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BIG DATA AS A STRATEGIC SUPPORT FOR DECISION-MAKING IN CONSTRUCTION PROJECTS

Big data como soporte estratégico para la toma de decisiones en proyecto de construcción.

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Master's Program in Project Management

BIG DATA AS A STRATEGIC SUPPORT FOR DECISION-MAKING IN CONSTRUCTION PROJECTS: CASE STUDY NEW ERA BROS REMODELING LLC

Thesis submitted in partial fulfillment of the requirements for the degree of Master in Project Management.

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Approval Page

The present thesis entitled: “Big Data as a Strategic Support for Decision-Making in Construction Projects; Case Study: New Era Bros Remodeling LLC” has been evaluated and approved in accordance with the requirements of Sabal University to obtain the degree of Master in project management.

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Dedication

To God, for giving me the strength, health, and wisdom to complete this significant stage of my life.

To my parents, for being my constant example of effort, unconditional love, and perseverance. Your support has been the driving force that helped me push forward even in the most difficult times.

To my husband and daughters, for being my endless source of love, inspiration, and strength. Your company, patience, and unwavering support were the foundation that allowed me to reach this goal.

To my cousin José Antonio, who, although no longer physically present, remains in my heart. Thank you for believing in me from the beginning, for your words of encouragement, and for teaching me by your example to never give up. This achievement is also yours.

To my sister, for being a support in times when I needed it most.

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To all of you, with deep love and gratitude, I dedicate this work, which represents not only an academic achievement but also a shared dream.

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To the memory of my beloved cousin José Antonio, whose faith in me continues to light my path. Thank you for believing in me so wholeheartedly.

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Abstract

This research project analyzes the role of Big Data as a strategic tool in decision-making within the construction sector. In an environment characterized by complexity, uncertainty, and the need for rapid and efficient responses, Big Data offers an innovative approach to managing massive and diverse information that can influence the planning, execution, and control of construction projects. Through a qualitative approach, opinions, perceptions, and experiences of professionals in the sector were gathered to understand how the use of Big Data improves efficiency, reduces risks, and optimizes decision-making.

The research is based on the premise that the construction sector faces growing challenges related to meeting deadlines, cost control, and resource management, making timely and reliable access to information a key success factor. The aim of the study is to demonstrate that although the use of this technology is still developing in many organizations, its progressive implementation represents a significant shift in how projects are planned and executed. The transformative potential of Big Data in construction project management lies not only in its technical capabilities but also in its contribution to more strategic, data-driven, and continuously improved decision-making.

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Chapter I

1.1 Introduction

The construction sector constantly faces complex and evolving challenges related to project planning, efficient resource management, schedule compliance, cost control, and quality assurance (Molenaar et al., 2020). In addition to these traditional challenges, new demands have emerged, such as sustainability, occupational safety, material traceability, and contractor management, all within an increasingly competitive and regulated environment (Sacks et al., 2018). In this context, decision-making becomes a critical process that requires advanced tools capable of analyzing large volumes of data efficiently and in real time.

In response to these needs, Big Data has emerged as a key technology that enables the processing, analysis, and interpretation of massive and diverse data sets. This facilitates the identification of patterns, risk prediction, and resource optimization (Bilal et al., 2016). Its application in construction not only improves operational efficiency but also strengthens the ability to anticipate potential problems, which translates into better planning, execution, and control of projects (Zhou et al., 2022).

The integration of Big Data represents a significant transformation in how construction projects are managed, allowing for more informed, strategic, and evidence-based decision-making (Perera et al., 2017). However, factors such as resistance to change, lack of technological infrastructure, shortage of specialized talent, and high adoption costs still limit its effective implementation (Khosrowshahi & Arayici, 2012).

This research aims to analyze, from a qualitative perspective, how Big Data can serve as a strategic support for decision-making in construction projects, by evaluating the perceptions and experiences of seasoned professionals in the field. The objective is to highlight its transformative potential and the benefits it can offer for comprehensive project management in a dynamic and competitive environment.

