The Rationality of Cooperation and Prevention in Contract Management: Reducing Conflicts in Heavy Construction and Electromechanical Assembly in Brazil Through the Application of the Causal Mark Theory

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This article argues that preventive contract management minimizes conflicts in heavy construction and improves project efficiency. Based on data from 324 heavy construction and electromechanical assembly contracts, including projects in the Mining Sector, the data demonstrate that projects with Contract Management have significantly lower damage/conflict rates. Inspired by prior research on the "Use of the Arrow of Time and Criteria for Transmission of Cause Marks in Conflict Management," presented at the 37th Annual IACM Conference, this study applies the "Cause Marks" theory to mathematically show how clear records prevent ambiguities and reduce financial and temporal impacts. Additionally, we support the thesis that cooperative and preventive attitudes are the most rational and beneficial in any administrative or business environment.

Keywords: contract management, conflict prevention, heavy construction, Cause Marks Theory

INTRODUCTION

Conflicts in Construction

Conflicts in the construction industry move billions of dollars annually. According to an Arcadis study, construction conflicts had an average value of 52,6 million dollars in 2021 and took around 15,4 months to be resolved. In Brazil, this average resolution time in the Judiciary is 31 months (Janone, 2022). The causes of conflicts in Construction are pointed out by HKA.

TABLE 1
GLOBAL TOP CAUSES OF CLAIMS OR DISPUTE. PERCENTUAL OF PROJECTS CONTAINING THOSE CAUSES

Global top causes of claim or dispute			
Cause	**Group**	**Percentual (%)**	**Rank**
Change in scope	Design	38,80%	1
Design was incorrect	Design	23,00%	2
Contract interpretation issues	Contractor	19,80%	3
Design information was issued late	Design	22,50%	4
Design was incomplete	Design	21,70%	5
Contract management and/or administration failure	Contractor	19,50%	6
Poor management of subcontractor/supplier and/or their interfaces	Area	19,40%	7
Access to site/workface was restricted and/or late	Area	17,90%	8
Physical conditions were unforeseen	Area	17,80%	9
Workmanship deficiencies	Contractor	17,50%	10

According to HKA, approximately 74% of conflict occurrences are related to design failures, as well as site issues involving costs and project management. These factors, often present in large ventures, represent 7 of the top 10 largest construction projects analyzed. This study aligns with previous analyses in determining the Three-Dimensionality of Contract Management.

What Is Preventive Contract Management?

Preventive contract management is a strategic and systematic approach aimed at the efficient management of contracts, focusing on anticipating problems and mitigating risks before they materialize (Haapio et al., 2007). In an increasingly complex and dynamic business environment, where contractual relationships involve multiple stakeholders and variables, prevention is crucial to ensuring compliance with obligations and minimizing disputes. Unlike reactive management, which addresses problems only after they occur, preventive contract management adopts a proactive stance, focusing on identifying potential vulnerabilities, strengthening contractual mechanisms, and ensuring alignment among all parties involved from conception through execution.

In this context, preventive contract management transcends traditional contract management practices by integrating disciplines such as risk analysis, corporate governance, regulatory compliance, and strategic planning. The preventive approach not only reduces costs associated with litigation and contractual failures but also strengthens business relationships, improves operational efficiency, and protects the organizational reputation.

Introduction to the Cause Marks Theory

A mark can be understood as a signal, record, or form of information (Costa, 2023). According to Russell's probabilistic directed determinism (predictive determinism), "an event E1 determines another

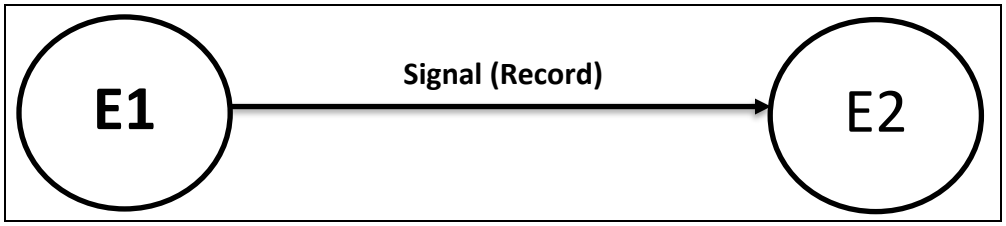
event E2 if and only if, given the occurrence of E1 at time t, the occurrence of E2 at a later time t' is probable" (Russell, 2003 [1913], p. 176).

