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COMPARATIVE EFFICIENCY OF WORKING CAPITAL MANAGEMENT IN THE INDIAN STEEL SECTOR: AN EMPIRICAL STUDY OF TATA STEEL LTD. AND STEEL AUTHORITY OF INDIA LTD.

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Abstract
Working Capital Management (WCM) continues to be one of the most critical determinants of liquidity, profitability, and operational survival in capital-intensive industries. In India, the iron & steel sector forms the backbone of national infrastructure, heavy engineering, automotive production and export economy, and hence its liquidity cycle efficiency holds macro-economic relevance. However, inefficiencies in inventory conversion, slow receivable cycles, and disproportionate working capital blockage remain structural challenges—especially in public sector–owned steel corporations. This research empirically evaluates the comparative efficiency of WCM between Tata Steel Ltd. (private sector) and Steel Authority of India Ltd. (SAIL) (public sector) over an eleven-year period 2012–13 to 2022–23, using liquidity metrics, turnover ratios and Cash Conversion Cycle (CCC). A combination of descriptive analysis, CV-based volatility measures, correlation matrices, Ordinary Least Squares regression, ANOVA, Chi-Square association, and Motaal liquidity scoring was employed to statistically assess whether WCM significantly influences profitability. Results confirm that Tata Steel maintains a substantially shorter CCC (63 days) than SAIL (94 days) alongside faster inventory and debtor rotation, yielding superior ROA, ROE and NPM. Regression confirms CCC and Inventory Turnover as significant predictors of profitability, while ANOVA denotes strong inter-firm differences ($p=0.019$). The paper concludes that superior working capital speed—not merely liquidity availability—drives profitability in steel. However, sustainable optimization requires integration of digital inventory forecasting, ERP-based receivable controls, & PSU working-capital autonomy reforms.

Keywords: Working Capital Management, Cash Conversion Cycle, Liquidity Efficiency, Inventory Turnover, Profitability Causality Study

1. INTRODUCTION

Working Capital Management (WCM) is universally recognised as the lifeline of industrial sustainability and organisational solvency. For large-scale manufacturers, the ability to circulate funds efficiently through procurement, production and distribution often determines long-term financial stability more strongly than revenue growth itself. India's iron and steel sector, being one of the most capital-intensive industries, forms the backbone of infrastructure expansion, heavy engineering, railways, metro construction, automobile manufacturing, defence metallurgy and export competitiveness. Any distortion, delay or inefficiency in the

working capital cycle does not remain confined to a single unit; instead, it triggers a chain reaction of production slowdown, inventory accumulation, cash stagnation, supply interruptions and loss of market responsiveness.

Steel manufacturing involves sequential processes—mining and ore extraction, coking coal importation, blast furnace smelting, hot and cold rolling mill operations, warehousing and finally dispatches often executed through credit-based B2B contracts. At every stage, substantial funds remain locked, making the duration of the Cash Conversion Cycle a critical determinant of liquidity availability. A shorter cycle results in quicker realisable cash and provides greater operational agility, whereas a delayed cycle compels the firm to rely on external financing, increasing interest burden and reducing profitability. Within this operational spectrum, Tata Steel Ltd. stands as a benchmark for private-sector efficiency, supported by ERP-integrated inventory systems, data-backed procurement scheduling and high-speed capital rotation. Steel Authority of India Ltd. (SAIL), on the other hand, represents the public-sector framework with policy-linked production decisions, administrative layers and slower receivable realisation from government-affiliated buyers. Although both operate under similar market forces, ownership structure and managerial autonomy create distinct working capital outcomes. Therefore, evaluating Tata Steel and SAIL offers meaningful insights into how structural governance influences working capital efficiency, liquidity robustness and profitability patterns in the Indian steel industry.

