology incorporates, among others, the following national and local standards: NTC ISO 9001:2015 Quality Management Systems, NTC ISO 10005:2018 Quality Management, NTC ISO 14001:2018 Environmental Management Systems, NTC ISO 45001:2018 - Occupational Health and Safety Management System, NTC ISO 27001:2013 Management System for Information Security. For the archeological management of the project, Law 397 of 1997 on Cultural Heritage, promotion and encouragement of culture is considered, being the competent authority the Colombian Institute of Anthropology and History - ICANH.

For social and environmental management, the company complies with Law 489 of 1998, which assigns social management of civil projects, framed for the department of Antioquia and its municipalities with Decree 673 of 2006 through the Social and Environmental Management Guide for the construction of public infrastructure works. For the integration of accounting areas, with the registration and support of accounting information according to Law 145/60, Law 43/90, Law 222/95, Decree 410/71, among others.

#### *Projects with positive development*

The projects in which the proposed methodology has been applied are as follows:

**Table 5**

*Projects with proposed methodology applied*

	PROJECT	TYPE	INTERVENTION
23	Santander	Park	Construction
24	Settling tanks	Tanks	Construction
25	Sandra K	Substation	Construction
26	Commune 3	Platforms	Construction

### ***Projects Withdrawn Due to Negative Development***

There is an additional project where the methodology was applied, and although the role of the researcher was in the auditing, the contracting company was NOT willing to continue the review process under the proposed methodology, for multiple cost reasons, so its use and the results of their analysis were stopped, but not before it was clear that the project would enter into early termination due to economic incapacity of the project.

This is due to the fact that from the beginning of the execution, the unit price analysis (APU's of execution costs) were reviewed and the economic unfeasibility of the project was reported under the offer submitted by the contractor and accepted by the contracting entity. The analysis indicated that at least 43% of the project should have been executed in eleven months, and hardly 2.6% had been executed; and the execution costs were on average higher than 50% of what was expected, in addition to the fact that the invoicing for the work executed would never cover the execution costs. It is clear of the reason for his retirement.

## **Results**

Two groups were formed with the companies analyzed: the first group was taken as a sample where there is no clear methodology applied, but of projects that finally met their objective, and a second group of companies in which the proposed methodology was applied. They showed the following improvements and achievements that did not resemble those of the initial companies:

**Table 6***Achievements in the company and its projects*

<b>Improved infrastructure</b>	<b>For the solution</b>
<ul style="list-style-type: none"> <li>• Low investment in hardware and software.</li> <li>• Greater control of minor equipment.</li> <li>• Improved management through the use of the Internet.</li> <li>• Low need for updating.</li> </ul>	<ul style="list-style-type: none"> <li>• Simplified procedures.</li> <li>• Rationalization in the use of resources.</li> <li>• Development of programs, plans, and information records of unified content.</li> <li>• Articulation of different plans.</li> </ul>
<b>Technical contributions achieved</b>	<b>Internal achievements</b>
<ul style="list-style-type: none"> <li>• Unification of criteria.</li> <li>• Common language in projects.</li> <li>• Applicable to all construction companies.</li> <li>• Gathering of sufficient and necessary information for administrative management.</li> <li>• Active, flexible and adaptable methodology.</li> <li>• Synthesis of operating manuals, processes and records.</li> <li>• Permanent and hierarchical availability of information to identify problems and active decision making.</li> <li>• Correct creation of databases.</li> <li>• Savings in resource management.</li> <li>• Compliance with contractual standards.</li> </ul>	<ul style="list-style-type: none"> <li>• Unification of methodologies and databases.</li> <li>• Duality of information is prevented.</li> <li>• Unification of manuals, procedures and registration.</li> <li>• Management of sufficient and necessary information,</li> <li>• Increased customer and user reliability.</li> <li>• Maximization of administrative personnel management.</li> <li>• Increased staff adherence and commitment.</li> <li>• Real-time information management and agility in decision making.</li> <li>• Improvement in audit processes.</li> <li>• Orientation of the company to continuous improvement.</li> </ul>
<b>Transactional system improvements</b>	<b>Strategic improvements</b>
<ul style="list-style-type: none"> <li>• Agility in the capture of records.</li> <li>• Permanent record of activities.</li> <li>• Access by third parties (workers, suppliers, other stakeholders).</li> <li>• Real-time information management.</li> <li>• Increased productivity.</li> <li>• Remote access.</li> </ul>	<ul style="list-style-type: none"> <li>• Process identification and simplification.</li> <li>• Flexibility in modifications, changes, adjustments and updates.</li> <li>• Ease of growth in its management.</li> <li>• Increased efficiency in the allocation of resources.</li> <li>• Increased speed of response to internal and external requirements, as well as the company's competitive advantages.</li> </ul>