However, paradoxes suggest that causality cannot be reduced solely to probability. If an unlikely coincidence occurs, there must be a common cause (Reichenbach, 1956 [1971], p. 157), which compartmentalizes its effects (Costa, 2023, p. 100).

Signal Transmission

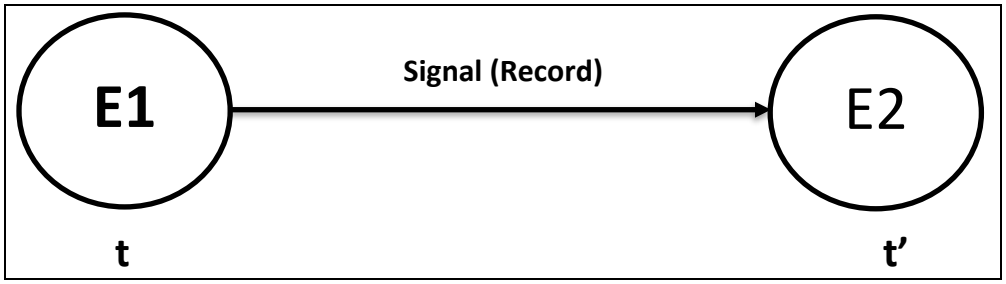
E1, or any other notation representing an event, refers to recurring elements in the cause of conflicts, while E2 represents the conflicts themselves.

FIGURE 1
SIGNAL TRANSMISSION



If event E1 occurs at time t' and transmits a signal to E2, and this signal reaches E2, then E2 occurs at time t". The direction of signal propagation thus determines both the temporal orientation and the timing of the event. The faster the signal transmission is, the faster the progression of time.

FIGURE 2
SIGNAL TRANSMISSION AMD TIME DIRECTION



Criteria for the Transmission of Cause Marks

Regarding the criteria for cause mark transmission, Reichenbach (1958 [1928], p. 136) states that, "if E1 is the cause of E2, then a small variation (a mark) in E1 is associated with a small variation in E2, whereas small variations in E2 are not associated with changes in E1."

A causal process is defined by its structural consistency over time, transmitting marks across a space-time interval while remaining within the speed-of-light limit. A mark is generated instantaneously at the moment of interaction and remains unchanged throughout its propagation unless additional local interactions occur (Costa, 2023).

Costa further explains that "if E1 is the cause of E2, then a signal from E1 can be transmitted to E2 within the limit of the speed of light, whereas signals from E2 cannot be transmitted back to E1" (Costa, 2023).

Therefore, the transmission of cause marks has a temporal dimension. As a logical consequence of the previous principles, a mark introduced in event E1 determines event E2, and the faster the introduction and transmission of the mark, the sooner event E2 is realized.

Practical Application of Cause Marks

Applying *Cause Marks* in contractual settings enhances the ability to identify early indicators of potential disputes. By ensuring clear, objective documentation, parties to a contract can minimize risks and streamline conflict-resolution mechanisms. This aligns with previous studies showing that structured documentation correlates with lower claim rates and faster resolution times.

The Contract as a Pillar of Legal and Commercial Relationships

Before understanding preventive contract management, it is essential to grasp the central role of contracts in commercial relationships (Hart; Moore et al., 2008). A contract is, in essence, a legally binding agreement that establishes the rights, duties, and obligations between the parties. It serves as a tool to formalize expectations, protect interests, and ensure the execution of mutual objectives. However, the complexity and specificity of many modern contracts create significant challenges.

Issues such as contractual ambiguities, changes in market conditions, communication failures between parties, and regulatory changes can compromise contract performance and lead to disputes. In this scenario, traditional contract management is often insufficient. The lack of continuous monitoring and preventive measures can expose parties to unnecessary risks, leading to financial losses, project delays, and reputational damage.

Preventive contract management, therefore, emerges as a response to these gaps, promoting Practices that anticipate problems and enable timely adjustments.

Fundamental Principles of Preventive Contract Management

Preventive contract management is guided by principles that ensure its effectiveness and comprehensiveness (Siedel, 2013). Among the most relevant are the principles of risk anticipation, clarity and precision, continuous monitoring, efficient communication, and flexibility and adaptability.

The principle of risk anticipation is tied to the idea that identifying and assessing potential risks from the contract drafting phase is critically important for contractual success. This involves analyzing sensitive clauses, anticipating scenarios of non-compliance, and evaluating the impact of external factors such as legislative changes. Meanwhile, the principle of clarity and precision emphasizes that drafting clear, objective contracts with legally robust language is essential to avoid ambiguities that could lead to disputes. Detailed definitions of responsibilities, timelines, and performance criteria are also crucial.