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1.2 Problem Statement

The construction industry currently faces increasingly complex challenges related to operational efficiency, meeting deadlines, cost control, and execution quality. These challenges demand more accurate and data-driven management, where strategic decision-making plays a central role in project success (Chong et al., 2016). However, many decisions in the sector are still based on partial information, empirical experience, or manual processes, which limit the ability to anticipate risks and optimize resources (Bilal et al., 2016).

In this context, Big Data emerges as a powerful technological tool with the potential to transform how information is gathered, processed, and used in construction. Thanks to its ability to manage large volumes of data in real time, Big Data allows for predictive analysis, the simultaneous evaluation of multiple variables, and decision-making based on concrete evidence (Kitchin, 2014). Nevertheless, its effective application in construction projects remains limited especially in developing countries—due to technological, cultural, and organizational barriers (Oyedele et al., 2018).

Moreover, while there is existing research that explores the technical use of Big Data, there is still an academic gap regarding the qualitative factors that influence its adoption. Specifically, it is necessary to explore how sector stakeholders—such as engineers, architects, and project managers—perceive this tool, what their practical experiences have been, and what organizational conditions they believe facilitate or hinder its implementation in strategic decision-making processes.

1.3 Justification

This research is justified by the need to address the current challenges faced by the construction sector in terms of efficiency, risk control, and improvement of decision-making processes. Especially in a context characterized by the technical complexity of projects, pressure to reduce costs and timelines, and the growing demand for sustainability and transparency, it becomes essential to incorporate technologies that allow for faster, more accurate, and more strategic information management (World Economic Forum, 2016).

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Big Data represents a valuable opportunity to transform management processes in construction by enabling the analysis of large volumes of data generated throughout the life cycle of a project. This technology makes it possible to integrate information from various sources (schedules, sensors, machinery, personnel, weather, costs, among others) and convert it into useful knowledge for anticipating risks, optimizing resources, and supporting key decisions (Zhang, Cheng & Teizer, 2015).

However, in the Latin American context—and particularly in many developing countries—the adoption of Big Data in the construction sector is still at an early stage. Factors such as resistance to organizational change, low investment in technological infrastructure, and the lack of specialized training limit its effective implementation (Oyedele et al., 2018). Added to this is the scarce academic output focused on understanding, from a qualitative perspective, how professionals in the sector perceive, use, or reject these tools.

Therefore, this study is justified not only for its academic value—by contributing knowledge about an emerging and underexplored phenomenon from the viewpoint of the involved actors—but also for its practical relevance, as its findings may guide construction companies, technical training institutions, and public policy makers in developing more effective strategies to drive the digital transformation of the sector.

1.4 Research Objectives

1.4.1General Objective

To analyze Big Data as a strategic support for decision-making in construction projects.

1.4.2 Specific Objectives

- To identify the perceived objectives of using Big Data in construction project management.
- To examine the practical applications of Big Data across the different phases of a construction project's life cycle.
- To explore the barriers and limitations to the implementation of Big Data in the construction sector.

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- To analyze the influence of Big Data on decision-making in construction projects.

Chapter II

2.1 Theoretical Framework

2.1.1 Big Data: The term Big Data refers to the management of large volumes of structured and unstructured data that, due to their complexity, cannot be processed using traditional methods. Its definition is based on the so-called “5 Vs”: Volume, Velocity, Variety, Veracity, and Value (Mayer-Schönberger & Cukier, 2013). These characteristics highlight the potential of data to generate useful knowledge in various sectors, including the construction industry.

The evolution of Big Data has been driven by the development of technologies such as cloud computing, artificial intelligence (AI), and machine learning, which enable not only the storage and real-time processing of data, but also the identification of patterns, the generation of predictions, and the support of strategic decision-making (Marr, 2016).

2.1.2 Decision-Making in Construction Projects: Decision-making in construction projects is a complex process that involves multiple technical, economic, human, and environmental variables. According to Turner (2014), project managers must make decisions under conditions of uncertainty, which requires accurate and timely information to minimize risks and maximize project performance.

Traditionally, such decisions were based on staff experience and limited historical data. However, in today’s context of greater complexity and competitiveness, a data-driven management approach is required. This justifies the inclusion of tools like Big Data to strengthen the analytical capacity and responsiveness of project teams (Pérez & Ríos, 2021).