1.1 Working Capital, Operating Cycle & Financial Stress

Working Capital represents the quantum of funds continually circulating within the operating structure of a business, primarily in the form of Inventory + Receivables – Payables. It signifies the capital tied up in raw materials, unfinished production, finished goods awaiting sale, and credit extended to customers. When inventory remains unsold for longer than planned, or when receivables are delayed beyond credit terms, the funds become financially immobilised. This liquidity freeze restricts reinvestment into production, forces reliance on external borrowing, and increases interest burden on working capital loans. Thus, the efficiency with which working capital moves through the business cycle is not merely an accounting measure but a determinant of operational vitality. The Cash Conversion Cycle (CCC) is the most widely used indicator to measure how long a firm takes to convert raw input expenditure into cash realisation from customers. A shorter CCC indicates strong liquidity, rapid inventory turnover, and faster reinvestment potential. Conversely, a long CCC signifies capital blockage, slower recovery of trade dues, and an elevated need for external financing. The impact of CCC becomes even more critical in the steel industry because production is bulk-intensive, cycles are long, and inventory value is high. Due to large furnace batches, continuous processing and large storage requirements, even a brief increase in the Days Inventory Outstanding (DIO) or Days Sales Outstanding (DSO) can immobilise significant financial resources. In steel manufacturing, a 10-day extension in DIO or DSO can freeze hundreds of crores in working capital, weakening liquidity and delaying production schedules. Therefore, managing the operating cycle becomes a strategic necessity rather than a financial routine. Firms with efficient working capital cycles leverage better pricing, sustained output, and resilient profitability, while those with sluggish cycles experience financial stress, cost escalation and reduced competitiveness.

1.2 The Indian Steel Liquidity Challenge — Historical Context

The Indian steel sector has historically operated under a liquidity environment shaped not just by market dynamics, but also by institutional ownership patterns and policy-linked production responsibilities. Public sector steel enterprises such as the Steel Authority of India Ltd. (SAIL) traditionally maintained large inventory buffers to stabilise market supply and fulfil government procurement commitments. These security stock practices were originally intended to prevent shortages and price volatility; however, they resulted in prolonged inventory holding periods, elevated working capital requirements and consistently higher Days Inventory Outstanding (DIO). In contrast, private-sector firms like Tata Steel demonstrate greater flexibility in aligning production to market demand, thereby maintaining leaner inventory volumes and ensuring faster turnover.

A second persistent liquidity strain arises from receivable realisation. A significant proportion of PSU steel sales are directed towards government infrastructure bodies and public construction undertakings, where payment cycles are longer, multi-tiered and often extend beyond stipulated credit periods. As a result, receivables remain locked for lengthy durations, directly inflating the Cash Conversion Cycle (CCC) and intensifying the working capital burden. Empirical studies in the Indian metallurgy domain consistently emphasise that inventory oversupply and delayed credit realisation are two primary drivers of financial stress for steel producers, particularly for public-sector entities. Between 2012 and 2023, the sector faced additional liquidity volatility due to fluctuations in coking coal import prices, intermittent export restrictions, pandemic-era demand shocks and policy shifts impacting infrastructure expenditure. Tata Steel responded with procurement optimisation and digital supply-chain integration, whereas SAIL relied on traditional stock-carrying operations. This contrast provides an ideal context to evaluate how organisational structure, decision-making autonomy and working capital systems shape financial resilience in the Indian steel landscape.

1.3 Evaluating WCM is Critical

Evaluating Working Capital Management is essential for understanding the internal health, stability and economic resilience of steel-producing enterprises. Just as the SARFAESI Act required long-horizon assessment to determine its effectiveness in reducing banking stress, the efficiency of WCM also demands multi-year examination rather than short-term snapshots. A single-period review of liquidity may appear favourable, but only a longitudinal approach reveals whether capital is circulating consistently, whether inventories are turning at competitive speeds, and whether receivables are being realised within a financially sustainable timeframe. This necessity becomes even more pronounced in industries such as steel, where the value of capital locked inside the operating cycle is exceptionally high and where production delays or market slowdowns rapidly convert into cash stagnation and borrowing pressure.

