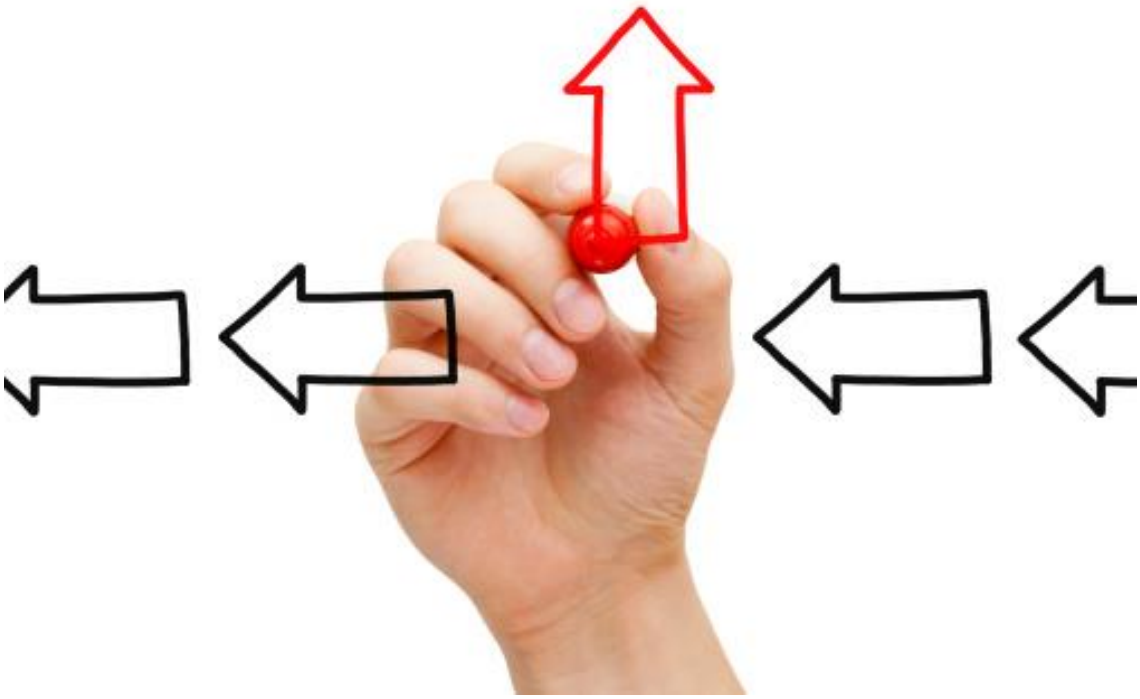
How to avoid abuse of deviations in the construction industry?



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Master Thesis

Construction Management and Engineering

June 2024

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How to avoid abuse of deviations in the construction industry?

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Preface

Completing this thesis brings me immense satisfaction. While it's common for students to express this sentiment, mine took a bit to say. In March 2020, I found myself writing another thesis when the pandemic hit, forcing me to return to my country and leave the thesis behind. It took more than two years and a lot of encouragement for me to gather the courage to give it another shot. Getting back into the research was incredibly challenging.

None of this would have been possible without the unwavering support of the people around me. First and foremost, I owe a huge debt of gratitude to my family, who witnessed firsthand the challenges I faced and stood by me unconditionally. My parents, Tjeerd Twijnstra and Maria del Carmen Duarte, never lost faith that I would eventually complete my thesis. Despite my dad's poor health, I'm grateful that he was able to witness this important milestone in my life, and I hope he'll be there for the next one—my wedding in a few months. And speaking of my wedding, I must give a special thanks to my fiancée, Vivienne Wolf, who has been my rock throughout this journey. My two brothers and sister also deserve a heartfelt thank you, as do all my pets, who provided comfort and companionship without judgment.

Of course, I can't forget to express my gratitude to the three members of my committee—Marian, Hans, and Leonie. They provided invaluable guidance and support throughout this lengthy process. However, I must give special thanks to Marian, the committee chair, who showed incredible patience with me every step of the way. Without her, none of this would have been possible. From the initial conversation about restarting the thesis to the final days of completion, she was a constant source of support and encouragement.

I also want to express my gratitude to the interviewees and experts who generously shared their time and wisdom with me. However, due to confidentiality reasons, I am unable to mention them by name.

There were moments when I doubted whether I would ever finish this thesis. While I'm proud of what I've accomplished, I can't help but feel a hint of sadness that it took so long. Nevertheless, I'm thrilled that I'm now a graduate of the prestigious TU Delft, just like my namesake grandfather, Ubbo Twijnstra.

To any students reading this, I want to offer my encouragement for whatever lies ahead in the thesis process. Finally, thank everyone who supported me from the bottom of my heart.

Ubbo Twijnstra

Asunción/Delft, June 2024

Abstract

Setting the scene

The research was prompted by the catastrophic events following the 2023 earthquake in Turkey and the observed deviations in construction projects. The earthquakes killed at least 54,000 people. One of the main causes of this catastrophe was the abuse of deviations. It appears that deviations could be a widespread occurrence worldwide. This research focuses in the Paraguayan construction industry. The distinction between change and deviation lacked clarity both in literature and practical application, prompting thorough examination. Changes entail official procedures, while deviations involve informal alterations to original plans. The literature identified potential causes, classifications, and costs associated with both. Causes are design errors and omissions, design changes, and unanticipated circumstances, with failure costs ranging from 3% to 20%. Quality is defined as conformance to established requirements. A project that delivers an outcome that is not fit for purpose has failed, even if it is on time and within budget. That is exactly what happens in the catastrophe. That is the quality issue that inspired this research. The purpose of this case study will be to explore the accepted deviations in the Paraguayan construction industry through interviews with key stakeholders. A tentative definition at this time for "accepted deviation" is an informally allowed variance in the project requirements.

The main research question is: How to avoid abuse of deviations in the construction industry?

Research approach

A literature study was performed to explore the topic. Given the novelty of the topic and limited existing literature, a qualitative research approach was deemed appropriate. The research was exploratory and inductive in nature. Four research methods were selected: literature review, interviews, document analysis, and expert evaluation. The literature review addressed the first and second sub-questions. Interviews and document analysis were utilized to tackle the third research question, while the fourth research question was addressed through a combination of literature review, interview analysis, and expert evaluation.

Eight professionals, encompassing both public and private sectors, took part in the interviews, with validation of specific findings sought from three experts within the private sector. All participants are drawn from Paraguay's construction industry, selected based on their expertise, roles, and availability.

Findings

Main findings will be presented along with their respective answers.

1) *What are differences between deviations and changes based on literature?*
   Changes and deviations differ fundamentally in both process and timing. Changes follow a formal procedure for evaluation and acceptance/rejection, whereas deviations lack a clear procedure. Additionally, the sequence of actions differs: changes are evaluated before the event, while deviations are assessed after the event, in other words, retrospectively. This retrospective evaluation leaves two options: accepting the deviation or rectifying it, which may involve redoing the work or performing additional tasks.

2) *What are the current theoretical methodologies to manage change orders and deviations?*

The literature extensively covers the management of formal changes but is lacking in guidance for handling deviations. Despite the existence of various types of deviations, literature suggests a single approach: acceptance. Once deviations occur, they are often accepted due to their past occurrence. However, it is vital to follow subsequent steps similar to those of approved changes, such as updating system configurations and the project plan. Monitoring the deviation and informing affected customers and stakeholders are also crucial steps.

3) *How are changes and deviations treated in practice?*

All participants acknowledged experiencing change orders, with a majority reporting numerous occurrences. Additionally, industry abuse of change orders was highlighted by some participants. Conversely, deviations were acknowledged by a majority of participants, with mixed opinions on industry abuse. Interestingly, there was no clear preference for any project phase regarding the timing of change orders, though deviations tended to occur midway through projects.

Change orders serve as the formal procedure for managing project changes and vary significantly between public and private projects. In the public sector, strict regulations govern change magnitude, involvement of public entities, and financial institution roles. Delays often arise during financial institution review. Conversely, the private sector adopts a more informal approach, often relying on verbal agreements.

Deviation occurrences result from bilateral agreements, unilateral decisions, and errors. Bilateral agreements resemble private sector practices, while unilateral deviations are contractor-initiated and may involve future regularization. Errors, lacking malicious intent, still represent deviations from specifications.

4) *What are good practices for managing deviations?*

I. The first step in managing deviations involves prevention efforts, though two out of three experts acknowledge deviations cannot be entirely avoided but can be minimized. Accepting certain deviations as inevitable emphasizes the importance of effective management. Analysis of interviews revealed six prevention measures deemed pertinent by all experts. According to experts, the order of relevance for prevention measures is: 1) improving final project design, 2) stipulating a paid, thorough contractor review in contracts, 3) reducing change order bureaucracy, 4) cultivating teamwork through improved communication, 5) considering unforeseen events, and 6) hiring qualified professionals. Suggestions on implementing these measures were generally agreed upon, though paid reviews and reducing bureaucracy may not be feasible in private projects.

II. The second step involves implementing good practices to manage any deviations that arise. All experts deem the identified four practices relevant and feasible, though opinions differ on who should lead. According to experts, the order of relevance for these measures is: 1) seeking opinions from specialists, 2) informal agreement documentation, 3) prioritizing execution in regulations, and 4) possessing experience and prioritizing safety. Suggestions on implementing these measures were generally agreed upon, though regulatory changes may not be viable.

Conclusion

Understanding and addressing deviations is crucial for progress and combating the abuse of deviations. Initially, a theoretical investigation into deviations, often overlooked in literature, was conducted. Deviations differ from formal changes in informality and occurrence sequence. Empirical study reveals various forms of deviations, including those stemming from informal agreements, unilateral contractor actions, and errors or omissions. Managing deviations practically is challenging due to limited theoretical guidance. However, they're often accepted as inevitable. Sometimes, formal change processes are initiated when deviations occur, involving project updates and customer notification. Preventive actions can reduce deviation likelihood, with six specific measures identified in this research. And mitigating the impact of deviations when they do occur, with four measures identified. The efficacy of these strategies relies on stakeholders' ethical behavior. While not fail-safe against catastrophic events, they benefit those with noble goals and raise awareness of deviation-related consequences.

Recommendations for practice

Firstly, it's essential to thoroughly comprehend the differences between changes and deviations in projects, particularly within the Paraguayan construction industry where clarity on these concepts is lacking. Understanding these concepts is the initial step towards improvement, encompassing diverse types, causes, and consequences.

Secondly, once the nature of deviations is understood, efforts should focus on minimizing them due to their potential negative impacts. Utilizing the six prevention measures outlined in this research is recommended to achieve this goal.

Thirdly, despite preventive efforts, deviations will inevitably occur in projects. Hence, it's crucial to understand how to effectively manage them by employing the four best practice measures.

Lastly, it's vital to recognize that these measures may not be exhaustive or universally applicable. They serve as a foundational guide, and stakeholders should assess each suggestion thoroughly and even develop new ideas as needed.

Recommendations for research

The topic of deviations offers ample room for investigation, as it remains relatively underexplored. Some of the suggestions for further research are the following:

- Narrowing the research focus to either the private or public sector to understand their distinct management approaches.
- Analyzing agile project management methodologies to assess their potential in minimizing the impact of deviations.
- Investigating the perspective of the client or financing entities, particularly in public projects, regarding changes and deviations.
- Examining the ethical dimensions of deviations, distinguishing between those driven by good intentions and those motivated by ulterior motives.
- Developing an approach or protocol for managing modifications that lie between formal changes and minor deviations.

Table of content

List of figures

List of tables

1. Introduction

1.1 General introduction to project deviations

This research was motivated by the catastrophic events in Turkey resulting from the 2023 earthquake and the variations in construction projects. The specific information regarding this regrettable incident will be discussed later in this chapter. Nevertheless, the issue of deviations in construction projects is likely to be widespread worldwide. Through the course of the research, it became evident that there is a lack of clarity in both the literature and practical application when it comes to distinguishing between change and deviation in construction projects. As a result, both concepts were thoroughly examined. These two concepts are closely connected, with changes referring to official modifications made to the original project and deviations referring to informal modifications made to the original project. The literature identified potential causes, classifications, and cost associated with changes and deviations.

Change can be classified by different writers according to its causes and types. In addition, they argue that the three main causes of change orders can be categorized into three groups: design errors and omissions; design changes; and unanticipated circumstances (Diekmann & Nelson,1985; Jacobs & Richter, 1978; Clark, 1990). The causes could stem from a lack of knowledge, inadequate information, lack of motivation (Hammarlund & Josephson, 1998), or even a lack of ethics. The failure cost of a project might range from 3% to 20% (Burati et al., 1992; Hammarlund and Josephson, 1991; Love and Li, 2000; Cnuddle, 1991). This is a significant quantity, thus it's interesting to look at ways to lessen the number and effect of the deviations. Consequently, there is a strong correlation between project quality and deviations.

According to Burati et al. (1992), “Quality is defined as conformance to established requirements" (p. 2). Hammarlund and Josephson (1998) defined that “some requirements are given by law and in regulations, building standards, etc., as well as in contract documents, site meeting records and other project documentation” (p. 3 or p. 683). Quality is the absence of defects, the absence of mistakes that necessitate rework, or that cause product failures in the field, customer complaints and claims etc. In this view, the definition of quality is cost-oriented, and higher quality is typically more affordable (Juran & Godfrey, 1999 , Section 2.2). The goal of quality is to meet customer expectations and comprehend their current and future demands. A product's suitability for usage is decided by the buyer, customer, or user (Husin et al., 2009). The word future is very important since the focus is not only in the project specifications. Fitness for purpose and conformance to requirements are similar, but not the same. It may be the case that a project accomplishes conformance to requirements but does not comply fitness for purpose (Wright & Therese Lawlor-Wright, 2018, p. 5). Love & Li (2000) stated that quality in construction had become an endemic feature of the construction industry.

A construction project's performance is greatly impacted by change (Ibbs, 1997). Pires et al. (2007) stated that in Portugal construction companies provided projects with major quality-related non-compliance issues as well as cost and time overruns of 14% and 40%, respectively. Building errors had a 50% design origin and a 40% construction origin, according to research by the UK's Building Research Establishment (BRE, 1981; BRE, 1988). The later the change, the more detrimental an impact is on productivity (Ibbs, 1997). Moreover, while more change is incurred, productivity decreases considerably. Project change of 10% reduces productivity by 2.48%.

A project that delivers an outcome that doesn't meet its intended purpose is considered a failure, regardless of whether it's completed on schedule and within budget. This often occurs when there's a heavy emphasis on managing project timelines and costs at the expense of quality. Barnes introduced the widely recognized iron triangle, which encompasses quality, time,

and cost. However, there's significantly more literature focused on time and cost than on quality. This discrepancy may be attributed to decision-makers prioritizing cost-cutting measures over quality, the inherent difficulty in measuring quality, and the challenge of transferring lessons learned about quality from one project to another (Wright & Therese Lawlor-Wright, 2018, p. 1-2)

Safety and quality go hand in hand. Both make an effort to reduce impediments to a job's efficient completion. From their perspective, alterations are typically brought on by unfavorable situations or mistakes made by people. These alterations are referred to as deviations in quality and accidents in safety (Husin et al., 2009).

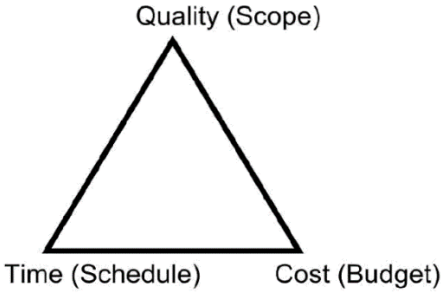

Figure 1: Iron triangle

1.2 Example of deviation abuse: Catastrophe in Turkey

A clear and recent example where is evident that quality was not the priority is what happened in Turkey and Syria. On February 6 2023, a 7.8-magnitude earthquake occurred in southern Turkey, not far from Syria's northern border (Center for Disaster Philanthropy, 2023). Almost nine hours after the first earthquake, another earthquake with a magnitude of 7.5 occurred. The earthquakes killed at least 54,000 people in Turkey and Syria. In 11 provinces of Turkey, there have been at least 230,000 buildings damaged or destroyed, and in northwest Syria, there have been at least 10,600 buildings fully or partially destroyed. $39.3 billion is the estimated total cost of the losses (Center for Disaster Philanthropy, 2023). The cost of reconstruction will increase based on how extensively the new construction regulations are applied.

Given that new building rules requiring earthquake resistance in new construction were imposed following the 1999 Izmir earthquake, which claimed 17, 000 lives, you may be wondering how this could have occurred in Turkey. Moreover, the codes underwent their most recent change in 2018 (Horton & Armstrong, 2023; Beaumont, 2023; " The News-Herald, 2023," 2023).

There are many expert opinions on this catastrophe, however the following are interesting in this analysis because they are related to deviations and quality.

1) According to Didem Aktas, a structural engineer and lecturer at University College London, buildings were either improperly implemented or not initially planned in accordance with the code (Said-Moorhouse, 2023). In the first cause, she implies that some of the buildings were designed in line with the code, but the building suffered a deviation during implementation and ended up not complying with the codes. Burati et al. (1992) stated that any change, error, or omission is a deviation, which this case clearly is one. Hammarlund and Josephson (1991) suggested that alterations which are related to deviations are causes of quality failures.

2) According to the CEO of the catastrophe modeling firm Temblor, building quality is the most important element (Beaumont, 2023). As Juran (2000) stated, quality is the absence of defects, the absence of mistakes that necessitate rework, or that cause product failures in the field (Juran & Godfrey, 1999, Section 2.2).

3) According to some experts, the policies of Erdogan as well as regional and municipal officials, who monitored and encouraged a construction boom that assisted in fueling economic growth, must be closely examined in order to identify the source of the lax enforcement of building rules (The News-Herald, 2023). This is intimately connected to the cost of control, which entails all the work required to identify faults or defects by assessing how closely project components correspond to the quality criteria. (Feigenbaum, 1991).

Speaking about policies, one that must be one of the biggest causes of this catastrophe is the following one. The government of Turkey has supported a program known as construction amnesties for the past 40 years, which enables builders to formally register non-code-compliant buildings for a price. Infringers could avoid having to bring their structures up to code by paying a fine. The government was able to gain popularity and money thanks to it. When it is politically sensitive, such as right before an election, the amnesties are frequently granted for a certain duration. The previous time occurred in 2018, just before local elections. The government reportedly received amnesty fees totaling $19 billion. Nine public offers of building amnesty were made between 2002 until the earthquake this year (Harrington, 2023; The News-Herald, 2023; Said-Moorhouse, 2023).

As can be seen, the amnesty law poses serious issues because it has encouraged a culture of irresponsibility in the building industry in a nation with a history of earthquakes and major fault lines (The News-Herald, 2023; Said-Moorhouse, 2023; Gauthier-Villars & Thomas, 2023). Architects and urban planners in the nation have long issued warnings about the inadequate enforcement of construction rules connected to seismic activity (Beaumont, 2023).

There are other factors that played a negative role in this calamity, e.g:

1. The building industry contributed to Turkey's economic growth (RFI, 2023). According to official statistics, the number of businesses engaged in the real estate industry has expanded by 43% during the past ten years. That means that the problem has grown a lot during that time since most of the buildings were built under the corrupt model.

2. According to architects, a lack of regard for construction rules and cooperation between politicians and housing developers have resulted from pressure to build more quickly and inexpensively (Bhattacharyya, 2023). The focus was in schedule and cost, but not in quality. In order to minimize expenses, the corporations recruit fewer specialists, which are not suitable and disregard different standards. Additionally, they used steel rods that are too thin to support the columns and sub standard concrete (The News-Herald, 2023; RFI, 2023). This is a clear example of a project's failure when it produces a result that is not suitable for its intended purpose, regardless of its adherence to the schedule and budget. (Wright & Therese Lawlor-Wright, 2019, p. 1-2).

3. Not only new buildings were not aligned with the building code, but also the remodeling. The Ministry of Environment and Urbanization has cited a variety of infractions, including the construction of additional stories, expanded balconies, and the removal of

columns to provide more space (Gauthier-Villars & Thomas, 2023; The National, 2023; Bhattacharyya, 2023).

4. Not following the building codes is already part of the idiosyncrasy of the country. There are several experts and studies that were already talking about this problem years ago. One of them is the paper from Bikçe & Çelik (2016). In addition to their investigation of the Mw = 7.2 Van Earthquake that happened on October 23, 2011, they also examined at least eight additional studies from earlier earthquakes. When the structural damages in structures built in accordance with TEC 2007 and earlier norms are compared, the same problems still exist. Most of those structures either did not adhere to the relevant code at the time of construction or had significant architectural defects, it has been discovered. In addition, according to Gunes (2015) between 50 and 75 percent of current structures do not have the design documentation and permissions necessary for their construction.

A significant proportion of Turkey's buildings do not adhere to either the structural or seismic codes that were in place at the time of their construction, or the more rigorous modern seismic code that is currently enforced (Gunes, 2015). Between 50 and 75% of existing buildings in Turkey are constructed without the requisite permits and design documentation. This issue is frequently reported in the media and acknowledged by government officials. These structures are typically built using substandard materials and craftsmanship as a result of inadequate or nonexistent oversight or inspections during the construction process (Gunes, 2015).

While a lack of safety or quality may be obvious right away, it often takes time for those issues to become apparent. Major quality concerns and safety problems have similar immediate effects, such as the loss of time and resources, the need for an investigation, the attribution of responsibility, the depletion of morale, loss of future business (Husin et al., 2009; Love & Li; 2000).

The tragedy in Turkey prompted the idea that project deviations should be investigated. However, it's a problem believed to exist worldwide, albeit to varying degrees, from minor to severe.

1.3 The purpose of the research

This research has been made in order to finish the master Thesis in Construction Management and Engineering. The goal of this case study was exploring the accepted deviations in the Paraguayan construction industry through interviews with key stakeholders. A proposed definition for “accepted deviation” is an informally allowed variance in the project requirements.

The problem of deviations in construction projects is believed to be a global problem, which strikingly did not often attract the attention of researchers. With this research we hope to make a small contribution to this neglected area. Being a poorly studied topic, this research was qualitative and explorative.

The main research question was: How to avoid abuse of deviations in construction industry?

1.4 Structure of the report

The structure of this thesis is made up of seven chapters. The second chapter consists of the research methodology, which indicates the purpose of this research, the research question and sub questions, the general description of the research, the research methods and other aspects such as reliability and validity. The third chapter consists of a literature review that covers what a deviation is, its types, causes and costs. In chapter 4, the results and analysis of the 8 interviews are presented. Chapter 5 deals with prevention measures and good practices for deviations. Chapter 6 covers the discussion and finally in chapter 7 are the conclusions. The appendices cover the interview protocol, the transcripts of the interviews, summary of the interviews, the Paraguayan national public contracting law, change order examples by theoretical cause type, interview fragments demonstrating recognitions and concepts of project deviations, deviations examples, quotes from interviews regarding deviation preventions and best practices, experts consultation protocol and experts consultation transcripts.

2. Research design

In this chapter, the research design is introduced. The chapter is divided into six sections, covering: The purpose of the study, research questions, general overview, research methods, data analysis and interpretation, reliability and validity, and ethical considerations.

2.1 The purpose of the study

The purpose of this case study was to explore the accepted deviations in the Paraguayan construction industry through interviews with key stakeholders. A tentative definition at this time for “accepted deviation” is an informally allowed variance in the project requirements. According to the literature review, there are very few studies in this area and it is probably a topic of worldwide interest and relevant. There are several studies that tackle deviation issues, but not the accepted or normalized ones. This study examined both deviations and changes, taking into account the limited existing literature on deviations. It is worth noting that the term "change" is strongly associated with deviation, and sometimes both terms are used interchangeably in the literature. The following table (Table 1) illustrates some of the authors and their respective works that were taken into account in this research, the full list can be seen in the References.

Table 1: Some of the used bibliography for this research.

Tipe	Name	Authors	Year
Journal	Causes of quality devaitions in design and construction	Burati et al	1992
Journal	Quantifying the causes and costs of rework in construction	Love and Li	2000
Journal	Lack of quality in construction – economic losses	Cnuddle	1991
Journal	Benchmarking the costs of poor quality in construction: A case study	Love et al	1998
Journal	Total Quality Control	Feigenbaum	1991
Journal	Sources of quality failures in building	Hammarlund & Josephson	1991
Journal	The causes and costs of defects in construction - A study of seven building projects	Hammarlund & Josephson	1998
Journal	In Search of the Root Cause, Quality Progress	Dew	1991
Journal	Root Cause Analysis: A Tool for Total Quality Management	Wilson, Dell & Anderson	1993
Journal	Success Evaluation Factors in Construction Project Management - Some Evidence from Medium and Large Portuguese Companies	Ribeiro, Paiva, Varajão & Dominguez	2012
Journal	Management functions and competitiveness in the Portuguese construction industry	Pires et al	2007
Book	Juran's quality handbook	Juran & Godfrey	1999
Journal	Project success and quality, balancing the iron triangle	Wright & Lawlor Wright	2018
Journal	Quantitative impacts of project change size issues	Ibbs	1997
Conference	The impact of rework on construction & some practical remedies	Dougherty et al.	2012
Journal	Measuring and Classifying Construction Field Rework - A Pilot Study	Fayek, Dissanayake, Campero	2003

As has been clearly seen in the catastrophe in Turkey, the abuse of deviations in construction is a big problem that must be investigated in order to understand why that happens and more importantly, how to mitigate them.

2.2 Research questions

How to avoid abuse of deviations in the construction industry?

This question will be answered with help of four sub-questions:

1) What are differences between deviations and changes based on literature?

2) What are the current theoretical methodologies to manage deviations (or change orders)?
3) How are the deviations and changes treated in practice?
4) What are good practices for managing deviations?

Table 2 summarizes the research methods for answering each sub question.

Table 2: Research methods for each research question.

Research question	How will they be answered?
Sub-question 1	Literature study
Sub-question 2	Literature study
Sub-question 3	Interviews and documents study
Sub-question 4	Literature study and interviews

2.3 General overview of the research

Certain attributes of the research problem align closely with those typically addressed by qualitative research methods. These include the necessity to explore, characterize, and formulate theories, the potential infeasibility of quantitative measurements for the phenomenon, and the relative novelty of the concept (Creswell, 2008). Hence, a qualitative research approach was opted for over a quantitative approach.

This section offers a thorough overview and chronological outline of the research methodology utilized in this study, as depicted in Figure 2. It details the systematic approach from the inception of the research, including the process of arriving at the topic and subsequent steps, from formulating research questions to reaching conclusions. Each stage is succinctly portrayed in the figure. Following sections elaborate on research methods, data analysis techniques, interpretation of results, and the reliability, validation, and evaluation processes. This structured overview aims to guide readers through the methodological framework that underpins the study, ensuring clarity and coherence in understanding the research approach.

In this research project, the objective was to capture a diverse array of perspectives through the eight initial interviews and three subsequent interviews with experts. Input was gathered from individuals spanning a spectrum of experience levels and roles, including employees and business owners from both the public and private sectors. This approach yielded a diverse range of variables, enriching the exploratory nature of the study and providing a comprehensive overview of the landscape (Creswell, 2008).

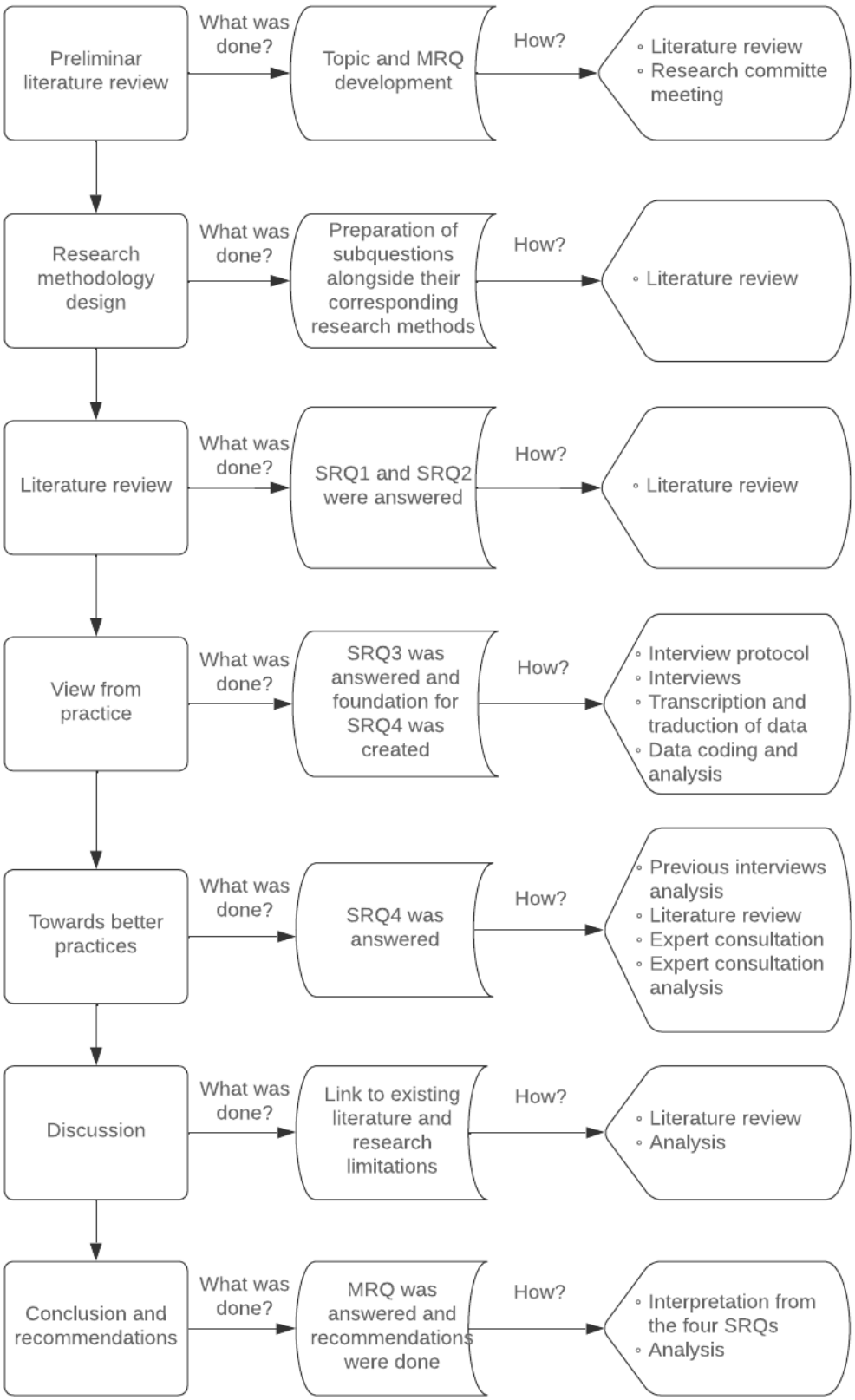

Figure 2: Overview of the Research Methodology.

Given that this study is exploratory, a qualitative form of design has been chosen as a way to investigate and comprehend the meaning that individuals assign to this problem (Creswell, 2008). Another aspect of qualitative research is that the researcher tries to comprehend participants by listening to them and basing their interpretation on what they say. Qualitative studies follow an inductive method of developing an extended model or theory from the data to broad topics.

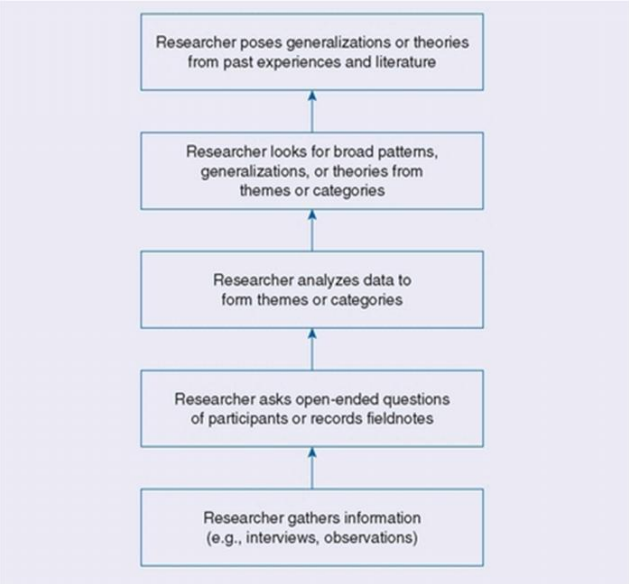

Figure 3: The Inductive Logic of Research in a Qualitative Study (Creswell, 2008).

The primary method of data collection involved conducting interviews. Initially, participants were prompted to provide specific information, which was later categorized, coded, and organized. Whenever feasible, the data was grouped thematically, allowing for comparisons among different topics and existing literature (Creswell, 2008). This analytical process facilitated drawing conclusions based on the findings.

Throughout the study, particularly during the interviews, the researcher maintained an open-minded approach, prioritizing active listening and learning from participants, rather than imposing preconceived notions from the literature (Creswell, 2008). Efforts were made to avoid directing responses, and all inputs, even unexpected or contradictory ones, were accepted.

The research process was dynamic and emergent, with each stage evolving throughout the study, particularly following data collection. Despite this adaptability, numerous adjustments were made to refine the scope and methodology of the research (Creswell, 2008).

2.4 Research methods

This section explains the theorical background of the methods used in this research and also how the research has been done. According to Stake (1995), various data collection techniques are used by researchers to gather comprehensive information. The methods carried out are literature review at various stages of the research, semi-structured interviews with a protocol to eight people who work in the construction industry, to a lesser extent document analysis and an expert consultation. For this purpose, an additional research protocol was conducted, followed by contacting and interviewing three experts.

2.4.1 Literature review

Performing a literature review is one of the most important acts in research. Is one of the first steps to find a gap in the literature and know if the topic can and should be investigated. It is also done during the research and sometimes at the end to answer a research question or to compare findings with the literature (Creswell, 2008).

The literature review serves multiple functions. Firstly, it shows the researcher all the studies that have been done and are being done in the area of interest of the research. Secondly, it provides the evidence that there is a gap in the literature. Thirdly, it offers a structure for determining the significance of the research. And fourthly, it allows the researcher to benchmark their results with existing data (Creswell, 2008).

The literature employed in qualitative research takes into consideration that the study is exploratory in nature, meaning that not much has been published about the subject before. As a result, instead of learning from the literature, it aims to learn from the participants (Creswell, 2008).

Considering the qualitative and inductive nature of the research, the literature is not extensive for the elaboration of the research questions. A second review of the literature will be done after the analysis of interviews to compare results (Creswell, 2008).

The literature review was carried out through Google Scholar. The research was restricted to papers with free access. This limitation prevented the use of all the information available on the web. For the web search, key terms and their synonym were chosen in different combinations (Creswell,2008). They were chosen according to the titles, keywords and summaries, thus trying to minimize non-relevant reading. Nonetheless, many were irrelevant or had little contribution to the investigation.

Due to the topic's novelty, literature specifically addressing deviations was scarce. As a result, the decision was made to extensively review subjects closely related to the research topic. To name a few examples, change causes, change consequences, change costs, project quality, security related to quality, Turkey news, formal management of changes, etc. The keywords used were ¨project management¨, ¨construction¨, ¨deviation¨, ¨rework¨, ¨engineering¨, ¨change management¨, “project change”, “safety”, “quality”, “project alteration”, “project requirement”, ”project modification” ... There were Xx documents chosen. Based on the data obtained from the search using the specified key terms and Google Scholar, it was found that there is a scarcity of literature on project deviations. The selected documents cover a wide spectrum of the topic.
One complexity within the topic stems from the diverse terminology employed by various authors to describe what this research categorizes as changes and deviations. For example, what some studies define as a project change is classified as a project deviation in this research, and vice versa.

