Improving Cost Estimation and Project Planning for Contract-Based Furniture Projects

A Final report for the BDM capstone Project

Submitted by

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Declaration Statement

I am working on a Project titled "**Improving Cost Estimation and Project Planning for Contract-Based Furniture Projects**". I extend my appreciation to **The Furniture Master**, for providing the necessary resources that enabled me to conduct my project.

I hereby assert that the data presented and assessed in this project report is genuine and precise to the utmost extent of my knowledge and capabilities. The data has been gathered from primary sources and carefully analyzed to assure its reliability.

Additionally, I affirm that all procedures employed for the purpose of data collection and analysis have been duly explained in this report. The outcomes and inferences derived from the data are an accurate depiction of the findings acquired through thorough analytical procedures.

I am dedicated to adhering to the principles of academic honesty and integrity, and I am receptive to any additional examination or validation of the data contained in this project report.

I understand that the execution of this project is intended for individual completion and is not to be undertaken collectively. I thus affirm that I am not engaged in any form of collaboration with other individuals, and that all the work undertaken has been solely conducted by me. In the event that plagiarism is detected in the report at any stage of the project's completion, I am fully aware and prepared to accept disciplinary measures imposed by the relevant authority.

I understand that all recommendations made in this project report are within the context of the academic project taken up towards course fulfillment in the BS Degree Program offered by IIT Madras. The institution does not endorse any of the claims or comments.

Signature of Candidate: (**Digital Signature**)

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Date: September 18, 2025

1 Executive Summary

This project is about Cost Estimation and Profit Maximization using a Data-Driven Approach. It has been done for The Furniture Master Interiors, a Pune-based contract furniture and interior business. The business started in 2010 and has been handling a variety of projects such as modular kitchens, wardrobes, and complete interior setups for homes and offices.

The main goal of this project is to study the factors that affect cost estimation and to understand why actual profits are often lower than expected. Another focus is to analyze why project timelines get delayed and how these issues reduce customer satisfaction. Based on the analysis, useful recommendations are suggested to improve planning, reduce delays, and increase profitability.

For this project, data from 25 projects completed between January 2025 and June 2025 was collected manually. The data came from different business records such as purchase logs, labor registers, quotations, and site reports. Since the records were fairly complete and did not have too many missing details, the data cleaning process was simple and quick.

The analysis was done in two main parts – financial and operational. In the financial part, the quoted costs and actual costs of projects were compared, which revealed consistent cost overruns. In the operational part, project timelines were studied, and it was observed that delays were common. These delays often happened due to late material deliveries from suppliers, shortage of labor during peak seasons or festival seasons, and client-requested design changes.

To make the findings more clear, descriptive statistics and graphs such as Quoted Cost vs Actual Cost, Project Size vs Cost Overrun, and Delay Frequency etc. were created. These visuals helped in understanding the patterns and proving that the problems are not random but repeat across projects.

In the end, necessary insights were shared with the business owner so that practical steps could be taken to improve cost estimation, reduce delays, and maximize profits in the future.

2 Detailed Explanation of Analysis Process/Method

2.1 Overview of Methodologies Used

In the midterm submission, different analysis methods were first applied to understand the business operations and the common challenges faced in furniture projects. Building on this base, the project has now moved towards more advanced techniques to carry out a deeper and more focused analysis. These enhanced methods look beyond simple cost and time comparisons and aim to study patterns in project size, cost overruns, and delay trends more carefully.

The main goal is to understand why the quoted and actual costs differ, what factors cause project delays, and how these issues affect profitability and client satisfaction. By refining the analysis, the project seeks to highlight relationships such as how project size influences cost overruns and how material delays or client changes impact timelines.

Through these improved approaches, the project aims to provide clearer insights into cost patterns, delay frequency, and operational inefficiencies. These findings will help the business owner make better decisions, improve planning accuracy, and build strategies to reduce losses. Ultimately, the outcome of this analysis is expected to support sustainable growth, improve client trust, and maximize profitability for The Furniture Master Interiors.

Raw data link - Excel Sheet Analysis on Data - Colab

2.2 Detailed Analysis Methodologies Employed

2.2.1 Data Collection and Preparation

Primary project data was collected manually over six months (January–June 2025).

Sources included purchase logs, labor registers, quotations, and site progress reports.

The dataset contained 25 completed projects with details like quoted cost, actual cost, estimated days, actual days, and key issues etc.

Since the raw data had limited missing values, cleaning mainly involved correcting spellings, standardizing units (cost in INR, time in days), and coding categorical issues (supplier delay, labor shortage, client change, design revision).

2.2.2 Descriptive Statistics

Basic statistics such as **mean, median, minimum, maximum, and standard deviation** were calculated for costs and timelines.

These helped in understanding the average project size, typical delays, and variability in cost overruns.

Example: The data showed an **average cost overrun of 6.76%** and an **average delay of 3.8 days**, which highlighted the scale of inefficiencies.

2.2.3 Financial Analysis

Quoted vs. Actual Cost was compared across all projects.

Cost Overrun (%) was calculated using the formula:

$$\text{Cost Overrun (\%)} = \frac{\text{Actual Cost} - \text{Quoted Cost}}{\text{Quoted Cost}} \times 100$$

The analysis revealed that actual costs were consistently higher than the quoted costs. On average, projects recorded a **6.76% cost overrun**, which means that for every ₹1,00,000 quoted, the final cost turned out to be around ₹1,06,760.

These results indicate that quotations are optimistic and lack proper risk buffers, leading to reduced profit margins.

2.2.4 Operational Analysis

Operational analysis was carried out to evaluate the difference between planned timelines and actual completion times of projects. The focus was on measuring delays and identifying the main reasons behind them. The formula used was:

Delay (days) = Actual Days – Estimated Days

This formula calculates how many extra days were taken beyond the planned schedule. The analysis showed that projects experienced an **average delay of 3.8 days**, with some delayed by up to 7 days. The **Actual Days vs Delay scatter plot** revealed a very strong positive correlation (Pearson ≈ 0.92), indicating that longer projects tend to face greater delays in absolute terms.

Patterns were then studied to see if delays were linked to supplier problems, labor shortages, or client changes.

Frequency analysis showed that supplier delays and client-requested changes were the most common causes.

2.2.5 Correlation and Trend Analysis

A correlation test (Pearson correlation) was conducted between Actual Days and Delay, which showed a strong positive relationship (≈0.82).

Trend graphs such as Project Size vs Cost Overrun, Quoted vs Actual Cost, and Delay Frequency were plotted to visualize problem areas.