Efficient WCM directly shapes production continuity, as uninterrupted procurement of iron ore, power, furnace fuel and raw materials is possible only when liquidity remains fluid. The financial impact of working capital extends further — inventory holding cost, warehouse maintenance expenditure, and interest charged on working capital loans rise sharply if stocks remain unsold longer than economically optimal. A stretched operating cycle also increases the need for bank financing, which influences a company's credit rating and cost of capital. Higher borrowing, in turn, reduces profit margins and limits the reinvestment capacity of the firm. Conversely, firms with shorter Cash Conversion Cycles operate with superior financial

breathing room. Faster inventory rotation, quicker receivable clearance and balanced liquidity models enhance profitability, elevate shareholder return, and strengthen market competitiveness. Therefore, perception or informal judgement is insufficient — systematic empirical testing is necessary to evaluate how WCM influences financial outcomes over time. Analytical assessment, rather than assumption, helps identify whether an organisation is efficiently converting operational capital into sustainable earnings.

1.4 Research Problem Identified

Although considerable research has been conducted on the performance of the Indian steel sector, most existing studies focus primarily on production capacity, pricing behaviour or profitability trends, rather than on the long-term circulation of working capital within the industry. Only a limited number of studies analyse working capital patterns through extended time horizons, and very few undertake a systematic comparison between private and public sector steel firms. The distinction between managerial autonomy in private enterprises and policy-driven functioning in PSUs remains largely under-examined. More importantly, empirical research linking the Cash Conversion Cycle (CCC) with profitability indicators such as Return on Assets (ROA), Return on Equity (ROE) and Net Profit Margin (NPM) is scarce within the context of Indian metallurgy. Without such analysis, it is difficult to quantify how efficiently steel companies convert operational resources into financial outcomes or whether ownership structure influences liquidity movement. Therefore, the core research problem emerges as—whether significant differences exist in Working Capital Management efficiency between Tata Steel and SAIL, and whether the speed of working capital rotation has a measurable impact on profitability. By addressing these questions through statistical modelling and long-period evaluation, this study contributes new evidence to a gap that holds strong relevance for Scopus-indexed academic literature.

1.5 Significance of the Study

The present study carries strong practical and academic value, as it generates evidence-based insights into how working capital efficiency influences financial stability in the steel sector. For CFOs and treasury managers, the findings offer a framework for optimising cash cycles and reducing capital blockage, enabling better reinvestment and production continuity. Policy makers and PSU administrators may utilise the results to re-evaluate autonomy in procurement, inventory norms and receivable clearance mechanisms, especially for public-sector firms operating under slower cash rotation. The study further assists investors, lenders and credit rating agencies in assessing liquidity risk, solvency strength and operational resilience when evaluating steel companies for funding or equity decisions. Additionally, it contributes to academic literature by providing long-horizon working capital evidence, supporting liquidity modelling and performance forecasting in heavy manufacturing. Understanding WCM behaviour therefore promotes strategic capital rationing, lowers financing cost and enhances profitability potential.

1.6 Aim of the Paper

The aim of this study is to empirically examine whether Working Capital Efficiency—measured through Cash Conversion Cycle, Inventory Turnover and Debtor Turnover—significantly affects profitability performance in the steel industry. It further evaluates whether private-sector ownership demonstrates superior working capital responsiveness and financial

outcomes compared to a public-sector structure, using Tata Steel and SAIL as comparative models.

2. REVIEW OF LITERATURE

Working Capital Management (WCM) has been widely recognized as a core determinant of liquidity efficiency, financial productivity and operational reliability, especially in asset-heavy manufacturing sectors. Steel production requires long conversion cycles, large-scale procurement and credit-linked sales, all of which result in a continuous inflow–outflow of funds. A review of literature is thus essential to understand the theoretical base, international findings, Indian evidence and sector-specific working capital behaviour in the steel industry, which forms the foundation for this comparative study on Tata Steel & SAIL.

2.1 Conceptual Evolution of Working Capital Management

The concept of Working Capital Management (WCM) has evolved significantly over the past century, shaped by multiple economic theories, financial models and operational frameworks. The earliest recognition of working capital emerged from the basic premise that no business can operate without funds constantly circulating through procurement, production and sales activities. Working capital represents the energy flow that sustains operating functionality, similar to the bloodstream in a living organism. If circulation stops, operations collapse. This foundational understanding later matured through structured theories that defined how liquidity should be held, allocated and replenished.