2.1.3 Applications of Big Data in Construction: Big Data is increasingly being applied in various areas throughout the lifecycle of construction projects. Among its main applications are:

- Project planning through predictive models.
- Management of materials and equipment.

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- Real-time monitoring of performance and site safety.
- Predictive maintenance of infrastructure (González & Herrera, 2022).

These uses allow the generation of key performance indicators (KPIs), early detection of deviations in schedules and budgets, and support for strategic decision-making based on evidence. Furthermore, the integration of Big Data with Building Information Modeling (BIM) methodologies significantly improves project visualization, coordination, and traceability (Azhar, 2011).

2.1.4 Challenges in the Implementation of Big Data: Despite its benefits, the adoption of Big Data in the construction industry faces various challenges. Among the most common are:

- Lack of staff training in data analysis.
- Resistance to change.
- High investment required for technological infrastructure.
- Difficulty integrating disparate information systems (Wamba et al., 2015).

Additionally, there are barriers related to data quality and governance, the protection of sensitive information, and the need to foster an organizational culture oriented toward data analysis as a basis for decision-making (Zhao et al., 2020).

2.1.5 Qualitative Approach in the Study of Big Data in Construction: The qualitative approach is especially valuable for investigating complex and evolving phenomena such as the adoption of Big Data in the construction industry. This approach makes it possible to explore the perceptions, beliefs, attitudes, and experiences of the actors involved in decision-making processes, generating an in-depth understanding of how this technology is interpreted, adopted, and applied in real contexts (Creswell, 2013).

Unlike the quantitative approach, which focuses on statistical and generalizable measurements, qualitative research is interested in the meanings people attribute to their experiences and in the contextual factors that influence their behavior (Merriam & Tisdell, 2015). In the case of Big Data,

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this entails analyzing how project managers, engineers, architects, site supervisors, and other professionals in the sector perceive its usefulness, what barriers they face to implementing it, and how this tool transforms their day-to-day practices.

2.1.6 Common Qualitative Methods in Big Data Studies: Among the most commonly used qualitative methods in studies related to emerging technologies such as Big Data are:

- Semi-structured interviews.
- Focus groups.
- Direct observation.
- Content analysis of organizational documents (Miles, Huberman & Saldaña, 2014).

These methods allow for the collection of rich and contextualized information, which is ideal for understanding how strategic decisions are made in complex environments such as construction projects.

Previous studies have shown that in-depth interviews can reveal not only the perceived advantages of Big Data (such as improved efficiency or risk reduction) but also cultural resistance, structural limitations, and gaps in staff training (Perera et al., 2017; Shuja et al., 2021). This comprehensive perspective helps in designing adoption strategies that are better aligned with organizational realities.

2.1.7 Justification of the Qualitative Approach in This Research: Since the use of Big Data in the construction sector is still in an emerging phase, it is appropriate to address it from an exploratory qualitative approach. This perspective enables the understanding of the social and organizational dynamics that influence the adoption of new technologies.

Qualitative research also allows for the identification of emerging patterns and the generation of theories grounded in the data (grounded theory), which is particularly useful when the phenomenon under study—such as the strategic use of Big Data—still lacks a widely validated conceptual framework in specific contexts (Charmaz, 2014).

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Chapter III

3.1 Methodology.

This research was conducted using a qualitative approach with an exploratory and descriptive design. Semi-structured interviews were used as the main data collection technique, targeting professionals in the construction sector with experience in project management and familiarity with the use of digital technologies.

Participants were selected through convenience sampling, prioritizing individuals with experience in projects where some form of data analysis had been applied. The information collected was analyzed through thematic coding, allowing the identification of patterns, perspectives, and relevant experiences related to the strategic use of Big Data.

3.2 Research Approach.

This research was conducted under a qualitative approach, which is characterized by its focus on deeply understanding social phenomena based on the experiences, opinions, and meanings constructed by the actors involved (Creswell, 2014). This approach is particularly suitable for studying how construction professionals perceive and implement the use of Big Data as support for strategic decision-making.

