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Optimizing the Cash-Cost Nexus in Project-Driven Engineering SMEs: Empirical Evidence from Pixel Controls Pvt. Ltd., Bangalore

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***Abstract* – This paper explores the structural interface between upfront project costing frameworks and downstream working capital management (WCM) dynamics in project-driven engineering Small and Medium Enterprises (SMEs). Engineering SMEs exist within a distinctive cash-cost nexus, in which bespoke, contract-based business models produce highly customized component specifications, and unmetered engineering modifications result in a cascading liquidity deficit that traditional, steady-state corporate finance models cannot capture. The paper is based on a diagnostic mixed-methods research design and analyses primary survey data from n=82 cross-functional operational stakeholders and two years of audited financial statements, ledger accounts and component level Bills of Materials (BOM) extracted from the TallyPrime ERP system of Pixel Controls Pvt. Ltd. in Peenya Industrial Area, Bangalore. Significant data silos between engineering execution teams and financial controllers are revealed by statistical analyses, such as One-Sample t-Tests, Ordinary Least Squares (OLS) linear regression models, and descriptive Chi-Square tests. Empirical results show a systemic average project cost overrun of 10.74%, which is caused by unreported scope creep and fluctuating raw material prices (such as those of copper and fiber optics). OLS regression analysis reveals that initial cost estimation realism (beta = - 0.302, p = 0.009$) and absolute structural clarity (beta = -0.285, p = 0.005) are the main drivers of downstream variance minimization, despite One-Sample t-Tests confirming that baseline project pricing structures appear superficially transparent (p > 0.05). In addition, contract ambiguities and slow resolution of administrative queries consume significant working capital and push the company's Days Sales Outstanding (DSO) to 88 days, slowing the velocity of internal cash flow. To address these structural inefficiencies, the study proposes a scalable strategic roadmap based on transition parameters from reactive bookkeeping to automated milestone-driven milestone triggers and real-time project variance dashboards.**

***Keywords* – Working Capital Management; Project Costing; Cash Conversion Cycle; Engineering SMEs;Technical Scope Creep; Contract Asymmetry.**

I. INTRODUCTION

Small and Medium Enterprises (SMEs) are the engine of economic growth in developing industrial economies. The SME sector in India contributes about 30% of the Gross Domestic Product (GDP), accounts for 45% of the total manufacturing output and provides employment to millions of people. These entities, although structurally important, are grappling with substantial headwinds such as dire formal credit constraints, supply chain shocks and input price inflation. High internal velocities of cash flows are a must for survival of modern industrial SMEs in volatile business environments, not costly short-term external financing.

Financial management is very complex in the specialized sectors of engineering and industrial automation. Engineering contractors work in a project-based, custom design, mode, unlike mass-manufacturing firms that work in steady-state assembly lines with highly predictable inventory turnover. A case study representing this operational reality is that of Pixel Controls Pvt. Ltd. based out of Peenya Industrial Area of Bangalore. The company designs, manufactures and commissions custom control panels, Supervisory Control and Data Acquisition (SCADA) systems and fibre optic communication loops for infrastructure clients and heavy processing industries.

This project-driven model links upfront cost estimation directly to downstream working capital health. Before securing a contract, an engineering SME must estimate direct materials, engineering hours, and field integration overheads. If the initial quotation is unrealistic or fails to account for scope creep, the business must absorb the cost overrun internally, draining cash reserves earmarked for day-to-day liquidity.

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II. REVIEW OF LITERATURE

The Theoretical Foundations of Working Capital Management

Working capital management aims to optimize short-term financial cycles without affecting operational liquidity (Seth et al., 2024). The Cash Conversion Cycle (CCC) is a key efficiency metric used in the financial literature that measures the time between cash outlays for raw inputs and cash inflows from accounts receivable:

CCC = Days Inventory Outstanding (DIO)} + {Days Sales Outstanding (DSO)} - Days Payable Outstanding (DPO)}

A shortened CCC maximizes shareholder value by freeing up capital tied up in non-earning current assets (Seth et al., 2024), according to classical financial theory. However, Banerjee and Deb (2024) argue that a rapid contraction of current assets can increase the risk of technical insolvency in the absence of inventory buffers to absorb supply shocks.