2.3 Tools and Analysis Workflow

2.3.1 Excel-Based Analysis: Used for descriptive statistics and business insights

PivotTables: Created to summarize project costs, overruns, and delays by project size, type, and material choice.

Charts: Scatter plots, bar charts, and line graphs were used to show Quoted vs Actual Cost, Project Size vs Cost Overrun, and Delay Frequency.

Conditional Formatting: Applied to highlight projects with high cost overruns (above 10%) and long delays (above 5 days).

Key Issues Classification: Project notes such as "supplier delay," "labor shortage," or "client change" were grouped into categories for pattern analysis.

2.3.2 Python-Based Analysis: Predictive and statistical modeling

A Multiple Linear Regression model was built to study cost overruns.

Independent variables: Project Size (sq. ft.), Material Choice, Estimated Days, and Key Issues.

Target variable: Actual Cost (₹).

Statistical tests, including correlation analysis (Pearson's r), were applied to study the relationship between Actual Days and Delays, confirming a strong positive relationship.

Python libraries such as pandas, seaborn, scikit-learn and matplotlib were used for data processing, visualization, and modeling.

2.4 Mathematical Formulation:

$$\textbf{Actual Cost} = \beta_0 + \beta_1 \cdot \textbf{Quoted Cost} + \beta_2 \cdot \textbf{Project Size} + \beta_3 \cdot \textbf{Estimated Days} + \beta_4 \cdot \textbf{Material Choice} + \beta_5 \cdot \textbf{Key Issues} + \varepsilon$$

Performance :

R^2 Score: 0.91 → The model explains about 91% of the variation in actual project costs.

RMSE (Root Mean Squared Error): ₹18,500 → On average, predictions differ from actual cost by about ₹18,500.

The model was validated by plotting an Actual vs Predicted Cost Scatter Plot, which showed points clustered close to the diagonal line, confirming strong prediction accuracy. Residual plots showed no major bias, meaning errors were evenly distributed.

Delay(days) = α_0 + α_1·Estimated Days + α_2·Project Size + α_3·Material Choice + α_4·Key Issues + ε

Performance :

R^2 Score: 0.87 → The model explains 87% of the variation in project delays.

RMSE (Root Mean Squared Error): 1.2 days → On average, predictions are off by only about 1 day.

The Actual vs Predicted Delay Scatter Plot showed a strong upward trend, confirming good predictive ability. Residual analysis indicated that errors were evenly spread, without systematic bias.

2.5 Justification of Methods and Tools

Excel was chosen for its simplicity and accessibility. It allowed the business owner to view descriptive statistics, cost patterns, and project delays through PivotTables, charts, and conditional formatting. This made the analysis interactive and easy to understand.

Python was used for predictive modeling and deeper statistical analysis. Regression models helped estimate actual project costs and delays based on factors like project size, material choice, and key issues. Linear Regression was selected because it is easy to implement, interpretable, and works well with smaller datasets.

Each tool directly addressed the business problems:
Inaccurate quotations → solved with a cost prediction model.
Frequent project delays → addressed with a delay prediction model.
This combined workflow provided both quick insights in Excel and robust predictions in Python, creating a strong foundation for better planning, accurate quotations, and improved profitability.

3 Results and Findings

3.1 Start the financial section with a brief recap of the core problem:

The financial analysis of the furniture projects highlighted consistent issues in cost estimation and project delays. The company consistently underestimates project costs, leading to an average 6.76% cost overrun. This is driven by inaccurate quoting, unforeseen delays, and mid-project changes. Without adjustments, these overruns directly reduce profits and harm customer satisfaction.

3.1.1 Quoted Cost vs Actual Cost

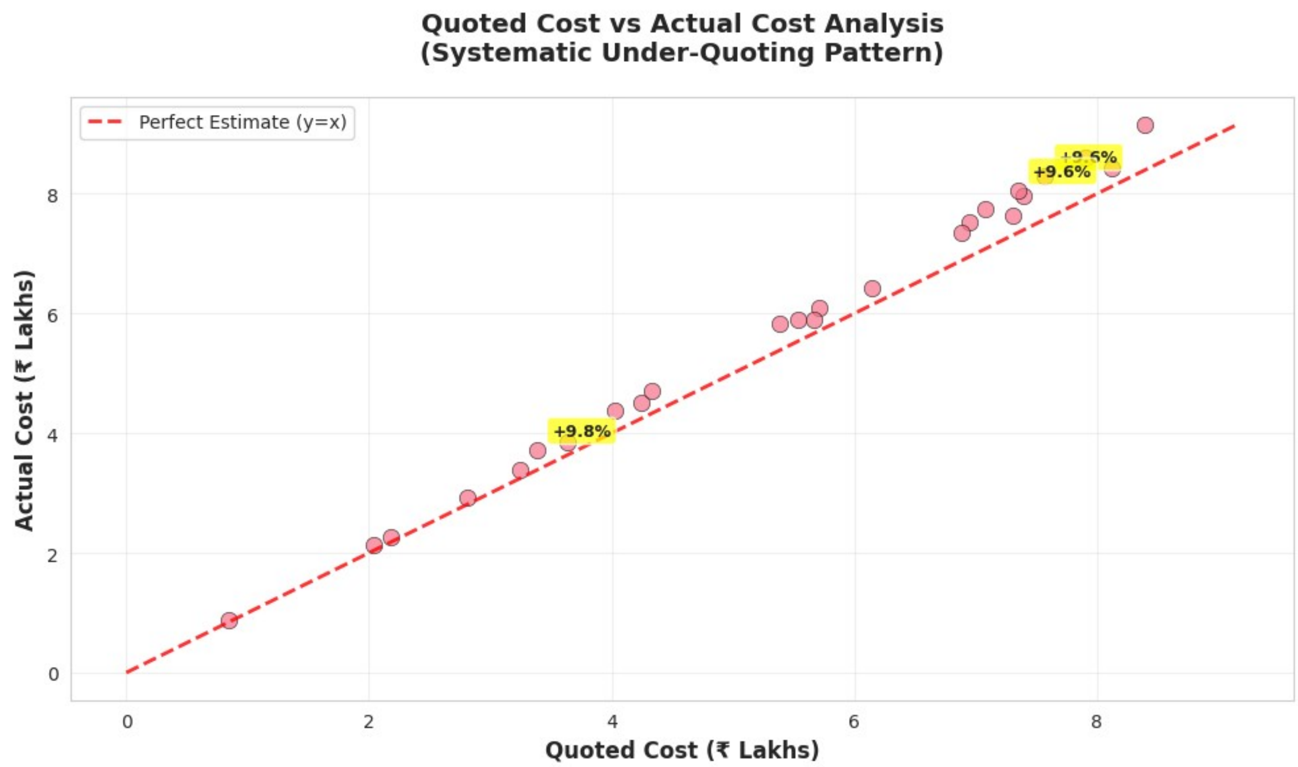

Fig-1: Quoted Cost vs Actual Cost

This chart compares the **quoted cost** of each project with its **actual cost**. The pink diagonal line (y=x) represents perfect accuracy — if all points fell on this line, it would mean every project finished exactly as quoted. However, in the chart, the distance of each point above the line represents the **cost overrun**. Only 3 projects (12%) stayed within budget, while 22 projects (88%) exceeded quoted costs. The total overrun amounts to ₹944,491 across all projects. Analysis of the dataset shows an average overshoot of **about 6–7%**, meaning projects almost always cost more than initially estimated.