**Indicators**

Indicators included measures of delivery time, budget variances, stakeholder satisfaction surveys and the degree of compliance with the proposed unified methodology (Axelos, PRINCE2® (Projects IN Controlled Environments), s.f.). They were also categorized into two components:

- Indicators specific to the methodology: they evaluated the relevance of each procedure and its possibility of modification, change or withdrawal.
- Indicators specific to the project being monitored: evaluated its development.

**Discussion**

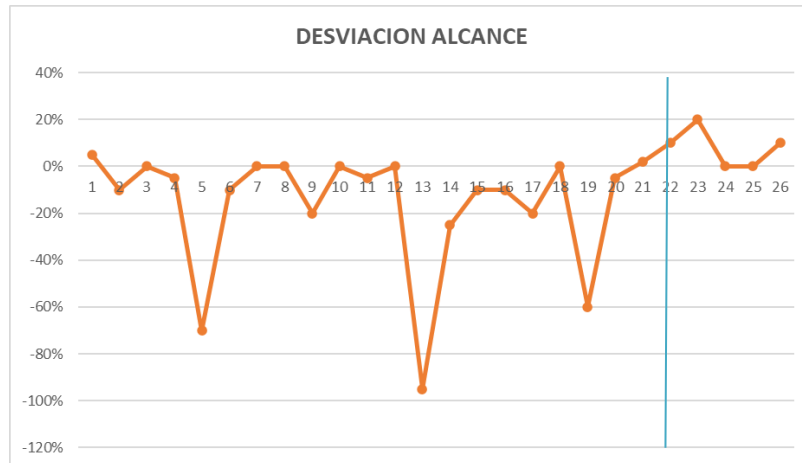
The projects developed with the proposed methodology result in the settlement in the deviation curves of the three main control elements: scope, budget and execution time. The quality element was not evaluated since, in the acceptance of the work by the contractor, compliance with the contractual specifications is evidenced, which is the basis for quality, therefore, it is considered satisfied.

### *Deviations in scope*

The scope of each project is reduced or increased with the possibility of adding or not the budget<sup>3</sup>, and depends on the capacity of each contracting entity to obtain resources and justify these additional investments in a timely manner.

### **Figure 3**

*Deviations projects studied VS. initial scope*



In the case of projects in which this methodology is applied, the scope tends to stabilize with the budget and is improved if the budget increases and only for the improvement of the end users of the contracting entity.

### *Budget variances*

It is commonly due to price increases that occasionally force a reduction in scope or an increase in the budget for the same scope. The latter is not always the case, so the projects remain "lame". In projects where this methodology is applied, the budget tends to stabilize with the contracted budget and is improved only if the scope increases, for the betterment of the end users of the contracting entity.

<sup>3</sup> In the case of public works in Colombia, Law 80 allows for additions of up to 50% of the initial budget

**Figure 4***Deviations of projects studied VS. initial budget*

It should be clarified that when there are deviations in the budget due to increases or contractual additions, it is due to the improvement in the costs of execution that allows the contractor's acceptance with the evident increase in the scope of the contract, but not due to the need to achieve the initial scope.

Budget additions that were convenient for the contracting company, but inconvenient for the contractor, were not accepted. This is due to the analysis of the activities identified as economically convenient and inconvenient, which allows for the orientation of the expenditure<sup>4</sup>.

#### *Deviations Over Time*

It obeys the same dynamics of increasing the contractual term in case of increasing the initial scope of the project. In the projects under this methodology, there were no delays due to the contractor's own reasons, let alone those of the contracting party.