2.4.2 Interview

Interviews are helpful when participants cannot be physically watched and when participants may share historical knowledge. Additionally, it gives the researcher choice over the line of inquiry. Of course, this approach has some drawbacks, including the following. It delivers information that has been indirectly filtered through interviewees' perspectives, the presence of the researcher may skew responses, not everyone has the same level of knowledge and clarity and the information is not delivered in the natural field.

In-depth qualitative interviews were conducted with participants, employing a meticulously designed interview protocol outlined in Appendix 1: Interview protocol. The interviews were structured in a semi-structured format, featuring open-ended questions across four distinct sections. They were audiotaped with the interviewee's permission, transcribed, and translated (Creswell, 2008). The interview protocol consisted of the following:

- A heading.
- The interviewer adhered to guidelines ensuring coherence among the interviews, encompassing both primary and auxiliary questions.
- An ice-breaker section at the beginning followed by the core sections.
- Notes were taken during the interview and two audio recording devices were available in case one of them did not work.

The goal was to minimize the number of questions to draw out comprehensive views and opinions from the interviewees, following Cresswell's approach (2008). Additionally, neutral questions were crafted to avoid guiding responses and uphold the "law of nondirection" as advocated by McCracken. (1998).

The initial segment, "Interviewee Introduction," consisted of four questions aimed at fostering a comfortable atmosphere and understanding the interviewees' backgrounds, serving as an icebreaker before delving into the core questions (Creswell, 2008). Subsequently, the interview explored "Project Changes" with nine questions, followed by a discussion on "Deviation" with nine additional inquiries. The final section, "Best Practices," comprised five questions, totaling twenty-seven questions in all.

The interview was carried out with eight people who work in the construction industry in Paraguay. Selection encompassed individuals from both the public and private sectors, five interviewees were from a public entity and the other three work in the private sector. Given the exploratory nature of the study, it was deemed that this approach would facilitate a more comprehensive exploration of the phenomenon of deviations. In Table 3, some characteristics of these eight people can be seen. They were chosen based on two criteria: their involvement in the construction industry and their accessibility. Ideally, all participants would possess significant experience.

Table 3: List of interviewees.

Public sector	**Public sector**	**Years of experience (approximately)**
Interviewee 1	Road manager at the Ministry of Public Works.	5
Interviewee 2	Purchasing manager at the Ministry of Public Works.	5
Interviewee 3	Manager at a Waterfront project at the Ministry of Public Works.	5
Interviewee 4	Manager at the Ministry of Public Works.	10
Interviewee 5	Inspection manager at a binational Hydroelectric .	40
Private sector	**Private sector**	
Interviewee 6	Owner of a building materials production company.	20
Interviewee 7	Owner of a architecture and restoration consultancy.	30
Interviewee 8	Owner of a construction company.	40

2.4.3 Document study

According to Creswell (2008), project documents can enhance research by providing valuable information, such as institutional quality guidelines, meeting minutes, reports, emails, and articles. Benefits of this approach include the flexibility to access the material at a time that is convenient for the researcher, the ability to collect the language and words of participants, and

the potential to avoid transcription costs and time by using written evidence instead. A method limitation is that documents may not be true or accurate, protected information may be inaccessible, and resources may be missing.

However, in this study, the research primarily relied on oral information regarding certain project procedures, such as project change orders, contracts and logbooks. The only document that underwent analysis was the national law concerning project changes that can be seen in the Appendix 4: National law on public procurement.

2.4.4 Expert consultation

Analysis of the interviews yielded suggestions for best practices regarding deviations. These findings were then cross-referenced with literature, followed by interviews with experts to assess and evaluate the suggestions. Experts were chosen based on accessibility and extensive experience in the field. This method facilitated the answering of the fourth research question.

A research protocol was implemented with a specific focus on evaluating potential good practices for deviations, aiming for conciseness. Discussion solely revolved around findings from previous interviews and reference to the literature review. The protocol is detailed in Appendix 9: Experts consultation protocol, while full transcripts of interviews with three private sector experts are provided in Appendix 10: Experts consultation transcripts. Table 4 provides a brief overview of the experts.

Table 4: Experts overview.

Occupational profile	Expert 1	Expert 2	Expert 3
Profession	Civil engineer	Architect	Civil engineer
Position	Owner	Designer	Budget manager
Years of experience	37	35	10
Type of company	Private	Private	Private

2.5 Data analysis and interpretation

The following Figure 4 illustrates the bottom-up approach to data analysis. Creswell stated that this must be seen as a more interactive process and not that fixed. An important part of this approach is the coding of the data. Allowing the codes to develop throughout the data analysis is the conventional method in the social sciences. To code the data in this situation, the researchers may create a qualitative codebook (Creswell, 2008). A formal code book was not generated as the analysis was conducted by a single individual. Initially, some basic reference codes were established. However, due to the iterative nature of the process, these codes evolved and expanded. They were subsequently organized into groups for analysis. The entire process was facilitated with the aid of the Atlas.ti software.

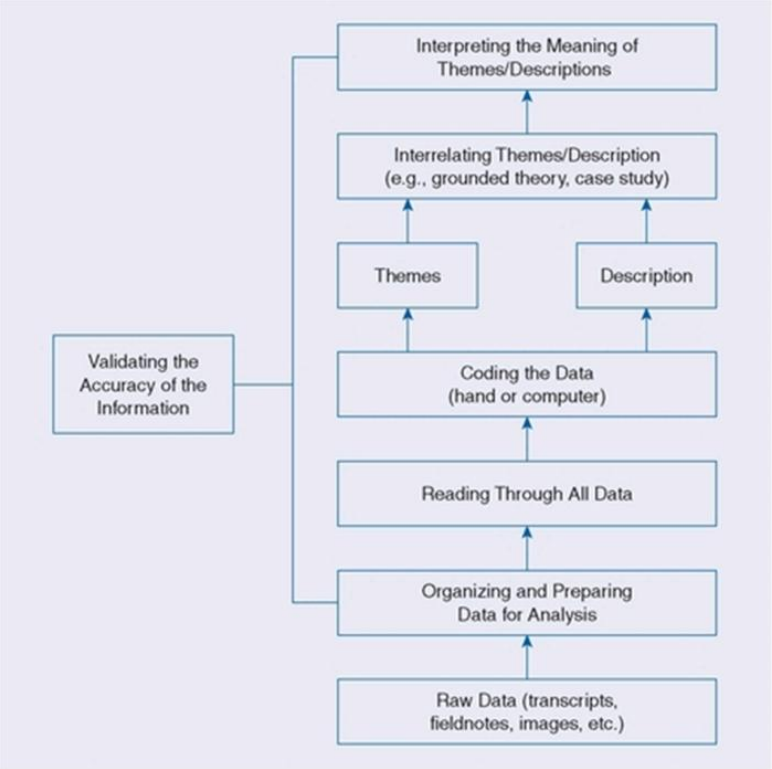

Figure 4: Data analysis in qualitative research (Creswell, 2008).

2.6 Reliability and validity

According to Gibbs (2007), "Qualitative validity means that the researcher checks for the accuracy of the findings by employing certain procedures, while qualitative reliability indicates that the researcher's approach is consistent across different researchers and different projects".

According to Yin (2003), qualitative researchers should record the case study methods and as many of the individual steps as they can. Additionally, he advises creating a thorough case study process and database. Gibbs (2007) offers the following reliability techniques:
• Verify that there were no evident transcription errors in the transcripts.
This task involved listening to the recordings twice. Initially, after each sentence, the recording was paused, transcribed, and this process was repeated until the entire recording was transcribed. Following the transcription, the recording was listened to again while simultaneously reading the transcription to identify any mistakes or misinterpretations. Moreover, during the translation phase, meticulous checks were performed to ensure no information was overlooked.

The following are some of the validity strategies (Creswell, 2008):

•Return the final report to the participants in order to asking them if about the accuracy of the findings.
The transcriptions of their interviews were shared with all interviewees to verify that their opinions were accurately represented and to ensure there were no errors in interpretation.

• Use detailed, in-depth description to communicate the findings.
In the analysis, excerpts from the interviews were cited, tables and figures were generated to enhance the elucidation of the findings, and appendices containing more extensive and detailed

analyses intentionally omitted from the main body of the research, as well as the original transcripts, were included.

• Include information that is contradictory to the findings.
All information, including contradictory findings, is included in the analysis without deletion or adjustment. While oversights are possible, efforts were made to identify contradictions as they provide additional validation to the investigation.

3. Literature review

This chapter is divided in four sections. The first one covers the types of deviations, the second one the causes of deviations, the third one is cost of deviations and the last one the formal procedures for change orders.

3.1 Types of deviations

Burati et al. (1992) stated that deviation includes changes in the products or results that need rework in order to comply with the requirements as well as the ones that do not require rework, but they use only the data associated with rework. Deviations for them encompasses change, errors and omissions. Not all construction changes are documented in official reports, and errors were frequently fixed right away rather than taking the time and effort to submit formal requests (Burati et al., 1992). A table with deviation type with a brief description can be seen in Table 5.

The three main causes of change requests are, (1) an outside occurrence; (2) a change that adds value; and (3) a mistake or omission while defining the project's or product's scope (PMI, 2000). Defect, in accordance with The Standardization Commission in Sweden (1987), is the failure to meet the requirements of the intended use.

Various authors categorize change based on its causes and types. Additionally, they contend that the three primary reasons for change orders can be broadly divided into three groups: design errors and omissions; design changes; and unanticipated circumstances (Diekmann & Nelson,1985; Jacobs & Richter, 1978; Clark, 1990). Ibbs' (1997) study also examined changes that were not required to have granted change orders.

According to Fayek et al. (2002) rework can be defined as “activities which remove work previously installed as part of the project regardless of source, where no change order has been issued and no change of scope has been identified by the owner”. In other words, all the works that have been done wrong and needed to be corrected. Omissions, errors and changes are not considered rework. Fayek et al. (2003) created a process for tracking field rework. When an incident is found in the field, the process begins. Based on the incident, the relevant authority receives a report and determines whether to redo it or accept the work as is. This last situation is the one this research is interested in and the one they ignored it.

This section discussed the definitions of two similar and confusing concepts, change and deviation. Every author has a different definition for change, deviation, rework, error, omission and so on.

Table 5: Deviations category (Burati et al.,1992).

Deviation category (1)	Brief description (2)
Construction change	Change in the method of construction
Construction error	Error made during construction
Construction omission	Omission made during construction
Design change/improvement	Design revision, modifications, and improvements
Design change/construction	Design change initiated by construction
Design change/field	Design change required due to field conditions (e.g., lack of as-builts)
Design change/owner	Design change initiated by the owner
Design change/process	Design change initiated by operations or process
Design change/fabrication	Design change initiated by the fabricator
Design change/unknown	Design change with an unknown source of initiation
Design error	Error made during design
Design omission	Omission made during design
Operability change	Change made to improve operability
Fabrication change	Change made during fabrication
Fabrication error	Error made during fabrication
Fabrication omission	Omission made during fabrication
Transportation change	Change made to method of transportation
Transporation error	Error made in method of transportation
Transporation omission	Omission made in transportation

3.2 Causes of deviations

Hammarlund and Josephson (1991) suggested several causes of quality failures. Among them are the alterations which are related to deviations. They also suggested that, as much as 4% of the actual project production cost may be lost due to quality failures after a project has been completed. It was interesting to discover that 51% of these failure costs were related to design, whereas 26% were connected to improper material installation and 10% to material failure.

Defects are typically thought to result from ignorance, insufficient information, or a lack of motivation. According to studies, the most frequent reason is carelessness; secondly, a lack of knowledge; and thirdly a lack of information (Hammarlund & Josephson, 1998). Hammarlund and Josephson found that half of the defect costs may be correlated with motivation. Only a small percentage of the motivational flaws were purposeful. The second cause was ignorance, which accounted for 29% of the defect cost, while far less was attributable to poor communication, stress, and risk. It is important to proceed cautiously when drawing conclusions from the study from Hammarlund and Josephson (1998) because they were usually unable to identify the exact causes. This could be also a problem analyzing the purposeful deviations without formal request.

A survey was undertaken by the National Economic Development Agency in 1987 with the goal of identifying strategies to enhance quality control in construction projects. It was discovered that poor workmanship and design were the key determinants of quality.

Eliminating or addressing the fundamental cause will stop the defect from recurring (Dew, 1991; Wilson et al., 1993).

3.3 Cost of deviations

As mentioned in the preceding section, Hammarlund and Josephson (1991) proposed that up to 4% of the total project production cost could be lost due to quality failures post-completion. Love and Li (2000) found in their research that the overall cost of rework was around 3% of the total cost of the project. This cost included variations and defects. Burati et al (1992) discovered that, on average, 12.4% of the total project expenses were attributable to deviations on the projects, where 9,5% are attributable to design deviations and 2,5% to construction deviations

(Burati et al., 1992). While Love and Li's (2000) study looked at two projects from the construction phase to the liability period, Burati et al. looked at nine projects from the design phase to the construction phase.

According to Love et al. (1998), quality costs are the overall cost resulting from issues that arise from the whole lifecycle of the project. Cnuddle (1991) established the failure costs in construction by examining the level of on-site non-conformance. He calculated the cost of non-conformance to be 10% to 20% of the project's overall cost. In addition, it was discovered that design deviations accounted for 46% of all deviation expenses, compared to construction deviations' 22%.

As few contractors keep adequate jobsite records for calculating change effect costs, the majority of research concentrated on changes that were finally accepted through the change order process (Ibbs, 1997). Considering the work culture in Paraguay, this will also be an issue.
He calculated project change by two methods, he uses net and absolute differences. Absolute changes take into account all the changes, while net changes effects take into account only the differences between the initial plan and final outcome costs. He did not find meaningful discrepancy. He found that the combined change cost of the design and construction phases is 5%.
Hammarlund and Josephson (1998) found that the expenditures associated with defects discovered during the investigation range from 2.3 to 9.4% of the construction budget. They divided in three the origin of the defect cost. The early stages accounted for 32% of the defect costs, site-related defect cost accounted for 45% and 20% or more of the cost of defects was caused by equipment or materials (Hammarlund and Josephson, 1998).

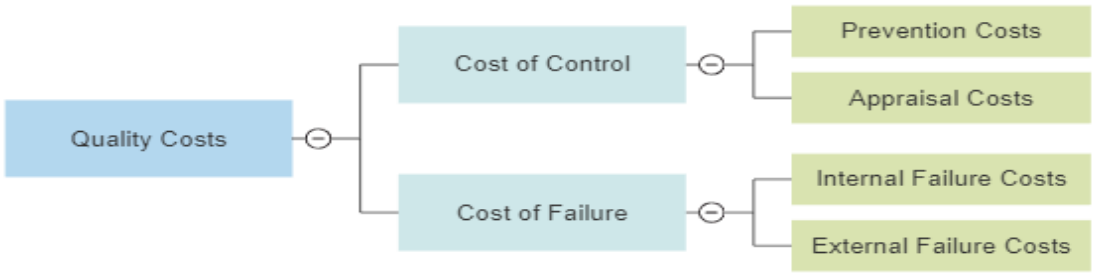

Figure 5: Quality costs (Feigenbaum, 1991).

As can be seen in Figure 5, Feigenbaum (1991) has divided quality costs in control and failure costs. The cost of control is divided in two, prevention costs and appraisal costs. The latter involve all the work needed to find errors or defects comparing how closely project items conform to the quality requirements, while on the other hand, prevention costs are the total of all expenditures or investments made to prevent or at the very least significantly reduce errors or defects. The cost of failure is also divided in two, internal failure costs and external failure costs. While externally incurred poor quality costs result in revenue loss, internal poor-quality costs raise an organization's operational costs. Rework and material waste are examples of internal poor-quality expenses, whereas defect correction, contractual claims, and lost future business are examples of external poor-quality costs (Love & Li, 2000).

The cost of non-conformance is the total cost to the project of everything that results from failing to meet a quality target, or from providing anything that is unfit for its intended use. These expenses may well include the following and can be substantial and general (Wright & Therese Lawlor-Wright, 2018, p. 13):

• Profit loss as a result of a deferred commission.
• Rework expenses, which in extreme circumstances could even put the organization out of business.
• Negative effects on interactions with subcontractors if liquidated damages are used.
• Wasteful investigation into the issue and subsequent retesting.
• Project delay charges that are frequently not covered by contracts.
• A breach in security that causes harm or death.

This last one is a sensitive topic considering all the ethics and laws involved in this possible scenario. The greed of a construction company can brings dire consequences. Alternatively, it could stem from the client's unwillingness to prioritize quality and invest accordingly. Of course, getting quality requires money. There is always a cost involved (Wright & Therese Lawlor-Wright, 2019, p. 14). The expense of planning and building for quality, as well as the costs of validating requirements and confirming as soon as possible that they have all been satisfied, must be compared against the cost of non-conformance. Implementing quality comes at a price that is both certain and can be rather high.

Achieving quality is not free; there is always some cost associated with it (Wright & Therese Lawlor-Wright, 2019, p. 14-15). The cost of non-conformance should be balanced against the cost associated with designing and constructing for high quality, as well as the costs of validating requirements and ensuring that they are met as soon as possible. The costs associated with implementing quality measures might be significant and are certain. On the contrary, while non-conformance is merely a potential occurrence, its cost should be determined based on its probability of happening. This results in a trade-off between the two scenarios, involving the expense of avoiding non-compliance and the cost of failing. Figure 6 and Figure 7 better illustrate this principle. The first one shows the overall optimum and the second in a risky project, where high-quality standards are used to establish the least overall cost in projects where there is a lot at stake since the cost of non-conformance is so high (Wright & Therese Lawlor-Wright, 2019, p. 14-15).

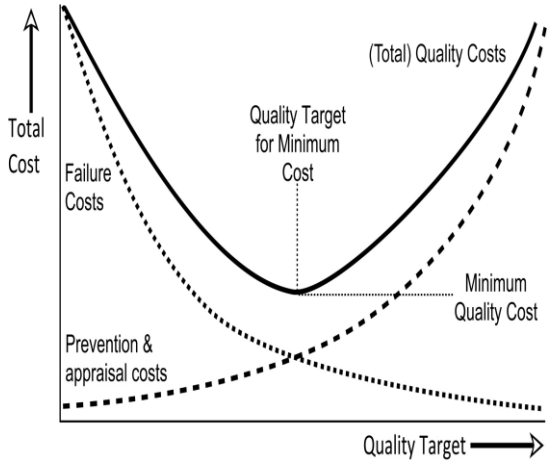

Figure 6: Overall optimum

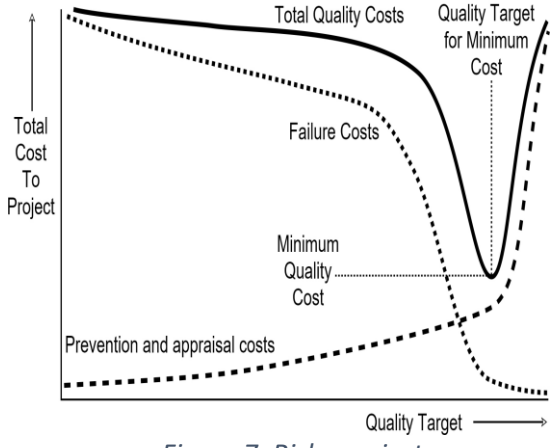

Figure 7: Risky project

3.4 Change order and deviation procedures

Unfortunately, changes are inevitable throughout the project lifecycle. These changes occur due to various reasons, including unexpected situations such as force majeure, changes in project requirements such as new requests from clients, and shifts in project environment such as

changes in terrain conditions, among others. Consequently, the project's technical team must be equipped to address these changes by establishing mechanisms to manage them effectively when they arise. Several procedures, tools and procedures can aid in this process.

Three examples of procedures are as follows. The reestablishment of project baselines following a change, implementation of a change control process, and reevaluation of the project and its tasks. Often, these change management procedures are already predefined within contractual agreements. (Project Management Institute, 2021, p. 66).

Below are some tools for organizing and controlling project changes. Firstly, there is the change log, which, as its name implies, is a detailed record maintained throughout the project documenting all proposed changes, whether they have been implemented or are in progress. These changes may vary in type and scope, encompassing alterations to project requirements, modifications to the project scope, or revisions to project documentation. Another tool akin to the change log is the issue log, which records any problems or situations encountered during project execution that could potentially impact project objectives. Additionally, a designated individual is assigned to track and address these issues whenever possible. By documenting such information, it becomes readily traceable if needed (Project Management Institute, 2021, p. 185).

Lastly, various methodologies exist for managing changes in projects, with each company or institution potentially employing its own approach. However, for illustrative purposes, one of them is the change control plan outlined by the Project Management Institute (2021). According to their guidelines, this plan serves as a pivotal component of project management, providing comprehensive details on the implementation of the change control system and delineating the roles and responsibilities of those tasked with its execution.

The process, outlined in Figure 8, ensures that all voluntary (Discretionary) and implicit (De facto) changes to design and work tasks are documented regarding their impact on the project and the final deliverable. "Discretionary" changes refer to those that are formally evaluated and can be approved or rejected, because they follow the whole analysis shown in the figure, e.g. increase project scope, while "de facto" changes denote those that have already occurred and must be accepted, e.g. a soil problem raised during excavation. This latter type is akin to certain types of deviations.

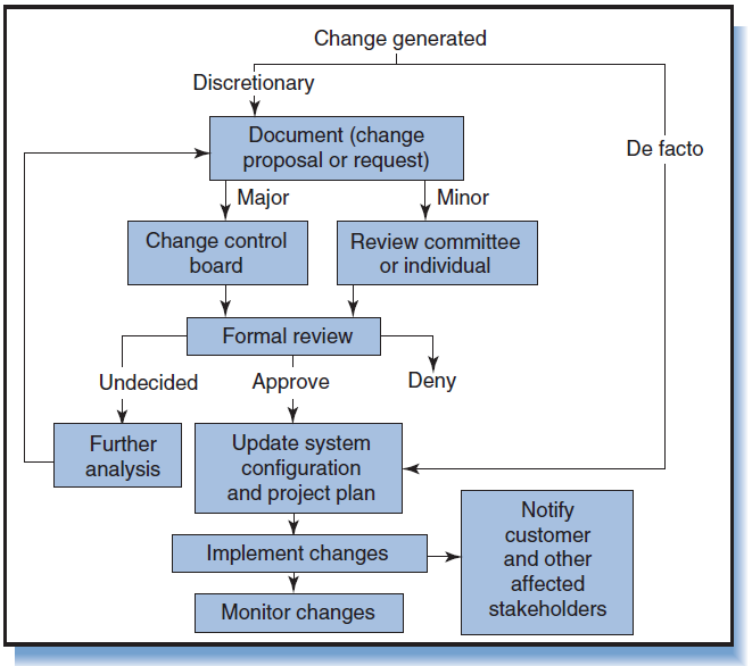

Figure 8: Change control process (Nicholas & Steyn, 2017, p. 418).

Each public entity or private company may manage changes in its own unique way, with change orders varying in formats, details, information, and structures. The following figure illustrates a fictitious example of a change order provided by Nicholas & Steyn (2017), which serves as a significant component of the aforementioned change process.

IRON *Butterfly Corp*

Change request			Page ... of ...
Title:			
Project no.	Task no.	Revision no.	Date issued
Description of change			
Reason for change			
Documentation attached			
Originated by:	Date:		
Request logged by:	Date:		
Cost implications			
Schedule implications			
Implications on performance of deliverable(s)			
Other implications (risks & issues)			
Proposed plan for implementation			
Implications evaluated by:		Date:	
Recommendation Recommended by:		Date:	
Documentation attached			
Approved by:	Date:	Approved by:	Date:

Figure 9: Change order example (Nicholas & Steyn, 2017, p. 419).

Project change control plays a crucial role in the monitoring and management of projects, encompassing various essential steps:

- Begin by identifying any potential project changes.
- Secondly, manage these changes in accordance with contractual procedures.
- Thirdly, evaluate the impact of the proposed change, encompassing factors such as cost, scope, schedule, as well as considerations for safety and quality.
- Fourthly, record all these steps, including approval status and outcomes of implemented changes.
- Finally, notify the project owner within the specified timeframe and according to the agreed-upon procedures outlined in the contract.

For point four, it's important to note that documenting changes in writing according to contract procedures is essential. Verbal agreements are not considered valid, so it's crucial to ensure that all changes are formalized in writing, even if initially discussed verbally (Project Management Institute, 2016, p. 40).

3.5 Conclusion

While there's abundant literature on changes, literature on deviations is scarce. This chapter addresses two sub-research questions. The first and second sub research question are again exposed here below.

1) What are differences between deviations and changes based on literature?

Firstly, changes are formal ones, they must comply with a pre-established procedure to evaluate and accept/reject the proposed change, while deviations do not have a clear procedure. And secondly, the action itself is in a different sequence. In a change, the situation is evaluated before the event happens, in other words, the proposed change is evaluated before the work is done and is decided whether to accept or reject the change. On the other hand, a deviation is evaluated after the event happens if it is evaluated at all. This means that the error or omission is accepted or the work must be redone it. Alternatively, deviations are frequently evaluated retrospectively, if evaluated at all. By this point, the work has already deviated from the specification, leaving only two options: accepting the error or omission as is in its deviated state, or rectifying it. This rectification can entail either redoing the work or performing additional complementary tasks.

2) What are the current theoretical methodologies to manage change orders or deviations?

Literature to manage formal changes is immense, while on deviations is limited. Several types of deviations exist, yet the literature solely provided one tactic, just accept it. It is noted that once they occur, they are typically accepted since they've already transpired. However, it's essential to follow the subsequent steps similar to those of an approved change, which include updating system configurations and the project plan. Additionally, it's crucial to monitor the deviation and inform the customer and other stakeholders impacted by it.

While this chapter shows some literature on deviations, changes and its management, the current situation in practice is unclear. Therefore, empirical research was performed which is described in the next chapter.

4. View from practice

In this chapter the results of the 8 interviews are shown. This chapter explores changes and deviations within the Paraguayan construction. Given the scarcity of literature identified in the preceding chapter, the objective here was to gain deeper insights into project deviations. Additionally, the examination also encompassed change orders due to their close association. The analysis of these interviews aimed to address the third research question:

3) How are the deviations and changes treated in practice?

This chapter furnishes a comprehensive overview of the exploratory interviews conducted with managers from public entities and private company owners. The original transcript can be seen in Appendix 2: Interviews transcripts.

The chapter is organized into four sections: this section, Data gathering and analysis (4.1), Selection of Interviewee (4.2), Interview results (4.3), and finally Conclusions (4.4).

4.1 Data gathering and analysis

The ATLAS.ti software was utilized for coding and analysis purposes. A total of 350 citations were marked, resulting in the identification of 200 unique codes, which were subsequently categorized into 16 groups. The Figure 10 displays the frequency distribution of each code. Roughly speaking, around one-third of the codes were utilized only once, while the most frequently used code was applied 10 times.

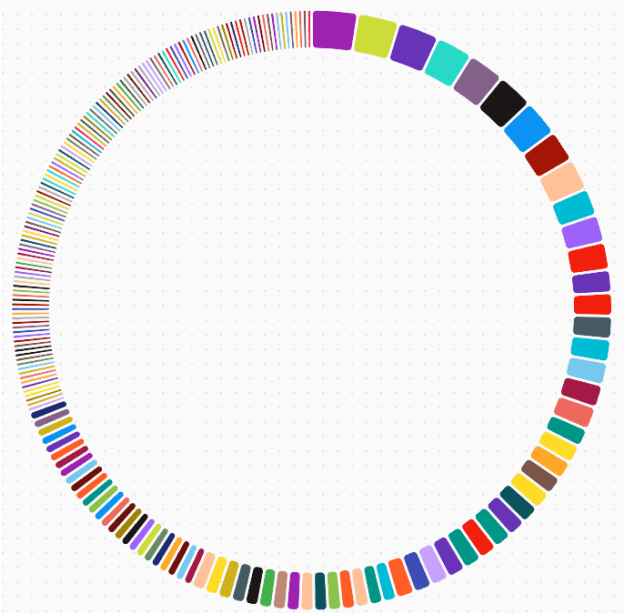

Figure 10: Code frecuency

4.2 Selection of interviewees

Initially, there were eight possible candidates from the public sector and ten from the private sector. They were selected for their involvement in the construction industry and for their accessibility. People from both sectors were chosen for two main reasons: to ensure a larger pool of interviewees and, more importantly, to gather diverse perspectives. The research focus is on exploring this phenomenon rather than placing emphasis on statistical representation. Out of the 18 candidates, only eight agreed to participate in the interview. Approximately half of them promptly provided a suitable date for the interview, while the others required some

persuasion. Among the ten candidates who did not proceed with the interview, four had initially confirmed their availability but later canceled due to various reasons after multiple follow-ups. The remaining six candidates did not respond at all.

After conducting the interviews, the transcripts were sent to each participant for confirmation that their responses accurately reflected their intended message. Six of them confirmed with the first email, while the other two required a second follow-up before responding positively. This can be seen in the Table 6**Error! Reference source not found.**.

Table 6: Chronology of the interviewees.

#	Public sector	Reply	Interview date	Transcript confirmation
1	Interviewee 1	Yes.	Held on Friday, September 8.	First attempt.
2	Interviewee 2	Yes.	Held on Friday, September 8.	First attempt.
3	Interviewee 3	Yes.	Held on Friday, September 8.	First attempt.
4	Interviewee 4	Yes.	Held on Friday, September 8.	Second attempt.
5	Interviewee 5	Yes.	Held on Sunday, September 10.	Second attempt.
#	**Private sector**	**Reply**	**Interview date**	**Transcript confirmation**
1	Interviewee 6	Yes.	Held on Thursday, August 31.	First attempt.
2	Interviewee 7	Yes.	Held on Wednesday, September 13.	First attempt.
3	Interviewee 8	Yes.	Held on Wednesday, September 13.	First attempt.

Of the eight interviewees, five are from a big public entity, whereas three are from small private companies. Regardless of the type of company, 7 out of 8 work mostly on public projects, thus leaving interviewee 6 in contrast to the rest. Regarding gender, it is equal, half of each one. The work experience of the participants is very varied. Two have up to ten years of experience, three have between ten and twenty years of experience, two between thirty and forty years of experience, and finally one has more than forty years of experience. The size of the projects in which they were involved are correlated by the size of the companies where they work, that is, those who work in large companies were or are in large projects and vice versa. A summary can be seen in Table 7.

In our data, we distinguish two groups. One comprises public entity managers engaged in significant projects with sizable teams, each member possessing varying levels of experience. The other group consists of private company owners managing smaller projects with more limited teams, although the range of experience within this group is not as extensive. As a result, interviewees were organized with these considerations in mind and ranked according to their level of experience.

Table 7: Interviewee overview.

	Job title	Type of company	Type of proyects	Size of company	Size of projects involved	Years of experiences
Interviewee 1	Manager	Public	Public	Big	Big	5-
Interviewee 2	Manager	Public	Public	Big	Big	5+
Interviewee 3	Manager	Public	Public	Big	Big	10+
Interviewee 4	Manager	Public	Public	Big	Big	15+
Interviewee 5	Manager	Public	Public	Big	Big	30+
Interviewee 6	Owner	Private	Private	Small	Small	15+
Interviewee 7	Owner	Private	Private and Public	Small	Small	30+
Interviewee 8	Owner	Private	Private and Public	Small	Small	40+

4.3 Interview results

4.3.1 Change orders

Change orders are the formal procedure to manage changes in a project. They differ drastically depending on they are public or private projects. According to interviewee 6, "*Typically these changes result in an increased budget, with budget reductions being a rare occurrence*". Many interviewees stated their belief that contractors use change orders to increase their profit, actually half of them mention this. The national law allows a 20% budget increase due to project changes (Appendix 4: National law on public procurement). Numerous interviewees highlighted that a deficient executive project often leads to the requirement for change orders.

Interviewees were asked about their opinion if the industry abuses change orders (Table 8). Most respondents believed that their projects experienced numerous changes and that the industry abused change orders. However, there were only three consistent patterns in their responses. These two related questions were asked at both ends of the interview, with the first question posed at the beginning and the second at the end. The first question was easy to answer as it lacked a negative connotation, while the second question was more challenging due to the inclusion of the word "abuse," which may have prompted a more defensive response.

The interpretation of these answers is subjective but noteworthy. Three respondents stated that their projects had many changes and that the industry abused change orders. Another three acknowledged that their projects had many changes but did not believe the industry abused change orders. This group might have been hesitant to admit to the industry's misuse of change orders. Finally, two respondents reported that their projects did not have many changes but believed that the industry abused change orders.

Interviewee 6 was the sole participant who offered insights specific to his field, structural engineering, revealing a perspective that diverged from his overall view of the industry. When questioned about whether he believed the industry exploited change orders, he remarked "*not in my area, since safety depends on our work, but I do believe there are many changes in the other areas of construction*".

Table 8: Interviewees opinion about changes frequency and industry abuse change orders.

	Have their projects undergone many changes?	Does the industry abuse change orders?	Coincidence
Interviewee 1	No	Yes	No
Interviewee 2	Yes	Uncertain	No
Interviewee 3	Yes	No	No
Interviewee 4	Yes	Yes	Yes
Interviewee 5	Yes	No	No
Interviewee 6	No	Yes	No
Interviewee 7	Yes	Yes	Yes
Interviewee 8	Yes	Yes	Yes
Total afirmative	6	5	3

Procedures

Private projects normally do not have a formal change order procedure, hence they are more flexible and informal. Interviewee 6 stated that changes are verbally, interviewee 7 said that the process is more dynamic, since the client is more closely involve and interviewee 8 stated that public and private projects have a similar procedure. Some of them have a formal procedure in the contract, so every private project handles the changes differently. The interviewee 6 stated that they do not generate many changes, since they are the first team working in a project and because their work is closely related to safety. So, if some things need to be changed, the client cannot argue against safety.

Public project change order procedures are better organized and are stricter. There is a national law that covers this topic; it can be seen in the National Law 2051 (Appendix 4: National law on public procurement). The most important point of this law is that changes cannot exceed 20% of the project budget. Also, there are other regulations, like the internal ministry protocols and more importantly, the financial entities regulations. Almost all interviewees stated that the most relevant actor regarding the duration and approval of changes is the financing entity. Delays frequently stem from financial matters. Interviewee 3 said "*The financial entity display less cooperative attitude towards change management*". Interviewee 8 said "*The difference is that the documentation for an international entity is more demanding than for a national entity. If the international entity is level 10, the national one is level 6 or 7*". In contrast, interviewee 4 said "*The biggest problem is usually financing. That is where the change order procedure usually gets stuck, especially when it is with a local fund. With an international fund there is usually not so much problem*".

Four of the five public interviewed work with Southern Common Market (Mercosur) funds. Several of the interviewee have worked with the IDB (Inter-American Development Bank). One interviewee worked with funds from the Japanese government.

Change order procedures can also be divided according to the size of the change. For minor changes, the procedures are simplified, for example, they are simply recorded in the Construction Log Book or if the formal process is carried out, the process is much faster. For example, interviewee 5 said "*For minor changes the process could even be one week and two months for major changes*", while interviewee 2 gave an example "*At the project's inception, before initiating bridge construction, a decision was made to relocate the bridge. The inspection team initiated discussions and proposed altering the bridge's location before the contractor's involvement. This process took 20 months*". She also stated "*Changes can be categorized into two types: those altering the project's scope and those that don't*".

Perhaps small and large changes are treated differently depending on the funding entity. However, the questions were not specific enough to uncover these differences. Figure 11 summarizes what interviewees said regarding change order procedures.