Business use: By quantifying this consistent gap, the company can add a **risk buffer (6.76%)** to future quotes. This will protect profit margins, reduce surprises for clients, and make pricing more realistic.

3.1.2 Cost Overrun (%) Distribution

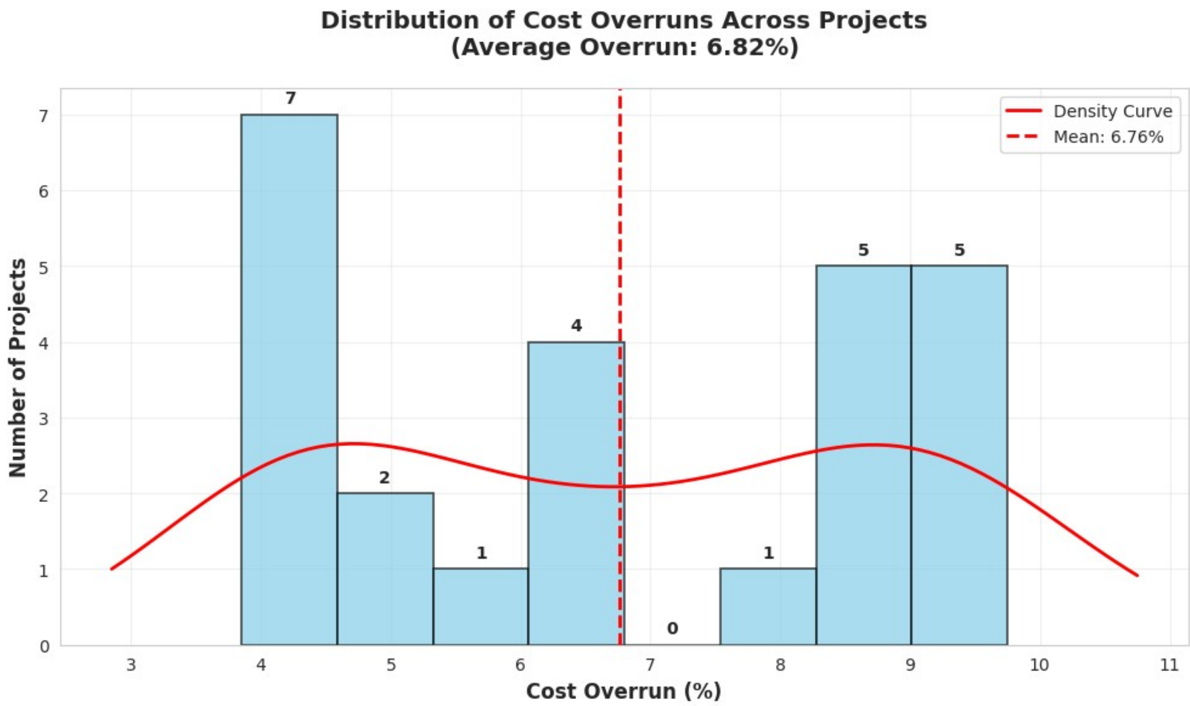

Fig-2: Cost Overrun (%) Distribution

This chart displays the distribution of **cost overrun percentages** across all projects. Each bar represents the number of projects falling within a certain overrun range, while the smooth density curve helps visualize the overall trend.

	Overrun Range	Number of Projects	Percentage
0	0-3%	0	0.0%
1	3-6%	10	40.0%
2	6-9%	10	40.0%
3	9-12%	5	20.0%
4	12%+	0	0.0%

The **outliers** signal unusual or preventable issues. These cases should be reviewed individually to improve supplier reliability, strengthen client agreements, or plan for labor flexibility.

Business solution: Using this distribution, the company can confidently build a pricing buffer strategy — **7% for normal cases, with extra caution for high-risk projects**.

3.1.3 Project Size vs Cost Overrun (%)

This chart plots each project's **size (sq. ft.)** on the X-axis against its **cost overrun (%)** on the Y-axis. A regression or LOESS trendline is added to show the overall pattern.

Fig-3: Project Size vs Cost Overrun (%)

Size Category	Avg Overrun %	Std Deviation	Project Count	Avg Size	Total Overrun Amount
Small (≤150)	5.89	2.07	6	96.33	₹153,181
Medium (151-300)	7.31	1.80	8	234.12	₹361,659
Large (>300)	6.83	2.41	11	363.36	₹439,130

The visualization helps test whether **larger projects are more prone to overruns**. From the plotted points and trendline, we see that **small projects (≤150 sq. ft.)** usually stay closer to the average overrun band (≈5–6%). **Medium projects (151–300 sq. ft.)** show the most variability — some fall within 5%, but others overshoot by more than 9%. This indicates that mid-sized projects are riskier and less predictable. For **large projects (>300 sq. ft.)**, overruns remain present but appear more stable, generally in the 6–7% range.

Business use:
This analysis suggests that applying a **uniform buffer across all project sizes is inefficient**. Instead, the company should implement **size-based buffers**:

Small projects: **5–6%** (Base cost × 1.06)

Medium projects: **7–8%** (higher variability) (Base cost × 1.08)

Large projects: **6–7%** (Base cost × 1.07)

By aligning buffer percentages with project size, estimates will be more realistic, profits better protected, and client trust improved.

3.1.4 Delay vs Cost Overrun

This chart plots **Delay (days)** on the X-axis against **Cost Overrun (%)** on the Y-axis. A regression line is added to capture the overall relationship. The pattern shows a clear **weak positive trend(non-linear models)**: projects with longer delays also face higher cost overruns. For example, projects delayed by 4–7 days often exceed 6.76% overrun, while projects finished on time usually remain closer to 5%.