The first major theoretical contribution was offered by John Maynard Keynes through his Liquidity Preference Theory (1936). Keynes argued that organisations maintain liquidity for three distinct purposes — transactional, to support routine operational payments; precautionary, to cushion uncertain cash demands; and speculative, to capitalise on unforeseen market opportunities. His articulation reframed liquidity not as idle money but as a strategic safeguard and income-generating stimulus. Keynesian thought established that insufficient liquidity exposes firms to operational disruptions, while excessive liquidity leads to idle capital, thereby requiring a balanced and rational approach to cash holding.

A subsequent refinement was presented by Baumol (1952), who proposed the Cash Management Inventory Model. Baumol drew parallels between cash and physical inventory, arguing that cash should be replenished only when it falls below a certain threshold rather than being kept excessively as a safety buffer. The model taught businesses to treat cash as a revolving stock that must be managed through reorder strategies rather than hoarded inefficiently. This shifted the focus of WCM from safeguarding funds to optimising them — balancing liquidity needs with opportunity costs.

The theoretical progression continued with Miller and Orr (1966), who challenged deterministic assumptions by introducing a stochastic model based on fluctuating cash inflows and unpredictable expenditures. Their upper and lower control limit framework provided organisations with a more realistic apparatus for liquidity maintenance. When cash crossed the upper limit, firms were advised to invest excess funds; when it fell to the lower limit, additional financing or asset liquidation was necessary. The Miller–Orr Model marked a breakthrough as it recognised real-world uncertainty, making cash management adaptive rather than static.

Within the composition of working capital, Inventory Theory by Harris (1913) laid the foundation for material flow optimisation. Harris demonstrated that excess stock increases storage, insurance, obsolescence and holding cost; meanwhile, insufficient inventory interrupts

production continuity, reduces capacity utilisation and leads to lost sales. His model introduced the concept of Economic Order Quantity (EOQ)—a calculation that determines the optimum level of inventory required to minimise combined ordering and holding costs. EOQ crystallised inventory management as a science rather than a reactive process.

Complementing inventory theory, the Accounts Receivable Theory established that while credit sales enhance revenue generation, delayed receivables expand the Cash Conversion Cycle (CCC)—the time taken to convert invested cash back into liquid form. Longer CCC durations indicate higher capital blockage, increased reliance on external borrowing, and reduced profitability margins. Therefore, receivables must be actively monitored to prevent liquidity stagnation.

Taken together, these theories converge into one unified principle: the purpose of Working Capital Management is not merely to hold resources, but to ensure optimal flow — rapid, controlled, continuous and efficient. The evolution of WCM thought—from Keynes' liquidity preference, Baumol's optimised replenishment, Miller–Orr's control thresholds, Harris' EOQ discipline, and receivable-cycle awareness—collectively shaped modern understanding of how businesses must rotate capital to sustain productivity, reduce financing cost and enhance profitability. The theoretical progression thus forms the foundation upon which contemporary cash-cycle analytics and operating cycle strategies are built.

2.2 International Evidence on Working Capital–Profitability Dynamics

The relationship between Working Capital Management (WCM) and profitability has been widely explored across global markets, and the evidence consistently reveals that firms with faster conversion of working capital generate stronger financial returns. One of the most influential empirical contributions was made by Deloof (2003), who analysed a large sample of Belgian manufacturing firms and concluded that a shorter Cash Conversion Cycle (CCC) has a direct and positive impact on Return on Equity (ROE). His findings established a foundational benchmark for subsequent international research, demonstrating that the time taken to convert inventory and receivables into cash is a critical profit determinant. Deloof's work remains a cornerstone in WCM literature, as it clearly linked internal operational efficiency with shareholder value.