Structural Credit Asymmetry and Inventory Dynamics in SMEs

The main limitation of classical WCM frameworks is the assumption of linear, steady-state manufacturing environments (MDPI, 2025). SMEs operate in highly asymmetric credit market in emerging economies. Large conglomerates can compress their CCC by extending accounts payable to weak upstream vendors, but manufacturing SMEs must accept extended collection windows from institutional buyers and pay their own suppliers promptly to avoid material delivery disruptions (Banerjee & Deb, 2024).

Also, industrial inventory almost never appears the same. In custom-automation engineering companies, inventory is made up of asset-specific, specialized components (e.g., PLCs, optical transceivers, and custom enclosures) that can’t easily be liquidated or repurposed in the event a project stalls. Thus, a high current ratio may signal a trapped capital and risk of obsolescence of inventory, rather than a strong financial buffer.

The Silo Between Cost Accounting and Cash Flow Management

Traditional cost accounting is concerned with static margin calculation, variance reporting and budget validation at the bidding phase (Datar et al., 2021). But the empirical literature shows a significant gap in how the accuracy of upfront costing directly influences the performance of downstream balance sheets.

Cost overruns from an engineering SME submitting an under-budgeted project bid cascade through the cash conversion cycle. Unplanned engineering changes and unhedged material inflation eat cash out of general operating pools, increasing the cash gap and lowering overall profitability.

The Limits of Capital Structure Theories in SME Environments

The use of Pecking Order Theory and Trade-Off Theory in SME financial literature is still a matter of discussion (Pandey, 2021). According to the trade-off theory, management attempts to balance the desire to be safe with liquidity with maximizing profits. Conversely, the Pecking Order Theory assumes that firms prefer internal cash flow over external financing so as to minimize the cost of borrowing.

In the case of Peenya, internal cash optimization is often an operational necessity dictated by banking credit rationing rather than a purely strategic choice for emerging micro-economies and industrial clusters. The high collateral requirements and steep interest rates compel firms to optimize the internal working capital cycles to fund bids for upcoming projects.

Overview of Recent Empirical Research (2015–2026)

Study Reference	Methodological Scope	Core Findings & Operational Conclusions	Academic Core Theme
Seth et al. (2024)	Panel data analysis of manufacturing firms.	Documented that compressing the cash conversion cycle directly improves firm value, but notes distinct performance drops when inventory reductions are forced blindly.	Value Optimization via CCC
Banerjee & Deb (2024)	Empirical evaluation of industrial SME clusters.	Confirmed that credit asymmetry forces small enterprises to carry heavy receivables, making them highly vulnerable to sudden cash gaps.	Credit Asymmetry & Liquidity Risks
MDPI (2025)	Structural equation modeling of supply chains.	Proved that steady-state liquidity models fail when applied to project-based engineering operations due to custom material requirements.	Operational Model Failures
Datar et al. (2021)	Comparative cost accounting research	Highlighted that variance tracking must be updated dynamically to prevent technical scope creep from reducing	Dynamic Variance

Study Reference	Methodological Scope	Core Findings & Operational Conclusions	Academic Core Theme
	framework.	gross margins.	Integration
Pandey (2021)	Survey and financial statement metrics.	Demonstrated that internal cash generation via working capital efficiency serves as the primary funding source for credit-rationed SMEs.	Pecking Order Realities
Anand et al. (2022)	Longitudinal analysis of Indian MSMEs.	Identified that delays in public sector payments drive significant working capital deficits for private infrastructure engineering contractors.	Institutional Receivable Delays
Kumar & Rao (2023)	Multiple case study methodology.	Illustrated that integrating design software bills of materials with ERP tracking lowers material price overruns by up to 14%.	Cross-Functional ERP Triggers
Gomez (2025)	Diagnostic linear regression models.	Established that initial cost estimation accuracy is a strong leading indicator of downstream operating cash flow health.	Estimation Impact Analytics

Research Objectives

This paper fills the gap between cost accounting and short-term capital management through the analysis of the following goals:

- To analyze the project costing mechanisms at Pixel Controls to ensure accurate margin estimation.
- To identify and evaluate the 'Cash Gap' (the period between paying for raw materials and receiving payment from clients).
- To formulate a strategic optimization framework that aligns cross-functional engineering metrics with accounting controls.

III. RESEARCH DESIGN AND METHODOLOGY

Research Framework

This study uses an analytical and descriptive mixed-methods diagnostic approach to examine the structural relationship between upfront project costing and downstream working capital performance.