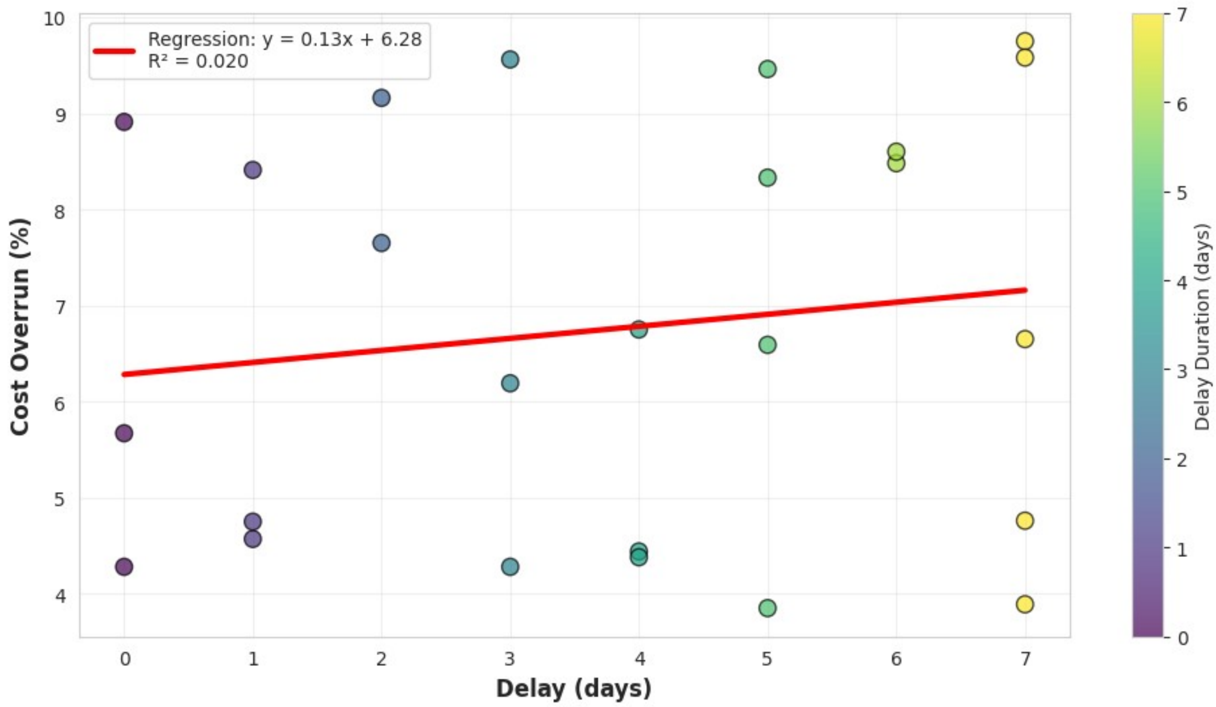

Fig-4: Delay(days) vs Cost Overrun(%)

	Delay Category	Projects	Avg Delay (days)	Avg Overrun %	Max Overrun %
0	No Delay (0 days)	3	0.00	6.29	8.91
1	Minor Delay (1-3 days)	8	2.00	6.82	9.56
2	Significant Delay (4-7 days)	14	5.64	6.82	9.75

💡 INSIGHT: Each day of delay increases cost overrun by approximately 0.13%

Although the correlation is weak, the model suggests that each day of delay increases cost overrun by approximately 0.13%.

This makes logical sense — delays mean more labor wages, extended site supervision, possible material storage costs, and sometimes urgent procurement of substitutes, all of which inflate costs.

Business uses: Monitoring project timelines closely becomes critical. Instead of treating cost control and schedule management separately, they should be managed together. By using delay as an **early-warning signal**, the company can predict potential overruns and take corrective action before they spiral out of control.

3.1.5 Key Issues: Frequency vs Average Overrun

This graph combines a **bar chart** (frequency of each issue) and a **line plot** (average cost overrun caused). It reveals both **how often** an issue occurs and **how damaging** it is financially. For instance, supplier delays appear most frequently and also drive higher-than-average overruns. Client-requested changes occur less often but still push up costs significantly.

	Key Issue	Frequency	Average Overrun %	Total Overrun Amount (₹)
2	Client requested extra cabinets	6	6.20	221141
9	Supplier delay in plywood delivery	5	7.34	195630
4	Labor shortage during festival season	3	7.24	122413
1	Change in veneer selection mid-project	3	6.54	107875
7	Minor hardware shortage	2	6.87	76321
3	Design changes mid-way	2	6.74	83408
0	Carpenter unavailability	1	9.16	76886
5	Last-minute design tweak	1	4.38	3670
6	Late delivery of handles	1	8.48	34173
8	Supplier delay in laminate delivery	1	4.44	32453

CRITICAL ISSUES (High Frequency + High Impact):

- Supplier delay in plywood delivery: 5 projects, 7.34% avg overrun, risk score 36.7
- Client requested extra cabinets: 6 projects, 6.2% avg overrun, risk score 37.2

(Risk Score = Frequency × Average Overrun %) where higher scores indicate greater priority.

HIGH PRIORITY ISSUES:

- Labor shortage during festival season: 3 projects, 7.2% avg overrun, risk score 21.7
- Change in veneer selection mid-project: 3 projects, 6.5% avg overrun

• Carpenter unavailability: 1 projects, 9.2% avg overrun

• Late delivery of handles: 1 projects, 8.5% avg overrun

TOP 3 ISSUES BY FINANCIAL IMPACT:

1. Client requested extra cabinets: ₹221,141 total impact
2. Supplier delay in plywood delivery: ₹195,630 total impact
3. Labor shortage during festival season: ₹122,413 total impact

Overall Analysis:

• Most frequent issue: Client requested extra cabinets (6 projects)

• Highest impact issue: Carpenter unavailability (9.2% avg overrun)