According to the principle of continuous monitoring, preventive contract management requires constant oversight of the parties' performance and compliance with contractual obligations. This involves using management tools to track milestones, deadlines, and deliverables. The principle of efficient communication, on the other hand, underscores the importance of maintaining open and transparent communication between the parties to align expectations and collaboratively address emerging issues. A lack of dialogue can exacerbate minor problems and escalate them into major conflicts.

Finally, we have the principle of flexibility and adaptability. According to this principle, in a constantly changing world, contracts should be drafted to allow for adjustments in the face of unforeseen circumstances without compromising the balance between the parties.

Benefits of Preventive Contract Management

The adoption of preventive practices in contract management provides organizations with a range of tangible and intangible benefits. Among the most significant are cost reduction, improved operational efficiency, strengthened business relationships, legal security, and reputation protection. Given that litigation and contractual delays represent significant costs for companies, it is reasonable to consider preventive management as a cost-saving tool, as it helps avoid expenses associated with legal disputes, fines, and penalties. In this sense, there is a higher likelihood of cost reduction when opting for preventive contract management.

By promoting an organized, well-structured management of contracts, the preventive approach contributes to optimizing resources and delivering results as planned. Thus, this form of management leads to the highest possible operational efficiency. Similarly, given that a proactive stance demonstrates commitment to the success of the contractual relationship — strengthening trust and collaboration between the parties — it follows that anticipating the possibility of conflicts is the most suitable approach to strengthening business relationships.

Preventive contract management also ensures that contracts comply with legal and regulatory standards, reducing the risks of sanctions and legal liabilities. In this sense, legal security appears as one of the benefits of this form of contract management. Correspondingly, preventive contract management addresses potential crises that could harm the organization's image with stakeholders and the market. Thus, reputation protection is also contingent upon the choice of preventive contract management.

Practical Application of Preventive Contract Management

Preventive contract management can be applied across sectors, including construction, information technology, healthcare, and government relations. Each sector has specificities that require special attention in the drafting and execution of contracts.

In construction, preventive contract management can be crucial, as delays and disputes are common. This type of contract management may include the definition of performance clauses, detailed timelines, and conflict resolution mechanisms.

In the technology sector, on the other hand, some software contracts often involve issues related to intellectual property, confidentiality, and delivery deadlines. The preventive approach ensures that these aspects are addressed with clarity.

In the healthcare sector, contracts with suppliers and service providers must align with regulations and include measures to ensure the quality and safety of services. In the public sector, government contracts require a high level of transparency and compliance with specific standards. Preventive contract management is essential to mitigate risks of corruption and mismanagement.

Data Analysis

In this section, we will analyze data on the extent of losses and damages that the lack of preventive contract management may cause. Through a selection of contracts with and without preventive monitoring, we will quantitatively assess the occurrence of economic-financial rebalancing ("CLAIMS").

Analysis Methodology

To analyze the effectiveness of *Cause Marks* in conflict prevention, this study examines contracts in heavy construction and electromechanical assembly. By structuring event records (*E1*) and tracking their impact on conflicts (*E2*), we assess how clear documentation influences dispute resolution. The analysis quantifies financial losses and resolution times, comparing projects with structured contract management to those without.

For this study, a sample of 324 contracts from construction projects was gathered, involving companies acting as both clients and contractors. Contract values ranged from R$1,000,760.00 to R$1,542,051,468.49, with an average of R$105,925,049.75. This broad range reflects the diversity in scale and complexity of the projects included in the analysis. Converted to USD, the average value was approximately $17.5 million, facilitating comparison with international standards.

The next step was to categorize these contracts into two distinct groups to enable a clearer comparative analysis. The first group, referred to as "Group 1," comprised contracts that incorporated Contract Management from the early stages. The second group, "Group 2," included contracts that lacked structured supervision during execution. After classification, the distribution was as follows: 120 of the 324 contracts belonged to Group 1, while the remaining 204 were in Group 2.

Subsequently, we assessed the damage, known as "CLAIMS", incurred by each contract. This process involved a thorough review of documents, correspondence, claims, and the values reported. Even in cases

where damages were not fully compensated, they were calculated and recorded. This approach ensured that all potential financial impacts were considered, providing a comprehensive view of the incurred damages.