3.2.1 Exploratory Design.

The exploratory design aims to investigate little-studied or emerging phenomena in order to understand their characteristics, relationships, and internal dynamics (Hernández, Fernández & Baptista, 2014). In this case, the application of Big Data in construction projects is still new, which justifies the need for qualitative exploration to identify perceptions, current uses, expected benefits, and existing barriers.

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3.2.2 Descriptive Design.

The descriptive design is used to detail how the phenomenon under study manifests itself by examining the key elements that comprise it. According to Sampieri et al. (2014), this design seeks to specify the properties, characteristics, and profiles of people, groups, communities, or processes. In this research, the descriptive design enabled the identification of how construction professionals apply or consider implementing Big Data in their management and decision-making processes.

3.2.3 Data Collection Technique.

The technique used was semi-structured interviews, directed at professionals in the construction sector (architects, project managers, and site supervisors) with experience in the use of information technologies in project management. This technique allows for the collection of rich, detailed, and flexible data, while providing a guiding framework that ensures consistency with the study's objectives (Kvale & Brinkmann, 2015).

In this research, participant selection was carried out through purposive or criterion-based sampling, prioritizing those with direct experience or relevant knowledge on the subject.

3.2.4 Data Analysis.

The data collected were analyzed using thematic coding, a qualitative method that allows the identification of significant patterns, categories, and relationships within participants' narratives (Nowell, Norris, White & Moules, 2017).

This process involved the transcription of interviews, thorough reading, open coding, axial categorization, and the creation of analytical matrices in order to organize the information in alignment with the study's objectives.

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Chapter IV

4.1 Analysis and Interpretation of Results.

The analysis of the data collected through semi-structured interviews with construction professionals led to the identification of four main emerging categories, each corresponding to the specific objectives of the study. The most relevant findings are described below:

4.2 General Perception of Big Data in Construction.

The interviewees agreed that Big Data represents an innovative tool with great potential for the sector. It is perceived as a useful technology for centralizing dispersed information and facilitating real-time access to critical data in project management.

“Before, we had to wait for weekly reports. Now, with data online, you can see in real time what’s happening on-site.” Project Manager (verbatim)

However, a gap was also noted between theoretical knowledge of the technology and its practical application within organizations. Some participants mentioned that although they are familiar with the concept, they lack the resources or institutional support necessary for effective implementation.

4.3 Current Applications of Big Data.

Among the most commonly mentioned uses by the interviewees were:

- Monitoring the physical progress of projects through digital platforms.
- Real-time control of costs and resource consumption.
- Prediction of operational risks (such as weather, logistics delays, and equipment failures).
- Performance analysis of personnel using digital records and IoT sensors.

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"With the data we collect from the access control system, we can cross-check it with daily productivity. That's something we didn't do before." Site Supervisor (verbatim)

These applications demonstrate a growing interest in using data to improve efficiency, transparency, and strategic responsiveness in construction projects.

4.4 Barriers to the Implementation of Big Data.

One of the most frequently mentioned categories was resistance to technological change, both from management and operational staff.

The following barriers were identified:

- Lack of technical training in data analysis.
- Low investment in digital technologies.
- Insufficient technological infrastructure.
- Lack of understanding of the return on investment (ROI) in the use of Big Data.

"There's still a very old-school culture. The boss wants to see papers, not dashboards." Project Manager (verbatim)

These statements reflect an organizational mindset that can hinder the adoption of digital tools, regardless of their proven benefits.

4.5 Impact on Decision-Making.

Most participants working in companies that have begun their digital transformation stated that Big Data has improved both the quality and speed of strategic decision-making. The integration of historical data with real-time information enables teams to anticipate deviations, adjust resources, and justify decisions to clients or superiors with quantifiable evidence.

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“When you have reliable data, you can justify why you decide to change the construction method or reschedule an activity. It’s a different level of argumentation.” Architect (verbatim)

The results showed that Big Data is perceived as a powerful tool for transforming construction project management. Key benefits identified include:

- Improved forecasting of risks and potential issues.
- Resource optimization and cost reduction.
- More informed decision-making based on real data.
- Greater efficiency in project progress monitoring.

However, significant barriers were also noted, such as resistance to technological change, lack of digital infrastructure, insufficient training in data analysis, and implementation costs. Despite these challenges, interviewees agreed that Big Data represents a major competitive advantage for companies that successfully incorporate it.