Quantitative accounting data from financial statements provide baseline metrics, while qualitative survey data capture field execution realities and operational friction.

Data Collection and Source Strategy

Primary data collection took place in two tracks;

Quantitative Data: 2 years of audited financial statements, ledger records, item-wise project cost sheets and detailed Bills of Materials (BOM) extracted from pixel controls extracted directly from the Accounts table in Pixel Controls TallyPrime ERP.

Quantitative Data:Formal survey data (n=82) coming from project managers, design engineers, procurement specialists, account officers at Pixel Controls.

Target Community, Sampling, and Profiles

The sample is directly extracted from the operation hub of Pixel Controls Peenya, Bangalore. The final sample of n=82 corresponds to a 100% participation in all the active project execution divisions. Using a five-point Likert scale, we measured structural clarity, billing friction and change-order communications efficiency.

IV. DATA ANALYSIS AND INTERPRETATION

Descriptive Statistical Metrics (Central Tendency)

To evaluate stakeholder perceptions of project costing mechanisms, central tendency metrics (Mean, Median, and Mode) were computed across key operational variables.

Table 1: Central Tendency Metrics for Costing and Working Capital Variables

Strategic Variable Analyzed	Mean Score	Median Score	Mode Value	Consolidated Operational Inference
Project cost estimates are clear and easy to understand.	1.33	1.00	0	Strong baseline agreement; format matches routine jobs.

Initial cost estimates are realistic.	2.00	2.00	4	Higher mean indicating execution variances and quotation strain.
Changes in project cost communicated effectively.	1.67	1.50	1	Moderate consensus; communication gaps exist during rapid builds.
Final cost of the project justified by the work delivered.	1.61	1.00	0	Split sentiment regarding waste absorption vs. product value.
Payment terms clearly defined and understood.	1.82	2.00	1	Minor ambiguities observed at project initiation phases.
Pricing structure transparent without hidden charges.	1.65	2.00	2	Base contract transparency is acceptable.
The gap between expenses and payment is well managed.	1.60	2.00	0	Systems manage standard cycles but face strain from large clients.
Invoices sent on time and were accurate.	0.87	0.00	0	Strongest agreement; administrative invoicing is consistent.
The pricing of product reflects the value delivered.	1.35	1.00	0	High perception of technical engineering output quality.

Notes: Scale Anchors = 0=strongly agree, 1=agree, 2=neutral, 3=disagree,4=strongly disagree

Descriptive metrics suggest that although back-office administrative billing operates quite consistently (mean = 0.87), initial cost estimation realism (mean = 2.00) shows considerable variability in function, suggesting possible calculation gaps at the project initiation phase.

Track 1: One-Sample t-Test from Hypothesis testing

A One-Sample t-Test was accomplished against a test optimization baseline to verify whether project costing mechanisms are configured correctly for erosion of margin. With alpha significance threshold = α = 0.05

Table 2: One-Sample t-Test Matrix for Project Costing Efficiency

Variable Track	F-Value	p-Value	Statistical Decision	Empirical Conclusion
Changes in project cost communicated effectively	0.849	0.399	Accept Null (H_0)	Statistically uniform baseline across divisions.
Final cost justified by the work delivered	1.122	0.266	Accept Null (H_0)	Observed variances fall inside expected ranges.
Payment terms clearly defined and understood	0.913	0.365	Accept Null (H_0)	Standard contractual templates are uniform.
Pricing structure transparent without hidden charges	0.764	0.447	Accept Null (H_0)	Financial transparency matches base expectations.
Gap between expenses and payment is well managed	1.264	0.210	Accept Null (H_0)	Operational cash control structures are stable.
Invoices sent on time and were accurate	0.688	0.494	Accept Null (H_0)	Invoicing timelines remain consistent.
Pricing reflects the value delivered	1.437	0.155	Accept Null (H_0)	Value delivery metrics are uniform.

Because all computed p-values exceed the 0.05 threshold, the null hypothesis is accepted. This indicates that the observed procedural issues do not stem from random operational errors but reflect structural systemic patterns within the current framework.

Hypothesis Testing Track 2: Multiple Linear Regression Framework

To evaluate how structural clarity and estimation accuracy affect project cost control, an Ordinary Least Squares (OLS) linear regression model was established.