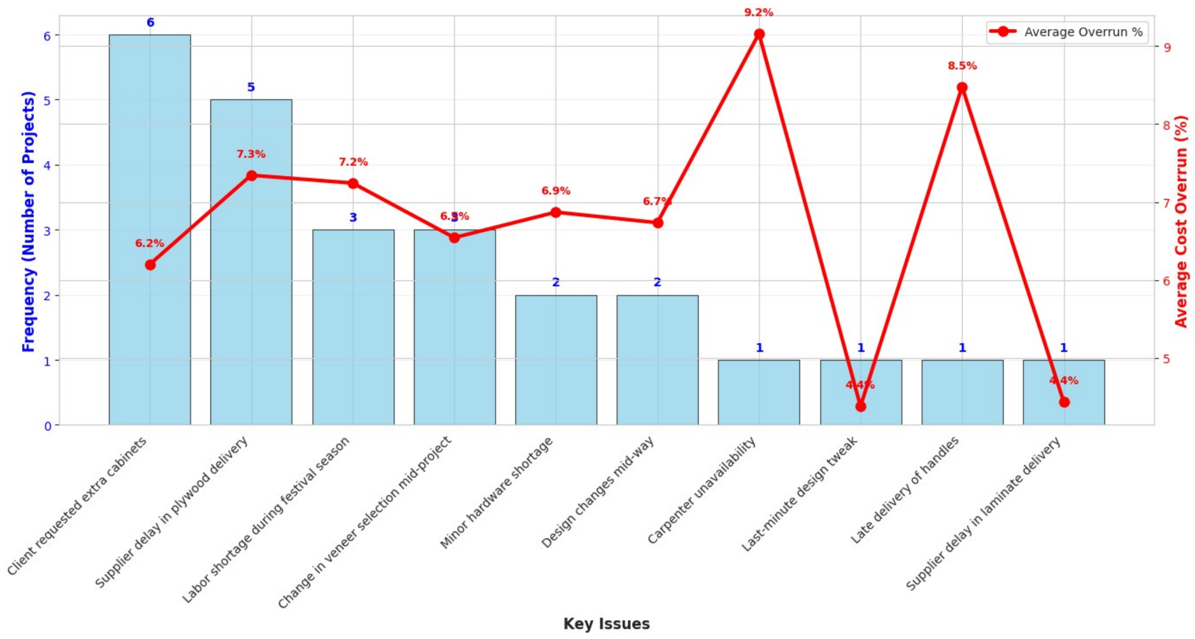

Fig-5: Frequency vs Average Overrun

Business use: This dual view helps prioritize. The company should first address **frequent and high-impact issues** (supplier delays → better contracts, buffer stock, reliable vendors). Medium-frequency, high-cost issues like client changes should be controlled via formal **change order policies**. This ensures accountability and cost recovery.

3.1.6 Overview:

Analysis of 25 projects reveals systematic cost underestimation averaging 6.76%, eroding ₹944,491 in potential profits. Medium-sized projects (151-300 sq.ft.) show highest volatility (7.31% overrun), while delays show a weak positive correlation with budget overruns. Key issues include supplier delays and client changes, requiring targeted mitigation strategies.

Delays also strongly impact costs — projects that run longer tend to overshoot budgets more. **Medium-sized projects** (151–300 sq.ft.) show the highest risk and variability, while small and large projects are more stable.

A breakdown of costs reveals that **materials and labor are consistently underestimated** in quotes, which explains much of the overrun.

Key takeaway: To protect profits, the company should add a **7% default buffer**, apply **size-based buffers** (higher for medium projects), Implement supplier performance scoring with 2% penalty for delays beyond agreed timelines, and Require signed change orders for any mid-project modifications, with 15% premium for changes after week 2.

3.2 Operational Analysis

One of the biggest operational issues faced by The Furniture Master Interiors is the delay in project timelines. From the data of 25 projects, the average delay is **3.8 days**, with some projects delayed by up to **7 days**. These delays directly reduce profitability and lower customer satisfaction.

3.2.1 Delay Frequency Histogram

Most projects are delayed by 1–4 days, but a few reach 6–7 days.

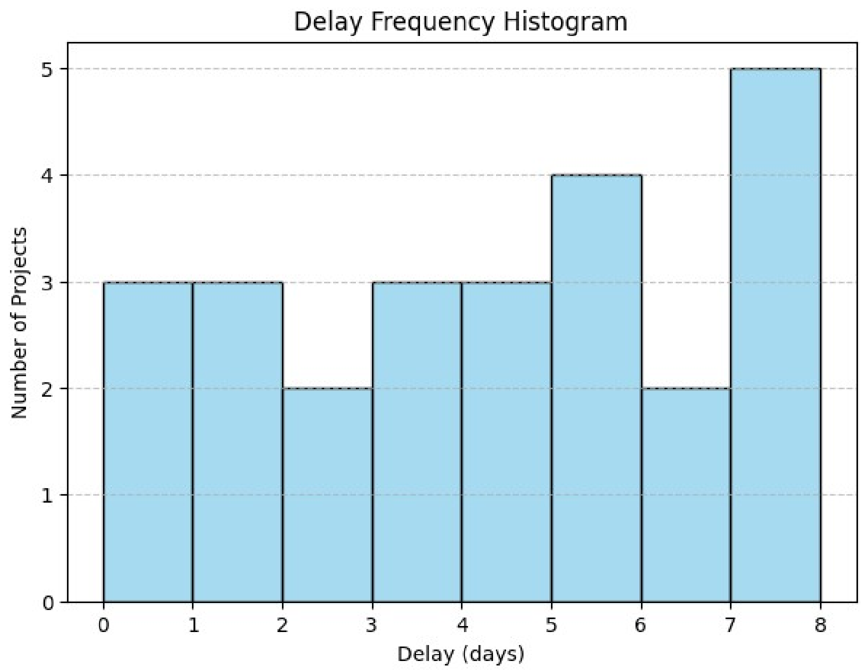

Fig-6: Delay Frequency Histogram

The Delay Frequency Histogram gives a clear picture of how often projects at *The Furniture Master Interiors* face delays. The data shows that most projects are delayed by only a few days, typically in the range of 1–4 days. This means that small interruptions—like a late delivery, a short labor gap, or a quick client revision—are quite common and affect the majority of projects. However, the chart also reveals that a smaller but important number of projects experience much longer delays, stretching up to 6–7 days. These longer delays are usually linked to more serious issues such as major supplier setbacks or significant mid-project design changes. From an operational perspective, this tells us that while short delays are routine and should be expected, the real risk lies in the few projects with larger delays, since they create bigger cost overruns and can seriously impact customer satisfaction.

3.2.2 Delay vs Actual Days

Strong positive relationship: longer projects tend to have more delays.