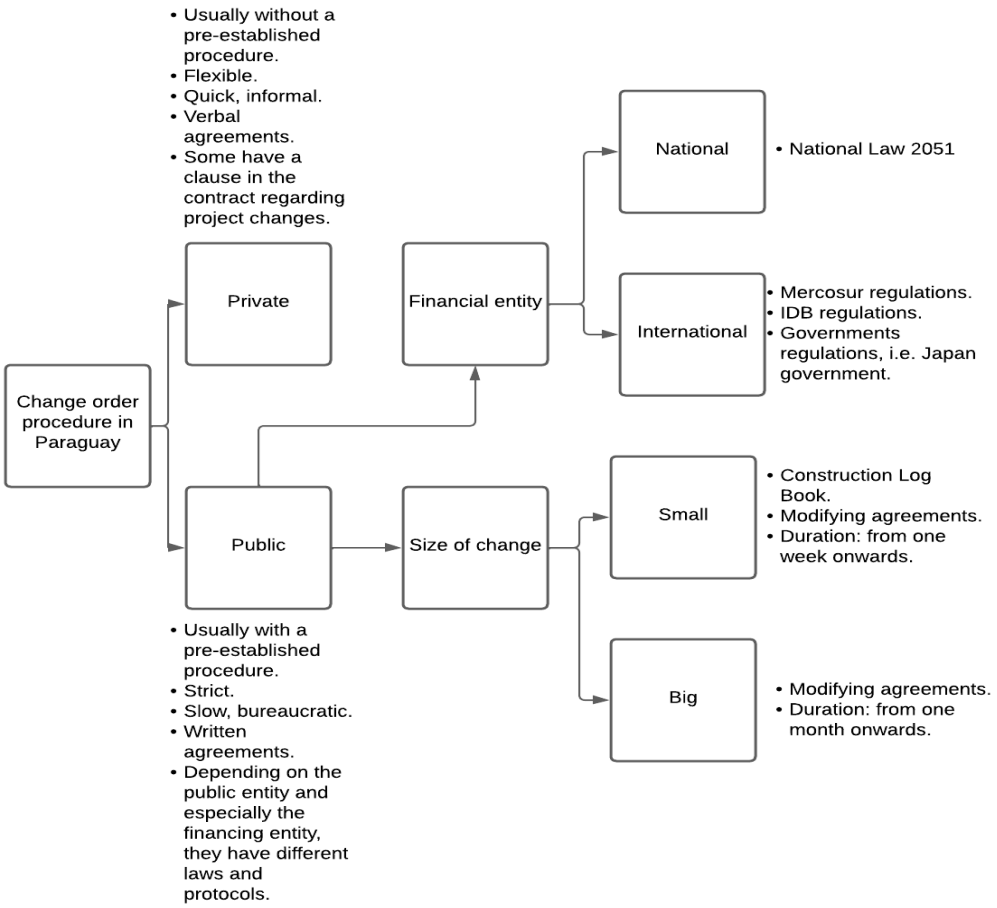

Figure 11: Interviewee feedback on project changes.

Procedures examples provided by interviewees

It is important to remember that the interviewees are categorized into two separate groups: those who work for public organizations and those who work for private firms. Although each business or company may have its own distinct procedures, there is generally some resemblance within each category. Therefore, below are illustrations from both classifications—an example from a private company and another from a governmental organization.

Private procedures examples

Interviewee 6 said that "*Generally, the client requests the change and the architect adapt the plans. If the change comes from the architect team, they inform the client. If there is a contract, in some cases there is a clause that says that if the budget varies by x% of the original budget, another contract must be made or other processes must be followed (according to each contract). In most cases the changes are verbal, not in writing. They are only written if the client requests it and they are normally done simply to have a supporting document as to why the*

change was made". Interviewee 7 stated that "*In private projects often involve more active involvement from the owner, leading to a more flexible and dynamic process*".

Public example

Here is a summary of the feedback provided by interviewees involved in public projects. Initiating changes follows a structured process beginning with the proposal of a modification agreement, often initiated by the contractor. This agreement progresses through approval stages, involving inspection, supervision, execution, and ultimately, ministerial approval. Additionally, a crucial step entails obtaining a no-objection status from the financial entity, which is contingent upon fund availability. These steps are undertaken in accordance with relevant laws and regulations, necessitating thorough documentation and justification for proposed changes. Approval typically originates from the financing entity, with regulations allowing modifications of up to 20% of the contract budget. Stricter documentation requirements are imposed for changes proposed by international entities compared to their national counterparts.

Timing of project changes

An intriguing aspect of project change lies in its timing within the project, in other words, the timing of project change orders. Interestingly, the current research has not revealed a distinct inclination toward any particular project phase, because there are five major changes at the beginning, four major ones in the middle, and four at the end (two minor and two major). Nonetheless, there is a subtle trend indicating a reduction in both the frequency and magnitude of changes as the project advances (Table 9). At the project's outset, five interviewees noted that major changes are commonly initiated, while four interviewees indicated that such changes are prevalent during the middle stages. Towards the project's conclusion, two interviewees suggested major changes are frequent, alongside two others mentioning just minor adjustments.

Table 9: Timing and common cause of project change orders.

Interviewee	Phase of the project			Common cause
	Start	Middle	End	
Interviewee 1	Major	Major	Minor	**Start:** by contractor. **Middle:** not specified. **End:** quantity adjustments.
Interviewee 2	Major		Minor	**Start:** design flaws. **End:** quantity adjustments.
Interviewee 3	Major			**Start:** design flaws.
Interviewee 4		Major		**Middle:** design flaws are seen at the start of the project, but changes are made in the middle.
Interviewee 5		Major	Major	**Middle:** not specified. **End:** not specified.
Interviewee 6	Major		Major	**Start:** soil issues. **End:** by the client, easier to visualize the project.
Interviewee 7	Major			**Start:** transition from plans to reality.
Interviewee 8		Major		**Middle:** design flaws.
Total	5 major	4 major	2 major, 2 minor	

Interviewee 5 said that "*Procedures are generally more stringent and time-consuming at the outset of the project compared to later stages*". This is primarily related to the workload depending on when the change occurs, rather than the timing of the change itself. However, this observation aligns with the research finding that significant changes are more prevalent at the project's onset, whereas minor adjustments become more frequent toward its conclusion.

Each project phase has its own typical change triggers. At the project's inception, common causes include soil-related challenges and design imperfections. In the middle phase, two respondents did not explicitly identify specific triggers, while two others attributed the cause also to design imperfections. As the project nears completion, two interviewees highlighted

quantity adjustments as a significant factor, while another two mentioned major changes without specifying the underlying causes.

Interviewee 6 stated "*In essence, early changes are often inevitable surprises related to the terrain, while late-stage changes are typically avoidable changes requested by the client*".

Interviewee 5 pointed out that protocols tend to be more rigorous and time-intensive in the initial phases of the project, contrasting with later stages. This observation aligns with research finding that significant changes are more prevalent at the project's onset, whereas minor adjustments become more frequent toward its conclusion.

Change order theory review by interviewees

The literature review revealed three primary causes of project change, all of which were acknowledged by the interviewees. They are: design errors and omissions; design changes; and unanticipated circumstances. They gave examples of each of them and in some of them how they had handled them and the outcome. The whole examples can be seen in Appendix 2: Interviews transcripts and more specifically in Appendix 5: Change order examples by theoretical cause type. This section simply presents two tables with a short explanation.

Table 10: Summary of change orders examples

Interviewees	Design errors	Design changes	Unanticipated circumstances.
Interviewee 1	1) Architecture team did not consider something and the construction company realize it at the budget stage.	1) They are commonly implemented to enhance project outcomes and efficiency.	1) An unforeseen surge in traffic due to private investments.
Interviewee 2	1) The actual axis of the pillar did not align as intended in the plan.	1) An intersection improvement initiative was implemented.	1) A water tank was constructed in the way of a future road after the final design was made. When it was time for construction, they found that out.
Interviewee 3	1) Lack of analysis of existing structures, two bridges were at the brink of collapse. 2) The geodetic point used as the project's origin was not found.	1) A structure design shifted from a tunnel to a viaduct.	1) Pandemic. 2) Reactions from residents in the project area, chaining themselves to trees to prevent deforestation. 3) Municipal demands beyond project plans.
Interviewee 4	1) An oversight regarding the replacement of pipes, specified in the contract but omitted from the plans and budget.	1) A modification in the design of an intersection of two roads.	1) Due to unusually heavy rain, some projects required expanding gutters and drains to handle the extra water.
Interviewee 5	1) Stakes used for leveling references are misplaced or lost, leading to errors in quantity estimates.	1) Extended storm drainage design for neighboring community areas.	1) Factors such as soil type and sand banks. 2) Social considerations
Interviewee 6	1) Failure to include a retaining wall for an excavation.	1) Made by the client towards the end because the project is easier to visualize at that stage.	1) Soil problems that they found when they began the excavations.
Interviewee 7	1) Steeper slope than anticipated. Solution 1, leveling the terrain. 2) A tender was initiated without a comprehensive intervention plan. 3) The presence of a high water table was overlooked. 4) The project did not account for sewer works.	1) Steeper slope than anticipated. Solution 2, change design and take advantage of the slope.	1) Changes were made to the work site due to a new nearby route, which posed a danger to the warehouse slated for restoration, as the route was planned after the restoration plan was made. 2) During a restoration, deteriorated concrete slabs and substantial cracks revealed underlying structural issues in the facade. 3) Unanticipated discoveries during conservation efforts are not uncommon.
Interviewee 8	1) Plans omitted crucial elements like drainage and electrical works. 2) In a restoration project, the water tank design location was in an incorrect place. 3) Footing was undersized.	1) In church restoration, he avoided disturbing the church by skipping the demolition of concrete bases, opting for a less disruptive method. 2) The plan to remove old roof sheets was dropped; new sheets were laid directly over them instead.	1) In a restoration project, ceramic tiles were found during ceiling demolition. Instead of installing a new ceiling, they were restored and left exposed. 2) While working on-site on basic maintenance, they unexpectedly encountered structural issues within the building.

Firstly, the table (Table 10**Error! Reference source not found.**) serves for easy reference and provides a brief explanation of each project change order example. All interviewees shared at least one example for each of the three causes of project changes. Notably, some participants provided multiple examples for a single cause. Design changes pose a unique challenge, as most changes ultimately manifest as changes in design. For instance, unanticipated circumstances or

design errors often necessitate design changes to resolve issues. However, every effort was made to minimize this bias.

This challenge becomes apparent when examining the distribution of examples for each cause: there are nine instances of design changes, while the other causes each have 14 examples. This imbalance arose because some interviewees initially offered wrong examples related to design changes and were then encouraged to provide additional instances, resulting in a higher count for the other causes.

Table 11: First cause of change orders

Interviewees	Design errors	Design changes	Unanticipated circumstances.
Interviewee 1			
Interviewee 2	First cause		
Interviewee 3	First cause	First cause	
Interviewee 4	First cause		
Interviewee 5			First cause
Interviewee 6		First cause	
Interviewee 7	First cause		
Interviewee 8	First cause		
Total	5	2	1

They also indicated which of these causes is more frequent (Table 11) with some providing secondary and tertiary causes as well. The interviewee 1 stated that "*all have similar occurrence rates and are managed uniformly*". As a result, his row is left in blank. Interviewee 3 identified two main causes as the primary drivers of change orders.

4.3.1.5 Change order improvement

In this section, firstly some challenges of change orders are presented and then their possible solutions. Regarding the challenges of change orders, the answers are not so varied; they gave two. Five interviewees expressed concerns about the prolonged duration of the change order process. Additionally, all the interviewees that work with change orders procedures highlighted the significance of obtaining approval from the financing entity, emphasizing its pivotal role in the entire process. International financial entities tend to impose stricter criteria compared to national ones, often causing delays or rejections during this stage of the change order process. Interviewee 8 stated "*If there was a rigor scale, the international entity would be rated at level 10, while the national counterpart could be rated at level 6 or 7*".

Almost all interviewees offered distinct perspectives on potential enhancements, the individuals or entities capable of leading these improvements, and the obstacles they perceive (see Table 12).

Table 12: Change order improvements.

	Change order improvement	Lead for improvement execution	Barrier
Int. 1	1) Collaboration from the outset among all stakeholders can expedite procedures significantly and consolidating multiple changes	Each director from the ministry, it is an internal decision.	Initiative of each director.
Int. 2	1) Providing more detailed and specific documentation to the financial entity. This may expedite their evaluation process and minimize	Collaborative decision made by representatives from each involved party.	Idiosyncrasy, whereby individuals may exhibit resistance to change and
Int. 3	1) Streamline bureaucratic procedures. 2) Establish dedicated technical teams within the financing entity for each project. These teams would closely monitor the project's progress and provide support for necessary changes.	Ministry.	The financing entity being a separate institution that operates independently from the ministry.
Int. 4	1) Projects could allocate a percentage of the budget specifically for handling potential changes, similar to the contingency fund.	Vice minister of public works.	Bureaucracy and limited availability of local funds.
Int. 5	1) Improving its efficiency, especially towards the project's conclusion. Maintaining up-to-date plans and quantities to promptly accommodate changes.	Contractor.	Contractor's willingness.
Int. 6	None. He does not work with change orders, he has verbal agreements with his clients.	For a company that works with change orders, the owner or general manager has to be in charge of improvements.	Analysis is required to visualize where and how the process could be improved, which means time and money.
Int. 7	1) Fostering a more dynamic approach and enhancing communication among all stakeholders.	Participants must contribute to implementing improvements for a dynamic process, proposing and implementing enhancements where needed.	resistance stemming from a lack of willingness and commitment among project participants.
Int. 8	1) Enhancing the effectiveness.	Private: client Public: government, specifically the technical planning secretary.	Bureaucracy.

Interviewee 4 gave the following solution to both, change orders and deviations "*Introducing a paid thorough review by the contractor into the contract could be considered, allowing for justified change proposals from the project's outset. While this responsibility theoretically lies with the contractors, they do not take it that seriously. If a paid review is included in the contract and the contractor later proposes a change, it becomes their responsibility, potentially eliminating the need for the change order process*".

4.3.2 Deviations

This section is dedicated to project deviations, which, as previously outlined, encompass informal changes—modifications to the project that bypass formal procedures like change orders or similar protocols. These deviations may stem from errors, omissions, force majeure events, contractor benefits, the desire to circumvent lengthy formal procedures, material shortages in the market, and so forth.

Deviation recognition

Of 8 interviewees, 7 recognized the existence of deviations in their projects. In this subsection, certain fragments from the interviews are provided to illustrate how the interviewees recognize the existence of deviations and potentially provide definitions for this phenomenon. The complete list is in the Appendix 6: interview fragments demonstrating recognitions and concepts of project deviations, however four fragments of the interviews are presented below. All four demonstrate something different. The first from the unpredictable nature of certain events, the second from the construction worker, the third from the contractor's point of view, and lastly one concept that several interviewees mentioned.

Interviewee 5 stated that "*There are two types of deviations: those that could have been predicted and those that could not. Predictable deviations are inherently difficult to foresee, as they involve changes from the original plan. Unpredictable deviations include force majeure events, which demand immediate and unavoidable adjustments, and cannot wait for the change order process*".

Interviewee 6 stated that "*Deviations can occur when workers make alterations without the explicit authorization or notification of the structural company*".

Interviewee 7 stated that "In private projects, architects sometimes implement deviations without prior consultation with the client.".

Interviewee 4 stated that "*Often, changes are implemented first, and the modification agreement is formalized afterward. While this practice is widespread, it is not considered ideal*".

The following Table 13 summarizes the responses of those interviewed regarding whether or not deviations are abused by the industry. Three were forceful in giving an affirmative answer. Three others were more impartial. Only one abstained from responding, supposedly for not knowing about this practice.

Table 13: Interviewee opinion about industry abuse deviations.

Interviewees	Does the industry abuse deviations?
Interviewee 1	More or less.
Interviewee 2	Yes
Interviewee 3	No
Interviewee 4	Her department no, others maybe.
Interviewee 5	No opinion.
Interviewee 6	Yes
Interviewee 7	Yes
Interviewee 8	Some, not the whole industry.
Total	3 yes, 3 divided, 2 no.

Deviation tactics

Describing procedures becomes challenging when deviations are involved, as deviations inherently imply actions outside the established protocols. As deduced from the literature review, formal changes adhere to a predefined procedure for evaluation and acceptance/rejection of proposed project changes. In contrast, deviations lack a clear procedural framework. Nevertheless, certain mechanisms are employed to circumvent the predefined process, such as change orders, often due to time constraints that prohibit waiting for the entire procedural sequence. Some indicated that facing deviations carries an inherent

risk for the contractor, potentially leading to non-payment. An overview of the tactics as mentioned in the interviews could be seen in Figure 12.

A concept borrowed from another field, specifically cyber security from the US government, introduces the following idea of "Tactics, techniques, and procedures (TTPs) describe the behavior of an actor. Tactics are high-level descriptions of behavior, techniques are detailed descriptions of behavior in the context of a tactic, and procedures are even lower-level, highly detailed descriptions in the context of a technique" (Johnson et al., 2016, p. 2). This framework serves to contrast changes and deviations. While changes adhere to clear procedures, deviations resemble high-level descriptions of behavior. Hence, the term "tactics" was chosen for deviations rather than "procedures."

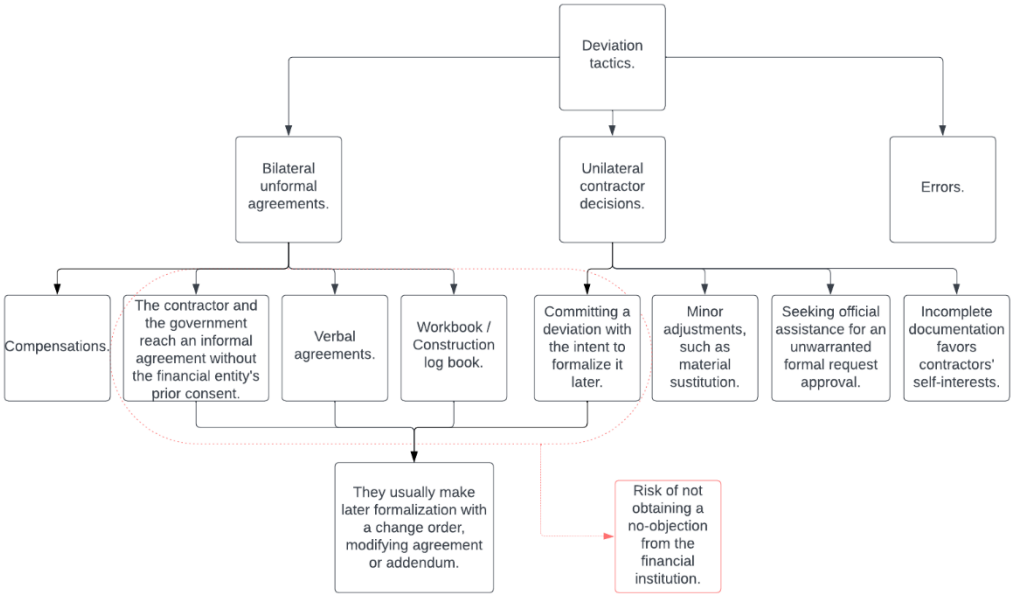

Figure 12: Deviation tactics.

1) Sometimes, these mechanisms require the consent of all involved parties, particularly the contractor and the supervisory body. Several interviewees stated that is usual to incur a deviation for later formalizing with a change order, modifying agreement, or addendum. The following fragment is an example of what they said. Interviewee 2 said "*Following the implementation of the change, she did initiate a change order process. This happens, because of the prolonged duration of a change order, which typically spans around three months. And the project cannot afford to be halted during this period*."

   Interviewee 4 stated that "*When they are minor, the agreements can be verbal or can be recorded in the workbook, but it is always a risk for the contractor to execute a job without having the change fully authorized, there is always the risk of not getting paid*".

   Another deviation tactic in which everyone is involved is compensation. Interviewee 7 said "*In addition to change orders, compensations are also made, which are relatively straightforward. Compensation involves exchanging one task for another to avoid altering the project budget*". Interviewee 5 gave a more elaborated explanation about this and is the following. "*Compensation might be granted as an exception. This involves identifying an item not yet implemented in the project, for example, item A, and using it as a basis for*

accommodating the new item necessitated by project changes, referred to as item B. The compensation involves executing item B while billing for item A. This request is formalized in writing to prevent any delays in the work, although it's not considered the most ideal solution. After the addendum is approved, the exchange is rectified to indicate that item A remains outstanding while item B has been completed".

Interviewee 3 said "*During the pandemic, the government mandated the continuity of public works. A notable example is the viaduct project previously discussed, where the contractor requested a change in 2018. However, it wasn't until 2020 that the decision to proceed with the alteration was made, bypassing formal approval processes. Managing such situations proved challenging, especially when the financing entity disagreed with the proposed changes. Nevertheless, the work proceeded without formal approval, with the government eventually assuming financial responsibility*".

2) Additionally, there exist unilateral deviations by the contractor, those can be minor deviations or by an urgent situation or also less ethical practices, usually for convenience. The following interviews fragments sustains that:

Interviewee 4 said that "*Often, avoidable deviations are manipulated to appear inevitable, a tactic employed by contractors seeking to increase their earnings" and also that "it's worth noting that some deviations originate from contractors seeking additional profits. In cases where budgeting mistakes have been made, contractors might attempt to rectify the situation at the state's expense, often relying on the assistance of responsible officials. Such actions are ethically questionable and go against the principles of fair practice*".

She also said "*Contractors find it inconvenient to wait, considering the downtime for their personnel and equipment. Consequently, they choose to proceed with the work and deal with payment matters later, a practice that often results in eventual payment*".

Interviewee 2 said something similar "*Contractors sometimes need to proceed with tasks for which they've already been compensated, and then submit a request for payment afterward. However, this poses a risk as there's no guarantee of receiving payment. The process involves the contractor submitting a variation of quantities, triggering the formal procedure of modifying agreements to determine if the financing entity approves the request*".

Interviewee 5 said that "*Contractors often aim to maximize profit and minimize effort, leading to deviations."*

Interviewee 6 said "*Deviations occur as minor adjustments within the project, such as a shortage of a specific type of rod. To address this, he may modify the number or diameter of rods accordingly. Similarly, material substitutions might occur, such as opting for a metal beam instead of a concrete one*".

An ambiguous scenario arises when documentation is incomplete or vague, allowing the contractor to prioritize their own interests over what might be optimal.

Interviewee 7 said "*Poor documentation in specifications and spreadsheets grants contractors significant freedom and room for interpretation. This deficiency in documentation leaves projects vulnerable to the contractor's discretion, allowing them to prioritize their own interests*".

3) Lastly, there are errors, which are presumed to be unintentional. This cannot be considered a tactic but is the remnant cause of deviation. However, there's a possibility that opportunists exploit this assumption.

   Interviewee 7 said "*For example, in one project, an architect mistakenly planned to install a regular beam instead of an inverted one*".

   Interviewee 2 said "*Mistakes within the project plan and the inherent complexity of road projects often result in fluctuations in quantities*".

4.3.2.3 Examples from public and private projects

The interviews yielded numerous examples of deviations, detailed in the Appendix 7: Deviations examples. Considering the sensitivity of the topic, they were categorized based on the comfort level of discussing them. Three groups were established: first, deviations easy to discuss and admit; secondly, more challenging topics known to all parties; and finally, extremely delicate deviations often illustrated with examples from external sources. They were also categorized according to the size of their impact. An image (Figure 13) was crafted to feature two examples from each category to enhance comprehension.

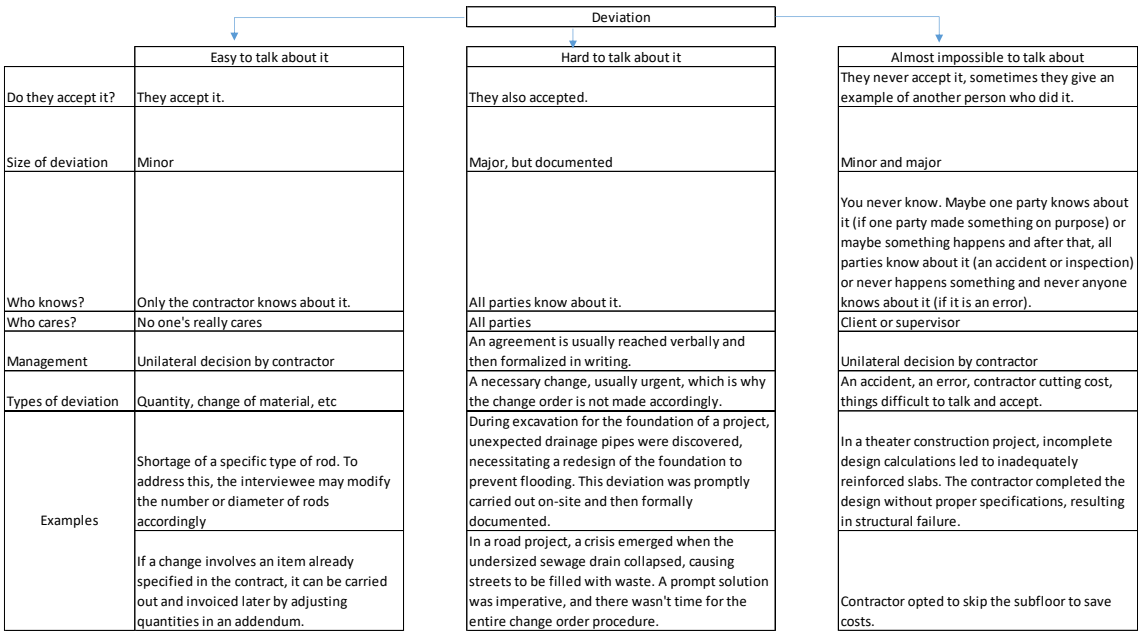

Figure 13: Deviation types

4.3.2.4 Timing

Interviewees were questioned about when deviations typically occur. Two interviewees did not provide information in this topic. The first interviewee refrained from commenting on deviations, claiming a lack of knowledge on the subject. Conversely, the third interviewee acknowledged this practice but couldn't pinpoint when it occurred as she hadn't encountered it frequently. Other interviewees did provide their perspectives on the matter, as outlined in the Table 14. A distinct pattern emerges showing deviations commonly occurring midway through the project.

Table 14: Timing and common cause of project deviations.

Interviewees	Phase of the project			Common cause
	Start	Middle	End	
Interviewee 1				
Interviewee 2		X		Minor adjustments, and bad project planning.
Interviewee 3				
Interviewee 4		X		Urgent situations, minor adjustments, and bad project planning.
Interviewee 5			X	Urgent situations.
Interviewee 6	X	X	X	Minor adjusments.
Interviewee 7		X		Often stemming from misinterpretations of the blueprints
Interviewee 8	X	X	X	Minor adjusments.
Total	2	5	3	

Interviewee 3 said that "*Regarding the state of the project where this occurs more often, she cannot provide a specific comment because she did not experience it enough*".

Interviewee 6 stated that "*These informal adjustments can take place at any phase of the project, given that they involve minor and non-hazardous modifications, and are not restricted to a specific timeframe*". Similarly, interviewee 8 said that "*Deviations are usually minor and don't substantially affect the budget. They occur throughout all stages of the project*".

Interviewee 2 "*Mentioned facing deviations during the execution phase, albeit minor ones, mostly concerning adjustments in quantities. These deviations tended to occur midway through the project*". Similarly, interviewee 4 said that "*These deviations predominantly take place during the middle phase of the project*".

Interviewee 5 stated "*The project experienced deviations in certain situations, such as unforeseen circumstances like inclement weather, imminent danger during work, or urgent need. These are more common towards the end of the project*".

Interviewee 7 said "*She acknowledged experiencing deviations, which tend to occur more frequently during execution, often stemming from misinterpretations of the blueprints*".

Deviation prevention

In line with the rest of the chapter on deviations, Interviewee 1 abstained from providing a response. However, Interviewees 5, 6, and 8 each offered two suggestions, while the remaining interviewees contributed one each. Notably, the idea of merely accepting deviations was mentioned three times, although it doesn't qualify as a prevention strategy. Beyond this, seven other distinct prevention suggestions were provided. The summarized information can be found in the Table 15, with specific quotes extracted from the interviews provided below. In this instance, it was decided to present all quotes from the interviews, as they are pertinent to the main research question.

Table 15: Overview of proposed measures to prevent deviations.

Interviewees	Deviation preventions
Interviewee 1	
Interviewee 2	Just embrace it.
Interviewee 3	Improve change order procedure.
Interviewee 4	Review of plans.
Interviewee 5	Just embrace it.
	Item quantity flexibility.
Interviewee 6	Work with qualified professionals.
	Just embrace it.
Interviewee 7	Improve soft skills.
Interviewee 8	Consider unforeseen events.
	Improve executive project.

Interviewee 2 said that "In her field of expertise, road construction, she finds it challenging to prevent such situations. This is because roadwork calculations are heavily dependent on assumptions regarding existing and required materials, which are influenced by unpredictable terrain variations".

Interviewee 3 said that "in her experience, to prevent this kind of situation, the goal wouldn't necessarily be to minimize the changes themselves, but rather to streamline the cumbersome bureaucracy associated with change orders. Accelerating the process of change orders could effectively mitigate the occurrence of changes without proper authorization".

Interviewee 4 said that "*One potential way to prevent deviations is to conduct a comprehensive review of plans and the construction site before commencing work*".

Interviewee 5 said that "*Unpredictable deviations include force majeure events, which demand immediate and unavoidable adjustments, and cannot wait for the change order process*".

Interviewee 5 also said that "*Additionally, there's usually a general civil construction item specified per cubic meter (m3). This simplifies billing by calculating the volume represented by each construction activity and updating the m3 accordingly. While this general item streamlines the collection process, comprehensive background information must still be documented*".

Interviewee 6 said that "*The client could have avoided the issue by opting to engage the interviewee for the construction or choosing another qualified professional*".

Interviewee 6 also said that "*The unpredictability of construction material availability makes it difficult to foresee and forestall these situations. Within the interviewee's professional sphere, this uncertainty surrounding material availability stands out as the primary source for deviations*".

Interviewee 7 said that "*Maybe to prevent such occurrences, fostering a dynamic work environment among all project stakeholders could be crucial. Emphasizing the development of soft skills to mitigate tensions, encouraging coordination, and promoting open dialogue can facilitate effective teamwork*".

Interviewee 8 said that "*Improving the project final design or considering unforeseen events could potentially prevent such occurrences*".

Deviation improvement and good practices

The interviews provided a range of suggestions for implementing best practices in similar situations for future projects. Table 16 was created to determine if participants believed it was feasible to prevent situations leading to deviations. Their suggestions on prevention were noted, as well as any negative responses indicating disbelief in preventability. To provide context for the prevention suggestions, a column was added listing the deviations discussed prior to the prevention question, as many participants mentioned other deviations afterward in the interview. Lastly, a column was included for suggestions on good practices in cases where deviations cannot be prevented.

Table 16: Deviation improvement and good practices.

Interviewees	Type of deviation they acknowledge	Prevention		Good practices
		It is posible?	How or why not?	Which?
Interviewee 1	Unaddressed			
Interviewee 2	Quantity adjustment.	No	Roadwork calculations depend on terrain-related material estimates.	At least reach an informal agreement and then formalize it.
Interviewee 3	Project scope changed, but change order process was overly bureaucratic.	Yes	Reduce change order bureaucracy.	Documentation and mutual agreement are essential.
Interviewee 4	Emergency situation due bad project design.	Maybe	The contract could stipulate a paid, thorough review conducted by the contractor.	Seek opinions from specialists to confirm the change/deviation necessity.
Interviewee 5	Unforeseen circumstances	No	It's hard to prevent urgent changes driven by necessity.	At least inform informally.
Interviewee 6	Change of material.	No	Predicting construction material availability is challenging.	Possess experience and prioritize safety.
	Not adhering to structural blueprints.	Yes	Hire qualified professional.	
Interviewee 7	Change in the construction method by the contractor	Yes	Cultivate teamwork through improved communication and collaboration.	Hold meetings to discuss minor changes and document decisions in meeting minutes or construction logs.
	Construction error			
Interviewee 8	Minor deviations	Yes	Improving the final project design.	Regulations should prioritize execution unless significant changes or costs are involved.
	Unforeseen circumstances		Taking into account unforeseen events.	

It's noteworthy that the majority of their contributions are distinct and not duplicated. Additionally, approximately half of the participants believe that deviations can be prevented. To elaborate, three responded affirmatively, one answered affirmatively depending on the deviation, one expressed uncertainty, one did not respond, and three answered negatively.

Below are quotes from two interviews, discussing preventions and good practices. To provide clear examples from contrasting perspectives, one participant was selected from the group that believes deviations can be prevented, while another was chosen from those who believe deviations cannot be prevented. The complete list of quotes from interviewees can be found in the Appendix 8: Quotes from interviews regarding deviation preventions and best practices.

Interviewee 7 did believe that deviation can be prevented. She said "*Create a dynamic work environment between the parties involved in the project. Work on soft skills to avoid tensions, work in coordination and dialogue to achieve teamwork*". For good practice she proposed "*Hold work meetings to discuss possible minor changes to the work and leave the decision in writing in the minutes or in the workbook*".

On the other hand, interviewee 5 did not believe that deviation can be prevented. He said "*They could be foreseen, if they are not immediate changes due to necessity, however, these types are difficult to prevent*". For good practice he proposed "*at least inform informally*".

4.4 Conclusions

The aim of the exploratory interviews was to gather perspectives from practitioners regarding changes and deviations in projects.

3) How are deviations and changes treated in practice?

All participants acknowledged having change orders, with six indicating that their projects undergo numerous change orders. Additionally, five participants mentioned industry abuse of change orders. Conversely, seven participants acknowledged the existence of deviations in their projects. Of these, three stated that the industry abuses deviations, three had a mixed opinion, and two indicated that the industry does not abuse deviations.

Interestingly, research has not uncovered a clear preference for any specific project phase regarding the timing of change orders. However, there appears to be a subtle trend suggesting a decrease in both the frequency and scale of changes as the project progresses. Conversely, deviations exhibit a distinct pattern, with deviations frequently occurring midway through the project.

Change orders are the formal procedure to manage changes in a project (see figure 9). They differ drastically depending on they are public or private projects. The public sector operates under strict regulations, yet practices vary concerning the magnitude of change, involvement of public entities, and especially the role of financial institutions. Typically, change orders encounter delays when reaching financial institutions, which conduct the final analysis of proposed changes. Conversely, the private sector tends to adopt a more informal approach, often relying on verbal agreements for changes, with only some contracts containing relevant clauses.

Regarding deviations, they occur through bilateral agreements, unilateral decisions, and error. Bilateral agreements resemble private sector practices, involving informal yet binding agreements, which may be verbal or written. Written agreements can be recorded in the construction logbook or through compensations, where urgent or necessary work replaces other project tasks either temporarily or permanently. This depends on whether the tasks were originally planned for the future or have already been canceled. These written tactics are often regularized later through formal processes like change orders or modifying agreements or addendum.

Unilateral deviations are initiated solely by contractors, sometimes with the intention of future regularization, whether ethically or unethically. Additionally, minor adjustments may go unreported if they do not impact the project significantly. In certain cases, incomplete documentation leaves contractors with discretion, leading to deviations from optimal practices. Lastly, errors, despite lacking malicious intent, still represent deviations from specifications.

5. Towards better practices

This chapter delves into the strategies for preventing deviations, and if they do occur, it explores best practices to minimize their impact. As we've observed, deviations stem from various causes and scenarios, differing between public and private projects. This chapter reexamines prevention methods and best practices, aiming to integrate insights from existing literature. It also suggests how these applications for prevention and best practices could in practice be implemented. Subsequently, an interview protocol was developed based on the findings, which was then utilized to interview three experts from the Paraguayan construction industry. This process aimed to evaluate the findings and recommendations.

In this chapter, deviations are essentially treated as risks. Prevention measures focus on reducing the frequency of deviations, while good practices aim to minimize the impact of any deviations that do occur.