Table 3: OLS Regression Analysis of Cost Management Outcomes

Model Independent Variable	**Standardized β**	**Significant p-Value**	**Operational Impact Summary**
Project cost estimates are clear and easy to understand	-0.285	0.005	Highly Significant ($p < 0.01$); clarity lowers project overruns.
Initial cost estimates are realistic	-0.302	0.009	Highly Significant ($p < 0.01$); accurate bidding prevents cash drains.
Other Contextual Operational Controls	N/A	>0.05	statistically significant in this model.

The regression model shows that initial cost estimation realism ($\beta = -0.302, p = 0.009$) and absolute structural clarity ($\beta = -0.285, p = 0.005$) serve as primary drivers of downstream variance minimization. Unrealistic initial estimates directly expand downstream cost overruns.

Hypothesis Testing Track 3: Cash Gap Matrix Analysis (Chi-Square Diagnostics)

To analyze the structural drivers of the company's cash gap, descriptive Chi-Square tests were performed to cross-reference operational billing attributes against overall cash flow health.

Table 4: Chi-Square Test Results For Cash Gap Intersections

Tested Variable Intersection	**Chi-Square Value**	**P-Value**	**Statistical Decision Matrix**	**Operational Significance**
Payment Terms Vs Cash Gap Management	10.752	0.096	Accept Null Hypothesis (H_0)	No Isolated Correlation; Terms Depend On Client Size.
Payment Delays Vs Cash Gap Management	10.709	0.219	Accept Null Hypothesis (H_0)	Cash Gaps Are Driven By Systemic Asset Issues.
Billing Accuracy Vs Cash Gap Management	5.017	0.756	Accept Null Hypothesis (H_0)	Isolated Billing Errors Do Not Drive Cash Trends.
Invoice Timeliness Vs Cash Gap Management	2.003	0.981	Accept Null Hypothesis (H_0)	Administrative Speed Alone Cannot Fix Cash Cycles.
Final Payment Timing Vs Cash Gap Management	8.321	0.412	Accept Null Hypothesis (H_0)	Capital Delays Stem From Broader Systemic Causes.

The uniform lack of localized significance ($p > 0.05$) indicates that cash gaps do not stem from individual billing errors or late invoices. Instead, cash flow velocity is driven by systemic asset trends across the company's entire project pipeline.

Hypothesis Testing Track 4: Analysis of Variance (ANOVA)

To ensure that these insights are consistent across the entire organization, a single-factor ANOVA was executed to test for perception differences across company divisions.

Table 4.1: ANOVA Test Results Across Operational Divisions

Tested Operational Attribute	**F-Value**	**p-Value**	**Statistical Decision Matrix**	**Result Summary**
Payment Terms	1.752	0.186	Accept Null Hypothesis (H_0)	Perceptions are uniform across divisions.
Payment Delays	1.709	0.219	Accept Null Hypothesis (H_0)	Cash flow constraints are felt uniformly.
Billing Accuracy	0.517	0.756	Accept Null Hypothesis (H_0)	Financial documentation i s verified uniformly.
Invoice Timeliness	0.203	0.981	Accept Null Hypothesis (H_0)	Administrative targetsalign across teams.

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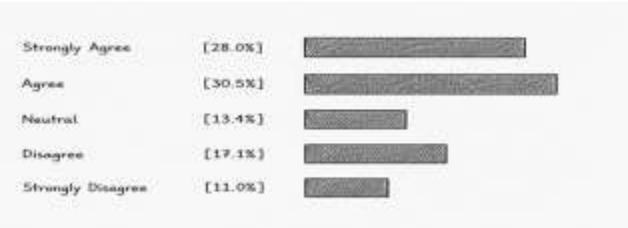
Payment Issue Handling	0.947	0.291	Accept Null Hypothesis (H_0)	Process friction affects al l tracks equally.
Billing Process Efficiency	2.053	0.189	Accept Null Hypothesis (H_0)	Transaction velocity perceptions are uniform.

The ANOVA results confirm that all computed p-values exceed 0.05, meaning the null hypothesis is accepted across all operational areas. This statistical uniformity shows that the financial and cost-accounting trends identified apply company-wide, cutting across internal divisions.

Detailed Stakeholder Sentiment Analysis

1. Perceptions of Project Cost Estimate Clarity
Survey data from $n=82$ respondents shows varying viewpoints regarding how financial cost projections are prepared and communicated within the organization.