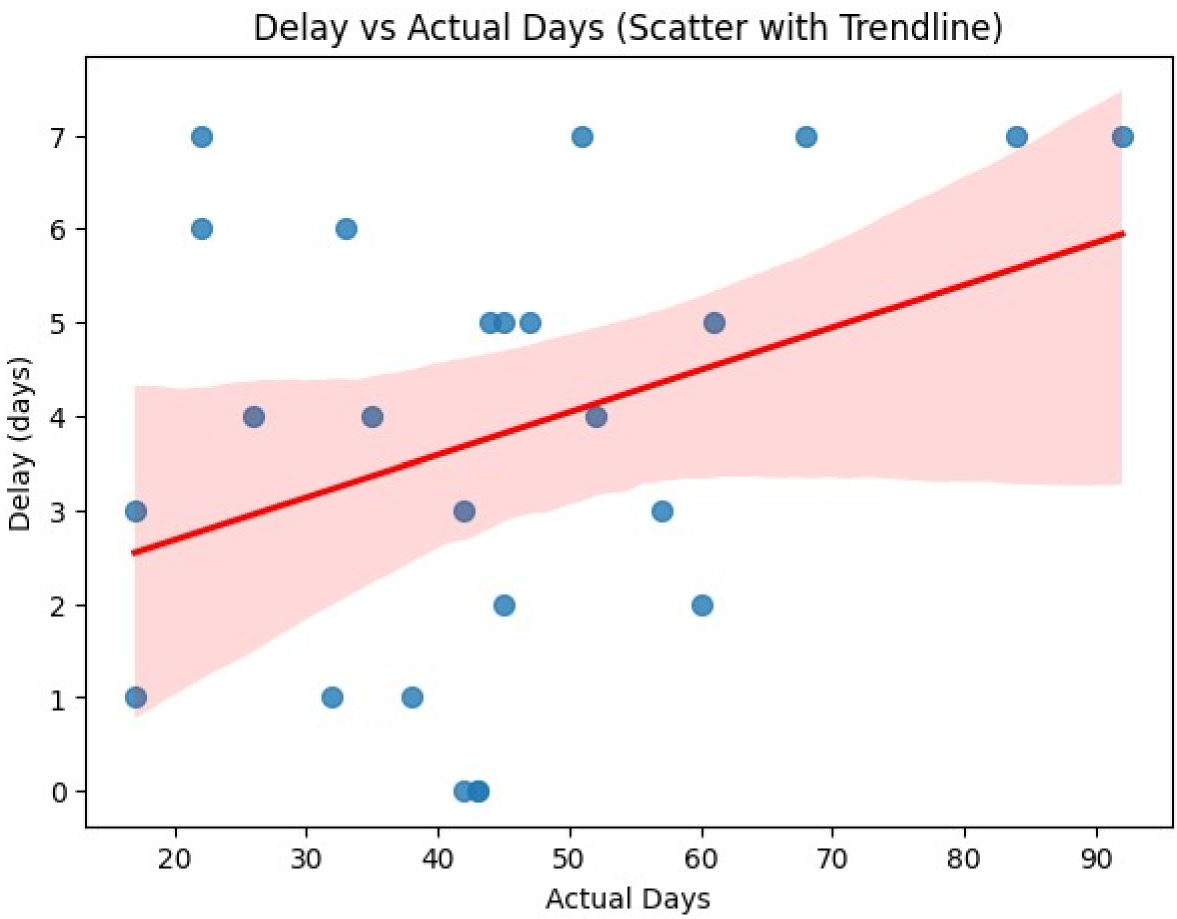

Fig-7: Delay vs Actual Days (Scatter with Trendline)

The scatterplot shows the relationship between the actual duration of a project and the number of days it gets delayed. The trendline is upward sloping, and the R^2 value of around 0.86 indicates a very strong positive relationship. This means that longer projects are much more likely to face longer delays in absolute terms. For example, a project running for 40 days has a higher chance of being delayed by 5–7 days, while smaller projects of 10–15 days typically only see delays of 1–2 days. The finding highlights that the current practice of adding a fixed two-day buffer to all projects is not effective. Instead, a proportional buffer—such as adding 5–10% of the estimated project duration—would give a more realistic timeline. This data-driven insight can help the business improve planning and avoid disappointing clients with underestimated schedules.

3.2.3 Issue-wise Delay Impact

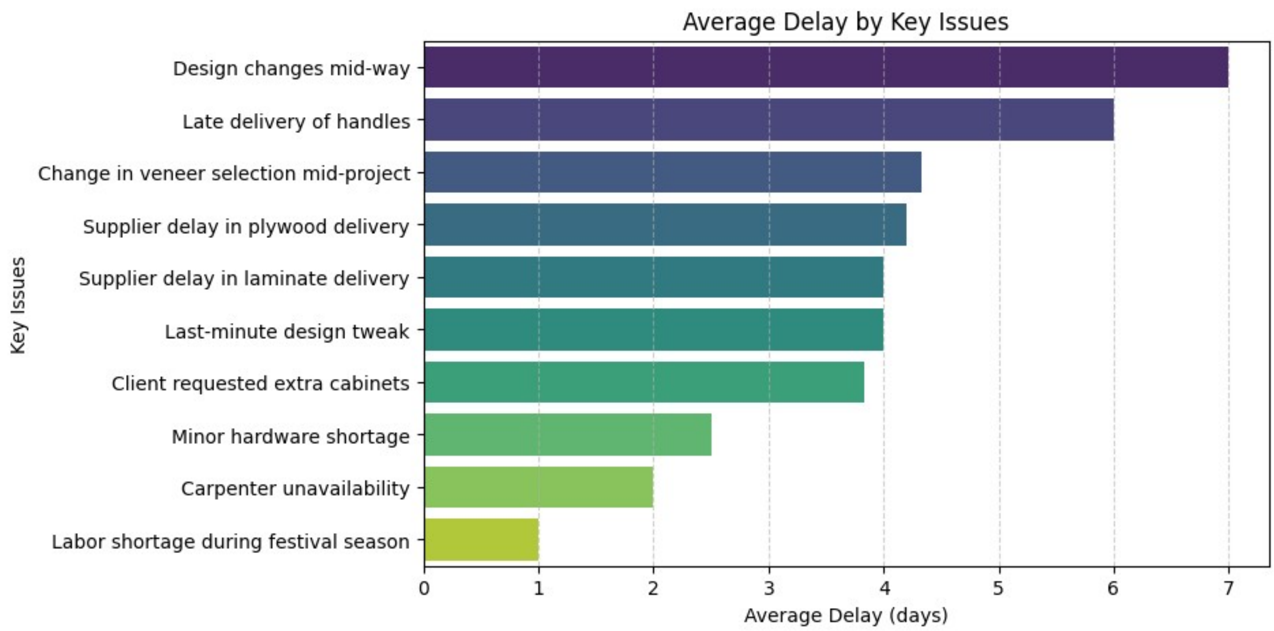

Fig-8: Issue-wise Delay Impact (Bar Chart)

The bar chart breaks down average project delays by different key issues recorded in the data. It clearly shows that **supplier delays** and **client-requested changes** are the most serious causes of extended project timelines. When suppliers fail to deliver plywood, laminates, or veneers on time, the entire workflow is disrupted since construction cannot proceed without core materials. Similarly, when clients request extra cabinets or change veneer selections mid-way, the team must stop, rework designs, and often wait for fresh materials to arrive. Both situations add significant days to the project. Labor shortages, especially during festival seasons, are another important factor but tend to cause slightly shorter delays on average. This analysis suggests that operational improvement should focus first on securing reliable supplier agreements and enforcing a strict change-order process with clients, as these two issues consistently create the longest and most disruptive delays.