Contract extensions that were convenient for the contracting company, but inconvenient for the contractor, were not accepted. In some cases, part of the contractual additions to the budget, or rather, part of the time required by the budgetary addition, were executed at the same time as the contractual term. This is due, again, to the timely analysis of the performance and unit costs of execution per executed activity of the economically convenient and inconvenient activities identified.

<sup>4</sup> This means that the contractual additions can be oriented in favor of the contracting company, reconciling activities that are beneficial for the execution of the project, but economically viable for the contractor's execution.

**Figure 5**  
*Deviations of studied projects VS. initial time*



The results demonstrate the viability and effectiveness of the unified methodology in the management of civil projects in Antioquia. However, it is recognized that this research may be limited by data availability and project participation in the case study (Creswell, 2018). The unified methodology led to better clarity in the definition of roles, more effective planning and more efficient execution of projects. The case studies showed improvement in time management, resources and stakeholder satisfaction (Isacás-Ojeda, Intriago-Pazmiño, Ordoñez-Calero, Jácome, & Sánchez-Ocaña, 2018).

Once the results are presented, the three relevant elements are considered solved and it is established that the proposed methodology does offer higher quality results for civil project management, timely, consistent and efficient management of information and resource savings.

## Conclusions

Of the companies analyzed, 88% had changes in both the execution budget and expected profits; 82% had changes in the contractual term (60% required additions and only 26% delivered ahead of schedule, after variation in the scope of the project). Similarly, 88% had smaller but consistent variations in scope. The projects associated with state-owned companies are those with the greatest variations in time or budget and led to variations in the scope of each project, which, however small they may have been, also meant changes in the budget and/or execution time

The projects under the management of the proposed methodology were fully developed, resulting in a settlement in the deviation curves of the three main control elements of a project: scope, budget and execution time, and compliance with the contractual specifications is evidenced, which is the basis of quality and, therefore, is considered satisfied. It is clarified that no record is kept of post-sales due to the impossibility of being linked to these companies once the project is completed, in addition to the fact that this information was not shared.

With the application of the unified methodology, deviations in scope are reduced and only increase with the possibility of adding or not budget by the contracting companies to the project. The scope is improved if the budget increases and only for the improvement of the end users of the contracting entity.

With respect to deviations in the cost (budget) is improved only if the scope increases, also for the betterment of the end users of the contracting entity.

It should be clarified that when there are deviations in the budget due to increases or contractual additions, it is due to the improvement of the execution costs that allows the contractor's acceptance, with the evident increase in the scope of the contract, and the initial scope has already been achieved. Budget additions that were convenient for the contracting company, but inconvenient for the contractor, were not accepted.

With respect to time deviations, there were no delays in the projects under this methodology due to the contractor's own reasons or those of the contracting party. Contract extensions that were convenient for the contracting company, but inconvenient for the contractor, were not accepted. In some cases, part of the contractual additions to the budget, or rather, part of the time required by the budgetary addition, were executed at the same time as the contractual term.

For integrated project management, we highlight the inclusion of new areas of knowledge and management (occupational health, social, environmental, archeological and accounting) and the refinement of existing processes.

The Colombian construction industry is a very representative sector for the nation, accounting for between 10% and 40% of Colombia's GDP. Like any economy, it has had ups and downs due to its own and exogenous factors of many subsectors, but it has always been representative for the national industry, always growing.

For this reason, it is necessary to be more rigorous every day in the specific investment of the sector and to minimize the investment, operational and execution risk factors in each project, through the application of appropriate management methodologies. It is necessary to close the uncertainty gap and increase the indicators that allow expeditious and timely decision making for conflict resolution.

The proposed methodology, like any other, does not ensure the success of a project, but it does ensure proper project management and timely decision-making with the required information, including the possibility of closing a project in advance in the event that its objective, scope or costs cannot be met<sup>5</sup>, by providing for the early or permanent review of these elements in the development of the project, expanding the control scheme of resources, reducing their inadequate management, corruption and the creation of "white elephants" to provide the best results in the management and social and economic investment of resources.