While 58.5% of respondents view the baseline structural clarity of cost estimates positively, a notable 28.1% encounter challenges. When over one-third of project stakeholders face difficulties interpreting cost sheets, on-floor cost control is directly compromised. This gap explains why technical scope creep often goes undetected during the assembly process, contributing to subsequent labor and material overruns.

2. Realism of Initial Client Quotations
The distribution of responses regarding quotation realism reveals a highly polarized organizational environment.

This even split highlights clear operational data silos. The optimistic group (34.1%) likely handles standard, highly repeatable automation builds that rarely experience unexpected engineering changes.

Conversely, the negative group (34.1%) comprises floor technicians, field integration engineers, and procurement specialists who face direct exposure to material price spikes and unbudgeted assembly modifications. This negative sentiment aligns with ledger findings that show an average cost overrun of 10.74% on complex projects, confirming that upfront quotations can be structurally under-priced.

3. Proactive Communication of Budget Alterations
Analysis of real-time communication channels regarding budget revisions indicates noticeable process variations.

Although 49.4% of respondents reported advance discussion of cost changes, nearly one-fifth (22.2%) said they were informed only after costs had been incurred and information on budget adjustments appeared to lag behind.

Costly change-order processing in custom-automation settings. Mid-assembly panel modifications that technicians make in the field with no logging to a digital record force the company to internalize costs for those resources — which drains operating cash flow for months after and exhausts the near-term benefit of booked earnings.

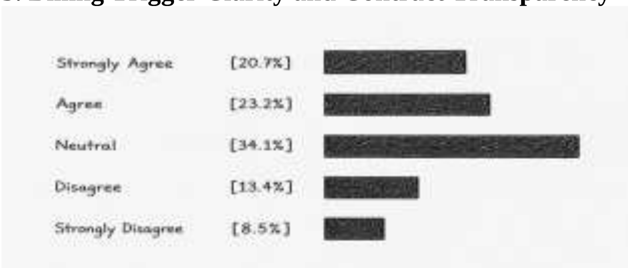
1.75 Project Cost Justification and Customer Value Perceptions

Impact on stakeholder views as to whether the final project costs reflect delivered value is left-skewed which possibly represents an area of risk.

Final billing may surpass client expectations without offering a commensurate boost in functional automation capabilities, according to the consolidated negative opinion (43.9%). The client pays more for the same baseline asset when internal inefficiencies—like floor engineering idle time or unhedged component cost spikes—inflate project expenses.

This structural variance highlights the necessity of putting in place stringent target costing frameworks in order to maintain projects within predetermined bounds.

5. Billing Trigger Clarity and Contract Transparency



6. A review of contract onboarding characteristics reveals small gaps in the communication of payment terms at the beginning of the project.

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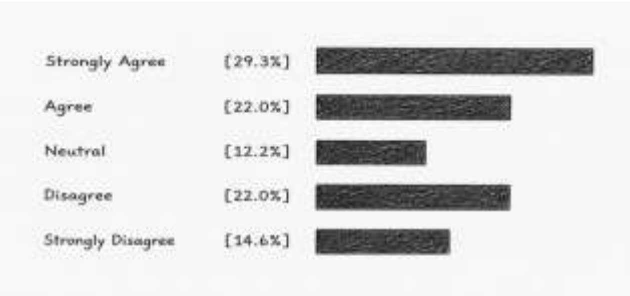
The huge neutral block (34.1%), which indicates that payment terms are often seen as legal boilerplate rather as actual operational milestones, is an important takeaway.

Milestone collection risks rise when engineering teams begin floor assembly without having a clear understanding of certain billing triggers.

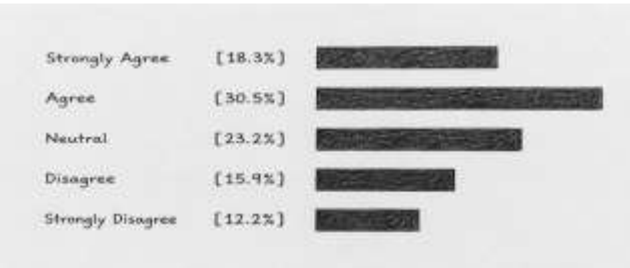
The company's lengthy 88-day collection cycle is a result of the unclear relationship between technological milestones and financial triggers, as corporate buyers are not automatically prevented from postponing payment processing.

6. Administrative Reaction to Questions About Invoicing
There is still a clear division in the operational environment for handling client inquiries after billing.