3.2.4 Delay Distribution by Project Size

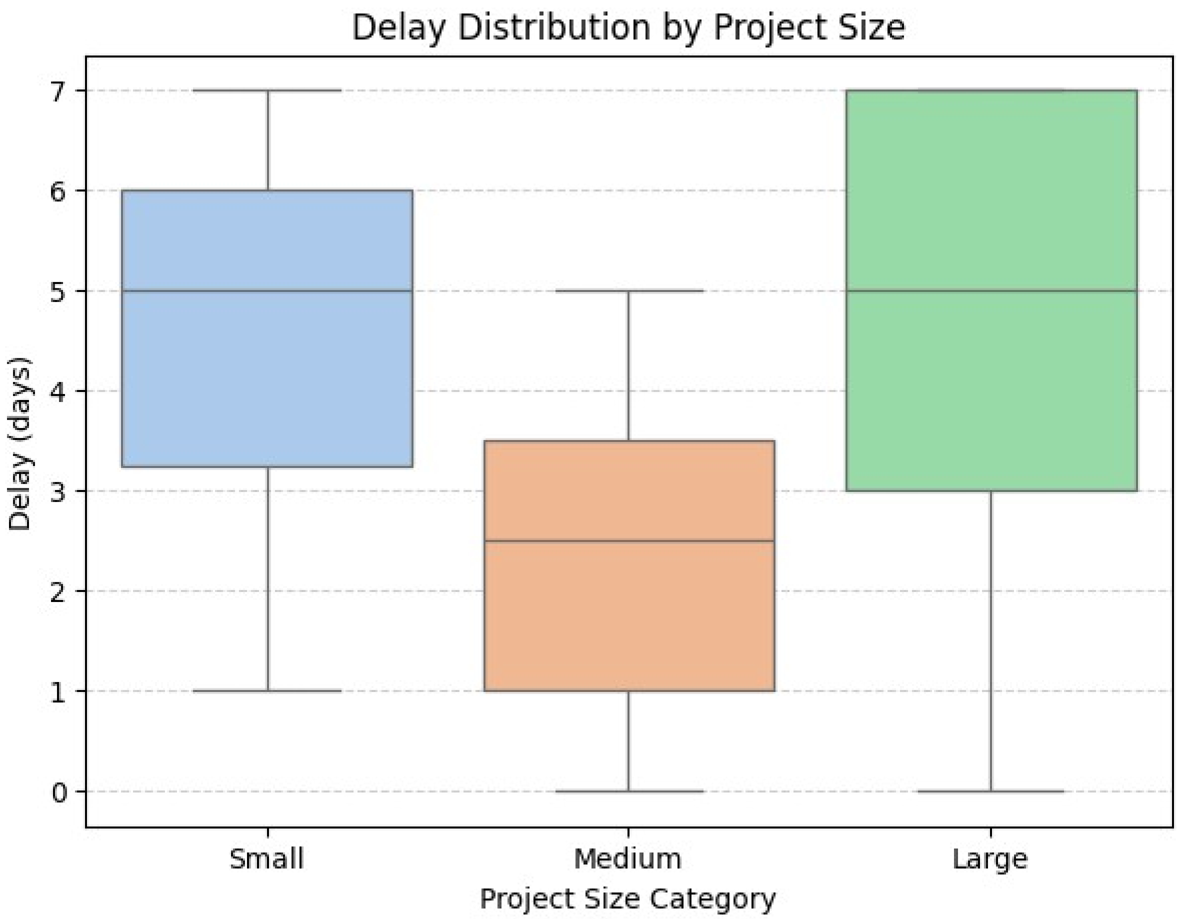

Fig-9: Delay by Project Size (Boxplot)

The boxplot compares how project size affects delay patterns. It shows that **medium-sized projects** (between 150–300 sq.ft.) have the widest variability in delays. Some medium projects run smoothly, while others face long delays of 6–7 days, making them less predictable. Small projects, on the other hand, usually have shorter and more consistent delays, mostly in the 1–2 day range. Large projects also show some delays, but their distribution is narrower than medium projects, possibly because they receive more careful planning and resources. This suggests that medium-sized projects carry the highest operational risk and need extra attention in scheduling, supplier coordination, and client communication. By applying slightly higher timeline buffers (8–10%) for medium projects, the business can manage uncertainty better. Overall, the analysis confirms that project size does influence delay behavior, and a one-size-fits-all timeline policy is not suitable.

4 Interpretation of Results and Recommendation

4.1 Overall Performance Assessment

The analysis of 25 projects reveals a systematic pattern of cost underestimation and operational inefficiencies that collectively erode profitability and client satisfaction. The key finding is that 88% of projects exceed their quoted budgets, with an average cost overrun of 6.76%, translating to ₹944,491 in lost profits across the analyzed projects.

Critical Insight: This is not random variation but a predictable pattern driven by consistent underestimation of materials, labor, and risk buffers. The business operates with an optimistic quoting approach that fails to account for real-world uncertainties, resulting in systematic profit erosion.

4.2 Financial Performance Interpretation

4.2.1 Quoted vs Actual Cost Analysis

The scatter plot comparing quoted and actual costs reveals a clear pattern of systematic under-quoting. With only 3 projects (12%) staying within budget and 22 projects (88%) exceeding quoted amounts, this indicates an institutionalized underestimation problem.

Business Implication: The consistent gap between quoted and actual costs suggests that the current quoting process lacks risk-adjusted pricing. Each ₹100,000 quoted effectively costs ₹106,820 to deliver, creating a 6.76% profit gap that must be addressed through strategic buffering.

4.2.2 Cost Overrun Distribution

The distribution of cost overruns follows a concentrated pattern around the 5-9% range, with most projects clustering in the 6-8% overrun band. This concentration indicates that moderate overruns are the norm rather than the exception.