The damage values were then related to the respective contract amounts, using the total project value as a reference. By dividing the damage amount by the total contract value, a standardized metric was obtained, facilitating comparison across different projects.

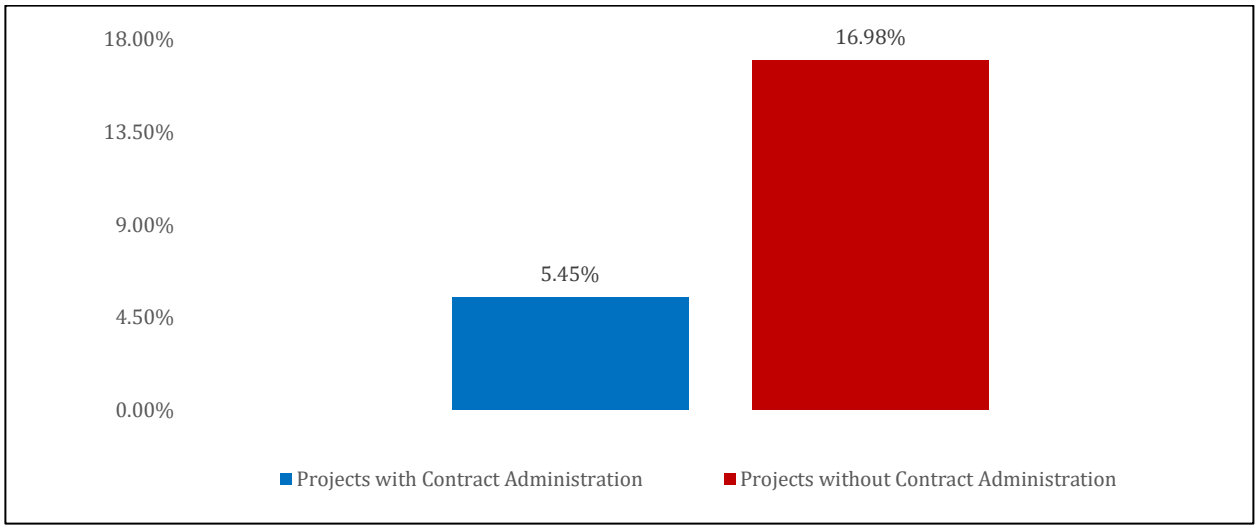
Separate spreadsheets were created for each group: one for Group 1 and another for Group 2. In each spreadsheet, we aggregated the total contract values and respective damage amounts. From the sum of these figures, it was possible to calculate the proportion of total damages relative to the total contract value for each group, providing a detailed view of the financial impact within each category.

The three scenarios analyzed in this study are presented below.

Scenario 1

In the first analysis, encompassing all 324 contracts, Group 1 (projects with Contract Management) reported a damage rate of 5.45% relative to contract values. In contrast, Group 2, comprising projects without Contract Management, showed an average damage percentage of 16.98%, highlighting greater vulnerability and financial exposure in projects without structured management.

FIGURE 3
SCENARIO 1- DAMAGE PERCENTAGE



Scenario 2

Focusing specifically on the contracts of one of the world's largest mining companies, a leader in the production of iron ore and nickel, operating in over 30 countries. This company stands out for its extensive logistical infrastructure, including railways and ports, and employs thousands of people. Considering its vast global impact, we applied the same methodology to analyze the effect of Contract Management in 70 of its projects, totaling approximately R$ 6.7 billion (around USD 1.11 billion).

The results align with the general findings but are even more significant. In "Group 1," comprising 48 projects under Contract Management, the average damage rate was 4.14%. In comparison, "Group 2", with 22 projects without this oversight, exhibited an average damage rate of 38.28%.

Financially, even with 26 additional projects in the group with Contract Management, the damages in contracts without this practice were approximately R$ 344 million higher (equivalent to USD 57 million, based on the exchange rate of 15/01/2025: 1 USD = 6.0377 BRL), highlighting the substantial impact of a structured Contract Management approach.