According to Davis et al. (1989), the absence of a formal and systematic quality management system may make quality deviations undetectable. Consequently, vital information is lost, hindering the identification of areas needing improvement to reduce or eliminate rework (Love & Li, 2000). As such, many of the deviations causes, consequences and possible prevention and good practices measures may have been omitted from this analysis; in fact, the analysis solely incorporates the findings from the interviews, which is limited due the low number of interviewees.

There is hardly any literature in the deviation field; almost everything is about similar topics, like changes and rework. However, some of these references are cited in this chapter since the concepts of change and rework overlap with the concept of deviations. It was tried to filter and prioritize the proposed prevention measures and good practices based on existing literature, but that was impossible due to scarcity. Hence, it was decided to go forward with all of them, and the experts were asked to give their relevance ranking and other related opinions. In the next section this will be further elaborated.

5.1 Deviation prevention

Notably, the idea of merely accepting deviations was mentioned three times, although this does not qualify as a prevention strategy. Interviewees 2, 5, and 6 expressed that certain situation, such as material shortages or variations in the quantity of materials needed for specific tasks (e.g., filling in a road project), are unavoidable and beyond preventative measures.

Beyond this, six distinct prevention suggestions were provided.

a) The contract could stipulate a paid, thorough review conducted by the contractor.
b) Hire qualified professionals.
c) Cultivate teamwork through improved communication and collaboration.
d) Improving the final project design.
e) Taking into account unforeseen events.
f) And lastly, improve change order procedure.

This final deviation prevention measure is linked to enhancing the process of change orders, underscoring once more the interconnectedness of these two concepts. Fortunately, this study delved into strategies for enhancing the change order procedure. Consequently, these recommendations will be applied in the subsequent chapter. Additionally, five interviewees expressed concerns about the prolonged duration of the change order process. All the

interviewees that work with change orders procedures highlighted the significance of obtaining approval from the financing entity, emphasizing its pivotal role in the entire process. All of this leads to the change order improvement (see Table 12: Change order improvements.), with their respective lead for the improvement and barriers.

5.2 Implementation of deviation prevention

This section outlines potential methods for implementing these six prevention measures. It's important to note that this isn't meant to be a comprehensive analysis, as there are numerous approaches for each measure. However, one measure in particular doesn't require extensive analysis—just the determination to take action. Many prevention measures entail implementation costs, comprising investments and expenses aimed at preventing errors or defects, or at least mitigating their impacts. In essence, these initiatives proactively address potential errors and defects by targeting their root causes (Love & Li, 2000).

Investing in and implementing preventive measures could effectively eliminate rework, potentially resulting in a 15% reduction in total construction expenses. This principle extends to deviations as well, facilitating the acquisition of funds needed to implement proposed measures. For instance, providing designers with ample time to refine the final project layout could enhance coordination and detail, leading to significant reductions in on-site production costs. Moreover, the project is likely to experience improved overall performance (Love & Li, 2000).

Each proposed prevention measure is described in sections 5.2.1 to 5.2.6 and comprises two components. First, its elaboration, foundation, or relation with existing literature; second, the methods for implementation, which are cited on Roman numbers and were asked of the experts.

5.2.1 The contract could stipulate a paid, thorough review conducted by the contractor

For this to come into effect, the government would need to draft legislation mandating comprehensive reviews, alongside allocating funds to meet this requirement. Conversely, private clients could potentially include this provision in contracts, albeit this would vary on a case-by-case basis. While both scenarios are unlikely to happen, if there's a genuine interest in implementation, the following are some suggestions on how to proceed.

Consultants noted that the contractor did not provide them with sufficient time to design and document the project. Consequently, documentation was not reviewed before awarding the subcontract trade packages (Love & Li, 2000). Such situations could be prevented if the proposed measure is implemented in practice.

I. Implement a policy implementation framework.
   It proposes a framework for new policy implementation. It also identified possibles problems, with their warning signs and their specific strategic responses. The problems could be Interpretation Issues, Organization mission issues, Organizational coordination issues, resource and organizational capacity constraints, Timeline issues, Political Interference issues, Program operator issues, Target compliance issues (Weaver, 2010). While Implementation Analysis is not a cure-all for avoiding governance issues, unforeseen challenges are bound to arise during policy implementation, and policymakers may still proceed with provisions despite being cautioned about potential risks. However, it provides a potentially potent instrument to ensure that governments make well-informed decisions and that their policies fulfill their intended objectives (Weaver, 2010).

While these tools may facilitate the implementation of a new law, they do not guarantee its success. Ultimately, the initiative to promote the law must always be present from the outset.

II. Implement a change management model.
Following the implementation of the law, all stakeholders will need to adjust to the new working framework. Therefore, a systematic approach to managing change becomes essential. In this field, there exists a vast array of literature and methodologies. Some notable approaches include the ADKAR Model (comprising 5 steps), Managing Change in Organizations (with 5 steps), The 8-Step Process for Leading Change, the Virginia Satir Change Model (comprising 6 stages), and finally, the Transition Model (consisting of 3 stages) (Project Management Institute, 2021).

5.2.2 Hire qualified professionals

To implement this preventive measure, all that's required is the willingness to take action. This would prevent situations where professionals make errors due to lack of knowledge, potentially leading to deviations and even safety issues. Hammarlund and Josephson (1988) stated that defects are often attributed to a lack of knowledge, information, or motivation.

Cost pressures persist, with the lowest bid still being a common strategy in supplier selection. This pressure extends across all key project stakeholders (Hammarlund and Josephson, 1998). This may result in the client or contractor prioritizing the lowest price and potentially hiring unqualified professionals.

The disregard for quality in construction has led to quality failures becoming widespread occurrences within the construction process (Love & Li, 2000). This means that the industry focuses more on price than quality.

Subcontractor-related damage and inadequate workmanship were identified as the primary sources of defects (Love & Li, 2000).

I. The importance of this measure is undeniable; its implementation isn't a mystery, but rather a willingness to do it.

5.2.3 Cultivate teamwork through improved communication and collaboration

Again, for this prevention measure there are endless possible approaches, to name some of the easiest:

I. Undoubtedly, the most straightforward approach is to actively promote these qualities among all stakeholders.
II. Additionally, conducting a thorough analysis and engagement with project stakeholders through the following steps—identification, understanding, prioritization, collaboration, and monitoring—can help promote these qualities or at least provide insights into how to nurture them.

Deal with changes promptly as they arise in a project. Delaying resolution will lead to greater disruption and expenses. Foster a positive environment that encourages the acknowledgment and resolution of change, for example, through partnering initiatives (Ibbs, 1997). This approach is only viable with effective communication and collaboration in place. On the other hand, only 12% of defects were caused by lack of communication.

It is through the coordinated actions of the project stakeholders that a project is carried out, or alternatively, that poor coordination among them leads to errors in the project (Hammarlund and Josephson, 1998). They also stated that lack of adequate information correlates with reduced motivation.

End users of the project should be involved from the outset. In certain projects, multiple user groups visited the site during the later stages, resulting in their input being provided too late (Hammarlund and Josephson, 1998). Interviewee 6 stated that changes initiated by the client tend to occur towards the conclusion of the project, because it is easier for them to visualize a built project than one in plans. Also, Love & Li (2000) stated that in the project, design changes were commonly instigated by end-users. This was due to the apartments being sold off-plan, resulting in occupants being unable to visualize the final product.

The composition of the project team greatly influenced project dynamics. Projects involving individuals and groups with prior experience working together generally proceeded much more smoothly than those without such history (Hammarlund and Josephson, 1998). That means that teamwork pays off and enhances communication and collaboration.

Two causes of project defects were pinpointed: insufficient efforts to motivate personnel and inadequate support from the office to the worksite (Hammarlund and Josephson, 1998).

It is suggested that construction firms and consulting companies integrate quality management practices and give priority to coordinating project documentation during the design development phase. This strategy can effectively reduce or eliminate the need for rework in projects (Love & Li, 2000). Rework refers to changes initiated by the client and end-user, along with errors and omissions in contract documentation. Errors and omissions undoubtedly constitute deviations, while the changes may encompass both formal and informal changes.

In 1987, the National Economic Development Office discovered that quality was predominantly affected by design issues, including poor coordination and incomplete documentation, as well as by shortcomings in workmanship, marked by lack of attention to detail and knowledge (Love & Li, 2000).

5.2.4 Improving the final project design

According to Ibbs (1997) project change are due to three factors, design errors and omissions account for the 65%, design changes 30% and only 5% for unforeseen conditions. Also, Burati et al. (1922) stated that design changes constituted the majority, ranging from 67% to 90%, of all changes observed across the projects This highlights a significant necessity for enhancing the final project design.

Time constraints present challenges in producing a comprehensive final design. Designers and contractors frequently worked under conditions of considerable time pressure (Hammarlund and Josephson, 1998).

Cost pressures persist, with the lowest bid still being a common strategy in supplier selection. This pressure extends across all key project stakeholders (Hammarlund and Josephson, 1998). This might cause the client or contractor to be reluctant to invest in a thorough final design.

Cnuddle (1991) discovered that 46% of the total deviation costs originated during the design phase.

Again, consultants noted that the contractor did not provide them with sufficient time to design and document the project. Consequently, documentation was not reviewed before awarding the subcontract trade packages (Love & Li, 2000). This suggests that there was significant room for improvement in the design process.

Another design consultant mentioned that their fees were too low, which constrained their ability to fully design and document the project (Love & Li, 2000). This resonates with the situation in the Paraguayan context, as highlighted by numerous interviewees. It also complicates the implementation of the measure, as one potential solution could involve increasing compensation for the design phase. However, while this solution seems straightforward in theory, it may prove challenging to implement in practice.

While seeking optimization in the design process is feasible, the reality is that current investment in this area is minimal. Thus, the most impactful solution would be to increase funding for this process.

I. Pay more for the design phase.

5.2.5 Taking into account unforeseen events

Given the extensive literature available and the commonplace nature of this topic in project management, it just has been chosen two implementation suggestions.

I. Conduct a risk analysis utilizing data from previous projects.
II. Implement risk management practices, which involve regularly reviewing the risk register.

5.2.6 Improve change order procedure

The client often took a considerable amount of time to make decisions crucial for both designers and contractors. This frequently led to changes in their routine plans as they waited (Hammarlund and Josephson, 1998).

Among the 9 proposals aimed at enhancing change orders provided by the interviewees, 4 were deemed suitable for adoption. The others were excluded either due to their resemblance to one another or because they were indirectly addressed by the 5 prior suggestions aimed at deviations prevention.

I. Offering detailed documentation to the financial entity can speed up evaluation and reduce data requests.
II. Set up dedicated technical teams within the financing entity to closely monitor progress and support required changes.
III. Allocate a budget percentage for potential changes.
IV. Keep plans and quantities current for a quick change order process.

5.3 Deviation good practices

This section delineates potential methods for implementing the four proposed good practice measures. While the primary goal is always to prevent deviations, if prevention is not feasible, efforts should be made to minimize their impact. The majority of interviewees highlighted that

deviations are a common occurrence, emphasizing the importance of acknowledging and effectively managing them rather than dismissing them.

Nine proposals surfaced (they can be seen in the previous chapter in Deviation improvement and good practices) and they might be categorized into three clusters: five in the communication category, two in the creation category, and two in the consideration category. Initially, these clusters are presented alongside their respective summarized proposals.

A) Communication

Informal agreement and then formalize it. (Interviewee 2)

Detailed deviation document and agreement from all involved. (Interviewee 3)

Provide informal notification. (Interviewee 5)

Keep record. (Interviewee 7)

Meetings. (Interviewee 7)

B) Creation

Specialist input to validate deviations. (Interviewee 4)

A regulation for minor deviations. (Interviewee 8)

C) Consideration

Experience. (Interviewee 6)

Safety. (Interviewee 6)

All communication suggestions were consolidated into one recommendation, “At least reach an informal agreement, document it and then formalize it”. The creation cluster remains unchanged. Finally, the consideration cluster was condensed into one suggestion, “Possess experience and prioritize safety”.

a) At least reach an informal agreement, document it and then formalize it.
b) Seek opinions from specialists to confirm the change/deviation necessity.
c) Possess experience and prioritize safety.
d) Regulations should prioritize execution unless significant changes or costs are involved.

5.4 Implementation of deviation good practices

Several literature references utilized in the prevention section could be reapplied here. Three of the good practice measures provide examples of how to apply them, while one is straightforward, suggesting to simply execute it without elaborate explanation.

Each proposed good practice measure is described in sections 5.4.1 to 5.4.4 and comprises two components. First, its elaboration, foundation, or relation with existing literature; second, the methods for implementation, which are cited on Roman numbers and were asked of the experts.

5.4.1 At least reach an informal agreement, document it and then formalize it

Essentially, the aim is to achieve consensus, even if informally, while also documenting and formalizing agreements whenever possible in the future. This approach eliminates the excuse

that the formal process is too lengthy and bureaucratic, ensuring that all parties are informed and in agreement with the actual happenings on site.

This good practice is similar to the prevention measure of “Cultivate teamwork through improved communication and collaboration”. Most of the literature presented could also be included here, but only two fragments were chosen to refresh the reader's memory.

Deal with changes promptly as they arise in a project. Delaying resolution will lead to greater disruption and expenses. Foster a positive environment that encourages the acknowledgment and resolution of change, for example, through partnering initiatives (Ibbs, 1997).

The client often took a considerable amount of time to make decisions crucial for both designers and contractors. This frequently led to changes in their routine plans as they waited (Hammarlund and Josephson, 1998).

I. Hold meetings to discuss deviations.
II. Document decisions in meeting minutes or construction logs.
III. Create an easy and quick deviation template procedure.

5.4.2 Seek opinions from specialists to confirm the change/deviation necessity

Defects are often attributed to a lack of knowledge, information, or motivation (Hammarlund and Josephson, 1998). The disregard for quality in construction has led to quality failures becoming widespread occurrences within the construction process (Love & Li, 2000).

It closely resembles the earlier prevention suggestion of hiring a professional, albeit with a nuanced distinction: here, specialists are engaged specifically to validate the necessity of the deviation. While in the private domain, this decision may vary based on individual clients and contractors, in the public sector, as several interviewees highlighted, it could serve as a deterrent against contractors exploiting changes/deviations for profit. Furthermore, these specialists could assist private clients or public financing entities in making informed decisions about those proposed changes/deviations.

I. Just do it.

5.4.3 Possess experience and prioritize safety

Experience is a quality that develops over time, making it essential to recruit individuals with substantial experience for key positions. However, this aligns closely with the preventive measure of hiring qualified professionals. To prioritize security, numerous options exist, but the proposal will focus on highlighting two.

Implement an automatic Safety Checking of Construction Models and Schedules (Zhang et al., 2013). Also, Kim et al. (2016) also proposed a system in BIM to improve security.

The key safety considerations include the dedication of management, the safety awareness demonstrated by top management through practices, procedures, and reviews, as well as the potential for errors in judgment or carelessness. On the other hand, project supervision, employee engagement and attitude, and the level of expertise and training were identified as critical quality factors affecting safety and quality management (Ogwueleka, 2013).

I. Implement technology to foster safety, for instance, an automatic safety checking in BIM.

II. Top management should promote safety across all project members.

5.4.4 Regulations should prioritize execution unless significant changes or costs are involved

This measure shares a commonality with the first measure for preventing deviations. Both require legal amendments by the government or the inclusion of new clauses in private contracts. Subsequently, a change system must be implemented to ensure the effective application of the change, positively addressing minor deviation issues.

However, this suggestion would primarily address project delays resulting from the approval of changes or the informality of deviation incurred due to not waiting for the change process to complete. In reality, even minor and irrelevant change proposals often undergo lengthy approval processes, prompting many contractors to resort to deviations to avoid downtime for their teams. Nonetheless, it's essential to implement other recommended good practices simultaneously.

I. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.
II. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.

5.5 Experts consultation

Following the previous analysis and the relation between the literature and interview results, an expert consultation was conducted to evaluate the findings. Appendix 9: Experts consultation protocol contains the interview protocol, while Appendix 10: Experts consultation transcripts includes the transcripts of the expert consultation interviews. This section is divided into three parts: introduction of experts, prevention of deviations, and good practices for managing deviations. This implies that the initial focus is on prevention strategies, but in case prevention fails, guidance is provided on effectively managing deviations.

5.5.1 Experts background

The experts were chosen based on their years of experience and their roles within their respective companies. Expert 1, a civil engineer, brings 37 years of experience in the private sector and is the owner of a construction company. Expert 2, an architect, possesses 35 years of experience in the private sector and works as a project designer at a small construction firm. Expert 3, also a civil engineer, has 10 years of experience and holds a position at a large construction company where she manages budgets. A summary is given in Table 17 it. All three individuals regularly handle changes and deviations, although it took them some time to distinguish the differences between the two concepts.

Table 17: Experts overview.

	Expert 1	Expert 2	Expert 3
Profession	Civil engineer	Architect	Civil engineer
Position	Owner	Designer	Budget manager
Years of experience	37	35	10
Type of company	Private	Private	Private

5.5.2 Deviation prevention

At the onset of this section, two inquiries were posed: one regarding the preventability of deviations and the other regarding whether they should merely be accepted. The overview of those answers can be seen in the Table 18 .

Table 18: Experts answer about prevention.

Question	Expert 1	Expert 2	Expert 3
Can deviation be avoided?	Yes	No	No
Just embrace the deviation?	Yes	Yes	It depends

Half of the interviewees and two out of three experts share the belief that deviations cannot be entirely avoided. However, one expert expressed confidence that with a well-defined project and adequately compensated professionals, deviations can be avoided. The other two experts suggested that while deviations can be reduced, complete prevention may not be feasible. Expert 2 emphasized the importance of good project design in minimizing deviations, with an estimated range of 2 to 5% of the project cost. Expert 3 noted that deviations tend to decrease with proper project design. Minor deviations are often addressed without consulting the client to avoid inconveniencing them, while major deviations require client involvement. Overuse of changes can reflect poorly on the company, leading to the preference for informal resolutions for minor deviations.

The interviews touched upon the idea of passively accepting deviations three times. The experts were specifically questioned about the advisability of recognizing and accepting deviations as they arise.

Expert 1 said "*Yes, but they must be documented*".

Expert 2 said "*It is inevitable to accept them if they still happen after everything possible has been done to avoid them, but you have to know how to resolve them*".

Expert 3 said "*It depends on the cost. If the amount is small, the company absorbs the extra cost, does not notify it and accepts it*"

Then the six prevention suggestions were presented to the experts and several questions were discussed. An overview can be seen in Table 19.

Table 19: Experts answer about prevention measures

Questions	Expert 1	Expert 2	Expert 3
Do you consider all of them relevant?	Yes	Yes	Yes
Do you think they could indeed prevent deviation in practice?	Yes	Yes	Not all of them
Who should be the lead of those actions?	Project developer	Project developer	The owner of the company, the employees and the supervisors

They were asked to rank them in order of relevance as can be seen in Table 20. The most prominent prevention measure is evidently “Improving the final project design”, followed by “The contract could stipulate a paid, thorough review conducted by the contractor”. However, no definitive conclusions can be drawn regarding the relevance of the remaining measures for prevention.

Table 20: Relevance ranking of prevention measures according to experts.

Prevention measures	Expert 1	Expert 2	Expert 3
The contract could stipulate a paid, thorough review conducted by the contractor.	2	2	2
Hire qualified professional.	6	6	3
Cultivate teamwork through improved communication and collaboration	4	4	5
Improving the final project design.	1	1	1
Taking into account unforeseen events.	5	5	4
Reduce change order bureaucracy.	3	3	6

Finally, some possible approaches were presented to implementing these six suggestions and were asked whether they agreed with them or had anything to add. Each prevention measure will be presented in Appendix 11: Experts' feedback on prevention measures, alongside its corresponding application methods and the feedback provided by each expert. Additionally, a summary of these answers is available in Table 21 for quick reference.

Table 21: Overview of the opinion of the experts on the proposals on how to apply the suggestions for preventing deviations.

Prevention measures	Expert 1	Expert 2	Expert 3
1) The contract could stipulate a paid, thorough review conducted by the contractor.			
I. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.	Disagree	Agree	Disagree
II. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.	Agree	Agree	Agree
2) Hire qualified professional.			
I. Just do it.	Agree	Agree	Agree
3) Cultivate teamwork through improved communication and collaboration			
I. Foster soft skills within the team.	Agree	Agree	Agree
II. Analysis and engagement of project stakeholders.	Agree	Agree	Agree
4) Improving the final project design.			
I. Pay more for that stage.	Agree	Agree	Agree
5) Taking into account unforeseen events.			
I. Conduct a risk analysis utilizing data from previous projects.	Agree	Agree	Agree
II. Implement risk management practices, which involve regularly reviewing the risk register.	Agree	Agree	Agree
6) Reduce change order bureaucracy.			
I. Offering detailed documentation to the financial entity can speed up evaluation and reduce data requests.	Agree	Agree	No idea
II. Set up dedicated technical teams within the financing entity to closely monitor progress and support required changes.	Agree	Agree	No idea
III. Allocate a budget percentage for potential changes.	Agree	Agree	No idea
IV. Keep plans and quantities current for a quick change order process.	Agree	Agree	No idea

The experts generally concurred with nearly all the measures. This does not imply that these are the only ways to implement these prevention measures, and it is possible that they agreed because it was the easiest response. For prevention measures 2 through 5, all three experts agreed with the proposed implementation methods. However, they did not agree on all implementation methods from prevention measures 1 and 6.

Regarding the first prevention measure, two of the three experts do not believe the initial implementation method is feasible. They doubt that either private clients or the government have the initiative to adopt such a strategy. In this case, the second implementation method depends on the first being executed, making it potentially irrelevant. Nonetheless, if the first step were somehow implemented, all three experts believe the second step could then be applied.

The last preventive measure is not very relevant since none of the three experts have experience with change orders. Expert 3 admitted to having no idea about it, while the other two agreed with the proposed methods but noted their lack of experience in this area. The outcome might have been different if the experts were from the public sector or at least from a private company that works on public projects.

5.5.3 Deviation good practices

In this section four good practices suggestions were presented to the experts and several questions were made about them. An overview can be seen in the Table 22 .

Table 22: Experts answer about good practices measures.

Questions	Expert 1	Expert 2	Expert 3
Do you consider all of them relevant?	Yes	Yes	Yes
Do you think they could indeed work in practice?	Yes	Yes	Yes
Who should be the lead of those actions?	Contractor and designer.	Each in their respective field.	The construction company.

They were asked to rank them in order of relevance as can be seen in Table 23. The four good practices are ordered by relevance as follows: Seek opinions from specialists to confirm the change/deviation necessity, at least reach an informal agreement, document it and then formalize it, regulations should prioritize execution unless significant changes or costs are involved and finally, possess experience and prioritize safety.

Table 23: Relevance ranking of good practices measures according to experts.

Prevention measures	Expert 1	Expert 2	Expert 3
At least reach an informal agreement, document it and then formalize it.	2	2	2
Seek opinions from specialists to confirm the change/deviation necessity.	3	1	1
Possess experience and prioritize safety.	1	4	4
Regulations should prioritize execution unless significant changes or costs are involved.	4	3	3

Finally, some possible approaches were presented to implementing these four suggestions and were asked whether they agreed with them or had anything to add. Each good practice measure (see Appendix 12: Experts' feedback on good practices measures) is accompanied by its corresponding application methods and the feedback provided by each expert. Additionally, a summary (Table 24) of these answers is available for quick reference.

Table 24: Overview of the opinion of the experts on the proposals on how to apply the good practices suggestions for deviations.

Good practice measures	Expert 1	Expert 2	Expert 3
1) At least reach an informal agreement, document it and then formalize it.			
I. Hold meetings to discuss deviations.	Agree	Agree	Agree
II. Document decisions in meeting minutes or construction logs.	Agree	Agree	Agree
III. Create an easy and quick deviation template procedure.	Agree	Agree	Agree
2) Seek opinions from specialists to confirm the change/deviation necessity.			
I. Just do it	Agree	Agree	Agree
3) Possess experience and prioritize safety .			
I. Implement technology to foster safety, for instance, an automatic safety checking in BIM.	Agree	Agree	Agree
II. Top management should promote safety across all project members.	Agree	Agree	Agree
4) Regulations should prioritize execution unless significant changes or costs are involved .			
I. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.	Agree	Disagree	Agree
II. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.	Agree	Disagree	Agree

Once again, this section makes it clear that the experts had similar opinions on nearly every point, except for their disagreement with government intervention through legislative measures.

5.5.4 Additional comments from experts

Two of them contributed interesting perspectives on the issue. Expert 1 highlighted the potential ethical implications associated with handling deviations, while Expert 3 provided another rationale for incurring deviations: to avoid inconveniencing the client, and sometimes even absorbing the cost of the deviation to maintain future contracts.

5.6 Conclusion

In this chapter, the focus was on identifying prevention methods and best practices. Similar to addressing risks, efforts were directed towards mitigating the likelihood of deviations occurring and minimizing their impacts if they do occur.

Following the analysis of the interviews, an expert consultation was conducted to validate the findings. During this consultation, experts were tasked with evaluating the interview findings to address the fourth sub-research question:

4) What are good practices for managing deviations?

I. The first step is to endeavor to prevent deviations.

Two out of three experts believe that deviations cannot be entirely avoided, but they can be minimized. They also advocate for accepting certain deviations as inevitable occurrences, emphasizing the importance of focusing on how to effectively manage them when they occur.

The analysis of interviews uncovered six measures for preventing deviations, which were subsequently reviewed with the experts. All three experts regarded these prevention measures as pertinent. While two experts believed in their practical ability to prevent deviations, one did not share this confidence. Two experts suggested that the project developer should oversee these prevention measures, while the other expert proposed that responsibility should fall on the owner of the construction company, their employees, and the inspectors.

The order of relevance according to the experts is as follows:

1) Improving the final project design.
2) The contract could stipulate a paid, thorough review conducted by the contractor.
3) Reduce change order bureaucracy.
4) Cultivate teamwork through improved communication and collaboration.
5) Taking into account unforeseen events.
6) Hire qualified professional.

Several suggestions were presented regarding the implementation of these measures. They agreed with most of the suggestions on how to implement the six prevention measures. The second measure, “the contract could stipulate a paid, thorough review conducted by the contractor”, may not be viable. The third measure, “reduce change order bureaucracy”, does not have a big impact in private projects.

II. The second step involves implementing good practices to manage any deviations that arise.

The experts were consulted regarding the four good practices identified from the interviews. They unanimously deemed all of them relevant and feasible in practice. However, opinions varied regarding who should spearhead these measures. Expert 1 suggested involvement from both the contractor and the designer, while expert 2 proposed each individual within their respective field. On the other hand, expert 3 asserted that only the contractor should lead.

The order of relevance according to the experts is as follows:

1) Seek opinions from specialists to confirm the change/deviation necessity.
2) At least reach an informal agreement, document it and then formalize it.

3) Regulations should prioritize execution unless significant changes or costs are involved.
4) Possess experience and prioritize safety.

Several suggestions were presented regarding the implementation of these measures. They agreed with most of the suggestions on how to implement the four good practices measures. The third measure, “regulations should prioritize execution unless significant changes or costs are involved”, may not be viable.

6. Discussion

This chapter is divided in general discussion about the topic, the interviewees, the expert consultation and recommendation for future research.

6.1 The topic

The scope of my research was restricted to open-access resources, as I did not have access to paid research materials. In addition, I frequently encountered difficulties in locating the primary source referenced in the papers I studied. This may have resulted in bias in my research and even caused me to overlook vital information.

It seems both the interviewees and the experts encountered challenges in grasping the concept of deviations. I also noticed this trend in the literature review: terms are being used interchangeably and without consistency between papers. Consequently, answers and interpretations could have been distorted.

Furthermore, it becomes crucial to establish precise definitions and differentiate between change and deviation. Some instances demand explicit action, necessitating a formal change order, while in others, minor deviations permit skipping bureaucratic procedures. However, a grey area exists where distinguishing between the two approaches proves challenging.

Moreover, discussing deviations, being a topic often associated with ethical lapses and diverging from standard procedures, may have been difficult for them to acknowledge. Both interviewees and experts mentioned lack of ethics as one of the causes of deviations. As per Gunes (2015), unlawful constructions have been erected in Turkey. These structures are typically built using substandard materials and craftsmanship, primarily because of inadequate or nonexistent oversight and inspections during the construction process.

Also, according to PMI (2000) there are three main causes of change requests are, (1) an outside occurrence; (2) a change that adds value; and (3) a mistake or omission while defining the project's or product's scope. The second cause can also be deemed unethical if a proposed change is done with the aim of favoring the contractor, such as eliminating a column to decrease expenses or employing other means to compromise quality in order to generate greater profits.

Referring back to Gunes' statement, deviations mainly stem from inadequate or lacking supervision and inspection during the construction process. Surprisingly, neither interviewees nor experts mentioned client inspection as a preventative measure for deviations.

Interestingly, they provided more information when examples involving others were presented, suggesting reluctance to accept deviations. However, this also serves as evidence that deviations indeed occur. The scope was limited to the Paraguayan construction industry, therefore, it was very limited. The number of samples was also not significant, so perhaps it does not represent the entire market well. Nevertheless, despite the limited sample size, I successfully conducted eight qualitative interviews, yielding plenty of detailed and profound information. However, the process of managing and analyzing the data was time-consuming.

6.2 Interviewees

According to Isreal & Hay (2006), researchers must safeguard research participants, build trust with them, uphold research integrity, prevent misconduct and improper behavior that could reflect poorly on their companies or institutions, and manage novel, difficult situations. Confidentiality is one important matter to consider. For people and places in qualitative research, researchers employ aliases or pseudonyms to hide identities and uphold anonymity

(Creswell, 2008). In order to protect the confidentiality of the interviewees, they were assigned numbers instead of names, and care was taken to avoid including specific details that could potentially identify them. However, this precaution may have impacted the depth of the investigation.

The interview protocol was initially conducted in English and later translated into Spanish. The interviews were then carried out in Spanish, transcribed, and subsequently translated back into English. During these translations, some concepts may have been lost or misinterpreted.

Some interviewees were more reserved than others. With this group, I found it necessary to engage in more dialogue to elicit information, which may have inadvertently influenced their responses.

When I sent each participant the transcript for their approval, two possibilities arose. Firstly, due to any delay in sending, they may have forgotten some of their statements. Secondly, despite receiving approval from everyone, it cannot be guaranteed that they thoroughly reviewed the transcript.

There aren't sufficient interviews to provide statistical significance to the study. The characteristics of the interviewees are dispersed and can be categorized into two distinct groups. The first group comprises individuals from public entities, engaged in large-scale projects with extensive teams and a wide range of experience, spanning from 2 to over 30 years, with an average of 13 years. In contrast, the second group consists of construction company owners involved in smaller projects with smaller teams, but with more consistent experience, ranging from 15 to 40 years, with an average of 28 years. Therefore, the private group boasts more than double the experience of the public group.

6.3 Expert consultation

The experts exclusively came from the private sphere, thus insights from the public sector were not captured. Conversely, five out of the eight interviewees represented public entities, leading to a lack of comprehensive validation of their opinions and suggestions. For instance, private companies seldom deal with change orders.

6.4. Interpretation of the interview results

It's intriguing to interpret certain findings from the analysis of the interviews.

The interviewees were questioned about the theory of changes, specifically regarding examples related to the three primary causes: design errors and omissions, design changes, and unanticipated circumstances. Among these causes, design changes emerged as particularly problematic, as design errors or unforeseen circumstances often necessitate a change in design. Explaining the nuanced difference between a genuine design change and one stemming from another cause proved challenging or even impossible at times. Consequently, some examples may not have been accurately categorized.

For instance, interviewee 7 stated "*Unexpected topographical challenges emerged at the construction site, with a steeper slope than anticipated at first. Initially, options such as leveling were considered, but ultimately, it was decided to leverage the slope within the project design. Consequently, significant modifications to the original design were necessary*".

It was initially considered a design error but later classified as a design change, as the slope was ultimately integrated into the project as an improvement. In another similar example, also a

topographical situation, it was labeled a design error because the project's overall quality was not enhanced; rather, the issue was merely rectified.

Another compelling example of a design change prompted by an unforeseen circumstance is as follows: Interviewee 8 mentioned "*There was a need to demolish a ceiling and install a new one. However, during demolition, ceramic tiles were discovered. Consequently, the decision was made to restore and leave them exposed, rather than proceeding with the installation of a new ceiling".*

The challenge in precisely categorizing examples is apparent in the varying numbers provided by the interviewees. While there were fourteen examples for each of the other two causes, design changes were represented by only eight examples. This difference arose because participants initially offered examples that, upon further clarification, were determined to belong to one of the other two categories.

Another intriguing aspect to consider is the responses from the interviewees regarding whether the industry exploits changes and deviations. The two tables from Chapter 4 were condensed and supplemented with additional elements for further analysis (Table 25). Notably, in the last row, there is a clear decrease in numbers. While this trend may indeed reflect actual occurrences, it could also indicate a psychological tendency to avoid admitting mistakes. The term "abuse" implies infringement, and incurring a deviation is considered more serious than incurring a change.

Table 25: Change abuse vs deviation abuse within the industry.

Interviewees	Change			Deviations
	Have their projects undergone many changes?	Does the industry abuse change orders?	Coincidence	Does the industry abuse deviations?
Interviewee 1	Yes	Uncertain	No	More or less.
Interviewee 2	Yes	No	No	Yes
Interviewee 3	Yes	Yes	Yes	No
Interviewee 4	Yes	No	No	Her department no, others maybe
Interviewee 5	No	Yes	No	No opinion
Subtotal public afirmative	4 out of 5	2 out of 5	No	1 out of 5
Interviewee 6	No	Yes	No	Yes
Interviewee 7	Yes	Yes	Yes	Yes
Interviewee 8	Yes	Yes	Yes	Some, not the whole industry.
Subtotal private safirmative	2 out of 3	3 out of 3	No	2 out of 3
Total affirmative	6 out of 8	5 out of 8	No	3 out of 8

There is also a noticeable contrast between responses from public and private interviewees. While the first question, which is relatively straightforward, elicited similar responses from both groups, with only one dissenting response from each. However, in the subsequent two questions, the disparity between the responses of the two groups widens.

The research yielded little information on procedures from the literature, indicating primarily that once deviations occur, they are accepted, followed by adherence to formal change order procedures (Project Management Institute, 2021). However, during interviews, numerous methods of handling deviations were mentioned. These included informal bilateral agreements between the client and contractor, unilateral decisions by the contractor, and errors. Interestingly, one expert noted that their private company utilizes a software to document all deviations, while the other two experts relied solely on recording informal bilateral agreements in workbooks. This highlights the diverse management approaches across different companies or entities. Despite initial assumptions that deviations were not systematically addressed, it is evident that certain stakeholders do have established practices for managing them.

This also suggests the possibility that there may be literature that I did not come across, or alternatively, that private companies are more advanced in their practices than what is documented in the literature.

6.5 Possible impacts for practice

By implementing the recommended actions for deviations, particularly those focused on prevention, the project might potentially achieve the following benefits:

1) Project cost savings ranging from 3% to 20% Burati et al., 1992; Hammarlund and Josephson, 1991; Love and Li, 2000; Cnuddle, 1991).

Implementing these steps undoubtedly incurs expenses. However, if the expenses are lower than the financial consequences of not adhering to the measures, profit can be generated. Furthermore, it is important to note that the potential consequences of deviations might result in not only the complete failure of the project but also the loss of human lives, as exemplified by the catastrophe in Turkey. Furthermore, applying the procedures yields additional advantages beyond the potential expense savings.

2) The potential to prevent calamities like the ones that had place in Turkey.