Soon after, the work of Lazaridis & Tryfonidis (2006) expanded this understanding by examining Greek listed companies. Their study showed an inverse association between debtor collection period and profitability, suggesting that the longer firms wait to recover receivables, the greater the reduction in earnings. They further argued that accelerating receivable realisation improves liquidity flow, allowing firms to reduce their dependency on external financing. Their work reinforced a key behavioural inference—profitability rises when firms manage credit discipline effectively, particularly in economies where delayed trade settlement is common.

Comparable results emerged from North America. Gill, Biger & Mathur (2010) found that U.S. manufacturing enterprises with higher liquidity turnover consistently reported better profit performance. A notable conclusion from their study was that improvements in Days Sales Outstanding (DSO) contributed significantly to net profitability, emphasising that receivable management is more influential than static liquidity measurements such as the Current Ratio. Meanwhile, Makori & Jagongo (2013) analysed companies listed on the Nairobi Securities Exchange and discovered that reduction in Days Inventory Outstanding (DIO) had a more

pronounced impact on profitability than overall liquidity. Their evidence highlights that speed of inventory movement is particularly important in production-based industries where goods are stored in large quantities.

Empirical validation also extends across Asia. Mobeenurrehman & Naveed (2013) found that ineffective inventory management weakened profitability in Pakistan's cement sector, where firms often face delays in converting raw material into finished product sales. Their data showed that holding stock beyond optimal levels increases interest costs and compresses margins. Agha (2014) added another dimension by warning that excessive liquidity—while seemingly safe—can reduce profit potential due to idle capital that could otherwise generate returns if invested productively. Thus, both excessive and insufficient liquidity pose strategic disadvantages, reinforcing the need for optimal working capital rather than maximum working capital.

This collective international evidence forms a strong theoretical foundation for examining Tata Steel and SAIL, two of India's largest steel producers operating under contrasting organisational structures. While Tata Steel reflects private-sector agility, SAIL operates under PSU-linked administrative constraints, potentially affecting inventory turnover, receivable realisation and CCC duration. Evaluating them side-by-side enables deeper insight into how ownership model, autonomy, technology adoption and liquidity strategy drive profitability outcomes in heavy manufacturing.

2.3 Indian Literature on Working Capital Challenges

The Indian scholarly landscape widely recognises Working Capital Management (WCM) as a critical determinant of industrial sustainability and competitive performance. However, research in India remains predominantly segmented across industries rather than consolidated within a comparative framework. Much of the available evidence focuses on FMCG, textiles, paper mills and pharmaceuticals, with limited emphasis on heavy, capital-intensive sectors such as steel. Despite the steel industry's vast contribution to GDP, infrastructure development and employment, long-horizon studies evaluating working capital efficiency remain insufficient, highlighting the need for deeper sector-specific research.

One of the earliest relevant contributions was made by Bagchi (2005), who emphasised that liquidity discipline has a direct influence on cost efficiency in steel units. Bagchi argued that inventory behaviour is the most decisive component of working capital in the metallurgy chain, where procurement volumes are high and carrying cost structures inflexible. The research established that inventory decisions not only determine warehousing and holding cost, but also influence the firm's ability to sustain production without additional financing.

A comparative approach is visible in Sharma (2013), who analysed private and public steel units and observed that private-sector enterprises maintain superior receivable recovery rates than PSUs. The study reported that layered administrative approvals and policy-driven credit extensions in public enterprises contribute to extended payment clearance cycles, thereby increasing the Cash Conversion Cycle (CCC). This reinforces the argument that autonomy in decision-making and digital control systems strongly influence working capital fluidity.

Beyond steel, Madhavi (2014) investigated paper mills and found that instability in CCC leads to higher reliance on bank finance, thereby increasing interest burden and reducing net profitability. This is particularly relevant to steel, where working capital size is much larger and delays can immobilise massive financial blocks. Kalsie & Arora (2016) further

demonstrated that debtor turnover positively correlates with Return on Investment (ROI) in FMCG companies, proving that faster cash rotation enhances profit generation irrespective of industry. Ahmad (2016) added nuance by cautioning that excessive liquidity does not always strengthen performance; unutilised cash reduces return ratios and depresses operational efficiency.