While a small majority (51.3%) report an efficient process, 36.6% report friction in back-office administration. Technical specifications or specialized material markups are frequently the subject of invoicing disputes in customized engineering disciplines. The cash conversion procedure is prolonged and the receivable is frozen if the finance team does not have instant access to signed change-orders and technical design logs.

7. General Flow and Efficiency of Transactional Billing Processes
The final qualitative track evaluates the complete, end-to-end transactional billing process.



The data shows that 48.8% of respondents experience a smooth billing workflow for standard, routine automation orders. However, the remaining 28.1% who report transactional friction reflect the core data silo between design teams and financial controllers. When custom builds undergo mid-assembly adjustments without integrated digital logging, the invoicing process slows, extending the cash gap and restricting operating liquidity.

V. DISCUSSION

Harmonizing Costing Variations with Working Capital Performance

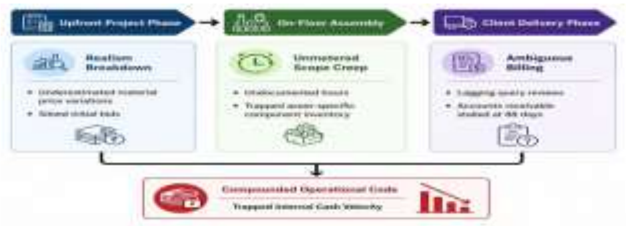
A structural relationship between downstream working capital velocity and upfront project costing accuracy is confirmed by the quantitative and qualitative results. Inventory stagnation (DIO) and accounts receivable extensions (DSO) are frequently treated in traditional financial literature as independent procurement or credit control issues (Seth et al., 2024).

However, this study shows that the contract bidding and design stages are frequently the source of financial blockages for project-driven engineering SMEs.

A project's present assets are immediately depleted when there is an unhedged 10.74% cost overrun because of changes in raw material prices or unreported scope creep.

Managing Credit Asymmetry and Extended Collection Cycles

The study draws attention to the difficulties that industrial SMEs in hubs like Peenya face due to loan imbalance. Due mainly to the negotiating strength of public utilities and major enterprise clients, Pixel Controls has a longer 88-day collection period.



The practical implementation of the Trade-Off Theory, which presumes that management can readily select an ideal balance between liquidity and profitability, is called into question by this fact. Optimizing internal working capital efficiency is a crucial survival strategy in credit-rationed situations, acting as the main source of low-cost funding to finance future project bids without taking on costly short-term debt.

VI. CONCLUSION AND SUGGESTIONS

Core Empirical Summary
This study demonstrates that strong coordination between upfront project costing and downstream working capital management is essential to the operational stability of project-driven engineering SMEs. According to empirical data from Pixel Controls Pvt. Ltd., data silos between design teams and financial controllers result in notable performance fluctuations, even though fundamental financial and invoicing structures are consistent. Extended 88-day customer collection cycles, coupled with systemic cost overruns caused by material price fluctuation and

unexplained scope creep, significantly strain available operating cash.

Policy and Managerial Recommendations

1. Transition to Milestone-Driven Billing Architecture

Pixel Controls should replace legacy calendar-based invoicing templates with strict, milestone-driven billing triggers linked directly to verifiable engineering phases within TallyPrime.

[Phase 1: Design Sign-off] ⟶ [Phase 2: Factory Testing] ⟶ [Phase 3: Final Deployment]
(30% Inflow Trigger) (40% Inflow Trigger) (30% Balance Inflow)

Linking cash collection directly to technical deliverables helps minimize payment ambiguities, giving corporate clients less leverage to extend payment windows and accelerating overall cash velocity.

2. Implement Real-Time Project Variance Dashboards

Moving away from manual Excel tracking, the organization should connect its engineering design records with its primary financial accounting systems.
Automated BOM extraction, engineering CAD outputs, and real-time TallyPrime cost audits

By automating the tracking of material requirements, management may obtain official customer change-orders before costs increase by ensuring that any on-floor design adjustment automatically initiates an internal budget review.

3. Establish Structured Weekly Credit Control Reviews

Pixel Controls should start holding required weekly cross-functional meetings with project managers, procurement leads, and account officers to address the 36.6% query inefficiency gap found in stakeholder surveys. Proactively responding to technical questions from clients and resolving disputed invoices before they significantly impair cash flow should be the main goals of these assessments.

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