The push to create more rapidly and affordably has led to a disregard for construction regulations and a lack of collaboration between politicians and housing developers (Bhattacharyya, 2023). The emphasis was placed on adhering to the schedule and managing costs, but not on ensuring high quality. To reduce costs, firms hire fewer specialists who are not suitable and ignore several norms (The News-Herald, 2023; RFI, 2023). According to Hammarlund and Josephson (1988), flaws are frequently ascribed to a deficiency in knowledge, information, or motivation. Cost pressures continue to exist, with the lowest bid remaining a prevalent approach in the selection of suppliers. The pressure mentioned is present among all important stakeholders involved in the project (Hammarlund and Josephson, 1998). This could lead to the client or contractor giving priority to the lowest price and potentially engaging inexperienced workers. This was a prime illustration of a project's failure when the delivered outcome does not meet its intended purpose, regardless of its adherence to the schedule and budget (Wright & Therese Lawlor-Wright, 2019).

3) Enhanced transparency and improved communication channels among project stakeholders, particularly between the contractor and client.

Address any modifications swiftly when they occur in a project. Postponing the resolution will result in increased disruption and costs. Cultivate a conducive atmosphere that promotes the recognition and effective handling of change (Ibbs, 1997). The successful execution of a project relies on the synchronized efforts of the project stakeholders. Conversely, inadequate coordination among them might result in project faults (Hammarlund and Josephson, 1998).

7. Conclusion and recommendations

7.1 Conclusion

This research aimed to address the issue of preventing the abuse of deviations in the construction industry, inspired by the catastrophe in Turkey resulting from an earthquake. To comprehensively understand deviations and address the main research question, four sub-research questions were formulated.

The research commenced with a research methodology chapter, followed by a literature review that addressed two of the sub-research questions. Subsequently, interviews were conducted and analyzed to address the third research question. Finally, an analysis and consultation with experts were undertaken to explore ways to improve the deviation phenomenon, which answered the fourth sub-research question.

With all the gathered information, the main research question can be answered, drawing upon the insights gained from addressing the sub-research questions.

SRQ1: What are the differences between changes with and without change order according to theory? (Or differences between changes and deviations)

Firstly, changes are formal ones, they must comply with a pre-established procedure to evaluate and accept/reject the proposed change, while deviations do not have a clear procedure. And secondly, the action itself is in a different sequence. In a change, the situation is evaluated before the event happens, in other words, the proposed change is evaluated before the work is done and is decided whether to accept or reject the change. On the other hand, a deviation is evaluated after the event happens if it is evaluated at all. This means that the error or omission is accepted or the work must be redone it. Alternatively, deviations are frequently evaluated retrospectively, if evaluated at all. By this point, the work has already deviated from the specification, leaving only two options: accepting the error or omission as is in its deviated state, or rectifying it. This rectification can entail either redoing the work or performing additional complementary tasks.

SRQ2: What are the current theoretical methodologies to manage deviations (or change orders)?

Literature to manage formal changes is immense, while on deviations is limited. Several types of deviations exist, yet the literature solely provided one tactic, just accept it. It is noted that once they occur, they are typically accepted since they've already transpired. However, it's essential to follow the subsequent steps similar to those of an approved change, which include updating system configurations and the project plan. Additionally, it's crucial to monitor the deviation and inform the customer and other stakeholders impacted by it.

SRQ3: How are the deviations and changes treated in practice?

All participants acknowledged experiencing change orders, with six indicating numerous change orders in their projects. Furthermore, five participants highlighted industry abuse of change orders. Conversely, seven participants acknowledged deviations in their projects. Of these, three stated industry abuse of deviations, three had mixed opinions, and two indicated no industry abuse of deviations.

Interestingly, research did not reveal a clear preference for any specific project phase regarding the timing of change orders. However, there appears to be a subtle trend suggesting a decrease in both frequency and scale of changes as the project progresses. In contrast, deviations exhibit a distinct pattern, frequently occurring midway through the project.

Change orders serve as the formal procedure to manage project changes. They vary significantly between public and private projects. The public sector operates under strict regulations, but practices differ regarding change magnitude, involvement of public entities, and the role of financial institutions. Delays often occur when change orders reach financial institutions, which conduct final analysis of proposed changes. Conversely, the private sector tends to adopt a more informal approach, often relying on verbal agreements for changes, with only some contracts containing relevant clauses.

Regarding deviations, they occur through bilateral agreements, unilateral decisions, and errors. Bilateral agreements resemble private sector practices, involving informal yet binding agreements, recorded in construction logbooks or through compensations. Unilateral deviations are initiated solely by contractors, sometimes with the intention of future regularization, whether ethically or unethically. Errors, lacking malicious intent, still represent deviations from specifications.

SRQ4: What are good practices for managing deviations?

I. The first step is to endeavor to prevent deviations.

Two out of three experts believe that deviations cannot be entirely avoided, but they can be minimized. They also advocate for accepting certain deviations as inevitable occurrences, emphasizing the importance of focusing on how to effectively manage them when they occur.

The analysis of interviews uncovered six measures for preventing deviations, which were subsequently reviewed with the experts. All three experts regarded these prevention measures as pertinent. While two experts believed in their practical ability to prevent deviations, one did not share this confidence. Two experts suggested that the project developer should oversee these prevention measures, while the other expert proposed that responsibility should fall on the owner of the construction company, their employees, and the inspectors.

The order of relevance according to the experts is as follows:

1) Improving the final project design.
2) The contract could stipulate a paid, thorough review conducted by the contractor.
3) Reduce change order bureaucracy.
4) Cultivate teamwork through improved communication and collaboration.
5) Taking into account unforeseen events.
6) Hire qualified professional.

Some suggestions were presented on how to implement these measures. They agreed with most of the suggestions on how to implement the six prevention measures. The paid review may not be viable. Reducing change order bureaucracy does not have a big impact in private projects.

II. The second step involves implementing good practices to manage any deviations that arise.

The experts were consulted regarding the four good practices identified from the interviews. They unanimously deemed all of them relevant and feasible in practice. However, opinions varied regarding who should spearhead these measures. Expert 1 suggested involvement from both the contractor and the designer, while expert 2 proposed each individual within their respective field. On the other hand, expert 3 asserted that only the contractor should lead.

The order of relevance according to the experts is as follows:

1) Seek opinions from specialists to confirm the change/deviation necessity.
2) At least reach an informal agreement, document it and then formalize it.
3) Regulations should prioritize execution unless significant changes or costs are involved.
4) Possess experience and prioritize safety.

Some suggestions were presented on how to implement these measures. They agreed with most of the suggestions on how to implement the four good practices measures. The regulation may not be viable.

MRQ: How to avoid abuse of deviations in the construction industry?
To pursue improvement or address potential abuse, understanding the phenomenon is the initial step. Initially, a theoretical exploration of the concept of deviation was undertaken, an aspect often overlooked in literature. Deviations differ from formal changes in two primary ways: informality and the sequence of events. Unlike formal changes, which undergo analysis before implementation, certain types of deviations occur first and are subsequently analyzed. However, practical research reveals numerous other deviation types, including those involving informal bilateral agreements, unilateral actions by contractors, and deviations due to errors or omissions, whether intentional or unintentional.

This discussion sheds light on how deviations are managed in practice. In theory, there is limited guidance on handling deviations; they are generally accepted since they cannot be entirely avoided, followed by the formal change process involving project updates, monitoring, and client notification.

The final sub-question plays a pivotal role in addressing the main research query. It outlines two critical steps: minimizing deviation occurrence through preventive measures (six identified in this study, but likely more exist), and mitigating the impact of deviations when they do occur (four measures identified, with potential for additional strategies). The effectiveness of these measures hinges on the ethical conduct of project stakeholders. While they may not prevent extreme situations like those observed in Turkey, they can benefit individuals with good intentions and foster awareness of quality and safety implications associated with deviations in projects.

7.2 Recommendations

7.2.1 Recommendations for practice

Firstly, thoroughly study and understand the distinction between the concepts of changes and deviations in projects. This is imperative, as interviews have revealed a lack of clarity on these matters, particularly within the Paraguayan construction industry. Understanding is always the initial step towards improvement. Upon acquiring a comprehensive understanding of the concept, the focus should shift towards elucidating the diverse types, causes, consequences, and other related aspects.

Secondly, once the nature of deviations in projects is understood, it becomes evident that they must be minimized due to the potential negative consequences they may bring. To achieve this, it is recommended to utilize the six prevention measures outlined in this research.

Thirdly, despite diligent efforts to prevent them, deviations will invariably arise in projects. Thus, it is crucial to understand how to effectively manage them, for which it is advisable to employ the four best practice measures.

Finally, it is important to acknowledge that these measures may not be exhaustive or universally applicable across all projects. They serve as a foundational guide, and it is imperative for each stakeholder to thoroughly assess each suggestion and even come up with new ideas.

7.2.2 Recommendations for research

Undoubtedly, there is ample room for investigation regarding deviations, given its status as a relatively underexplored topic. While the possibilities are vast, the following are some suggestions for further research:

- Applying a similar approach with a broader scope or in another region of the world could yield valuable insights into how deviations are perceived and managed within different contexts. By conducting interviews and consulting experts from diverse backgrounds and regions, we can gain a deeper understanding of the challenges and practices associated with deviations in various industries and cultural settings.
- Exploring additional and innovative ways to implement the proposals for preventing deviations and promoting good practices can enhance effectiveness and bring more clarity to the subject.
- Narrow the research scope to either the private or public sector, as they are managed differently.
- Maybe analyze agile project management methodologies, which promote flexibility and adaptability in project execution. Agile approaches enable iterative development cycles, allowing teams to respond quickly to changes and maybe it can minimize the impact of deviations.
- It could be intriguing to explore changes and deviations from the perspective of the financing entity, particularly in public projects where they often have the final say on whether to accept the changes.
- Investigating why private projects tend to be more informal than public ones, and exploring clients' perspectives on deviations, could provide valuable insights into project dynamics and stakeholder perceptions.
- Explore the ethical dimensions of two types of deviations: those motivated by good intentions, such as problem-solving or project improvement, and those driven by ulterior motives, such as financial gain at the expense of quality or safety compromises.
- Seek out an approach or protocol tailored for managing modifications in projects that lie somewhere between a formal change and a minor deviation.
- Analyze the differences in how changes and deviations of varying sizes are treated by different financial institutions, public entities, and private companies.

7.3 Reflection

Undoubtedly, navigating through a thesis journey is always a formidable challenge in any academic pursuit. It's a phase where students often find themselves treading unfamiliar ground, especially when it comes to conducting research, and my experience was no different. My undergraduate thesis proved to be quite demanding, presenting a complex process that was far

from straightforward. However, my master's thesis journey turned out to be even more arduous.

Prior to my successful attempt, I had embarked on another thesis endeavor. On that occasion, I stumbled upon a topic by chance, yet struggled to secure the cooperation of a company to support my research. Despite sending numerous emails over several months, the response was largely unfavorable, with many going unanswered. It was only through attending a company and job exhibition that I managed to secure several interviews. Unfortunately, the outbreak of the COVID-19 pandemic brought everything to a halt, forcing me to return to my native country of Paraguay. There, I spent two years working for a construction company before deciding to make another attempt.

This time, thanks to the guidance of my supervisors, I swiftly identified a compelling and relevant topic. The subject matter resonated with me on a personal level, as it offered a practical focus that aligned with my interests. Given the limited existing literature on the topic, I relied heavily on interviews to gather information. However, numerous challenges arose along the way. Having been out of academia for some time, I struggled to regain my academic momentum, while my proficiency in English had also waned due to its limited use in my home country. Yet, the most significant challenge came in the form of my family's health issues, particularly those of my sister and father.

The methodological development of my research proved to be particularly challenging, as my lack of experience and departure from traditional research approaches (e.g. ground theory, case study, etc.) posed significant hurdles. While the literature review was less complicated, it still presented its own set of challenges. Three primary issues emerged: the scarcity of literature, the interchangeable use of terminology among authors, and the paid research articles that were inaccessible to me. These will be further elaborated upon below.

Firstly, the scarcity of literature presents both a challenge and an opportunity. While the absence of existing literature makes it difficult to structure and support the research, it also provides the freedom to explore uncharted territory and pursue areas of personal interest. Secondly, the interchangeable use of terms such as "change," "deviation," "modification," and "alteration," along with related terms like "rework" and "adjustment," complicates matters. This ambiguity often leads to confusion, as it is unclear whether authors are referring to changes or deviations based on the definitions established in this research. Thirdly, the prevalence of paid research articles poses a significant obstacle. Despite encountering promising articles, the inability to access them can be frustrating and hinder the research process.

Despite these setbacks, I found solace in the enthusiasm and engagement of my interviewees, who displayed a genuine interest in the topic. I believe that my research has the potential to contribute positively to society by addressing a pressing global issue. However, such outcomes are rare in research endeavors, particularly in technical or specific topics.

Fortunately, the subsequent chapters proved to be more straightforward. The only minor complication arose when arranging interviews with participants. Several individuals postponed me or even canceled on me. There is a common perception that thesis work is a futile endeavor, and interviewees often agree to participate solely out of a sense of altruism. However, once the interviews commenced, the process flowed more smoothly and they showed more interest.

I find the thesis process to be incredibly challenging; it's not something everyone can tackle. Working on the same topic for an extended period can be frustrating and monotonous,

especially compared to the dynamic and varied nature of classes. During the master's program, you're exposed to a wide range of topics, but the thesis requires you to focus solely on one. However, completing the thesis brings immense satisfaction. It's a testament to perseverance and a significant milestone in one's academic journey. I'm grateful to everyone who supported me throughout this stage.

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Appendix 1: Interview protocol

For this research, a semi-structured interview was chosen. At the beginning of the interview, it would be state the confidentiality character of this research, in order to make the interviewees comfortable speaking and it would be asked if they agree to the interview being recorded. I will use two devices for that purpose to guarantee the recording in case one device does not work.

Since is an explorative research, the questions are a bit broad. It has been chosen 27 questions and they are grouped into four themes, which are the following and in that order; Interviewee background presentation, changes with change orders, changes without change orders, and best practices. The first theme attempts to know the interviewee. The second and third are related and mixed up and could be the case that answers about changes with change orders answer a question of a change without change orders theme and vice versa. Finally, is the best practice theme, where the interviewee will give their opinion.

h. Interviewee background presentation (4) [4]
    a. What kind of company did you work for?
    ( ) Private ( ) Public
    b. In which type of projects did you work?

( ) Buildings, ( ) Roads ( ), Water supply ( ), Social development ( ), Others ( ).

    c. How much experience do you have in managing construction projects?
    d. How big were the projects in which you were involved? How many employees were involved in the project/s? (Amount of time or money)

It is nice to know you a bit better. I am sure you will add a lot of value to my research, which is related to changes in projects. I want you to answer with your general experience, not just with your current project. I remind you not to worry, my research is confidential and I will not mention any interviewee or companies' names.

i. Changes with change orders (9) [13]
    a. What is the formal procedure for dealing with changes?

* Backup questions (is it project specific? Is it in all projects the same? If not, what are the differences?)

    b. Did the projects experience any changes (formal ones)?
    c. Did those changes follow the procedure?
    d. Did that work? (If a has multiple answers, b, c and d also have multiple answers)
    e. In which state of the project does this more often happen?
    f. Various authors categorize change based on its causes and types. Additionally, they contend that the three primary reasons for change orders can be broadly divided into three groups: design errors and omissions; design changes; and unanticipated circumstances.
        i. Do you recognize those?
        ii. Can you give me examples of them?
        iii. How do you deal with them?

iv. Which one happens more often?

Thank you for all the valuable insight, the next set of questions will explore the project changes without change order procedures.

j. Changes without change orders (9) [22]
    a. Did the projects experience changes without a change order?
    b. Give an example of one of those.
    c. How did you manage those?
    d. Did you make a change order afterward?
    e. What is the reason for that?
    f. Do you think there is a way to prevent it?
    g. Do you have another similar or different example?
    h. In which state of the projects does this more often happen?
    i. What were the causes?

Finally, we are in the last step of the interview. We have spoken about several aspects of the changes in construction projects. Now we will focus on the possible improvements and a general overview.

k. Best practices (5) [27]
    a. Do you think there is room to improve the change order procedure? (General or specific?)
    b. What do you think are good practices to treat changes without a change order?
    c. Do you think these improvements are possible? (*Depending of the answer; why not? How?)
    d. Do you think the industry abuses the change orders?
    e. Do you think the industry abuse changes without change orders?

Thank you very much for all your answers and your time. It was exciting to hear about your experiences. If you remember something about the topic and want to share it with me, I will be pleased to come by again or you could send me by mail or even you could call me. I have one last request if you are willing to further help me out with this research. It would be of great contribution if you could check the results of your interview once I finish coding and analyzing it. This is useful for validation in research.

Appendix 2: Interviews transcripts

Interviewee 1

1. Interviewee background presentation

    a. What kind of company do you work?
    First in a private company and then in a public entity.

    b. In which type of project did you work?
    Supervision of road works.

    c. How much experience do you have in managing construction projects
    2 years.

    d. How big was the projects in which you were involved? How many employees were involved in the project/s? (Amount of time or money)
    I was working on several projects at the same time. Approximately each project had a budget of 10 million dollars and they manage 300 to 400 people. Local roads cost 350.000 dollars per kilometer and departmental routes cost 650.000 dollars per kilometer.

2. Changes with change orders
    a. What is the formal procedure to threat changes?
    The contractor presents the modifying agreement to the ministry. If there is an inspection team, they check it first. The executing unit controls and corrects errors, then internally goes to different departments, such as legal affairs, internal audit, and finally the minister signs it. The process changes a little depending on the financing entity. When there is an external financing entity it takes longer because it controls everything in detail.

    b. Did the project experience any changes (formal ones)?
    Yes, all projects have changes.

    c. Did those changes follow the procedure?
    Yes, by the explained procedure and by law 2051, which says that changes can represent up to 20% of the budget.

    d. Did that work? (If a has multiple answer, b, c, d also multiple answers)
    Yes.

    e. In which state of the project does this more often happen?
    In all stages. The review and changes already begin before the project begins. Normally the contractor reviews the entire project and proposes changes. In the middle, it is also common. In the end, it happens the least; normally they are just quantity adjustments.

    f. Various authors categorize change based on its causes and types. Additionally, they contend that the three primary reasons for change orders can be broadly

divided into three groups: design errors and omissions; design changes; and unanticipated circumstances.

i. Do you recognize those?
Yes.

ii. Can you give me examples of them?
Design errors and omissions: topographical errors. Stakes are normally placed for level reference and these stakes are usually lost and this causes quantity errors.

Design changes: These are usually made to improve the project.

Unforeseen circumstances: Underestimating traffic in an area when designing a road. For example, there may be an increase in traffic due to private investments, which is what is happening in the north of the country.

iii. How do you deal with them?
In all cases, the options are analyzed and the best is chosen. Always following the procedure explained above.

iv. Which one happens more often?
All three alike.

3. Changes without change orders
   a. Did the project experienced changes without a change order?
   No. The law and procedures do not allow you to do that. If you make an unauthorized change, there is a risk that the contractor will not be paid for the work performed.

   b. Give an example of one of those?
   It does not apply.

   c. How did you manage those?
   It does not apply.

   d. Did you make a change order afterwards?
   It does not apply.

   e. What is the reason of that?
   It does not apply.

   f. Do you think there is a way to prevent it?
   It does not apply.

   g. Another example same or differently?
   It does not apply.

h. In which state of the project does this more often happen?
It does not apply.

i. What were the causes
It does not apply.

4. Best practices
   a. How could the change order procedure be improved?
   Work together from the beginning between the parties to speed up the processes. Apart from saving time in the processes themselves, time is also saved because discrepancies between the parties are avoided at another time later in the change order process.

      i. Who should be in the lead of such improvement?
      In our entity it would depend on each director, it would be an internal process.

      ii. What barriers do you foresee?
      There is none, it depends on each director.

   b. What are good practices to treat changes without a change order?
   Does not apply.

   c. Do you think the industry abuse the change orders?
   No, I think the changes are usually to improve the project. In any case, what could be improved is to group the changes into fewer modifying agreements, for example, instead of having 3 modifying agreements, having only 1.

   d. Do you think the industry abuse changes without change orders?
   I am not aware of this being done, much less can I speak of abuse.

Interviewee 2

5. Interviewee background presentation
    a. What kind of company do you work?
    Public company.

    b. In which type of project did you work?
    Roadways with their works such as bridges.

    c. How much experience do you have in managing construction projects
    In the private sector 3 years as a structural engineer and 4 years in the public sector in project management.

    d. How big was the projects in which you were involved? How many employees were involved in the project/s? (Amount of time or money)
    In the private sector 20 to 30 workers and now in the public sector 150 workers. The current project budget is 150 million dollars, but for my work package it is 40 million dollars with an expected time of 30 months.

6. Changes with change orders
    a. What is the formal procedure to threat changes?
    The changes must come from the contractor or the inspection, they must be substantiated and analyzed, we have to formalize the changes unless they are adjustments of quantities within the work, in which case we could formalize them later with a modifying agreement. The ideal is to formalize the change completely first, including with the financing entity and then give the execution order for the change. There are two types of changes, those that modify the scope of the work and those that do not. Those that modify the scope of the work are more bureaucratic, because you have to deal with the financing entity. For this reason we try to avoid those kinds of changes.

    b. Did the project experience any changes (formal ones)?
    Yes. At the beginning of the work, before starting to build a bridge, it was moved. The inspection began working before the contractor and proposed changing the location of the bridge. The whole process took 20 months. The entire project had to be updated and then the contractor started. There were other changes, such as changes in quantities or in the superstructure of the bridge, but these changes did not lead to delays.

    c. Did those changes follow the procedure?
    Yes. But maybe only because there was no rush to move the project forward. If the requested changes bogged down the project, the contractor would pressure to carry out the work without having the modified agreement signed.

    d. Did that work? (If a has multiple answer, b, c, d also multiple answers)
    Yes.

    e. In which state of the project does this more often happen?

Normally at the beginning to correct project design errors and at the end of the project, but in the latter case they are usually simply adjustments of quantities to regularize what was done.

f. Various authors categorize change based on its causes and types. Additionally, they contend that the three primary reasons for change orders can be broadly divided into three groups: design errors and omissions; design changes; and unanticipated circumstances.
    i. Do you recognize those?
    Yes.

    ii. Can you give me examples of them?
    Design errors and omissions: a road passed through a city and along the way the pipes had to be replaced. It was written in the contract, but it was not in the plans or the budget. The person in charge forgot about that. The correction was easy to accept, because it was something that had to be done and was actually written into the contract.

    Design changes: intersection design improvement.

    Unforeseen circumstances: during the execution of a road, a community water tank was found that was on the route and no one had anticipated. This tank interfered with the road project. The tank had to be moved because you cannot leave the community without water. What happened is that the design of the project was done in 2015 and the water tank did not exist at that time. At some point between 2015 and 2023 the tank was built and the road project was not updated.

    iii. How do you deal with them?
    It was already answered in the previous question.

    iv. Which one happens more often?
    Design errors and omissions. They tend to be poorly done, poorly planned projects. If the project is well designed, the other change order cases will decrease. Second, unknown circumstances, and lastly design changes.

7. Changes without change orders
    a. Did the project experienced changes without a change order?
    Yes, but minor changes, only change in quantities.

    b. Give an example of one of those?
    The contractor needs to continue executing an item, for which they have already received payment in full, so they continue doing the work and then request payment. It is a risk because they may not get paid.

    c. How did you manage those?

Once the contractor presents the variation of quantities, the formal procedure of the modifying agreement is carried out and it is seen whether the financing entity accepts it or not.

d. Did you make a change order afterwards?
Yes.

e. What is the reason of that?
The agreement takes too long. When the process is executed without problems it takes 3 months. The work cannot stop during that time.

f. Do you think there is a way to prevent it?
In road works, which is the area where I work, I don't think there is a way to prevent it. In the calculations of road works, assumptions are used regarding the quantities of existing material and material to be used; it depends greatly on the terrain and is variable.

g. Another example same or differently?
No.

h. In which state of the project does this more often happen?
In the middle, during the execution.

i. What were the causes?
Errors in the project and the very nature of a road project.

8. Best practices
   a. How could the change order procedure be improved?
   The only thing we could improve is to detail and specify more the documents that we pass to the financial entity, this way perhaps they will take less time to evaluate and this also prevents the financial entity from asking for more data to approve the change. In general, all parties could speed up and detail their processes more.

      i. Who should be in the lead of such improvement?
      It should be a joint decision of the representatives of each party.

      ii. What barriers do you foresee?
      The idiosyncrasy. People don't want to improve.

   b. What are good practices to treat changes without a change order?
   There are no good practices if changes are not treated with the formal agreement procedure. It could be reaching an informal agreement and then formalizing it.

   c. Do you think the industry abuse the change orders?
   Yes. Normally contractors win bids with very low prices, often with unrealistic prices. So, they look to change some items for others to lower costs and thus earn more money. Furthermore, in changes in quantities, the unit cost cannot

be changed, only the quantity, so they seek to change the item itself and with that they can set new prices.

d. Do you think the industry abuse changes without change orders?
I think that in other sectors yes, but not in our department. Changes without a change order are strictly dealt with here, there are already records that these types of changes are not paid.

Interviewee 3

1. Interviewee background presentation
    a. What kind of company do you work?

    Currently in a public company but before I was in a private company.

    b. In which type of project did you work?

    Buildings, roads, high voltage works and telecommunications.

    c. How much experience do you have in managing construction projects
    10 years.

    d. How big was the projects in which you were involved? How many employees were involved in the project/s? (Amount of time or money)
    For example, the budget for a waterfront was 82 million dollars and for a road it was 26 million dollars.

2. Changes with change orders
    a. What is the formal procedure to threat changes?

    We are governed by Law 2051, the internal procedures of the ministry and the regulations of Mercosur, because it is financed by a foreign entity. Normally the contractor must present the documents that support the change request to the inspection. It must have technical justification; the inspection must approve it. The execution period or modification of the contract conditions may vary. The inspection passes to the ministry where the technical evaluation is done again. It is consulted with the financing entity. Once the no-objection is obtained, the process within the ministry continues. Then it is analyzed legally, financially, contract review (the contracting unit), audit. At the end of all this internal analysis within the ministry, the modifying agreement is signed. The ministry then refers it to the National Directorate of public procurement. Finally, the modifying agreement is published and the process ends there. For minor changes, they can be requested simply through the Construction Log Book.

    b. Did the project experience any changes (formal ones)?
    Yes. In one project the change was big, from being a tunnel to being a viaduct.

    c. Did those changes follow the procedure?
    Yes.

    d. Did that work? (If a has multiple answer, b, c, d also multiple answers)
    There is always bureaucracy, but it is more related to the financial part. There were also difficulties in accepting the changes with the financing entity. One of the changes was not accepted by the financing entity and the government had to pay for the change. It is not easy to introduce a change within a project, it always

takes a process. Something similar also happened in another project. The financial entity handles projects differently than us, it is not very friendly with change management.

e. In which state of the project does this more often happen?
   At the beginning.

f. Various authors categorize change based on its causes and types. Additionally, they contend that the three primary reasons for change orders can be broadly divided into three groups: design errors and omissions; design changes; and unanticipated circumstances.
   i. Do you recognize those?
      Yes.

   ii. Can you give me examples of them?
      Design errors and omissions: the geodetic point from which the project started was not found; when an attempt was made to layout the project from a known point, the axis was displaced by many meters from the axis of the plan. Therefore, everything was misplaced, the contractual quantities did not coincide.
      Another example is that of two bridges that were about to collapse, which were not taken into account in the new project.
      Design changes: where a tunnel was to be built there was a main pipeline for a water supply company, so the design had to be changed. Since moving that adductor was too expensive. From a tunnel it became a viaduct. The viaduct took up an area of the city's botanical garden.
      Unforeseen circumstances: the reaction of the residents in the project area, they chained themselves to the trees to prevent the felling of the trees. Another example would be when the municipality demanded more things than what was planned for in the project and since we could not give them they complicated us the progress of the project. One last example, the pandemic.

   iii. How do you deal with them?
      All changes are handled differently, the first example I mentioned to you was handled in the following way. A general review was carried out, which involved doing all the studies again, topographical, geotechnical, hydrological and hydraulic. Once the project was adjusted, the modifying agreement was requested.

   iv. Which one happens more often?
      All three are practically the same, perhaps unforeseen circumstances are the ones that occur less frequently.

3. Changes without change orders
   a. Did the project experienced changes without a change order?
      Yes, but not many.

b. Give an example of one of those?
More than anything it was because of the pandemic. The government gave the order not to stop public works. The case of the viaduct that we talked about previously. The contractor requested the change in 2018 and only in 2020 was the decision made to make the change without having the change order approved.

c. How did you manage those?
The financing entity did not agree with the change, finally the work was carried out without its approval and the government took over the financing.

d. Did you make a change order afterwards?
Not applicable, it was an unfinished change order.

e. What is the reason of that?
It does not apply in this case.

f. Do you think there is a way to prevent it?
Yes, not reduce the changes themselves, but reduce the bureaucracy of change orders. If change orders were faster, there would be fewer changes without change orders.

g. Another example same or differently?
Variations in the type of material. In a project, a material was requested that was not available in the area, there was only one possible substitute. I asked the contractor to carry out other studies that were not in the technical specifications in order to support that change. All laboratory studies came out positive within international standards, since Paraguay does not have standards of this nature. As the material met the quality standards, the change was recorded in the Construction Log Book.

h. In which state of the project does this more often happen?
I can't comment on the subject. Normally changes are made with change orders. I only know of the case that I mentioned to you, but it was exceptional due to the pandemic.

i. What were the causes
Bureaucracy, financial entity did not accept the change and absence of material requested in the original project.

4. Best practices
   a. How could the change order procedure be improved?
   The only thing I can think of is to reduce the bureaucracy. The modifying agreement process usually lasts longer than stipulated, varying from 3 months to more than 12 months. Perhaps the financing entity should have a technical team for each project, which monitors the project more closely to verify and support the necessary changes.

i. Who should be in the lead of such improvement?
It's hard to answer that, but maybe we (ministry) could do it.

ii. What barriers do you foresee?
That the financing entity is another institution and they are independent of us. We can only propose.

b. What are good practices to treat changes without a change order?
There should always be at least documentation of what happened and that all parties agree.

c. Do you think the industry abuse the change orders?
No, but I do believe that there is a flaw in the design and planning of the projects, which is why they later need corrections with the change orders.

d. Do you think the industry abuse changes without change orders?
No.

Interviewee 4

1. Interviewee background presentation
    a. What kind of company do you work?
    Ministry of public works and communications.

    b. In which type of project did you work?
    Buildings, roads, water supply, generally in contract management.

    c. How much experience do you have in managing construction projects
    15 years, since 2008.

    d. How big was the projects in which you were involved? How many employees were involved in the project/s? (Amount of time or money)
    The last ones were quite large, one of 100 million dollars from the World Bank (75 million financed by the World Bank and 25 million self-financed). Another also of 100 million dollars, but 100% external fund. In the current project the budget is also approximately 100 million dollars. These three were road projects. In this type of work, the contractor usually has more than 100 people and we usually have approximately 20 people.

2. Changes with change orders
    a. What is the formal procedure to threat changes?
    Law 2051 and any financial entity force you to work according to their rules. When you want to make a change, a modifying agreement must be made, which must go through several instances. First, it is proposed by the contractor, then it must have the approval of the inspection, then the supervisor, then the executing unit, and finally the minister. It must have no objection from the financial entity. The process is quite long and obviously, there must be money available to be able to execute the change. If the change only changes the deadline and not the budget, it is easier to be approved. Minor changes are easier to carry out, they can be made simply with an execution order or entry in the workbook.

    b. Did the project experience any changes (formal ones)?
    Yes, all works generally have modifying agreements. The contract never ends as it was plan.

    c. Did those changes follow the procedure?
    Not always. Many times, it is executed first and then the modifying agreement is carried out. It is a common practice but it is not ideal. Hence, the contractor may have problems getting paid for the changes made.

    d. Did that work? (If a has multiple answer, b, c, d also multiple answers)
    Yes, the only thing is that the process can take even more than a year if there is no budget availability.

    e. In which state of the project does this more often happen?
    In the middle of the project. In the beginning, you start to realize the issues, and in the middle, you start to manage the changes needed. Normally contractors

while managing a change continue working on other areas of the project that are not affected by the change.

f. Various authors categorize change based on its causes and types. Additionally, they contend that the three primary reasons for change orders can be broadly divided into three groups: design errors and omissions; design changes; and unanticipated circumstances.
    i. Do you recognize those?
    Yes, I agree.

    ii. Can you give me examples of them?
    Design errors and omissions: In civil work, the axis of the pillar did not coincide in reality with the plan. A boundary pillar was designed concentrically and had to be eccentric.
    Design changes: design change of an intersection of two routes. One was departmental and the other national, and the design was planned to be "t" shaped. But since the national route is of greater importance, it was given a curvature to give it priority over the other route.
    Unforeseen circumstances: Lately the rains have been heavier than normal, so in some projects we were forced to enlarge the gutters and storm drains.

    iii. How do you deal with them?
    First of all, it is to recognize what happened and look for a solution. Normally we look for more than one solution and choose the most convenient one. Normally a cost/benefit analysis is not carried out, we just choose the cheapest one.

    iv. Which one happens more often?
    Design errors and omissions by far. Then design changes and finally unforeseen circumstances

3. Changes without change orders
    a. Did the project experienced changes without a change order?
    Yes, normally they are executed first and then a modifying agreement is made.

    b. Give an example of one of those?
    In a road project, the sewage drain collapsed because it was undersized, the streets were filled with waste, and it was a disaster. A solution had to be found quickly and we didn't have the time for the whole procedure of a change order.

    c. How did you manage those?
    First of all, the technical financial analysis was carried out as usual and the file was passed to the financial entity. In this case, as it was a problem that needed a quick solution, the contractor was given the execution order before the financial entity gave it no objection. The contractor finished the work and then the financial entity gave it no approval, so 3 years have passed and the contractor still could

not collect. The government has to take care of the payment, but until today it has not done so.

In other changes, when they are minor, the agreements can be verbal or can be recorded in the workbook, but it is always a risk for the contractor to execute a job without having the change fully authorized, precisely because of what happened in the previous example, there is always the risk of not getting paid.

d. Did you make a change order afterwards?
In the case discussed, the work was carried out in the middle of the change order process. The change was rejected, but the change was already made. Since the government was the one that gave the order, it is the one that should pay for the change. The procedure was not followed due to the urgency of the problem.

e. What is the reason of that?
The procedure takes a long time and usually one is in a hurry. It is not convenient for the contractor to wait either because he has his people and equipment down, therefore it is not convenient for him to wait for the entire process. They prefer to execute when they have their people and equipment in place available and figure out how to get paid later. In most cases they end up getting paid. It is also a problem for the government/ministry, since interest is stipulated in the contract, therefore in the end interest ends up being paid. The interest is the normal one that is handled in the market.

f. Do you think there is a way to prevent it?
Perhaps doing a review of the plans and the construction site before starting the work. Normally the project is reviewed many times by different specialists, but there are always errors. Perhaps a paid thorough review of the contractor should be added to the contract, in order to propose justified changes from the beginning. In theory, it is something that the contractor has to do, but they don't take it that seriously. If there is that paid item and they come later to want to propose a change, it should be their responsibility and the change order process would not be needed.
Moreover, many of the changes arise from contractors because they want to make more money. Maybe they made a mistake in their budget and are seeking to correct that at the state's expense, hoping that the responsible officials will help them with it. And obviously, that's not right.

g. Another example same or differently?
On a road construction site in the interior of the country where it was a flood zone. We had many bridges and drainage systems (structures). Every day it rained it flooded and the work was stopped for days. We had a lot of changes to that project, especially the structures. It had a deadline of 12 months, financed by the World Bank. When it is a work of less than 1 year, the World Bank does not recognize readjustments. This work took 4 years, during which they could not readjust their prices.

h. In which state of the project does this more often happen?
In the middle of the project.

i. What were the causes?
In the second example, because it was a flood zone and the hydrological studies were not so current and it was a time in which the rainfall regime changed a lot. The drainage system could not cope. And in the first example because the change order took a long time.