FIGURE 4
MINING SECTOR PROJECTS - MONETARY DAMAGE IN USD

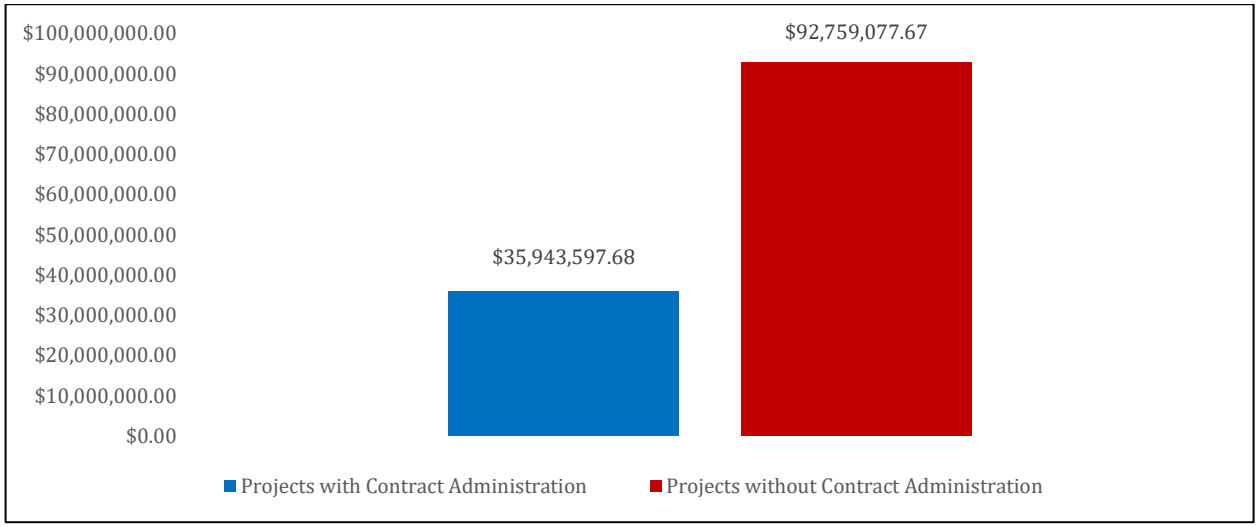
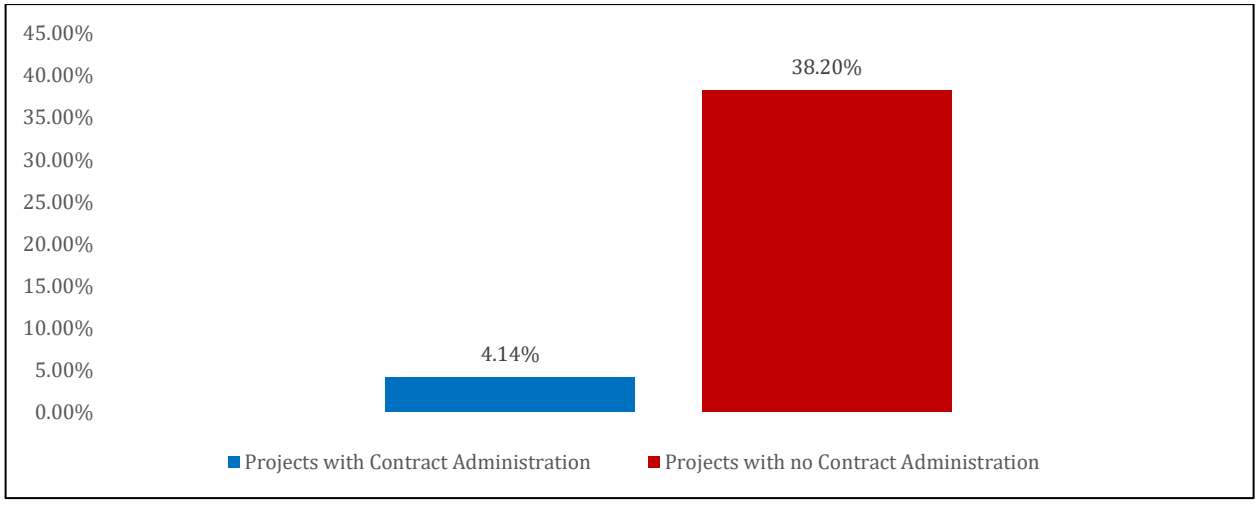