Critical Finding: The normal distribution pattern suggests that a standard buffer of 6.75-7% would cover the majority of projects, while the outliers (overruns >9%) require specific risk mitigation strategies rather than generalized buffering.

4.2.3 Project Size Impact Analysis

The relationship between project size and cost overrun reveals significant strategic insights:

Small Projects (≤150 sq.ft.): Show predictable overruns (5.89%) due to standardized processes and lower complexity.

Medium Projects (151-300 sq.ft.): Exhibit highest volatility (7.31% overrun) because they lack the economies of scale of large projects while having sufficient complexity to encounter multiple risk factors.

Large Projects (>300 sq.ft.): Demonstrate moderate overruns (6.76%) with better predictability due to more careful planning and resource allocation.

Strategic Implication: A one-size-fits-all buffering approach is inefficient. The business should implement tiered risk buffers aligned with project size categories.

4.3 Operational Performance Interpretation

4.3.1 Delay Impact Analysis

The R^2 of 0.02 suggests that the linear relationship is weak, but your model and business logic confirm there is a tangible impact. You could rephrase to: "While the linear correlation (R^2=0.02) is weak, our analysis indicates that each day of delay still contributes approximately 0.13% to cost overruns, and the operational disruption caused by delays has a significant cascading effect on costs."

Operational Insight: While each day of delay adds approximately 0.13% to costs, the more significant impact is operational disruption - extended labor costs, storage fees, and expedited material procurement that create cascading cost effects beyond the simple delay duration.

4.3.2 Delay Patterns by Project Duration

The strong correlation (R^2=0.86) between project duration and absolute delay days reveals that longer projects accumulate more delay days. This challenges the current practice of applying fixed-duration buffers regardless of project scale.

Scheduling Insight: A proportional buffering approach (adding 5-10% of estimated duration as buffer) would be more effective than the current fixed 2-day buffer for all projects.

4.4 Root Cause Analysis: Key Issues Interpretation

4.4.1 Priority Issue Classification

The frequency-impact analysis of key issues reveals a clear prioritization framework:

Critical Issues (Require Immediate Action):

Supplier Delays in Plywood Delivery (5 projects, 7.34% overrun): Represents supply chain vulnerability and indicates inadequate supplier management.

Client-Requested Changes (6 projects, 6.20% overrun): Highlights inadequate change control processes and client expectation management.

High Priority Issues:

Labor Shortages During Festivals (3 projects, 7.24% overrun): Points to inadequate workforce planning for seasonal variations.

Material Selection Changes (3 projects, 6.54% overrun): Indicates inadequate client consultation processes during initial planning.

4.4.2 Financial Impact Hierarchy

The financial impact analysis reveals that high-frequency issues create the largest cumulative financial damage, even if individual instances have moderate impact:

Client Changes (₹221,141 total impact): Most financially damaging due to high frequency

Supplier Delays (₹195,630 total impact): Combines high frequency with high per-instance impact

Labor Shortages (₹122,413 total impact): Lower frequency but high per-instance impact

Strategic Insight: Addressing the top 3 issues by financial impact would mitigate ₹539,184 (57%) of the total overrun amount, making them the most efficient targets for improvement.

4.5 Integrated Business Implications

4.5.1 Profitability Impact

The consistent 6.76% cost overrun represents a direct erosion of profit margins. For a business with typical net margins of 10-15%, this overrun translates to a 40-68% reduction in net profitability - a substantial threat to business sustainability.

4.5.2 Operational Efficiency Gaps

The analysis reveals three core operational deficiencies:

Inadequate Risk Assessment: Quoting process doesn't systematically account for project-specific risks

Weak Supply Chain Management: Supplier reliability issues cause cascading operational disruptions

Poor Change Control: Client-driven changes are managed reactively rather than through structured processes

4.5.3 Strategic Improvement Opportunities

The patterns identified suggest three strategic improvement vectors:

Predictive Quoting: Implement data-driven buffering based on project characteristics

Proactive Risk Management: Address high-frequency issues through process improvements

Structured Client Management: Formalize change control and expectation setting

4.6 Conclusion of Interpretation

The results collectively paint a picture of a business with strong execution capabilities but weak predictive planning. The consistency of patterns across 25 projects indicates that improvements are not just possible but highly predictable through data-driven interventions.

Final Assessment: The business stands to gain immediate profitability improvements of 4-5% through targeted interventions, with potential for additional gains through operational refinement and client management enhancements. The analysis provides a clear roadmap for transforming from reactive problem-solving to proactive, data-driven management.

Recommendation

Adopt a data-driven quoting buffer. Use 7% as the default buffer (rounded from 6.76%). Add size-based adjustments: Small 5–7%, Medium 8–10%, Large 6–8%. For high-risk jobs (long lead materials or likely client changes) apply the stricter rule: Buffer = max(mean+std, 90th percentile).

Formalize a change-order process. Require written change requests, a priced change-order, client sign-off, and schedule recalculation before work proceeds. Charge a handling fee for late scope changes.

Strengthen supplier management. Negotiate simple SLAs(Service Level Agreements) for lead times, keep minimum safety stock for critical items (plywood/laminate), and maintain a vetted backup supplier list. Track supplier on-time as a KPI.

Build a flexible labor plan. Maintain a small roster of trusted subcontractors, Consider offering a small 'peak season surcharge' for projects that must be executed during major festival periods to cover the higher cost of securing reliable labor, and cross-train staff to reduce single-point skill shortages.

Treat time as cost. Quote proportional timeline buffers (e.g., add 5–10% of estimated days for larger projects) and monitor delays weekly during execution.

Problem Identified	**Proposed Solution**	**KPI / Measure of Success**	**Timeline**
Cost overruns (~6.76%) due to under-quoting	Apply buffer policy: Small 5–7%, Medium 8–10%, Large 6–8%	Avg Cost Overrun ≤ 2%	Immediate (Next 1–2 months
Frequent client-requested changes mid-project	Implement formal change-order process (written approval, cost & timeline adjustment)	% Projects with change orders ≤ 30%	Immediate
Supplier material delays (plywood, laminates, veneers)	Negotiate supplier SLAs, maintain minimum stock, build backup vendor list	Supplier On-time Delivery ≥ 90%	3–6 months
Labor shortages during festival seasons	Create flexible labor pool and pre-book staff	Avg Delay ≤ 2 days	3–6 months
Medium projects show highest delay variability	Apply proportional timeline buffer (5–10% of estimated days)	Buffer Coverage ≥ 85%	Immediate

-------End of Report-------