4. Best practices
   a. How could the change order procedure be improved?
   The biggest problem is usually financing. That is where the change order procedure usually gets stuck, especially when it is with a local fund. With an international fund there is usually not so much problem. Perhaps you could have a percentage item of the project to cover the expenses of possible changes in order to speed up the process when they occur. Just as there is usually a contingency item.

      i. Who should be in the lead of such improvement?
      The vice minister of public works, for being an engineer and being in the operational part. The minister is also an engineer, but she focuses more on the political side.

      ii. What barriers do you foresee?
      Bureaucracy and the scarcity of local money. In many projects, there are only payments in a timely manner if the project has an external fund and there are delays if it has a local fund. If we add a percentage to address the changes, the budget problem would be bigger.

   b. What are good practices to treat changes without a change order?
   Perhaps when they propose a change that needs to be carried out quickly, at least it should be asked two or three specialists to verify the change. In this way at least confirm that the change is necessary. The biggest problem is when they make changes that are not necessary. Many changes that are avoidable make it seem like they are inevitable. Contractors do this so they can earn more money.

   c. Do you think the industry abuse the change orders?
   I don't know whether to use the word abuse, but I am sure that no project exists without some change order. Many times changes are necessary because projects already start with deficiencies.

   d. Do you think the industry abuse changes without change orders?

In this case, I could use the word abuse. Since it is so complicated to make a formal change, we make a lot of informal changes. Those of us who manage contracts have the responsibility of not making a change that is not necessary because we are subject to audit at any time. If they are unnecessary changes or with some double intention, the audit could realize it.

Interviewee 5

1. Interviewee background presentation
    a. What kind of company do you work for?
    Public entity, in the binational Yacyreta hydroelectric plant.

    b. In which type of project did you work?
    Binational coastal defense.

    c. How much experience do you have in managing construction projects?
    13 years of specific experience in construction project management, in addition to 30 years of general experience in the construction industry.

    d. How big was the projects in which you were involved? (Amount of time or money) How many employees were involved in the project/s?
    75 million dollars + 2.5 million dollars for the preparation of the executive project.

2. Changes with change orders
    a. What is the formal procedure to threat changes?
    First, inform the corresponding area about the change you wish to make. Second, order the corresponding modification by a service order and finally, submit by order note for approval. The process usually lasts approximately 1 week if they are minor changes and 1 to 2 months if they are large changes. Procedures are stricter and slower at the beginning of the work than as the work progresses.

    b. Did the project experience any changes (formal ones)?
    Yes.

    c. Did those changes follow the procedure?
    Yes.

    d. Did that work? (If a has multiple answer, b, c, d also multiple answers)
    Yes.

    e. In which state of the project does this more often happen?
    In the Middle and at the end.

    f. Various authors categorize change based on its causes and types. Additionally, they contend that the three primary reasons for change orders can be broadly divided into three groups: design errors and omissions; design changes; and unanticipated circumstances.
        i. Do you recognize those?
        Yes.

        ii. Can you give me examples of them?
        Design errors and omissions: not providing a retaining wall for an excavation.

Design changes: the design of the storm drain of a work was changed because new areas of influence from other communities were incorporated. Therefore, more drains had to be made and the diameter of the sewers expanded.

Unanticipated circumstances: the type of soil, sand banks, the social part of the project.

iii. How do you deal with them?
Making changes with additional projects approved accordingly.

iv. Which one happens more often?
Unanticipated circumstances.

3. Changes without change orders
   a. Did the project experienced changes without a change order?
   Yes and no, approval of the changes was always requested, except for unforeseen circumstances such as weather reasons, danger during work or some immediate need. In those cases you have to act quickly and then the change is regularized (then it is formally requested).
   There are other cases where authorized changes are made that were not in the contract, so the contractor cannot collect without formalizing the change. For example, in one project the construction company had 5 million dollars that they could not collect because they were not part of the initial contract.

   b. Give an example of one of those?
   The construction system of a coastal defense was changed. Initially it was going to be dry construction, but the water was rising, therefore, the construction system had to be changed. In this case, the same materials were used, only the quantity changed, therefore, it was a simple change. 100% of the original contract was charged and with the addendum the rest was charged.

   c. How did you manage those?
   If it is an existing item in the contract, it can be carried out and collected later with a correction of quantities in an addendum. When it is a new item it is more complex, it is also done through an addendum, but it takes more time. In the latter case, we exceptionally make compensation. We are looking for an item that is not going to be carried out yet in the project, one for example that is going to be used at the end of the work, let's call this item A. And the new item that must be carried out, due to some change in the project, let's call it B. The compensation consists of carrying out B and charging A. This is requested in writing, so the work is not delayed in this way, however, it is not the ideal. Later, when the addendum is approved, this is corrected, stating that A has not yet been done and that B has already been done.
   The changes are always analyzed and formal, everyone has notes, orders, etc., the only problem lies in the collection. The addendum is the one that formalizes the changes or the one that regularizes the quantities and prices of changes already made.

We also usually have an item that is civil construction in general per m3, therefore, when something is built, we calculate how much m3 it represents and update the m3 made and left over. It is a general item, so it is easier to collect. But in the same way all background information must be documented.

d. Did you make a change order afterwards?
The change process began before the change itself, but what usually takes the longest is finishing the entire process, especially in the financial part. Therefore, in these exceptional cases the formal change process normally begins, but before it is completed the change is already made.

e. What is the reason of that?
The entire process can take a long time.

f. Do you think there is a way to prevent it?
They could be foreseen, if they are not immediate changes due to necessity, however, these types are difficult to prevent.

g. Do you have another example?
In one building the contractor did not install hot water pipes to save money. They also did not install an air navigation antenna, but they corrected that omission later.

h. In which state of the project does this more often happen?
At the end of the project.

i. What were the causes?
I already answered before.

4. Best practices
   a. How could the change order procedure be improved?
   Maybe improve the speed of the process, especially at the end of the project.

      i. Who should be in the lead of such improvement?
      The contractor. They should constantly update their plans and quantities to be ready faster if a change arises.

      ii. What barriers do you foresee?
      The will of the contractor.

   b. What are good practices to treat changes without a change order?
   At least inform informally.

   c. Do you think the industry abuse the change orders?
   Of course they do, and it is for their own convenience. Most want to change the initial project. Change orders are used because with these proposed changes the project is more viable, it is cheaper to do it and they have the elements to do it. Many people apply for a tender and the first thing they do when they win the

tender is request changes. For example, they may be representatives or owners of a concrete or precast or pipe factory, and they use that to their advantage. It also happens that they do not verify the project before submitting to the tender, so then they request to change the project.

d. Do you think the industry abuse changes without change orders?
Yes, especially if the inspection is not efficient, since the contractor will always try to do things at his convenience and with as little work as possible.

Interviewee 6

1. Interviewee background presentation
    a. What kind of company do you work for?
    Private company, construction company specializing in structure since 2007.

    b. In which type of project did you work?
    They are always structural design. Houses, buildings, factories, reforms.

    c. How much experience do you have in managing construction projects?
    From the beginning, 16 years.

    d. How big was the projects in which you were involved? (Amount of time or money) How many employees were involved in the project/s?
    It varies, but normally in the technical part we are 5 professionals. The construction workers vary more, in a small project of a house they are generally from 7 to 10, in a building from 18 to 25, I generally handle several projects at the same time. In addition, there are outsourced teams for unusual jobs. Project times are as follows on average, a house 4 to 6 months, a building one month per floor. These times are only for the structural part.

2. Changes with change orders
    a. What is the formal procedure to threat changes?
    There isn't one. Generally, the client requests the change and the architect and I adapt the plans. If the change comes from us, we inform the client, but there is no formal procedure. If there is a contract, in some cases there is a clause that says that if the budget varies by x% of the original budget, another contract must be made or other processes must be followed (according to each contract). In most cases changes are verbal agreements, not written. They are only written if the client requests it and they are normally done simply to have a supporting document as to why the change was made.

    b. Did the project experience any changes (formal ones)?
    Yes. Normally the changes happen because the client wanted to change something. The architect changes the architectural drawing and sends it to us so that we can adapt the structure. The earlier in the project the easier to make changes. The changes do not usually come from our side, since we are the first to enter the worksite. When there are design changes after we have finished the structure, the first thing I do is check the structure with the new loads. Sometimes it happens that some material is not on the market and the design has to be adjusted with what is available on the market. Or when carrying out a reform one finds a problem that needs a solution to keep the work safe, these changes would be in the form of reinforcements. When there are design changes after we have finished the structure, the first thing I do is check the structure. Many times there is no need to change anything, because the structure has been designed with high safety coefficients and in other cases some reinforcement is placed. Normally the changes increase the budget, it is rare the case that the budget decreases.

c. Did those changes follow the procedure?
It does not apply in my case, since we do not work with a formal procedure.

d. Did that work? (If a has multiple answer, b, c, d also multiple answers)
We always reach an agreement with the client, considering that we are in charge of the structure and therefore the safety of the work. They cannot argue against a technical change that solves a safety issue or an unexpected situation.

e. In which state of the project does this more often happen?
The changes regarding the terrain logically at the beginning, while the changes by the client at the end, because only at the end can they visualize the work in reality, but the changes are difficult to apply because the project is already advanced. In other words, the former are unavoidable terrain surprise changes and the latter are normally avoidable design changes. In the middle of the project, there are usually not many changes.

f. Various authors categorize change based on its causes and types. Additionally, they contend that the three primary reasons for change orders can be broadly divided into three groups: design errors and omissions; design changes; and unanticipated circumstances.
    i. Do you recognize those?
    Yes.

    ii. Can you give me examples of them?
    Design errors and omissions: for example, the architecture team did not consider something and we realize it at the budget stage, therefore, it does not become a problem.

    Design changes: they are almost always made by the client in the final stage as we discussed before.

    Unforeseen circumstances: we have also already discussed this, they would be the soil problems that we found when we began the excavations

    iii. How do you deal with them?
    In all it is a matter of talking and reaching an agreement. In my field it is not very difficult because security is involved.

    iv. Which one happens more often?
    Design changes by the client in the final phase.

3. Changes without change orders
    a. Did the project experienced changes without a change order?
    Yes, but actually, in my case no change has a formal change order. There are the formal changes and the informal ones. The formal changes are the ones I discuss with the client, and the agreements are verbal. The informal changes are those

that I decide alone, as they are irrelevant to the safety and use of the structure or the ones that other people change without my authorization or without notice me.

b. Give an example of one of those?
It was a residence. I calculated and someone else built. The other person did not follow the plans and was not a structural engineer either. He was a builder who had a lot of experience but he did it by repetition, without doing calculations and trying to do it cheaper.

c. How did you manage those?
They called me for an emergency, they were desperate. In these types of cases, money no longer matters. We had to reinforce and we managed to save the structure.

d. Did you make a change order afterwards?
No, I only delivered the updated structural drawing.

e. What is the reason of that?
The client did not work that way, they do not have an established procedure for changes.

f. Do you think there is a way to prevent it?
It is difficult to predict the availability of construction materials. And in my profession, this variable is the most responsible for informal changes. In the first example, the client could have avoided the problem, he should have hired me for the construction or another professional, since he used my calculations and hired an irresponsible construction builder.

g. Do you have another example?
Other examples would be minor changes to the project. In my area it may happen that there is a shortage of a certain type of rod. Instead of putting a certain number of rods of a certain diameter, I put more or less of another diameter. Or I change the material, a beam that was going to be made of concrete, I finally put a metal one. If the beam is smaller there is no problem, a problem would be if the change is to a larger beam. And the change in material does not affect the aesthetics either because they are generally hidden. In other words, they are usually commercial changes that do not affect the safety or use of the work.

h. In which state of the project does this more often happen?
At any stage, as they must be something minor and not dangerous and can happen at any time.

i. What were the causes?
I already answered that. Material market shortage and others that have not followed my structural drawing to make it cheaper.

4. Best practices

a. How could the change order procedure be improved?
   It does not apply in my case, because the changes are normally requested by the client and we resolve them verbally.

   i. Who should be in the lead of such improvement?
      It doesn't apply in my case either, but in a large company, it should be the owner or general manager, since is the one who sees all the departments of the company.

   ii. What barriers do you foresee?
      Time and money. Analysis is required to see where and how it can be improved.

b. What are good practices to treat changes without a change order?
   In my case, it helps to have experience to be able to solve a lack of materials in the local market and, as always, first analyze the change from a safety point of view. You always have safety first, then look at aesthetics versus economics.

c. Do you think the industry abuse the change orders?
   Not in my area, since safety depends on our work, but I do believe there are many changes in the other areas of construction.

d. Do you think the industry abuse changes without change orders?
   Again, not in my area, but it's hard to know, because only the one who makes changes without change orders knows they did it.

Interviewee 7

1. Interviewee background presentation
    a. What kind of company do you work for?
    Independent professional and consultant. My clients are from both the private and public spheres. Furthermore, I am a university professor.

    b. In which type of project did you work?
    Housing and cultural heritage.

    c. How much experience do you have in managing construction projects?
    Since 2010 in management of more complex projects, before that they were simpler projects.

    d. How big was the projects in which you were involved? (Amount of time or money) How many employees were involved in the project/s?
    Restoration of the historic Sapucai railway station and the creation of a museum, the budget was 2 million dollars. The construction company had approximately 20 employees.
    Restoration of the historic port of Asunción with a budget of 4 million dollars and 70 workers.
    Restoration of the development banks of Villa Rica and Pilar, 20 workers in each site.

2. Changes with change orders
    a. What is the formal procedure to threat changes?
    In a public work, either the contractor or the inspection can propose a change in the project. Inspection presents these changes to supervision. Supervision makes the necessary verifications to approve or reject the proposed change. The process usually takes 15 to 30 days.
    In a private work, the process is usually more dynamic, because the owner participates more directly in the work.
    In conservation projects, it is usually stated that they are open projects that are subject to changes in relation to the findings that may arise in the process.
    Apart from the changes, compensations are also made, which are easier. Compensation refers to the act of performing one job in exchange for another so as not to modify the budget of the work.

    b. Did the project experience any changes (formal ones)?
    Yes.

    c. Did those changes follow the procedure?
    Yes.

    d. Did that work? (If a has multiple answer, b, c, d also multiple answers)
    Yes, it just takes longer than necessary sometimes.

    e. In which state of the project does this more often happen?

An important moment is at the beginning of work when the work is taken from graphics to reality, where adjustments are normally made. In the middle of the project, there may be changes caused by the initial changes. In the end, there are usually no changes.

f. Various authors categorize change based on its causes and types. Additionally, they contend that the three primary reasons for change orders can be broadly divided into three groups: design errors and omissions; design changes; and unanticipated circumstances.

   i. Do you recognize those?
   Yes.

   ii. Can you give me examples of them?
   Design errors and omissions: In one project, a tender was called without having the intervention project, there was only the protocol. The form did not reflect the actions that had to be carried out. The site of the work had been modified, the Paraguary-Villarrica route was just carried out. The route separates the land and passes very close to the warehouse that was to be restored. There was only the road and not the sewer works, so the place flooded. Nor was it considered that there was a superficial water table. Therefore, the project completely changed what the protocol established.
   In this case, since the project changed so much and many changes had to be made, there was a lot of management work. Furthermore, the financing entity was the Japanese Government and they are very strict. Since the budget was not going to be enough, the Ministry of Public Works had to be involved (which was in charge of managing the money), the Japanese Embassy and the provincial government, which was involved to complete the missing budget.
   The procedure for calling for tenders for heritage assets is as follows. First, the national secretary of culture approves an intervention protocol. The intervention protocol is an investigation of an asset to know the characteristics and conditions in which the asset is located, in addition to offering guidelines for its conservation. Additionally, to the protocol, there must be a project that accompanies these protocol guidelines. The project must include the schedule, the forms, the technical specifications and other documentation.
   In this case, an agreement was made in which the national university was in charge of carrying out the project.
   The conservation area lacks of specific specifications. Basic documentation should be generated for the types of works and especially for heritage assets.

   Design changes: the construction site had a steeper slope than expected. First, filling in the land (leveling) was evaluated, but finally it was decided to take advantage of the slope in the project, so the design had to be changed.

Unforeseen circumstances: findings in conservation works. As in all conservation work, this situation is common. Many times it is already contemplated in the contract or modifying agreements are made or the discovery is documented and left as it was found for a future call for bids.
In the case of the port, for example, during the execution, a deteriorated and old concrete slab system and important cracks were found in the façade due to settlement of the building, which were of a structural nature. Therefore, they had priority in being approved for security and not to restore something without solving its structural problems, so that finally these structural problems lead to other major defects.

iii. How do you deal with them?
It was already answered in the previous question.

iv. Which one happens more often?
Errors and omissions by far. In my field there is a lot of deficiency in the development of projects, mainly due to lack of funds.

3. Changes without change orders
    a. Did the project experienced changes without a change order?
    Yes.

    b. Give an example of one of those?
    I was supervising a conservation project. In one project a special wall had to be built, named the Brazilian or Claustra bond. After several insistences to the contractor, they did not do the work and finally requested a change. Make a normal wall instead of special wall.

    c. How did you manage those?
    The change was accepted between the parties, the contractor made the change and then it was formalized in a modifying agreement

    d. Did you make a change order afterwards?
    Yes.

    e. What is the reason of that?
    The pace of the work is different from that of documentation management.

    f. Do you think there is a way to prevent it?
    Create a dynamic work environment between the parties involved in the project. Work on soft skills to avoid tensions, work in coordination and dialogue to achieve teamwork.

    g. Do you have another example?

In the private sphere it is not unusual for the architect to make a change and then notify the client. Architects usually justify these changes using relevant reasons, such as that the change was a necessary structural change.
It happened to me that in a project one of the architects was going to make a normal beam instead of an inverted beam. The formwork was ready and was about to be loaded with concrete. I arrived and was able to avoid the mistake and it was finally done as it should be done.
In another case, some bathrooms that should not have been demolished were demolished. Then new bathrooms had to be built. It was a loss for the contractor.

h. In which state of the project does this more often happen?
During execution. Due to the misinterpretation of the blueprints.

i. What were the causes?
They are usually inattention which causes errors.

4. Best practices
   a. How could the change order procedure be improved?
   Make it more dynamic and increase communication between the parties. When detecting a need to make a change to the project, inform immediately and begin the formal change process as soon as possible. Inform about the possibility of a change, hold a technical meeting, make a decision regarding the change, and then obtain approval of the change.

      i. Who should be in the lead of such improvement?
      Construction work is teamwork. All project participants must be part of the implementation of an improvement. Each participant must cooperate so that the change is dynamic. Anyone who detects the need for improvement should propose the improvement.

      ii. What barriers do you foresee?
      People's lack of will and commitment to work. Many people don't want to see that there is a problem, like an ostrich putting its head in the ground.

   b. What are good practices to treat changes without a change order?
   Hold work meetings to discuss possible minor changes to the work and leave the decision in writing in the minutes or in the workbook.

   c. Do you think the industry abuse the change orders?
   Yes. Many professionals or companies abuse the 20% budget increase allowed by law. They win a tender with low prices and when they win the tender they look for additional works to bill that extra 20%. It is not a good practice, it is unethical. For example, in a restoration work on a structure, the architect presented a modifying agreement requesting the recovery of 100 meters of paving stones in front of the work. This proposal did not make sense, since the change was outside the area of the work.

d. Do you think the industry abuse changes without change orders?
Yes, I think so. Since usually the documentation is not good in specifications and sheets, therefore this gives a lot of freedom to the contractor and their free interpretation of it. Therefore, due to this deficiency in the documentation, it is at the mercy of the contractor to do the best possible from his perspective or to abuse this lack of documentation and do what is best for him.
It is also difficult to stop the work for each change. Every project break represents a loss of pace and money, so many prefer to make an informal change so as not to interrupt the pace of work and not lose money.

Interviewee 8

1. Interviewee background presentation
    a. What kind of company do you work for?
    I am the owner of a construction company, most of the work I do is work for a private company that carries out works for a public entity. I was maintenance and infrastructure manager of a meat industry for 7 years. I have been teaching at the engineering university for 15 years.

    b. In which type of project did you work?
    Electrical installations, structural calculation consulting, building design, industrial assembly, building restoration.

    c. How much experience do you have in managing construction projects?
    40 years.

    d. How big was the projects in which you were involved? (Amount of time or money) How many employees were involved in the project/s?
    A relevant example from my beginnings is a greenhouse for Shell which sought the production of one and a half million plants per year. It had one and a half hectares of construction. The budget was $400,000 at the time.
    Another example is when working in the refrigerator. 6 people worked to carry out the project and 150 people worked on the execution.
    Those for restoration were the López palace and the historic port of Asunción, both with a budget of 4 million dollars.

2. Changes with change orders
    a. What is the formal procedure to threat changes?
    It depends on the project, but it is usually the same procedure with some differences. You must have documentation and justification to be able to make changes in all cases. In the case of an international tender, the financing entity is the one that approves the changes; If it is national, there is a public procurement law that regulates the change to 20% of the contract budget. The difference is that the documentation for an international entity is more demanding than for a national entity. If the international entity is level 10, the national one is level 6 or 7.

    b. Did the project experience any changes (formal ones)?
    The majority suffer changes, because a good executive project is not carried out.

    c. Did those changes follow the procedure?
    Yes.

    d. Did that work? (If a has multiple answer, b, c, d also multiple answers)
    I already had a requested change rejected, but with the corrections it was finally accepted. But there were projects that were canceled because a good executive project was not made and an agreement was not reached to make the changes.

    e. In which state of the project does this more often happen?

In all phases, but usually in the middle.

f. Various authors categorize change based on its causes and types. Additionally, they contend that the three primary reasons for change orders can be broadly divided into three groups: design errors and omissions; design changes; and unanticipated circumstances.

   i. Do you recognize those?
   Yes.

   ii. Can you give me examples of them?
   Design errors and omissions: the case of the Metrobús that is public knowledge. The company that won the tender was in charge of the design and construction, but the project did not contemplate drainage works, electrical works, etc. Therefore, they did not take that into account and then the design had to be changed to be able to carry out the project, but unfortunately, they no longer reached an agreement.
   In a restoration project, the design contemplated placing an elevated water tank. This should never be placed in a historic building, because it is difficult to know the true condition of the structure. In this case, it was considered a design error and we had to redesign the tank and place it underground.
   Another example is a duplex (a two-story home). I was hired to build but with another engineer's structural design. I realized that the footing was undersized, but the owners preferred to follow the original plan. In this case there was no design change, but there was a structural calculation error.

   Design changes: in a restoration project for a church in the interior of the country, I changed the construction process. The bases, which were made of concrete, had to be demolished, but that was going to affect the church due to vibrations, so I changed to another method to avoid that problem.
   Another example would be in another restoration work. A ceiling needed to be demolished and replaced with a new one. When demolishing, ceramic tiles were found, so it was decided to restore them and leave them visible, without a ceiling. In the same work, the removal of the old roof sheets was contemplated; in the end, they were not removed and the new ones were placed directly on top of the old ones.

   Unforeseen circumstances: this is quite common in restoration, but not so much in new construction. For example, in the López palace, our work was basic maintenance and painting, but while on site we found structural problems in the building, so change was resorted to solve the problem.

   iii. How do you deal with them?
   I already answered that in the previous question.

iv. Which one happens more often?
Design errors and omissions. Perhaps because in the design stage the lowest price normally wins, quality-price is now beginning to be used as well.

3. Changes without change orders
    a. Did the project experienced changes without a change order?
    Yes, but normally they are changes in which there is no representative change in the budget. They are minor changes, but they are reported and approved anyway. They can be from both parties, or a customer order or a contractor order.

    b. Give an example of one of those?
    Increase in the section of a pillar.
    Another example, an excavation was being carried out with a backhoe to create the foundation of a work, it should have been footings, but an existing drainage system was found that was not known to exist. The foundation system had to be changed, because it was starting to flood. So we had to act at the moment. In other words, a problem arose, the design was changed, the change was made and then it was reported.

    c. How did you manage those?
    If it is an urgent change, I make the change and then report. If it is an error, it is corrected, especially in restoration works. Many times a verbal agreement is reached, the change is made and then it is regularized with a modifying agreement.

    d. Did you make a change order afterwards?
    In some cases.

    e. What is the reason of that?
    In big changes to formalize them.

    f. Do you think there is a way to prevent it?
    Improving the executive project or taking into account unforeseen events.

    g. Do you have another example?
    It's not personal, it happened to a fellow calculator. The work was a theater. He was carrying out the design and calculation, but he did not finish it, the specifications of the steel rods were not there. The contractor finished drawing that work and the slabs ended up falling, which were large, 19m x 19m. The steel rods (16mm diameter) were attached to one-fifth of the span and were not locked. They didn't have stirrups either.
    Another non-personal example is that in a construction site they made a floor without a subfloor to reduce costs.

    h. In which state of the project does this more often happen?
    In all stages.

i. What were the causes?
I already answered that.

4. Best practices
   a. How could the change order procedure be improved?
   The procedure itself is fine, it just can take a long time, especially with a public entity. In other words, it could be found a way to speed up the process.

      i. Who should be in the lead of such improvement?
      The client. If it is with the state, I think it should be the technical planning secretary.

      ii. What barriers do you foresee?
      If it is with the state, the bureaucracy.

   b. What are good practices to treat changes without a change order?
   I think there should be a regulation. Let the change procedure favor execution as long as it does not imply many changes in the final result of your work or a higher cost. I think it's a matter of making a better procedure.

   c. Do you think the industry abuse the change orders?
   Some do abuse changes to optimize costs.

   d. Do you think the industry abuse changes without change orders?
   The same answer as the previous one. Some abuse changes without change orders to optimize costs.

Appendix 3: Rearranged interviews by themes

Each interview is divided in four themes. First, the presentation of the interviewee; secondly, their knowledge and opinion about the changes with change orders, in other words, the formal changes of the projects; thirdly, their knowledge and opinion about the changes without change orders, in other words, the projects deviations, which are the main topic of this research; and lastly, their opinion about practices of the industry regarding changes in projects and how to improve them.

The second theme is divided into three parts, whereas the last one is related to the theory as follows; various authors categorize change based on its causes and types. Additionally, they contend that the three primary reasons for change orders can be broadly divided into three groups: design errors and omissions; design changes; and unanticipated circumstances. The interviewees were asked if they recognized them and to give examples.

Length variation exists between the answers of the interviewees. The causes may be their character, their time availability during the day of the interview, their experience, their specific knowledge of the phenomenon, their openness to talk about the subject, etc. In the next chapter analysis of them are made.

They are first divided by company type, public or private, and then sorted in chronological order according to the interview dates. Each of them received a number instead of their name in order to maintain their privacy.

4.1 Interviewee number 1

4.1.1 Interviewee background presentation

He initially worked in a private company and later transitioned to a public entity, where he primarily supervised road construction projects. He is a road manager at the Ministry of Public Works and is the chief of the other three interviewees from the Ministry. He has 2 years of experience in managing construction projects. The projects he was involved in typically had budgets of around 10 million dollars each and employed between 300 to 400 people.

4.1.2 Changes with change orders

4.1.2.1 Procedure

The contractor presents the modification agreement to the ministry, where it undergoes initial review, especially if an inspection team is involved. After this, the executing unit examines and corrects any errors. It then progresses through various internal departments, such as legal affairs and internal audit, before reaching the minister for final approval. The process may vary depending on the financing entity, with external financiers typically requiring more thorough scrutiny, leading to a lengthier process.

4.1.2.2 Personal experiences

Every project undergoes changes, managed through the established procedure and in compliance with Law 2051, which stipulates that changes may account for up to 20% of the budget. These changes occur at various stages of the project lifecycle. Reviews and adjustments typically commence even before the project initiation. Changes are frequently proposed by the contractor during this phase. Similarly, they are commonplace in the middle stages of the

project. Towards the project's conclusion, they are less frequent, often limited to quantity adjustments.

4.1.2.3 Personal opinion related to theory of change orders

He identified the three primary causes of change orders based on existing literature and provided examples for each. He emphasized that these causes share similar occurrence rates and are managed uniformly. Options are carefully assessed, and the most suitable one is selected, adhering to the prescribed procedure.

Design errors and omissions: These typically involve inaccuracies in topographical data. Often, stakes used for leveling references are misplaced or lost, leading to errors in quantity estimates.

Design changes: These changes are commonly implemented to enhance project outcomes and efficiency.

Unforeseen circumstances: Examples include underestimating traffic volume when planning road construction. For instance, an unforeseen surge in traffic due to private investments, as observed in the northern region of the country, can necessitate adjustments.

4.1.3 Deviations

4.1.3.1 Deviation recognition

He had never experienced any type of deviation. The regulations and procedural norms explicitly forbid any unauthorized change. Any departure from these guidelines carries the potential risk of the contractor not receiving payment for the completed work. Hence, certain subsections remain vacant as they are not applicable.

4.1.3.2 Examples

He abstained from offering examples as he has not personally encountered any deviations.

4.1.3.3 Deviation management and prevention

He did not have any experience in this topic.

4.1.4 Industry reality and best practices

4.1.4.1 Industry reality

He believes that the industry typically uses change orders to enhance projects rather than exploit them. Nonetheless, there's room for improvement by consolidating multiple changes into fewer modifying agreements, such as condensing three agreements into one. As for the abuse of mitigations in the industry, he couldn't provide insights as he's not acquainted with such practices.

4.1.4.2 Change orders

Collaboration from the outset among all stakeholders can expedite procedures significantly. Not only does this streamline the processes themselves, but it also prevents potential disagreements between parties further along in the change order process. Within his department, each director should take the lead on such improvements, as it is an internal process. Consequently, there are no inherent barriers, with the successful implementation contingent upon the initiative of each director.

4.1.4.3 Deviations

Again, he refrained from offering an opinion on this matter, given his lack of prior experience with the subject.

4.2 Interviewee number 2

4.2.1 Interviewee background presentation

She works for a public company, primarily focusing on roadway projects, including bridges. With a total of 7 years of experience in construction projects, she spent 3 years as a structural engineer in the private sector and 4 years in project management in the public sector. Projects in the private sector typically involved 20 to 30 workers, while in the public sector, around 150 workers are involved. The budget for the current project is $150 million, with her specific work package accounting for $40 million. The expected duration for her work package is 30 months.

4.2.2 Changes with change orders

4.2.2.1 Procedure

The initiation of changes is primarily the responsibility of the contractor or the inspection team. These changes need to be well-documented and thoroughly analyzed. It's essential to formalize these changes promptly, except for adjustments in work quantities, which can be formalized later through a modifying agreement. Ideally, changes should be fully formalized upfront, including approval from the financing entity, before the execution order is given. Changes can be categorized into two types: those altering the project's scope and those that don't. Changes affecting the project's scope involve more bureaucracy, especially when dealing with the financing entity, so efforts are made to minimize such changes.

4.2.2.2 Personal experiences

She encountered a plethora of changes, typically occurring at the project's outset to rectify design flaws and towards the project's conclusion, albeit usually involving just quantity adjustments to regularize completed work. These changes typically adhere to the change order protocol, potentially due to the absence of urgency in advancing the project. However, if the requested changes had caused project delays, the contractor might have pressured them to proceed with the work without the modified agreement being finalized.

For instance, at the project's inception, before initiating bridge construction, a decision was made to relocate the bridge. The inspection team initiated discussions and proposed altering the bridge's location before the contractor's involvement. This process took 20 months. While other changes, such as changes in quantities or bridge superstructure, didn't impede progress.

4.2.2.3 Personal opinion related to theory of change orders

She identified the three primary causes of change orders based on existing literature and provided examples for each. Design errors and omissions happen more often. Projects tend to be poorly done, and poorly planned. Moreover, if the project is well designed, the other two change order cases will also decrease. Secondly, unknown circumstances, and lastly design changes.

Design errors and omissions: a road construction project within a city encountered an oversight regarding the replacement of pipes, specified in the contract but omitted from the plans and budget. The rectification was readily accepted given its contractual obligation.

Design changes: an intersection improvement initiative was implemented.

Unforeseen circumstances: during a road construction project when a community water tank was discovered along the route, not accounted for in the original design. This unanticipated obstacle necessitated relocating the tank to ensure the community's water supply, the road

project design was finalized in 2015, at which time the existence of the water tank was not accounted for. However, sometime between 2015 and 2023, the water tank was constructed without updating the corresponding road project plans, underscoring the need for project plans to adapt to evolving realities over time.

4.2.3 Deviations

4.2.3.1 Deviation recognition

She mentioned facing deviations during the execution phase, albeit minor ones, mostly concerning adjustments in quantities. These deviations tended to occur midway through the project.

4.2.3.2 Examples

Mistakes within the project plan and the inherent complexity of road projects often result in fluctuations in quantities. Contractors sometimes need to proceed with tasks for which they've already been compensated, and then submit a request for payment afterward. However, this poses a risk as there's no guarantee of receiving payment. The process involves the contractor submitting a variation of quantities, triggering the formal procedure of modifying agreements to determine if the financing entity approves the request.

4.2.3.3 Deviation management and prevention

Following the implementation of the change, she did initiate a change order process. However, due to its prolonged duration, which typically spans around three months, work cannot afford to be halted during this period. In her field of expertise, road construction, she finds it challenging to prevent such situations. This is because roadwork calculations are heavily dependent on assumptions regarding existing and required materials, which are influenced by unpredictable terrain variations.

4.2.4 Industry reality and best practices

4.2.4.1 Industry reality

She believes that the industry tends to abuse change orders. Contractors often secure contracts with exceedingly low bids, leading to unrealistic pricing. Consequently, they may seek to substitute certain items to reduce costs and increase profits. Moreover, in cases of changes in quantities, the unit cost remains unchanged, prompting contractors to substitute the item itself to establish new prices.

However, she holds a more cautious view regarding deviations. While she acknowledges that other sectors may exploit them, she maintains that her department handles changes without formal change orders strictly. There are existing records indicating that such changes are not compensated.

4.2.4.2 Change orders

One potential enhancement to the existing change order process could involve providing more detailed and specific documentation to the financial entity. This may expedite their evaluation process and minimize the need for additional data requests, streamlining the overall procedure. Enhancing clarity and efficiency across all involved parties' processes could contribute to faster approvals.

Implementing this improvement would ideally require collaborative decision-making among representatives from each party. However, a notable barrier to this endeavor is the prevailing idiosyncrasy, whereby individuals may exhibit resistance to change and improvement efforts.

4.2.4.3 Deviations

Without adhering to the formal agreement procedure, there are no established best practices for managing changes. One potential approach could involve initially reaching an informal agreement and subsequently formalizing it through the proper channels.

4.3 Interviewee number 3

4.3.1 Interviewee background presentation

She currently works in a public company, having previously been employed in a private company. Her experience encompasses various project types, including buildings, roads, high voltage works, and telecommunications. She holds a decade of experience in managing construction projects. The projects she was involved in varied in size and budget. For instance, a waterfront project had a budget of 82 million dollars, while a road project had a budget of 26 million dollars.

4.3.2 Changes with change orders

4.3.2.1 Procedure

Their procedures are dictated by the national Law 2051, internal ministry protocols, and Mercosur regulations, particularly when the project is financed by a foreign entity. Typically, the contractor submits supporting documentation for a change request to the inspection, requiring technical justification for approval. The timeline or modifications to contract conditions may vary. Following inspection approval, the process transitions to the ministry for a reevaluation of technical aspects, consultation with the financing entity, and obtaining a no-objection. Subsequently, the ministry continues the process, conducting legal, financial, contract review, and audit analyses. After internal ministry scrutiny, the modifying agreement is signed and forwarded to the National Directorate of Public Procurement. The finalized modifying agreement is then published, marking the conclusion of the process. Minor changes, however, can be easily requested through the Construction Log Book.