FIGURE 5
MINING SECTOR PROJECTS - DAMAGE PERCENTAGE

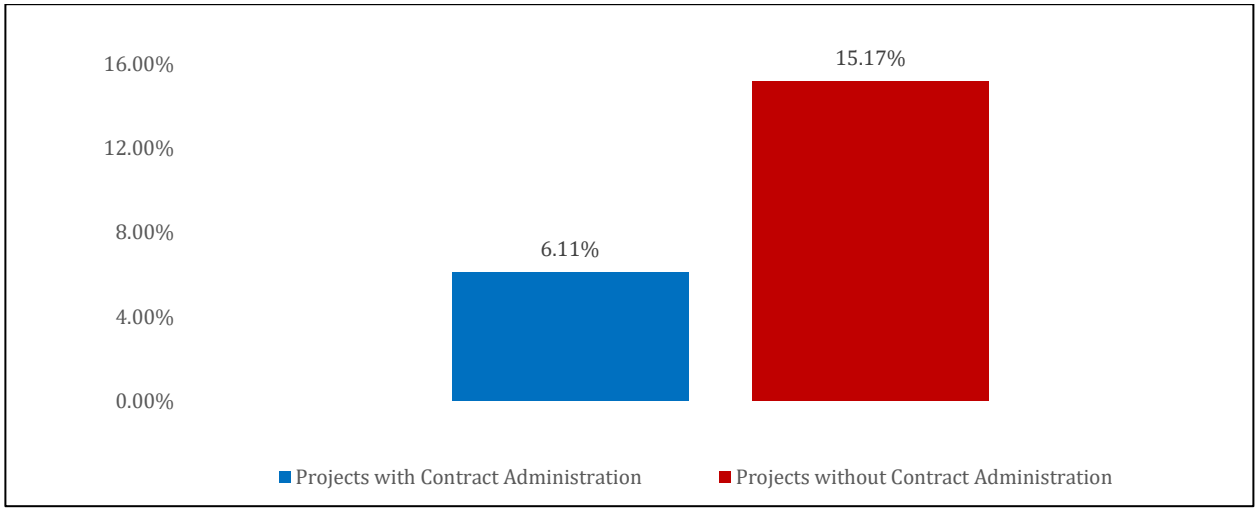


Scenario 3

In the third and final scenario, we focused our analysis on contracts that excluded the projects from the large mining company previously mentioned. This set also comprises contracts from various sectors, each with distinct characteristics in terms of complexity, scope, and contractual structure. Within this set, Group 1 contracts, which implemented Contract Management practices from the outset, recorded an average damage rate of 6.11% of the contract values.

In contrast, Group 2, comprising contracts that did not follow a structured Contract Management approach, showed a significantly higher average damage rate of 15.17% of contract value. The results obtained in this scenario complement previous findings, offering further insights into the implications of different approaches to contract administration.

FIGURE 6
SCENARIO 3 - DAMAGE PERCENTAGE



FINAL CONSIDERATIONS

This study demonstrates that Preventive Contract Management (PCM) significantly reduces disputes and financial damages in heavy construction and electromechanical assembly projects. The analysis of 324 contracts reveals a clear correlation between structured contract management and lower conflict rates, reinforcing the thesis that a preventive and cooperative approach is the most rational business strategy. Despite its demonstrated effectiveness, PCM remains underutilized across many organizations. Interestingly, this does not appear to be due to financial constraints, as the costs of implementing structured contract management are substantially lower than the financial losses caused by disputes and inefficiencies. Instead, cultural and organizational barriers persist, preventing broader adoption.

There is still a stigma surrounding contract management, particularly in more conservative industries or among teams that maintain a reactive rather than preventive mindset. Many companies remain attached to traditional models, treating contract administration as a bureaucratic function rather than a strategic tool for risk mitigation and efficiency. This resistance highlights the need to shift perceptions, demonstrating that PCM is not merely about compliance but serves as a critical mechanism for improving outcomes and preventing conflicts before they arise.

In this context, the Cause Marks theory provides a structured foundation for understanding and improving contract management. Just as in causal models, where an initial event (E1) leads to subsequent effects (E2), the absence of clear, structured records in contract management increases the likelihood of disputes. The proper transmission and preservation of information over time reduce ambiguities and prevent contractual risks from escalating. The quantitative analysis reinforces this causal relationship: contracts with structured records (E1) showed a lower incidence of disputes (E2), proving that clarity and organization in documentation directly contribute to minimizing financial and operational risks.

By reinforcing the economic and strategic benefits of PCM, this study underscores the need to transition from a reactive to a preventive stance in contract administration. More than just a theoretical approach, this shift represents an evidence-based strategy that enhances efficiency, reduces disputes, and strengthens business relationships. The Cause Marks theory further supports this perspective by demonstrating that structured documentation and clear contractual records serve as essential mechanisms for risk mitigation. Ultimately, adopting preventive management practices is not merely a best practice but a fundamental step toward ensuring contractual sustainability, predictability, and long-term business stability.

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