The study concludes that the combination of PMBoK, ISO 21500 and PRINCE2 is beneficial for civil project management in Antioch, providing an adaptable and robust framework. A gradual implementation of this integrated methodology is recommended, with emphasis on training and skills development of project managers. Future research could explore the application of this integrated methodology in other regional contexts and types of projects, such as the social, archaeological and other functions.

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<sup>5</sup> It may be due to cost variations from the time of the proposal to the date of execution, beyond the control of the contractor and the contractor, which in our case was applied to a project, as mentioned above.

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## Annexes

### Annex 1

#### Table of projects studied

**Table 5**

#### Projects studied

No.	PROJECT			Budget		Weather		Scope		Quality
				Millions	Desv.	Months	Desv.	Final	Desv.	
1	Vial Linares 2	Vias	Construction	\$ 1.923,50	30%	5,0	10%	105%	5%	100%
2	Las Mirlas Road Circuit	Vias	Construction	\$ 6.847,50	40%	8,0	-5%	90%	-10%	100%
3	Potrillo Village	Sewer	Auditors	\$ 394,00	0%	5,0	20%	100%	0%	100%
4	Urb. Niquia Village	Urbanism	Construction	\$ 342,90	34%	3,0	15%	95%	-5%	100%
5	Decameron Rionegro	Urbanism	Construction	\$ 1.500,00	-65%	8,0	-60%	30%	-70%	100%
6	Éxito Parking Lot - La Ceja	Urbanism	Construction	\$ 794,40	30%	4,0	15%	90%	-10%	100%
7	Alc. Panorama	Urbanism	Construction	\$ 562,90	-14%	4,0	30%	100%	0%	100%
8	Urb. Bracamonte	Urbanism	Construction	\$ 2.431,00	10%	7,0	30%	100%	0%	100%
9	Rionegro	Acu. Y Alc.	Construction	\$ 24.236,30	45%	8,0	50%	80%	-20%	100%
10	Vehicular bridges	Maintenance	Construction	\$ 2.609,70	10%	5,0	20%	100%	0%	100%
11	Perpetuo Socorro Square	Park	Construction	\$ 1.526,10	-5%	6,0	20%	95%	-5%	100%
12	Robledo Diagnostic Center	Building	Construction	\$ 1.014,30	30%	6,0	100%	100%	0%	100%
13	La Estrella	Acu. Y Alc.	Auditors	\$ 4.641,17	100%	12,0	50%	5%	-95%	5%
14	San Carlos	Sewer	Auditors	\$ 281,06	0%	5,0	-25%	75%	-25%	100%
15	El Bagre	Building	Auditors	\$ 861,90	20%	8,0	20%	90%	-10%	100%
16	Commune 7	Urbanism	Auditors	\$ 151,40	20%	8,0	5%	90%	-10%	100%
17	Home improvements	Housing	Auditors	\$ 86.786,40	-15%	9,0	-10%	80%	-20%	100%
18	Path of Life	Urbanism	Auditors	\$ 3.661,00	-1%	7,0	0%	100%	0%	100%
19	Metro Plus	Acu. Y Alc.	Construction	\$ 1.328,70	-50%	6,0	10%	40%	-60%	100%
20	Educational Centers	Buildings	Construction	\$ 1.385,70	30%	8,0	10%	95%	-5%	100%
21	Envigado - V. S. Catalina	Acu. Y Alc.	Construction	\$ 5.911,20	35%	7,0	30%	102%	2%	100%
22	Segovia	Coliseum	Auditors	\$ 855,90	20%	12,0	20%	110%	10%	100%
23	Santander	Park	Construction	\$ 575,10	30%	4,0	30%	120%	20%	100%
24	Mine Sedimenters	Tanks	Construction	\$ 166,30	0%	7,0	0%	100%	0%	100%

No.	PROJECT			Budget		Weather		Scope		Quality
				Millions	Desv.	Months	Desv.	Final	Desv.	
25	Sandra K	Substation	Construction	\$ 528,90	0%	5,0	0%	100%	0%	100%
26	Commune 3	Platforms	Construction	\$ 2.175,90	10%	6,0	0%	110%	10%	100%