4.3.2.2 Personal experiences

She encounters numerous modifications in her projects, with a higher frequency observed at the project's inception. In one particular project, a substantial change occurred, transitioning from a tunnel design to that of a viaduct. The management of change orders may face complications, often entangled in bureaucratic processes, especially within the financial domain. This bureaucratic hurdle could potentially lead to the rejection of a change request. On one occasion, a change was not accepted by the financing entity, necessitating the government to bear the associated costs. Introducing changes within a project is inherently challenging, requiring a meticulous process. The financial entity approaches projects in a distinct manner compared to their internal procedures, displaying a less cooperative attitude towards change management.

4.3.2.3 Personal opinion related to theory of change orders

She identified the three primary causes of change orders based on existing literature and provided examples for each. All three have the same occurrence, perhaps unforeseen circumstances are the ones that occur less frequently. In addressing them, all are handled differently, the following is just an example. A general review is carried out, which involves doing all the studies again, topographical, geotechnical, hydrological, and hydraulic. Once the project is adjusted, the modifying agreement can be requested.

Design Errors and Omissions: In one instance, the geodetic point used as the project's origin was not found. Attempts to layout the project from a known point led to a significant displacement of the axis from the planned position, resulting in misalignments and discrepancies in contractual quantities. Another example involved two bridges on the verge of collapse, which were overlooked in the new project.

Design Changes: A tunnel project had to be altered due to the presence of a crucial water supply pipeline. Instead of relocating the costly adductor, the design shifted from a tunnel to a viaduct, extending into an area of the city's botanical garden.

Unforeseen Circumstances: Reactions from residents in the project area, chaining themselves to trees to prevent deforestation, exemplify unexpected challenges. Municipal demands beyond project plans and complications arising from the ministry's inability to meet them also impede project progress. Additionally, the pandemic serves as another unforeseen circumstance.

4.3.3 Deviations

4.3.3.1 Deviation recognition

Typically, changes are implemented through change orders, but some did experience changes without a change order, although they were infrequent, for instance, due to the pandemic. Regarding the state of the project where this occurs more often, she cannot provide a specific comment because she did not experience it enough.

4.3.3.2 Examples

During the pandemic, the government mandated the continuity of public works. A notable example is the viaduct project previously discussed, where the contractor requested a change in 2018. However, it wasn't until 2020 that the decision to proceed with the alteration was made, bypassing formal approval processes. Managing such situations proved challenging, especially when the financing entity disagreed with the proposed changes. Nevertheless, the work proceeded without formal approval, with the government eventually assuming financial responsibility.

Another scenario involves material variations due to unavailability. In one project, a specific material required was not locally accessible, prompting the search for a suitable substitute. To validate this change, additional studies were commissioned, deviating from the initial technical specifications. Positive laboratory results meeting international standards supported the substitution, leading to its documentation in the Construction Log Book.

These challenges stemmed from bureaucratic constraints, disagreements with the financing entity, and the unavailability of originally specified materials.

4.3.3.3 Deviation management and prevention

She did not a change order afterwards, because it was an unfinished change order. In her experience, to prevent this kind of situation, the goal wouldn't necessarily be to minimize the changes themselves, but rather to streamline the cumbersome bureaucracy associated with change orders. Accelerating the process of change orders could effectively mitigate the occurrence of changes without proper authorization.

4.3.4 Industry reality and best practices

4.3.4.1 Industry reality

She does not believe the industry abuses the change orders or deviations, however, she does believe that there is a flaw in the design and planning of the projects, which is why they later need corrections with the change orders.

4.3.4.2 Change orders

One potential solution that comes to mind is to streamline bureaucratic procedures. Currently, the process for modifying agreements often exceeds the expected duration, spanning from three months to over a year. One suggestion could be to establish dedicated technical teams

within the financing entity for each project. These teams would closely monitor the project's progress and provide support for necessary changes.

As for leadership in implementing this improvement, she suggested that perhaps the ministry could take the lead. However, she acknowledged potential barriers, such as the financing entity being a separate institution that operates independently from the ministry. While the ministry can propose such changes, ultimate decision-making authority may lie with the financing entity.

4.3.4.3 Deviations

It's crucial to ensure there's always documentation detailing what occurred and obtaining agreement from all involved parties.

4.4 Interviewee number 4

4.4.1 Interviewee background presentation

She is a manager in a public company, specifically in the ministry of public works. She has fifteen years of experience, in which she worked on building projects, roads, water supply, mostly in contract management.

The last projects in which she was involved were quite large (from her perspective or should I categorize the projects?), with a budget of 100 million dollars each. All three were road projects. In this type of work, the contractor normally employs more than 100 people and they employ approximately 20.

4.4.2 Changes with change orders

4.4.2.1 Procedure

Law 2051 and regulatory requirements from financial entities mandate strict adherence to their prescribed procedures. Initiating any change necessitates the formulation of a modification agreement, a process subject to various approval stages. Initially proposed by the contractor, the modification must secure approvals from the inspection, supervisor, executing unit, and ultimately, the minister. Additionally, it must receive a no-objection status from the financial entity. The entire process is time-consuming, and contingent on the availability of funds for implementation. Changes affecting only the project timeline, without impacting the budget, are comparatively more straightforward to obtain approval. Minor modifications are simpler to implement, often requiring only an execution order or entry in the project workbook.

4.4.2.2 Personal experiences

In most construction projects, adjustments through modification agreements are a common occurrence. It is rare for a project to unfold exactly as planned without any change. Although the procedure is generally favorable, there are occasions when it can become lengthy, lasting over a year, particularly in the presence of budget constraints.

Change orders are more frequently encountered during the middle phase of a project. This trend arises from the fact that, at the project's outset, issues start to be apparent, and it's during the middle stage that necessary adjustments start to be carried out. Contractors typically navigate changes while concurrently progressing with work in project areas unaffected by the changes.

4.4.2.3 Personal opinion related to theory of change orders

She identified the three primary causes of change orders based on existing literature and provided examples for each. In addressing changes, her initial step involves recognizing the issue and searching for a solution. Typically, they explore multiple solutions and opt for the most convenient one. Rather than conducting a cost/benefit analysis, the preference is usually for the most economical option. She emphasized that design errors and omissions are overwhelmingly the most frequent reasons for project changes, followed by design changes, and finally, unforeseen circumstances.

Design Errors and Omissions: In a civil project, the actual axis of the pillar did not align as intended in the plan. A boundary pillar, initially designed concentrically, had to be altered to an eccentric configuration.

Design Changes: A modification in the design involved an intersection of two roads, one being departmental and the other national. The initial plan depicted a "T" shape, but given the greater significance of the national route, it was curved to prioritize its importance over the other route.

Unforeseen Circumstances: Due to unusually heavy rainfall, certain projects necessitated the expansion of gutters and storm drains to cope with the increased water flow.

4.4.3 Deviations

4.4.3.1 Deviation recognition

The described process for handling change orders isn't consistently followed, leading to deviations in projects. Typically, changes are made before formalizing a modification agreement, which is widely practiced but not considered ideal. This poses risks for contractors who may not be compensated if the agreement is rejected. Despite the procedure generally being favorable, this procedure can become lengthy, sometimes exceeding a year, especially in cases of budget constraints. These alterations predominantly take place during the middle phase of the project.

4.4.3.2 Examples

In a road project, a crisis emerged when the undersized sewage drain collapsed, causing streets to be filled with waste. A prompt solution was imperative, and there wasn't time for the entire change order procedure. Despite the customary technical and financial analysis, the urgency led to the contractor receiving an execution order before obtaining a no-objection from the financial entity. The work was completed swiftly, but the financial entity did not approve. Three years have passed leaving still the contractor unpaid. The responsibility for payment falls on the government, but as of the day of the interview, it remains unresolved. This instance highlights the prolonged duration of the change order process.

In another scenario, a road construction project in a flood-prone area with numerous bridges and drainage systems faced constant interruptions due to rain-induced flooding. The project, financed by the World Bank with a 12-month deadline, encountered numerous changes, particularly related to structures. Despite taking four years to complete, the project could not avail of price readjustments due to the World Bank's policy for works lasting less than a year. The primary cause in this case was the outdated hydrological studies for the flood zone, coupled with significant changes in rainfall patterns.

Regarding minor deviations, agreements may be verbal or documented in the workbook. However, executing a job without full authorization poses a risk for the contractor, as exemplified by the first case; there is always the risk of not getting paid.

4.4.3.3 Deviation management and prevention

In the initial case discussed, the work proceeded in the middle of the change order process, however, this was rejected after the work had already been executed. Given that the government issued the order, it was their responsibility to cover the costs associated with the change. The procedure was not followed due to the urgency of the problem.

Such situations are not uncommon due to the lengthy duration of the procedure, often necessitating quick actions. Contractors find it inconvenient to wait, considering the downtime for their personnel and equipment. Consequently, they choose to proceed with the work and deal with payment matters later, a practice that often results in eventual payment. This approach poses challenges for the government or ministry as contract stipulations include interest payments, contributing to additional costs. The interest rates typically align with market rates.

One potential way to prevent deviations is to conduct a comprehensive review of plans and the construction site before commencing work. Although projects undergo multiple reviews by various specialists, errors persist. Introducing a paid thorough review by the contractor into the contract could be considered, allowing for justified change proposals from the project's outset. While this responsibility theoretically lies with the contractors, they do not take it that seriously. If a paid review is included in the contract and the contractor later proposes a change, it becomes their responsibility, potentially eliminating the need for the change order process.

It's worth noting that some deviations originate from contractors seeking additional profits. In cases where budgeting mistakes have been made, contractors might attempt to rectify the situation at the state's expense, often relying on the assistance of responsible officials. Such actions are ethically questionable and go against the principles of fair practice.

4.4.4 Industry reality and best practices

4.4.4.1 Industry reality

She expressed uncertainty regarding the abuse in change orders but asserted that practically every project involves some form of change order. Frequently, these changes become imperative due to inherent deficiencies at the project's initiation. Conversely, she didn't hesitate to affirm that the industry tends to abuse deviations. Given the complexity of formal change processes, informal changes become more prevalent. Those responsible for contract management bear the duty of refraining from unnecessary changes, as they are susceptible to audits at any given time. Any unwarranted changes or those with potential ulterior motives could be flagged during an audit.

4.4.4.2 Change orders

When the progression of a change order procedure encounters obstacles, it often gets entangled in the financial domain, particularly when dealing with local funds. Conversely, with international funds, such hurdles are usually less prevalent. She proposes that to expedite the process during unforeseen changes, projects could allocate a percentage of the budget specifically for handling potential changes, similar to the contingency fund. The lead for implementing this particular enhancement should rest with the vice minister of public works, given their engineering background and operational focus. Although the minister is also an engineer, her emphasis lies more on the political aspects. There are, however, certain barriers to this proposal, namely bureaucratic challenges and the limited availability of local funds. In numerous projects, timely payments are assured only when backed by external funding, while those relying on local funds often face delays. Introducing a percentage to address changes could exacerbate budgetary constraints.

4.4.4.3 Deviations

When there is an urgent need for a quick change, leading to a deviation as the only viable solution, it might be beneficial to seek input from two or three specialists to validate the necessity of the change. This approach ensures a confirmation that the alteration is indeed essential. The primary challenge arises when changes are made unnecessarily. Often, avoidable changes are manipulated to appear inevitable, a tactic employed by contractors seeking to increase their earnings.

4.5 Interviewee number 5

4.5.1 Interviewee background presentation

He works for a public entity, specifically at the binational Yacyreta hydroelectric plant. His experience spans 13 years in managing construction projects, complemented by 30 years in the construction industry overall. The projects he has been involved in have varied in scale. Currently, he is working on a binational coastal defense project with a budget totaling $75 million, along with an additional $2.5 million allocated for the preparation of the executive project.

4.5.2 Changes with change orders

4.5.2.1 Procedure

The formal procedure to address changes involves three main steps. Firstly, the change must be communicated to the relevant department. Next, a service order is issued to initiate the necessary changes. Finally, a formal request for approval is submitted via an order note. The duration of this process typically ranges from one week for minor changes to one to two months for larger ones. Additionally, procedures are generally more stringent and time-consuming at the outset of the project compared to later stages.

4.5.2.2 Personal experiences

The project experienced formal changes, and they followed the procedure effectively. This typically occurs in the middle and towards the end of the project.

4.5.2.3 Personal opinion related to theory of change orders

He identified the three primary causes of change orders based on existing literature, unforeseen circumstances emerge as the most prevalent cause. Each change is meticulously evaluated, and the most appropriate course of action is chosen, in line with established protocols. He manages these changes by obtaining additional project approvals. Here are examples of each scenario:

Design errors and omissions: Failure to include a retaining wall for an excavation.

Design changes: Adjusting the storm drain design to accommodate newly incorporated areas of influence from neighboring communities, necessitating additional drains and expanded sewer diameters.

Unforeseen circumstances: Factors such as soil type, sand banks, and social considerations impacting the project.

4.5.3 Deviations

4.5.3.1 Deviation recognition

The project experienced changes without a formal change order in certain situations, such as unforeseen circumstances like inclement weather, imminent danger during work, or urgent needs. In these instances, immediate action is required, and the change is subsequently formalized. Additionally, there are authorized changes made outside of the contract terms, requiring formalization before the contractor can receive payment. The deviations are more common towards the end of the project.

4.5.3.2 Examples

In one project, the construction company encountered a situation where they had $5 million that remained uncollected because it wasn't specified in the original contract. Although the change was authorized, it lacked formalization through a change order.

Another instance involved a deviation in the construction method of a coastal defense system. Initially planned as dry construction, it had to be adapted due to rising water levels. Despite this deviation, the materials remained the same; only the quantity was adjusted, making it a straightforward alteration. The billing for the entire original contract was completed, with the additional amount covered in an addendum.

If a change involves an item already specified in the contract, it can be carried out and invoiced later by adjusting quantities in an addendum, essentially representing an increase in quantity. However, if it introduces a completely new item, the process becomes more complex and time-consuming. In such cases, compensation might be granted as an exception. This involves identifying an item not yet implemented in the project, for example, item A, and using it as a basis for accommodating the new item necessitated by project changes, referred to as item B. The compensation involves executing item B while billing for item A. This request is formalized in writing to prevent any delays in the work, although it's not considered the most ideal solution. After the addendum is approved, the exchange is rectified to indicate that item A remains outstanding while item B has been completed.

In a certain building project, the contractor opted not to install hot water pipes initially in order to cut costs. Additionally, they omitted the installation of an air navigation antenna. However, they rectified this last oversight at a later stage.

4.5.3.3 Deviation management and prevention

All deviations undergo thorough analysis and formality; everyone involved maintains detailed records, notes, and orders. The only issue that typically arises is concerning payment. The addendum serves to formalize changes or adjust quantities and prices for deviations already implemented.

Additionally, there's usually a general civil construction item specified per cubic meter (m3). This simplifies billing by calculating the volume represented by each construction activity and updating the m3 accordingly. While this general item streamlines the collection process, comprehensive background information must still be documented.

The process of initiating a change order begins before the actual deviation occurs. Unfortunately, this entire process can be quite lengthy. Delays frequently stem from financial matters. Therefore, in exceptional cases where waiting for the full change order process is not feasible, the change is already implemented before the financial evaluation concludes.

There are two types of deviations: those that could have been predicted and those that could not. Predictable deviations are inherently difficult to foresee, as they involve changes from the original plan. Unpredictable deviations include force majeure events, which demand immediate and unavoidable adjustments, and cannot wait for the change order process.

4.5.4 Industry reality and best practices

4.5.4.1 Industry reality

Certainly, the industry often abuses change orders to its advantage, driven by convenience and a desire to alter the original project. Many seek changes to make the project more feasible, cost-effective, and better suited to their capabilities. It's not uncommon for winning bidders to immediately request changes. For instance, they might be representatives or owners of concrete, precast, or pipe factories, exploiting this position to their advantage. Additionally,

insufficient project verification before tender submission can lead to subsequent change requests.

Likewise, the industry abuses deviations, especially in cases of lax inspection. Contractors often aim to maximize profit and minimize effort, leading to deviations.

4.5.4.2 Change orders

Enhancing the change order procedure might involve improving its efficiency, especially towards the project's conclusion. Leading this improvement falls to the contractor, who should maintain up-to-date plans and quantities to promptly accommodate changes. Potential obstacles could arise from the contractor's willingness to prioritize and actively engage in this enhancement process.

4.5.4.3 Deviations

Good practices for handling deviations include at least providing informal notification.

4.6 Interviewee number 6

4.6.1 Interviewee background presentation

He is a civil engineer and own a small construction company specialized in structures. He has worked there since 2007, that would be 16 years of experience. The company makes houses, buildings, factories and renovations.

He manages several projects at the same time. Normally five professionals are involved in each project. Construction workers vary in number depending on the project. They can be from seven to twenty-five. The execution time logically also varies, for example four months for a house to one month per floor in a building.

4.6.2 Changes with change orders

4.6.2.1 Procedure

There isn't one. Generally, the client requests the change and the architect and he adapt the plans. If the change comes from them, they inform the client, but there is no formal procedure. If there is a contract, in some cases there is a clause that says that if the budget varies by x% of the original budget, another contract must be made or other processes must be followed (according to each contract). In most cases the changes are verbal, not in writing. They are only written if the client requests it and they are normally done simply to have a supporting document as to why the change was made.

4.6.2.2 Personal experiences

Typically, changes arise when the client expresses a desire for modifications. The architect revises the architectural drawings and forwards them to the company for the necessary structural adjustments. The early stages of the project offer greater flexibility for changes. It is uncommon for changes to originate from the company's side, given their initial involvement in the worksite. If design changes arise after completing the structure, the first step is to assess its compatibility with the new loads.

Occasionally, challenges arise due to the unavailability of certain materials in the market, necessitating adjustments based on what is accessible. During renovations, unforeseen issues may surface, prompting structural reinforcements as a solution. When such design changes occur post-structure completion, a thorough structural evaluation is conducted. While some instances may not necessitate alterations due to the usage of high safety coefficients that the company typically uses, others may require additional reinforcement. Typically, these modifications result in an increased budget, with budget reductions being a rare occurrence.

As said before, the company does not work with a formal procedure, but they always reach an agreement with the client, considering that the company is in charge of the structure and therefore the safety of the work. The client cannot argue against a technical change that solves a safety issue or an unexpected situation.

Regarding the timing of changes, alterations related to the terrain predominantly occur at the project's outset. On the contrary, changes initiated by the client tend to occur towards the conclusion of the project, because it is easier for them to visualize a built project than one in plans. However, implementing these changes becomes challenging at this stage due to the project's advanced state. In essence, early changes are often inevitable surprises related to the

terrain, while late-stage changes are typically avoidable adjustments requested by the client. The middle phase of the project generally experiences fewer modifications.

4.6.2.3 Personal opinion related to theory of change orders

He recognized the three main reasons for change orders according to the literature and gave examples of each of them. He stated that dealing with them is a matter of talking and reaching an agreement. In his field, it is not very difficult because security is involved. He stated that design changes by the client in the final phase are the most common.

Design errors and omissions: the architecture team did not consider something and the construction company realize it at the budget stage, therefore, it does not become a problem for the client and they solve right away.

Design changes: they are almost always made by the client in the final stage as we discussed before.

Unforeseen circumstances: soil problems that they found when they began the excavations.

4.6.3 Deviations

4.6.3.1 Deviation recognition

The company does not make any changes with a formal change order. Instead, changes are classified into two categories: formal changes and informal changes. Formal changes involve agreements with the client, which, as mentioned in the previous section, are communicated verbally without formal documentation. Informal changes are internal decisions made independently by the company and are typically inconsequential to the safety and functionality of the structure. Additionally, informal changes can occur when workers make alterations without the explicit authorization or notification of the structural company.

These informal adjustments can take place at any phase of the project, given that they involve minor and non-hazardous modifications, and are not restricted to a specific timeframe.

4.6.3.2 Examples

The scenario involved a residential project where the individual being interviewed performed the calculations, and another party, not a structural engineer but a builder, executed the construction. He had a lot of experience but he did it by repetition, without doing calculations and trying to do it cheaper. Unfortunately, this builder deviated from the plans.

The client urgently contacted the interviewee due to an emergency situation arising from the construction issues caused by this builder. In such critical cases, financial considerations become secondary for the clients. The structural company had to implement reinforcements to salvage and secure the structure.

Additional instances of similar challenges include minor adjustments within the project. In the interviewee's field, circumstances might arise, such as a shortage of a specific type of rod. To address this, the interviewee may modify the number or diameter of rods accordingly. Similarly, material substitutions might occur, such as opting for a metal beam instead of a concrete one. The feasibility of these alterations depends on factors like size, with smaller beams posing no problem, while larger beams can be problematic due to interference with other structures or with aesthetics. Importantly, such material changes often don't impact aesthetics, as they are typically concealed. Essentially, these adjustments are primarily pragmatic and commercial in nature, not compromising the safety or functionality of the completed work.

4.6.3.3 Deviation management and prevention

In the previous example of the emergency reinforcement he only delivered the updated structural drawing, not even, in that case, they made a formal change order before or afterward of executing the change.

Preventing such scenarios proves challenging. The unpredictability of construction material availability makes it difficult to foresee and forestall these situations. Within the interviewee's professional sphere, this uncertainty surrounding material availability stands out as the primary source for informal changes. On the other hand, in the initial example, the client could have avoided the issue by opting to engage the interviewee for the construction or choosing another qualified professional. Unfortunately, the client's decision to enlist an unprofessional construction builder who disregarded calculations led to a structural emergency.

4.6.4 Industry reality and best practices

4.6.4.1 Industry reality

The interviewee stated that in his area there is no abuse of change orders, considering everything discussed above, that the safety of the project depends on the work in his area, but he does believe that there are many changes in other areas of construction.

He added that regarding the deviations it is similar. He does not believe that there is abuse in his area, however he stressed that it is difficult to know, because generally only those who make deviations are the ones who know they did it.

4.6.4.2 Change orders

For the interviewee it is difficult to talk about an improvement in the change order procedure, because in his case, the changes are usually requested by the client and a verbal agreement is reached, in other words, they do not have any type of formal change order. However, he stated that in a larger company or in another area they may work with change orders, and therefore there is room for improvement.

In that case, the person in charge of promoting and implementing possible improvements should be the owner or general manager, since they are the ones who supervise all the company's departments. However, he foresees barriers to applying it. Analysis is required to visualize where and how the process could be improved, which means time and money.

4.6.4.3 Deviations

For the interviewee, when faced with the need to incur a deviation, experience plays a crucial role. This experience enables them to effectively address challenges such as material shortages in the local market. In such situations, the interviewee adheres to a consistent approach: prioritizing safety considerations above all else. The primary focus is on ensuring structural integrity and safety and then looking at aesthetics versus economic aspects.

4.7 Interviewee number 7

4.7.1 Interviewee background presentation

She works as an independent professional and consultant, serving clients from both the private and public sectors. Additionally, she holds a position as a university professor. Her projects primarily focus on housing and cultural heritage preservation. She possesses extensive general experience in the construction industry, and since 2010 specifically in construction management.

Some notable projects she's been involved in include the restoration of the historic Sapucai railway station and the creation of a museum, with a budget of $2 million and approximately 20 employees. Additionally, she's worked on the restoration of the historic port of Asunción, with a budget of $4 million and a team of 70 workers. Furthermore, she's been engaged in the restoration of the development banks of Villa Rica and Pilar, each with a team of 20 workers.

4.7.2 Changes with change orders

4.7.2.1 Procedure

In a public project, either the contractor or the inspection team can propose changes to the project. The inspection presents these changes to the supervision. Supervision conducts the necessary checks to approve or reject the proposed changes. Typically, this process takes 15 to 30 days. Conversely, in private projects often involve more active involvement from the owner, leading to a more flexible and dynamic process.

Conservation projects often declare themselves as open projects subject to changes based on any findings that may arise during the process.

In addition to changes, compensations are also made, which are relatively straightforward. Compensation involves exchanging one task for another to avoid altering the project budget.

4.7.2.2 Personal experiences

She did experience a lot of changes in the projects and they had followed the procedure. They just take longer than necessary sometimes. The occurrence is most common during the initial stages of the project, as the transition from plans to actual construction often prompts adjustments. Mid-project, additional changes may arise due to the initial alterations made. Toward the project's completion, changes are typically less frequent.

4.7.2.3 Personal opinion related to theory of change orders

She identified the three primary causes of change orders based on existing literature. Design errors and omissions emerge as the predominant cause of project alterations. In her field, there's a notable shortfall in project development, primarily attributed to inadequate funding. The conservation area currently lacks specific specifications. It is imperative to generate basic documentation outlining the types of works needed, with particular attention given to preserving heritage assets. Next are examples of each change order cause.

Design errors and omissions: In a particular project, a tender was initiated without a comprehensive intervention plan; only a protocol was available. The spreadsheet failed to accurately outline the necessary actions. Furthermore, alterations had been made to the work site, as the Paraguary-Villarrica route was recently completed, dividing the land and passing dangerously close to the warehouse slated for restoration. Additionally, the project did not account for sewer works, leading to flooding at the site. Moreover, the presence of a high water table was overlooked. Consequently, the project deviated significantly from the initial protocol.

Given the substantial changes necessitated by these discrepancies, extensive management efforts were required. Complicating matters, the funding entity, the Japanese Government, maintained stringent standards. With the original budget proving inadequate, the Ministry of Public Works, responsible for financial management, had to intervene. Collaborative efforts involving the Japanese Embassy and the provincial government, this last one was required to afford additional funding to address the shortfall.

The procedure for calling for tenders for heritage assets is as follows. Initially, the national secretary of culture grants approval for an intervention protocol. This protocol serves as a comprehensive assessment of the asset, detailing its characteristics and current condition, while also providing guidelines for its preservation. Moreover, alongside the protocol, a corresponding project is required to adhere to these guidelines. This project encompasses various elements, such as scheduling, spreadsheet forms, technical specifications, and additional documentation.

In the instance described, an agreement was reached whereby the responsibility for executing the project was entrusted to the national university.

Design changes: Unexpected topographical challenges emerged at the construction site, with a steeper slope than anticipated at first. Initially, options such as leveling were considered, but ultimately, it was decided to leverage the slope within the project design. Consequently, significant modifications to the original design were necessary.

Unforeseen circumstances: Unanticipated discoveries during conservation efforts are not uncommon. Sometimes it is already contemplated in the contract or modifying agreements are made. Alternatively, if the discovery is significant, it is documented and preserved for potential future action.

For instance, during the restoration of the port, deteriorated concrete slabs and substantial cracks were uncovered in the facade, indicating underlying structural issues. These findings were deemed critical for safety and required immediate attention, prioritizing structural stabilization before addressing other restoration needs to prevent exacerbating existing defects.

4.7.3 Deviations

4.7.3.1 Deviation recognition

She acknowledged experiencing deviations, which tend to occur more frequently during execution, often stemming from misinterpretations of the blueprints.

4.7.3.2 Examples

She provided several examples, they are usually inattention which causes deviations in the form of errors.

During her supervision of a conservation project, there was a requirement for a special wall construction known as the Brazilian or Claustra bond. Despite repeated instructions to the contractor, they failed to comply and eventually requested a change to construct a regular wall instead. Both parties agreed to this change, the contractor made the deviation, and it was later formalized through a modifying agreement.

In private projects, architects sometimes implement deviations without prior consultation with the client. However, they often justify these deviations based on valid reasons, such as necessary structural adjustments. For example, in one project, an architect mistakenly planned to install a regular beam instead of an inverted one. Fortunately, the error was caught before the concrete was poured, and the correct beam was ultimately installed.

Similarly, in another case, unnecessary demolition of bathrooms occurred, resulting in additional construction work and financial loss for the contractor.

4.7.3.3 Deviation management and prevention

In several deviations, she initiated a change order following they were made to formalize them, as the pace of work differed from that of documentation management.

Maybe to prevent such occurrences, fostering a dynamic work environment among all project stakeholders could be crucial. Emphasizing the development of soft skills to mitigate tensions, encouraging coordination, and promoting open dialogue can facilitate effective teamwork.

4.7.4 Industry reality and best practices

4.7.4.1 Industry reality

She believes that the industry does indeed abuse change orders. Many professionals or companies exploit the 20% budget increase permitted by law. They secure tenders with low prices and then seek additional work to bill the extra 20%, which she considers unethical. For instance, in a restoration project involving a structure, an architect proposed a modifying agreement to recover 100 meters of paving stones outside the designated work area, which seemed nonsensical.

Similarly, she acknowledges that the industry often takes advantage of deviations. Poor documentation in specifications and spreadsheets grants contractors significant freedom and room for interpretation. This deficiency in documentation leaves projects vulnerable to the contractor's discretion, allowing them to prioritize their own interests. Furthermore, halting work for each change is impractical, as it leads to delays and financial losses. Consequently, many opt for deviations to maintain workflow and avoid financial setbacks.

4.7.4.2 Change orders

Enhancing the change order procedure involves creating a more dynamic approach and improving communication between involved parties. Prompt notification and initiation of the formal change process upon identifying the need for a project change are crucial. This includes informing stakeholders about potential changes, holding technical meetings, making decisions regarding the change, and obtaining approval for implementation. Improvements to the change order procedure require collective effort and teamwork. Each participant should contribute to implementing improvements to ensure a dynamic process. Individuals who recognize areas for enhancement should take the initiative to propose and implement improvements.

Potential obstacles may include a lack of willingness and commitment among individuals involved in the project. Overcoming resistance and fostering a culture of openness and adaptability will be critical to successfully implementing improvements in the change order procedure.

4.7.4.3 Deviations

Good practices for managing deviations involve organizing work meetings to discuss potential minor adjustments to the project. These decisions should be documented in writing, either through meeting minutes or the workbook, to maintain clarity and accountability.

4.8 Interviewee number 8

4.8.1 Interviewee background presentation

He owns a construction firm, specializing in projects for private entities contracted by public organizations. Previously, he served as the maintenance and infrastructure manager in a meat industry company for 7 years and taught at an engineering university for 15 years. His project expertise spans electrical installations, structural consulting, building design, industrial assembly, and restoration.

With 40 years of experience, he has managed diverse construction projects, ranging from small-scale ventures to large undertakings like the greenhouse for Shell, covering 1.5 hectares and costing $400,000. During its execution, six individuals were involved in project management, while 150 workers contributed to its completion. Notable projects include the restoration of the López Palace and the historic port of Asunción, each with a budget of $4 million.

4.8.2 Changes with change orders

4.8.2.1 Procedure

The formal procedure for handling changes varies depending on the project, but generally follows a similar process with some distinctions. Documentation and justification are required for any proposed changes. In international tenders, approval for changes typically comes from the financing entity. For national projects, there are regulations outlined in the public procurement law, allowing changes up to 20% of the contract budget. The documentation requirements are more rigorous for international entities compared to national ones. For instance, if the international entity is rated at level 10, the national counterpart might be rated at level 6 or 7.

4.8.2.2 Personal experiences

Changes are quite common in projects, often due to the absence of a thorough executive plan. There have been instances where proposed changes were initially rejected but eventually accepted after necessary adjustments were made. However, there were also cases where projects were canceled due to the absence of a robust executive plan and failure to reach an agreement on necessary changes. Changes tend to occur across all phases of the project, but they are more frequent during the middle stages.

4.8.2.3 Personal opinion related to theory of change orders

He outlined three main reasons for change orders by drawing from existing literature. Design errors and omissions stand out as the primary drivers behind project changes. This could be attributed to the tendency during the design phase to prioritize the lowest bid, although there's a shifting trend towards considering quality-price balance as well. To illustrate each cause, he offers examples.

Design errors and omissions: the widely publicized Metrobús project. The company awarded the contract for both design and construction faced a significant challenge. The problem originated from the tender documents, which omitted crucial elements like drainage and electrical works. Consequently, these essential aspects were overlooked during the initial design phase. Subsequently, adjustments to the design became imperative to proceed with the project. Unfortunately, efforts to negotiate these necessary modifications ultimately proved unsuccessful.

In a restoration project, the design contemplated placing an elevated water tank. Placing such a structure in a historic building poses significant challenges, as accurately assessing the

structure's condition is complex. Recognizing this as a design flaw, we had to revise the plan, opting to relocate the tank underground for preservation purposes.

Another case involves the construction of a duplex, where he was tasked with executing a structural design created by another engineer. During the construction process, it became evident that the footing was inadequately sized. Despite identifying this issue as a structural calculation error, the owners chose to adhere to the original plan without making any adjustments to the design itself.

Design changes: In a restoration project for a church in a rural area, he adjusted the construction approach. The concrete bases planned for demolition posed a risk of disturbing the church due to vibrations. Therefore, he implemented an alternative method to circumvent this issue.

Another example arose in a different restoration project. There was a need to demolish a ceiling and install a new one. However, during demolition, ceramic tiles were discovered. Consequently, the decision was made to restore and leave them exposed, rather than proceeding with the installation of a new ceiling. Additionally, in the same project, the removal of old roof sheets was in the plan. Ultimately, it was decided not to remove them, and instead, the new sheets were placed directly over the existing ones.

Unforeseen circumstances: these situations are quite typical in restoration projects, though they occur less frequently in new construction contexts. Consider one of his projects focused mainly on basic maintenance and painting. While working on-site, they unexpectedly encountered structural issues within the building. Consequently, they promptly made adjustments to tackle these issues and resolve the situation.

4.8.3 Deviations

4.8.3.1 Deviation recognition

The projects do have deviations. These deviations are usually minor and don't substantially affect the budget. They're reported and approved nonetheless, arising from either party, be it a customer or contractor order. They occur throughout all stages of the project.

4.8.3.2 Examples

During excavation for the foundation of a project, unexpected drainage pipes were discovered, necessitating a redesign of the foundation to prevent flooding. This deviation was promptly carried out on-site and then formally documented. Another instance involves increasing the section of a pillar.

In a theater construction project, incomplete design calculations led to inadequately reinforced slabs. The contractor completed the design without proper specifications, resulting in structural failure. Similarly, another construction site opted to skip the subfloor to save costs.

4.8.3.3 Deviation management and prevention

If it is an urgent situation, he makes the deviation and then reports. If it is an error, it is corrected, especially in restoration works. Many times a verbal agreement is reached, the deviation is made and then it is regularized with a modifying agreement, particularly in cases of significant deviations that warrant formalization.

Improving the executive project or considering unforeseen events could potentially prevent such occurrences.

4.8.4 Industry reality and best practices

4.8.4.1 Industry reality

Some within the industry abuse change orders as a means to optimize costs. Similarly, some abuse deviations for the same purpose of cost optimization.

4.8.4.2 Change orders

Enhancing the effectiveness of the change order process is crucial, particularly in public projects where it often becomes drawn out due to bureaucratic complexities. The responsibility for driving this improvement lies with the client, or in the context of state projects, with the technical planning secretary. However, navigating through bureaucratic hurdles within state procedures is anticipated as a significant barrier to progress in this regard.

4.8.4.3 Deviations

Implementing a clear regulation could be beneficial. Such a regulation could prioritize executing changes as long as they do not significantly alter the final outcome of the work or incur additional costs. This approach aims to streamline the procedure and ensure that minor adjustments can be made without the need for formal change orders.

Appendix 4: National law on public procurement

Article 62.- Modification agreements in public works

In the event that it is necessary to expand, modify or complement a specific work due to unforeseen causes or techniques presented during its execution, the Contracting Party may celebrate with the same contractor, without bidding, but with a prior favorable report from the corresponding General Auditor, the modifying agreements that require attention to the aforementioned changes, provided that the unit prices of the original contract are maintained, adjusted to the date of execution of the respective agreement; and in cases where the complementary works are not provided for in the original contract, these are agreed between the parties after signing the agreement.