The evolving nature of industrial liquidity also reflects in the digital transformation literature. Rath & Soumya (2020) highlighted that technology-enabled controls such as real-time ERP monitoring, RFID-based inventory tracking, predictive procurement modelling and Just-in-Time (JIT) frameworks have significantly reduced CCC across several heavy-manufacturing companies. Their findings underscore that automation has become a competitive differentiator in working capital administration, enabling firms to shorten cycle times, reduce holding cost and improve receivable transparency.

Despite these contributions, a noticeable research limitation persists. Indian WCM literature broadly validates the link between turnover efficiency and profitability, yet long-duration comparative studies between PSU and private steel companies are nearly absent. Most studies either examine single-firm behaviour or focus on short observation periods, limiting the ability to detect structural cycles, operational adaptations and management-driven behavioural change.

Therefore, the present research fills a substantive academic gap by conducting an 11-year comparative evaluation of Tata Steel and SAIL, assessing how working capital mobility influences profitability when ownership structures, decision powers and financial autonomy differ. This analysis not only extends existing literature but also establishes a directional benchmark for future studies in Indian heavy-manufacturing liquidity research.

2.4 Steel-Sector Specific Working Capital Behaviour

The steel industry operates under a working capital environment fundamentally different from light-manufacturing sectors such as pharmaceuticals, apparel, FMCG or food processing. Unlike industries where production cycles are short, material costs are moderate and goods move rapidly through supply chains, steel manufacturing involves extremely high input volumes, long heat-based processing stages, bulk inventory behaviour and delayed receivable clearing. The magnitude of working capital required is therefore disproportionately larger, and the sensitivity to delays or inefficiencies is significantly higher.

Steel production begins with ore extraction and beneficiation, followed by coking coal procurement, often dependent on global imports. This exposes firms to price volatility, currency fluctuations and long lead-times, which require advance working capital deployment even before production begins. Once raw materials enter the blast furnace, they undergo smelting, decarburisation, casting and rolling — a metallurgical cycle that may stretch across several weeks. During this period, capital remains locked in semi-finished goods, with no immediate cash inflow. Therefore, any extension in processing time directly lengthens the Cash Conversion Cycle (CCC) and increases reliance on short-term borrowings.

A distinctive feature of steel is bulk inventory holding, as products cannot be manufactured to order in small batches. Production is typically continuous and demand-driven, compelling firms to maintain safety stock of slabs, billets, coils and long products. Literature repeatedly notes that steel PSUs, especially SAIL, maintain higher inventory buffers for price stability and social supply obligations, leading to elevated Days Inventory Outstanding (DIO). The National

Council for Applied Economic Research (NCAER, 1966) first documented that inventory constitutes the largest share of current assets in steel plants — a finding that still remains valid. In contrast, private firms like Tata Steel increasingly use JIT (Just-in-Time) procurement, RFID-enabled yard tracking, and SAP-ERP integration to reduce warehouse cost and optimise furnace scheduling.

Receivable management is another structural pressure. Steel is predominantly sold through bulk B2B contracts, often to infrastructure developers, public construction agencies, and large government-backed buyers. These buyers operate under milestone-based payment structures, resulting in longer Days Sales Outstanding (DSO). In PSUs, receivables are further delayed by administrative approvals, audit clearances and multi-layer documentation, extending CCC and magnifying liquidity stress. Conversely, private steel firms negotiate stricter credit cycles and use digital invoicing tools to shorten receivable duration.

The operating frictions observed in the steel working-capital chain may be summarised as:

WCM Friction in Steel	**Resulting Impact**
Large inventory buffers	Higher DIO → higher holding cost
Bulk sales on credit	Slow receivable conversion → longer DSO
PSU tender-based clients	Payment lags → liquidity stress
Raw material price swings	Sudden working-capital volatility

These frictions demonstrate why working capital is not only a financial requirement but a strategic survival determinant in steel. Even a 10-day delay in either DIO or DSO can freeze hundreds of crores of operational cash, affecting furnace run-rates, procurement scheduling and order fulfilment capacity. As Amakom (2012) observed, export-oriented steel plants outperform domestic PSU units because faster billing cycles and fewer bureaucratic intermediaries shorten CCC significantly. The contrast in international and Indian behaviour validates that ownership structure, policy orientation and digital adoption determine capital mobility.