4.6 Summary of Thematic Analysis.

Emerging Category	Main Subcategories
Perception of Big Data	Innovation, usefulness, lack of practical implementation.
Current Applications	Monitoring, cost control, performance, risk prediction.
Implementation Barriers	Lack of training, cultural resistance, limited investment.
Impact on Decision-Making	Strategic justification, speed, error reduction.

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4.7 Conclusion.

The analysis conducted from a qualitative perspective confirmed that Big Data plays an increasingly strategic role in decision-making within the construction sector. Its application facilitates real-time access to information, enhances the analytical capabilities of management teams, and enables greater precision and speed in both operational and strategic decisions. However, its impact largely depends on an organization's digital maturity, staff training, and leadership commitment to fostering a data-driven culture.

Various practical applications of Big Data in construction projects were identified, such as project progress monitoring, cost control, personnel performance management, and operational risk prediction. These applications are beginning to take hold mainly in companies that have already adopted technologies such as BIM (Building Information Modeling) and IoT sensors, demonstrating that Big Data can be effectively integrated with other digital tools to enhance project management.

Research participants agreed that Big Data offers tangible benefits, including greater clarity in processes, better justification of decisions, predictive capabilities, and reduced errors. They also highlighted that access to accurate, real-time information allows for proactive responses to deviations, contributing directly to more effective and goal-aligned decision-making.

The most relevant barriers identified include the lack of specialized training in data analysis, resistance to change among staff, insufficient technological infrastructure, and a traditionalist organizational culture. These limitations pose significant obstacles to the effective adoption of Big Data, particularly in small and medium-sized construction companies. Overcoming them will require strategic leadership, technological investment, and a clear vision for digital transformation.

Finally, this study highlights the importance of continuing to investigate and document experiences with the application of Big Data in construction. Doing so will help generate

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contextualized knowledge that can guide future innovation initiatives and foster continuous improvement in the sector.

4.8 Recommendations.

4.8.1 Promote a Data-Driven Organizational Culture.

is recommended to foster an organizational culture that values the use of data as a key input for decision-making. To achieve this, it is essential to raise awareness among project leaders and executives about the strategic benefits of Big Data, promoting a mindset shift toward digital transformation. For example:

- Train managerial staff in data analysis tools and their applicability in construction.
- Incorporate evidence-based decision-making into organizational policies.

4.8.2 Invest in Technological Infrastructure and Digital Platforms.

Many of the barriers identified are related to the lack of technological infrastructure. Therefore, it is suggested to progressively invest in systems that allow for the collection, storage, and analysis of large volumes of data, such as BIM integrated with IoT sensors, real-time monitoring systems, cloud platforms, and interactive dashboards. For example:

- Conduct initial technology assessments to prioritize investments.
- Adopt scalable solutions according to the company's financial and technical capacity.

4.8.3 Design Technical Training Programs on Big Data Applied to Construction.

The lack of data analysis skills was a recurring limitation mentioned by interviewees. It is therefore recommended that companies, in partnership with universities and technical training institutions, implement continuous training programs in data analytics, artificial intelligence, and digital project management. For example:

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- Integrate Big Data and analytics modules into professional development programs in the sector.
- Train both technical and administrative staff to promote cross-functional knowledge.

4.8.4 Implement Controlled Pilots for the Progressive Adoption of Big Data.

Before full-scale implementation, companies are advised to develop pilot projects to validate the benefits of using Big Data in specific areas such as cost control, worksite productivity, or risk management. This helps minimize risks, generate impact evidence, and adjust processes before a full rollout. For example:

- Select medium-scale projects as test environments.
- Establish evaluation indicators before, during, and after the pilot.

4.8.5 Strengthen Inter-Institutional Alliances for the Sector's Digital Development.

Lastly, it is recommended to foster alliances between construction companies, tech developers, research centers, and public entities to promote collaborative initiatives that accelerate the sector's digital transformation and broaden access to technologies like Big Data. For example:

- Promote technological observatories in the construction industry.
- Seek access to public or private funds aimed at technological innovation.

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