Modifying agreements may only be entered into to the extent that, jointly or separately, they do not exceed twenty percent of the amount and term originally agreed upon and that they are not intended to grant the contractor more favorable conditions with respect to those originally indicated in the bases and in the contract.

Article 63.- Modification agreements in acquisitions, locations and services

The Contracting Operational Units (COU) may, within their approved and available budget, under their responsibility and for well-founded and explicit reasons, agree to increase the quantity of goods requested through modifications to their current contracts, within the following twelve months of the signature, provided that the total amount of the modifications does not exceed, as a whole, twenty percent of the amount or quantity of the concepts and volumes originally established therein and the unit price of the goods is equal to that originally agreed upon, and may apply price adjustments in accordance with the formulas established in the respective tender documents. In the case of contracts that include goods or services of different characteristics, the percentage will be applied to each item or concept of the goods or services in question.

Any modification to the contracts must be formalized in writing by the contracting parties and the respective legal instruments will be signed by the public official or employee who made it in the original contract or whoever replaces it or is authorized to do so.

It is prohibited to make contractual modifications that refer to prices, advance payments, progressive payments, specifications and, in general, any change that involves granting more advantageous conditions to a supplier compared to those originally established.

The procedure described in this article may not be used when the total amount exceeds the thresholds set for the call for public bidding.

Appendix 5: Change order examples by theoretical cause type

Design errors and omissions examples

1) These typically involve inaccuracies in topographical data. Often, stakes used for leveling references are misplaced or lost, leading to errors in quantity estimates. (Interviewee 1)
2) A road construction project within a city encountered an oversight regarding the replacement of pipes, specified in the contract but omitted from the plans and budget. The rectification was readily accepted given its contractual obligation. (Interviewee 2)
3) Two bridges on the verge of collapse, which were overlooked in the new project. (Interviewee 3)
4) The geodetic point used as the project's origin was not found. Attempts to layout the project from a known point led to a significant displacement of the axis from the planned position, resulting in misalignments and discrepancies in contractual quantities. (Interviewee 3)
5) In a civil project, the actual axis of the pillar did not align as intended in the plan. A boundary pillar, initially designed concentrically, had to be altered to an eccentric configuration. (Interviewee 4)
6) Failure to include a retaining wall for an excavation. (Interviewee 5)
7) The architecture team did not consider something and the construction company realize it at the budget stage, therefore, it does not become a problem for the client and they solve right away. (Interviewee 6)
8) A tender was initiated without a comprehensive intervention plan; only a protocol was available. The spreadsheet failed to accurately outline the necessary actions. (Interviewee 7)
9) The project did not account for sewer works, leading to flooding at the site. (Interviewee 7)
10) The presence of a high water table was overlooked. (Interviewee 7)
11) Unexpected topographical challenges emerged at the construction site, with a steeper slope than anticipated at first. Initially, options such as leveling were considered, but ultimately, it was decided to leverage the slope within the project design. Consequently, significant modifications to the original design were necessary. (Interviewee 7)
12) The problem originated from the tender documents, which omitted crucial elements like drainage and electrical works. Consequently, these essential aspects were overlooked during the initial design phase. Subsequently, adjustments to the design became imperative to proceed with the project. Unfortunately, efforts to negotiate these necessary modifications ultimately proved unsuccessful. (Interviewee 8)
13) In a restoration project, the design contemplated placing an elevated water tank. Placing such a structure in a historic building poses significant challenges, as accurately assessing the structure's condition is complex. Recognizing this as a design flaw, they had to revise the plan, opting to relocate the tank underground for preservation purposes. (Interviewee 8)
14) During the construction process, it became evident that the footing was inadequately sized. Despite identifying this issue as a structural calculation error, the owners chose to adhere to the original plan without making any adjustments to the design itself. (Interviewee 8)

Design changes

1) These changes are commonly implemented to enhance project outcomes and efficiency. (Interviewee 1)
2) An intersection improvement initiative was implemented. (Interviewee 2)
3) A tunnel project had to be altered due to the presence of a crucial water supply pipeline. Instead of relocating the costly adductor, the design shifted from a tunnel to a viaduct, extending into an area of the city's botanical garden. (Interviewee 3)
4) A modification in the design involved an intersection of two roads, one being departmental and the other national. The initial plan depicted a "T" shape, but given the greater significance of the national route, it was curved to prioritize its importance over the other route. (Interviewee 4)
5) Adjusting the storm drain design to accommodate newly incorporated areas of influence from neighboring communities, necessitating additional drains and expanded sewer diameters. (Interviewee 5)
6) Changes initiated by the client tend to occur towards the conclusion of the project, because it is easier for them to visualize a built project than one in plans. (Interviewee 6)
7) In a restoration project for a church in a rural area, he adjusted the construction approach. The concrete bases planned for demolition posed a risk of disturbing the church due to vibrations. Therefore, he implemented an alternative method to circumvent this issue. (Interviewee 8)
8) The removal of old roof sheets was in the plan. Ultimately, it was decided not to remove them, and instead, the new sheets were placed directly over the existing ones. (Interviewee 8)

Unanticipated circumstances

1) An unforeseen surge in traffic due to private investments, as observed in the northern region of the country, can necessitate adjustments. (Interviewee 1)
2) During a road construction project when a community water tank was discovered along the route, not accounted for in the original design. This unanticipated obstacle necessitated relocating the tank to ensure the community's water supply, the road project design was finalized in 2015, at which time the existence of the water tank was not accounted for. However, sometime between 2015 and 2023, the water tank was constructed without updating the corresponding road project plans, underscoring the need for project plans to adapt to evolving realities over time. (Interviewee 2)
3) Pandemic. (Interviewee 3)
4) Reactions from residents in the project area, chaining themselves to trees to prevent deforestation. (Interviewee 3)
5) Municipal demands beyond project plans and complications arising from the ministry's inability to meet them also impede project progress. (Interviewee 3)
6) Due to unusually heavy rainfall, certain projects necessitated the expansion of gutters and storm drains to cope with the increased water flow. (Interviewee 4)
7) Factors such as soil type and sand banks impacting the project. (Interviewee 5)
8) Social considerations. (Interviewee 5)
9) Soil problems that they found when they began the excavations. (Interviewee 6)

10) Alterations had been made to the work site, as the Paraguary-Villarrica route was recently completed, dividing the land and passing dangerously close to the warehouse slated for restoration. (Interviewee 7)
11) During the restoration of the port, deteriorated concrete slabs and substantial cracks were uncovered in the facade, indicating underlying structural issues. (Interviewee 7)
12) Unanticipated discoveries during conservation efforts are not uncommon. (Interviewee 7)
13) In a restoration project. There was a need to demolish a ceiling and install a new one. However, during demolition, ceramic tiles were discovered. Consequently, the decision was made to restore and leave them exposed, rather than proceeding with the installation of a new ceiling. (Interviewee 8)
14) While working on-site on basic maintenance, they unexpectedly encountered structural issues within the building. Consequently, they promptly made adjustments to tackle these issues and resolve the situation. (Interviewee 8)

Appendix 6: interview fragments demonstrating recognitions and concepts of project deviations

“She mentioned facing deviations during the execution phase, albeit minor ones, mostly concerning adjustments in quantities”. (Interviewee 2)

“Typically, changes are implemented through change orders, but some did experience changes without a change order, although they were infrequent”. (Interviewee 3)

“Projects experience deviations, typically manifested as changes implemented before formalizing a modification agreement”. (Interviewee 4)

“Often, changes are implemented first, and the modification agreement is formalized afterward. While this practice is widespread, it is not considered ideal”. (Interviewee 4)

“The project experienced changes without a formal change order in certain situations, such as unforeseen circumstances like inclement weather, imminent danger during work, or urgent needs”. (Interviewee 5)

“There are two types of deviations: those that could have been predicted and those that could not. Predictable deviations are inherently difficult to foresee, as they involve changes from the original plan. Unpredictable deviations include force majeure events, which demand immediate and unavoidable adjustments, and cannot wait for the change order process”. (Interviewee 5)

“Deviations are internal decisions made independently by the company and are typically inconsequential to the safety and functionality of the structure”. (Interviewee 6)

“Deviations can occur when workers make alterations without the explicit authorization or notification of the structural company”. (Interviewee 6)

“In private projects, architects sometimes implement deviations without prior consultation with the client”. (Interviewee 7)

“Both parties agreed to this change, the contractor made the deviation, and it was later formalized through a modifying agreement”. (Interviewee 7)

“These deviations are usually minor and don't substantially affect the budget. They're reported and approved nonetheless, arising from either party”. (Interviewee 8)

Appendix 7: Deviations examples

Below are excerpts from the interviews where interviewees provide examples of deviations. These excerpts were subjectively categorized based on the magnitude of their impacts into three groups: minor, medium, and large impact deviations.

Minor impact deviation examples:

Interviewee 3 stated "Another scenario involves material variations due to unavailability. In one project, a specific material required was not locally accessible, prompting the search for a suitable substitute. To validate this change, additional studies were commissioned, deviating from the initial technical specifications. Positive laboratory results meeting international standards supported the substitution, leading to its documentation in the Construction Log Book".

Interviewee 4 stated "Regarding minor changes, agreements may be verbal or documented in the workbook".

Interviewee 6 stated "Deviations are minor adjustments within the project. In the interviewee's field, circumstances might arise, such as a shortage of a specific type of rod. To address this, the interviewee may modify the number or diameter of rods accordingly. Similarly, material substitutions might occur, such as opting for a metal beam instead of a concrete one. The feasibility of these alterations depends on factors like size, with smaller beams posing no problem, while larger beams can be problematic due to interference with other structures or with aesthetics. Importantly, such material changes often don't impact aesthetics, as they are typically concealed. Essentially, these adjustments are primarily pragmatic and commercial in nature, not compromising the safety or functionality of the completed work".

Medium impact deviation examples:

Interviewee 4 stated "In a road project, a crisis emerged when the undersized sewage drain collapsed, causing streets to be filled with waste. A prompt solution was imperative, and there wasn't time for the entire change order procedure. Despite the customary technical and financial analysis, the urgency led to the contractor receiving an execution order before obtaining a no-objection from the financial entity. The work was completed swiftly, but the financial entity did not approve. Three years have passed leaving still the contractor unpaid. The responsibility for payment falls on the government, but as of the day of the interview, it remains unresolved. This instance highlights the prolonged duration of the change order process".

Interviewee 4 also stated "In another scenario, a road construction project in a flood-prone area with numerous bridges and drainage systems faced constant interruptions due to rain-induced flooding. The project, financed by the World Bank with a 12-month deadline, encountered numerous changes, particularly related to structures. Despite taking four years to complete, the project could not avail of price readjustments due to the World Bank's policy for works lasting less than a year. The primary cause in this case was the outdated hydrological studies for the flood zone, coupled with significant changes in rainfall patterns".

Interviewee 5 stated "Another instance involved a deviation in the construction method of a coastal defense system. Initially planned as dry construction, it had to be adapted due to rising water levels. Despite this deviation, the materials remained the same; only the quantity was adjusted, making it a straightforward alteration. The billing for the entire original contract was completed, with the additional amount covered in an addendum".

Interviewee 8 stated “During excavation for the foundation of a project, unexpected drainage pipes were discovered, necessitating a redesign of the foundation to prevent flooding. This deviation was promptly carried out on-site and then formally documented. Another instance involves increasing the section of a pillar”.

Large impact deviation examples:

Interviewee 5 stated “In a certain building project, the contractor opted not to install hot water pipes initially in order to cut costs. Additionally, they omitted the installation of an air navigation antenna. However, they rectified this last oversight at a later stage”.

Interviewee 6 stated “The scenario involved a residential project where the individual being interviewed performed the calculations, and another party, not a structural engineer but a builder, executed the construction. He had a lot of experience but he did it by repetition, without doing calculations and trying to do it cheaper. Unfortunately, this builder deviated from the plans. The client urgently contacted the interviewee due to an emergency situation arising from the construction issues caused by this builder. In such critical cases, financial considerations become secondary for the clients. The structural company had to implement reinforcements to salvage and secure the structure”.

Interviewee 8 stated “In a theater construction project, incomplete design calculations led to inadequately reinforced slabs. The contractor completed the design without proper specifications, resulting in structural failure”.

Interviewee 8 also stated “Similarly, another construction site opted to skip the subfloor to save costs”.

Appendix 8: Quotes from interviews regarding deviation preventions and best practices

Interviewees	Prevention	Good practices
Interviewee 1	Unaddressed	Unaddressed
Interviewee 2	In road works, which is the area where I work, I don't think there is a way to prevent it. In the calculations of road works, assumptions are used regarding the quantities of existing material and material to be used; it depends greatly on the terrain and is variable.	There are no good practices if changes are not treated with the formal agreement procedure. It could be reaching an informal agreement and then formalizing it.
Interviewee 3	Yes, not reduce the changes themselves, but reduce the bureaucracy of change orders. If change orders were faster, there would be fewer changes without change orders.	There should always be at least documentation of what happened and that all parties agree.
Interviewee 4	Perhaps doing a review of the plans and the construction site before starting the work. Normally the project is reviewed many times by different specialists, but there are always errors. Perhaps a paid thorough review of the contractor should be added to the contract, in order to propose justified changes from the beginning. In theory, it is something that the contractor has to do, but they don't take it that seriously. If there is that paid item and they come later to want to propose a change, it should be their responsibility and the change order process would not be needed. Moreover, many of the changes arise from contractors because they want to make more money. Maybe they made a mistake in their budget and are seeking to correct that at the state's expense, hoping that the responsible officials will help them with it. And obviously, that's not right.	Perhaps when they propose a change that needs to be carried out quickly, at least it should be asked two or three specialists to verify the change. In this way at least confirm that the change is necessary. The biggest problem is when they make changes that are not necessary. Many changes that are avoidable make it seem like they are inevitable. Contractors do this so they can earn more money.
Interviewee 5	They could be foreseen, if they are not immediate changes due to necessity, however, these types are difficult to prevent.	At least inform informally.
Interviewee 6	It is difficult to predict the availability of construction materials. And in my profession, this variable is the most responsible for informal changes. In the first example, the client could have avoided the problem, he should have hired me for the construction or another professional, since he used my calculations and hired an irresponsible construction builder.	In my case, it helps to have experience to be able to solve a lack of materials in the local market and, as always, first analyze the change from a safety point of view. You always have safety first, then look at aesthetics versus economics.
Interviewee 7	Create a dynamic work environment between the parties involved in the project. Work on soft skills to avoid tensions, work in coordination and dialogue to achieve teamwork.	Hold work meetings to discuss possible minor changes to the work and leave the decision in writing in the minutes or in the workbook.
Interviewee 8	Improving the executive project or taking into account unforeseen events.	I think there should be a regulation. Let the change procedure favor execution as long as it does not imply many changes in the final result of your work or a higher cost. I think it's a matter of making a better procedure.

Appendix 9: Experts consultation protocol

The primary objective of the expert consultation is to evaluate and validate the findings of this research revealed from the interview analysis.

The interviewees are from different areas and were consulted independently. Three were consulted, all of whom are professionals with many years of experience.

I. Interviewee presentation
    a) Years of experience?
    b) Which type of company do you work for?

II. Half of the respondents believe that deviations could be prevented. Do you agree they could be prevented? Why (not)?

III. The concept of passively accepting deviations was mentioned three times. Is it advisable to simply acknowledge and embrace deviations as they arise?

IV. Additionally, six other prevention suggestions were concluded.
    a) The contract could stipulate a paid, thorough review conducted by the contractor.
    b) Hire qualified professional.
    c) Cultivate teamwork through improved communication and collaboration.
    d) Improving the final project design.
    e) Taking into account unforeseen events.
    f) Reduce change order bureaucracy.

    1. Do you consider all of them relevant?
    2. Can you sort them based on their relevance?
    3. Do you think they could indeed prevent deviation in practice?
    4. Who should be the lead of those actions?
    5. The following are recommendations on how to apply them, do you agree or have something to add?

II. The contract could stipulate a paid, thorough review conducted by the contractor =
    I. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.
    II. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.

III. Hire qualified professional = just do it

IV. Cultivate teamwork through improved communication and collaboration =
    I. Foster soft skills within the team.
    II. Analysis and engagement of project stakeholders.

V. Improving the final project design = pay more for that stage

VI. Taking into account unforeseen events =
    I. Conduct a risk analysis utilizing data from previous projects.
    II. Implement risk management practices, which involve regularly reviewing the risk register.

VII. Reduce change order bureaucracy =

I. Offering detailed documentation to the financial entity can speed up evaluation and reduce data requests.
II. Set up dedicated technical teams within the financing entity to closely monitor progress and support required changes.
III. Allocate a budget percentage for potential changes.
IV. Keep plans and quantities current for a quick change order process.

V. Research has identified four best practices for instances where a deviation is necessary.

a) At least reach an informal agreement, document it and then formalize it.
b) Seek opinions from specialists to confirm the change/deviation necessity.
c) Possess experience and prioritize safety.
d) Regulations should prioritize execution unless significant changes or costs are involved.

1. Do you consider all of them relevant?
2. Can you sort them based on their relevance?
3. Do you think they could indeed work in practice?
4. Who should be the lead of those actions?
5. The following are recommendations on how to apply them, do you agree or have something to add?

a) At least reach an informal agreement, document it and then formalize it =

I. Hold meetings to discuss deviations.
II. Document decisions in meeting minutes or construction logs.
III. Create an easy and quick deviation template procedure.

b) Seek opinions from specialists to confirm the change/deviation necessity = just do it
c) Possess experience and prioritize safety =

I. Implement technology to foster safety, for instance, an automatic safety checking in BIM.
II. Top management should promote safety across all project members.

d) Regulations should prioritize execution unless significant changes or costs are involved =

I. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.
II. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.
III.

VI. Is there any topic related aspect we failed to discuss that you were expecting?

Appendix 10: Experts consultation transcripts

Expert 1

I. Interviewee presentation
   a) Years of experience?
      37
   b) Which type of company do you work for?
      Private and now owner of a construction company.

II. Half of the respondents believe that deviations could be prevented. Do you agree they could be prevented? Why (not)?
Yes, with a well-defined project with well-paid professionals so that they can carry out the work properly.

III. The concept of passively accepting deviations was mentioned three times. Is it advisable to simply acknowledge and embrace deviations as they arise?
Yes, but they must be documented.

IV. Additionally, six prevention suggestions were concluded.
   a) The contract could stipulate a paid, thorough review conducted by the contractor.
   b) Hire qualified professional.
   c) Cultivate teamwork through improved communication and collaboration.
   d) Improving the final project design.
   e) Taking into account unforeseen events.
   f) Reduce change order bureaucracy.

   1. Do you consider all of them relevant?
      Yes.

   2. Can you sort them based on their relevance?

1	Improving the final project design.
2	The contract could stipulate a paid, thorough review conducted by the contractor.
3	Reduce change order bureaucracy.
4	Cultivate teamwork through improved communication and collaboration.
5	Taking into account unforeseen events.
6	Hire qualified professional.

   3. Do you think they could indeed prevent deviation in practice?
      Yes.

   4. Who should be the lead of those actions?
      The one who planned the project.

   5. The following are recommendations on how to apply them, do you agree or have something to add?

a) The contract could stipulate a paid, thorough review conducted by the contractor =
    i. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.
    ii. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.

    The first one is not going to happen. The second is more relevant and easier to apply.

b) Hire qualified professional = just do it

    I agree.

c) Cultivate teamwork through improved communication and collaboration =
    i. Foster soft skills within the team.
    ii. Analysis and engagement of project stakeholders.

    I agree with both. Soft skills are really important for those who lead. The second measure for public projects.

d) Improving the final project design = pay more for that stage

    I agree, unfortunately no one pays well for design.

e) Taking into account unforeseen events =
    i. Conduct a risk analysis utilizing data from previous projects.
    ii. Implement risk management practices, which involve regularly reviewing the risk register.

    I agree.

f) Reduce change order bureaucracy =
    i. Offering detailed documentation to the financial entity can speed up evaluation and reduce data requests.
    ii. Set up dedicated technical teams within the financing entity to closely monitor progress and support required changes.
    iii. Allocate a budget percentage for potential changes.
    iv. Keep plans and quantities current for a quick change order process.

    I agree. However, there is not as much bureaucracy in the private part, the agreements are more verbal. In my projects I usually budget 4% of the budget for unforeseen events.

V. Research has identified four best practices for instances where a deviation is necessary.
   a) At least reach an informal agreement, document it and then formalize it.
   b) Seek opinions from specialists to confirm the change/deviation necessity.
   c) Possess experience and prioritize safety.
   d) Regulations should prioritize execution unless significant changes or costs are involved.

1. Do you consider all of them relevant?
   Yes.

2. Can you sort them based on their relevance?

1	Possess experience and prioritize safety.
2	At least reach an informal agreement, document it and then formalize it.
3	Seek opinions from specialists to confirm the change/deviation necessity.
4	Regulations should prioritize execution unless significant changes or costs are involved.

3. Do you think they could indeed work in practice?
   Yes.

4. Who should be the lead of those actions?
   Contractor and designer.

5. The following are recommendations on how to apply them, do you agree or have something to add?
   a) At least reach an informal agreement, document it and then formalize it =
      i. Hold meetings to discuss deviations.
      ii. Document decisions in meeting minutes or construction logs.
      iii. Create an easy and quick deviation template procedure.

      I agree. Although the same thing should be written in the work book as would be written in a template. I usually have meetings to justify deviations that I have already made.

   b) Seek opinions from specialists to confirm the change/deviation necessity = just do it

      I agree.

   c) Possess experience and prioritize safety =
      i. Implement technology to foster safety, for instance, an automatic safety checking in BIM.
      ii. Top management should promote safety across all project members.

      I agree, especially with the second one.

d) Regulations should prioritize execution unless significant changes or costs are involved =
    i. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.
    ii. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.

    I agree. The regulations must be implemented first and then how to best manage minor deviations

VI. Is there any topic related aspect we failed to discuss that you were expecting?
We did not talk about the ethical part of the person hired, their willingness to do things. Do the job as best as possible and not intentionally choose poor quality materials or mediocre suppliers/professionals who charge cheaper.
It also happens that the inspector and the contractor agree to accept poor quality materials, for example, if a concrete was loaded with lower resistance.
In short, the ethics of all those involved are important.

Expert 2

I. Interviewee presentation

a) Years of experience?
35

b) Which type of company do you work for?
Designer in private company.

II. Half of the respondents believe that deviations could be prevented. Do you agree they could be prevented? Why (not)?
No, with a good project design they can be reduced. But there will always be deviations, at least a low percentage, between 2 to 5% of project cost.

III. The concept of passively accepting deviations was mentioned three times. Is it advisable to simply acknowledge and embrace deviations as they arise?
It is inevitable to accept them if they still happen after everything possible has been done to avoid them, but you have to know how to resolve them.

IV. Additionally, six other prevention suggestions were concluded.

a) The contract could stipulate a paid, thorough review conducted by the contractor.
b) Hire qualified professional.
c) Cultivate teamwork through improved communication and collaboration.
d) Improving the final project design.
e) Taking into account unforeseen events.
f) Reduce change order bureaucracy.

1. Do you consider all of them relevant?
Yes.

2. Can you sort them based on their relevance?

1	Improving the final project design.
2	The contract could stipulate a paid, thorough review conducted by the contractor.
3	Reduce change order bureaucracy.
4	Cultivate teamwork through improved communication and collaboration.
5	Taking into account unforeseen events.
6	Hire qualified professional.

3. Do you think they could indeed prevent deviation in practice?
Yes. By having a % stipulated for unforeseen events, at least if they happen, they will not impact the project as much.

4. Who should be the lead of those actions?
The project developer

5. The following are recommendations on how to apply them, do you agree or have something to add?
    a) The contract could stipulate a paid, thorough review conducted by the contractor =
        i. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.
        ii. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.

        The second is more important, because the government, even if it passes the law, the people may not apply the revision well. Finally, the contractor has to improve how they do the project review and that is the most important thing.

    b) Hire qualified professional = just do it
    I agree, but It always has to be done, it is not something that should be improved.

    c) Cultivate teamwork through improved communication and collaboration =
        i. Foster soft skills within the team.
        ii. Analysis and engagement of project stakeholders.

        I agree, especially with the second, this is how it is possible to integrate all those interested in the project, inside and outside of it.

    d) Improving the final project design = pay more for that stage
    I agree. It's not a matter of expecting the market to pay extra for the design; in reality, the market doesn't allocate any specific payment for it. Projects are negotiated with the project design cost already accounted for.

    e) Taking into account unforeseen events =
        i. Conduct a risk analysis utilizing data from previous projects.
        ii. Implement risk management practices, which involve regularly reviewing the risk register.

        I agree.

    f) Reduce change order bureaucracy =
        i. Offering detailed documentation to the financial entity can speed up evaluation and reduce data requests.
        ii. Set up dedicated technical teams within the financing entity to closely monitor progress and support required changes.
        iii. Allocate a budget percentage for potential changes.

iv. Keep plans and quantities current for a quick change order process.

I agree, although these procedures may not be as applicable in private projects. I prefer the second proposal. The first one isn't as effective because lengthy change documents often go unread by those responsible for approval. Hence, a technical team that can swiftly resolve issues proves more practical. Typically, those responsible for approving changes are less involved in the day-to-day work

V. Research has identified four best practices for instances where a deviation is necessary.
   a) At least reach an informal agreement, document it and then formalize it.
   b) Seek opinions from specialists to confirm the change/deviation necessity.
   c) Possess experience and prioritize safety.
   d) Regulations should prioritize execution unless significant changes or costs are involved.

1. Do you consider all of them relevant?
   Yes.

2. Can you sort them based on their relevance?

1	Seek opinions from specialists to confirm the change/deviation necessity.
2	At least reach an informal agreement, document it and then formalize it.
3	Regulations should prioritize execution unless significant changes or costs are involved.
4	Possess experience and prioritize safety.

3. Do you think they could indeed work in practice?
   Yes.

4. Who should be the lead of those actions?
   Each in their respective field.

5. The following are recommendations on how to apply them, do you agree or have something to add?
   e) At least reach an informal agreement, document it and then formalize it =
      i. Hold meetings to discuss deviations.
      ii. Document decisions in meeting minutes or construction logs.
      iii. Create an easy and quick deviation template procedure.

      I agree with all. I like the deviations template; it gives order and organization.

   f) Seek opinions from specialists to confirm the change/deviation necessity = just do it

I agree.

g) Possess experience and prioritize safety =
   i. Implement technology to foster safety, for instance, an automatic safety checking in BIM.
   ii. Top management should promote safety across all project members.

   I agree. Especially the second one. The first measure is technology that not everyone handles.

h) Regulations should prioritize execution unless significant changes or costs are involved =
   i. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.
   ii. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.

   It is difficult for the government to change the regulations or for the private client to add that to the contract.

VI. Is there any topic related aspect we failed to discuss that you were expecting?
No.

Expert 3

I. Interviewee presentation

a) Years of experience?
10

b) Which type of company do you work for?
Budget manager in a private company.

II. Half of the respondents believe that deviations could be prevented. Do you agree they could be prevented? Why (not)?
It depends, deviations decrease if projects are designed correctly. If the deviations are small, they are often made without consulting the client so as not to tire them out over a small thing; however, if they are large, the client must be consulted. If you abuse the changes, the company will also look bad, so in small deviations informality is chosen.

III. The concept of passively accepting deviations was mentioned three times. Is it advisable to simply acknowledge and embrace deviations as they arise?
It depends on the cost. If the amount is small, the company absorbs the extra cost, does not notify it and accepts it.

IV. Additionally, six other prevention suggestions were concluded.

a) The contract could stipulate a paid, thorough review conducted by the contractor.
b) Hire qualified professional.
c) Cultivate teamwork through improved communication and collaboration.
d) Improving the final project design.
e) Taking into account unforeseen events.
f) Reduce change order bureaucracy.

1. Do you consider all of them relevant?
Yes.

2. Can you sort them based on their relevance?

1	Improving the final project design.
2	The contract could stipulate a paid, thorough review conducted by the contractor.
3	Hire qualified professional.
4	Taking into account unforeseen events.
5	Cultivate teamwork through improved communication and collaboration.
6	Reduce change order bureaucracy.

3. Do you think they could indeed prevent deviation in practice?
Not avoid, but reduce a lot.

4. Who should be the lead of those actions?
The owner of the company, the employees and the supervisors.

5. The following are recommendations on how to apply them, do you agree or have something to add?
    a) The contract could stipulate a paid, thorough review conducted by the contractor =
        i. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.
        ii. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.

        The first measure is difficult to happen, but I agree with the second.

    b) Hire qualified professional = just do it
    I agree.

    c) Cultivate teamwork through improved communication and collaboration =
        i. Foster soft skills within the team.
        ii. Analysis and engagement of project stakeholders.

        I agree, especially with the second one.

    d) Improving the final project design = pay more for that stage

    I agree.

    e) Taking into account unforeseen events =
        i. Conduct a risk analysis utilizing data from previous projects.
        ii. Implement risk management practices, which involve regularly reviewing the risk register.

        I agree.

    f) Reduce change order bureaucracy =
        i. Offering detailed documentation to the financial entity can speed up evaluation and reduce data requests.
        ii. Set up dedicated technical teams within the financing entity to closely monitor progress and support required changes.
        iii. Allocate a budget percentage for potential changes.
        iv. Keep plans and quantities current for a quick change order process.

        In the private sphere, change orders are not long. We use the PROCORE system and we manage it quickly through that system.

V. Research has identified four best practices for instances where a deviation is necessary.

a) At least reach an informal agreement, document it and then formalize it.
b) Seek opinions from specialists to confirm the change/deviation necessity.
c) Possess experience and prioritize safety.
d) Regulations should prioritize execution unless significant changes or costs are involved.

1. Do you consider all of them relevant?
   Yes.

2. Can you sort them based on their relevance?

1	Seek opinions from specialists to confirm the change/deviation necessity.
2	At least reach an informal agreement, document it and then formalize it.
3	Regulations should prioritize execution unless significant changes or costs are involved.
4	Possess experience and prioritize safety.

3. Do you think they could indeed work in practice?
   Yes.

4. Who should be the lead of those actions?
   The construction company.

5. The following are recommendations on how to apply them, do you agree or have something to add?
   i) At least reach an informal agreement, document it and then formalize it =
      i. Hold meetings to discuss deviations.
      ii. Document decisions in meeting minutes or construction logs.
      iii. Create an easy and quick deviation template procedure.

      I agree. In fact, we do it.

   j) Seek opinions from specialists to confirm the change/deviation necessity = just do it

      I agree.

   k) Possess experience and prioritize safety =
      i. Implement technology to foster safety, for instance, an automatic safety checking in BIM.
      ii. Top management should promote safety across all project members.

      I agree, especially with the last one.

l) Regulations should prioritize execution unless significant changes or costs are involved =
   i. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.
   ii. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.

   I agree, especially with the last one.

VI. Is there any topic related aspect we failed to discuss that you were expecting?

In the private sector it is very different from the public sector. In the private sector, changes tend to be informal and rapid. There are no bureaucratic problems. And many times, we absorb change costs to please the client, because we want to continue working with them. The customer is not bothered by small deviations.

Appendix 11: Experts' feedback on prevention measures

1. The contract could stipulate a paid, thorough review conducted by the contractor =
    I. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.
    Expert 1: is not going to happen.
    Expert 2: I agree.
    Expert 3: is difficult to happen.

    II. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.
    Expert 1: this is more relevant and easier to apply.
    Expert 2: this is more important, because the government, even if it passes the law, the people may not apply the revision well. Finally, the contractor has to improve how they do the project review and that is the most important thing.
    Expert 3: I agree.

2. Hire qualified professional
    I. Just do it.
    Expert 1: I agree.
    Expert 2: I agree, but it always has to be done, it is not something that should be improved.
    Expert 3: I agree.

3. Cultivate teamwork through improved communication and collaboration =
    I. Foster soft skills within the team.
    Expert 1: I agree, soft skills are really important for those who lead.
    Expert 2: I agree.
    Expert 3: I agree.

    II. Analysis and engagement of project stakeholders.
    Expert 1: I agree. This is more applicable in public projects.
    Expert 2: I agree, this is how it is possible to integrate all those interested in the project, inside and outside of it.
    Expert 3: I agree. I like this more than the previous one.

4. Improving the final project design
    I. Pay more for that stage.
    Expert 1: I agree, unfortunately no one pays well for design.
    Expert 2: I agree. It's not a matter of expecting the market to pay extra for the design; in reality, the market doesn't allocate any specific payment for it. Projects are negotiated with the project design cost already accounted for.
    Expert 3: I agree.

5. Taking into account unforeseen events =
    I. Conduct a risk analysis utilizing data from previous projects.

Expert 1: I agree.
Expert 2: I agree.
Expert 3: I agree.

II. Implement risk management practices, which involve regularly reviewing the risk register.
Expert 1: I agree.
Expert 2: I agree.
Expert 3: I agree.

6. Reduce change order bureaucracy =
   I. Offering detailed documentation to the financial entity can speed up evaluation and reduce data requests.
   II. Set up dedicated technical teams within the financing entity to closely monitor progress and support required changes.
   III. Allocate a budget percentage for potential changes.
   IV. Keep plans and quantities current for a quick change order process

   Expert 1: I agree. However, there is not as much bureaucracy in the private part, the agreements are more verbal. In my projects I usually budget 4% of the budget for unforeseen events.

   Expert 2: I agree, although these procedures may not be as applicable in private projects. I prefer the second proposal. The first one isn't as effective because lengthy change documents often go unread by those responsible for approval. Hence, a technical team that can swiftly resolve issues proves more practical. Typically, those responsible for approving changes are less involved in the day-to-day work.

   Expert 3: No idea, in the private sphere, change orders are not long. We use the PROCORE system and we manage it quickly through that system.

Appendix 12: Experts' feedback on good practices measures

1. At least reach an informal agreement, document it and then formalize it =
    I. Hold meetings to discuss deviations.
    Expert 1: I agree. Although the same thing should be written in the work book as would be written in a template. I usually have meetings to justify deviations that I have already made.
    Expert 2: I agree.
    Expert 3: I agree, in fact we do it.

    II. Document decisions in meeting minutes or construction logs.
    Expert 1: He gave a general answer for the 3 measures.
    Expert 2: I agree.
    Expert 3: I agree, in fact we do it.

    III. Create an easy and quick deviation template procedure.
    Expert 1: He gave a general answer for the 3 measures.
    Expert 2: I agree. I like the deviations template; it gives order and organization.
    Expert 3: I agree. In fact we do it.

2. Seek opinions from specialists to confirm the change/deviation necessity.
    I. Just do it.

    Expert 1: I agree.

    Expert 2: I agree.

    Expert 3: I agree.

3. Possess experience and prioritize safety.
    I. Implement technology to foster safety, for instance, an automatic safety checking in BIM.
    Expert 1: I agree.
    Expert 2: I agree, but this measure is technology that not everyone handles.
    Expert 3: I agree.

    II. Top management should promote safety across all project members.
    Expert 1: I agree, I like this more than the previous one.
    Expert 2: I agree, especially with this one.
    Expert 3: I agree, especially with this one.

4. Regulations should prioritize execution unless significant changes or costs are involved.
    I. Develop a strategy for enacting this law in public settings, and simultaneously devise a plan for integrating this clause into contracts within private contexts.
    Expert 1: I agree. The regulations must be implemented first and then how to best manage minor deviations.
    Expert 2: Disagree, it is difficult for the government to change the regulations or for the private client to add that to the contract.
    Expert 3: I agree.

II. After achieving this, employ a change management model to guide project stakeholders through the transition to the new working procedure.
Expert 1: He gave a general answer for the 2 measures.
Expert 2: He gave a general answer for the 2 measures.

Expert 3: I agree, especially with this one.