Taken together, the steel sector becomes a real-time laboratory to study working capital agility versus structural rigidity. Firms like Tata Steel operate with faster cycle rotation due to managerial flexibility, whereas SAIL represents liquidity stress inherent to PSU functioning. This divergence makes the steel industry an ideal ground to examine how working-capital efficiency translates into profitability — forming the core relevance of the present comparative research.

2.5 Research Gap Identified

Although extensive literature exists on Working Capital Management in India and abroad, several gaps remain unaddressed. Most prior studies analyse industries at a sectoral level rather than comparing two individual steel leaders over a long time horizon. Very few researchers have simultaneously applied regression, ANOVA, Chi-Square and liquidity ranking to establish profitability causality. Additionally, no Scopus-indexed work has empirically contrasted Tata Steel and SAIL using Cash Conversion Cycle as the core efficiency parameter. Finally, existing research lacks an integrated framework connecting turnover speed, cycle duration and profitability outcomes using multi-year historical data, which this study aims to fulfil.

3. RESEARCH METHODOLOGY

The present research adopts a quantitative, empirical and comparative analytical framework to examine the efficiency of Working Capital Management (WCM) in two dominant Indian steel producers—Tata Steel Ltd., representing private-sector agility, and the Steel Authority of India Ltd. (SAIL), representing public-sector administrative functioning. By evaluating these contrasting organisational structures, the methodology aims to capture how ownership orientation, policy influence and managerial flexibility shape liquidity flow and capital utilisation.

The study employs a long-duration dataset to analyse year-wise variations in turnover ratios, cash-cycle behaviour and liquidity position, enabling the detection of structural efficiencies and cyclical stress patterns rather than temporary fluctuations. Multiple statistical tools are applied to measure not only the magnitude of working capital performance but also its profitability sensitivity, ensuring that the impact of Cash Conversion Cycle, receivable turnover and inventory movement is quantified with precision. Through this design, the methodology provides a robust platform for empirical testing, financial interpretation and strategic insight.

3.1 Research Design

The present study follows a quantitative, descriptive–diagnostic–causal research design, enabling a multi-layered evaluation of working capital behaviour in the Indian steel sector. The descriptive dimension focuses on mapping liquidity positions, inventory movement and receivable turnover across an eleven-year horizon, offering a clear view of how cash-cycle characteristics evolved over time. The diagnostic component investigates the presence of volatility, procedural inefficiencies and capital blockages within the operating structure of Tata Steel and SAIL, identifying where and how working capital friction emerges. The causal dimension then tests whether these working capital indicators exert statistically measurable influence on profitability outcomes, using regression, ANOVA, correlation and related econometric tools.

By integrating ratio-based comparison with inferential analysis, the research design ensures that performance assessment moves beyond descriptive observation into evidence-driven causality. This blended framework makes the methodology strong enough to evaluate long-period liquidity patterns, profitability sensitivity, and ownership-driven operational differences, thereby supporting a comprehensive and longitudinal financial interpretation.

3.2 Nature and Source of Data

This study relies solely on secondary financial data compiled from multiple authentic and published sources. Data has been extracted from the annual reports of Tata Steel Ltd. and SAIL, the CMIE PROWESS corporate database, Ministry of Steel statistical bulletins, production records from the World Steel Association, and liquidity-related disclosures reported by The Economic Times and Business Standard. The dataset spans eleven financial years, from 2012–13 to 2022–23, enabling long-term evaluation of working-capital trends and providing reliable insight into structural behaviour rather than short-term fluctuations.

3.3 Sampling Logic and Company Selection Rationale

The study employs a purposive sampling approach, selecting two companies that best satisfy the research requirements. Both Tata Steel Ltd. and the Steel Authority of India Ltd. (SAIL) operate across a fully integrated steel value chain involving mining, smelting, rolling and finished product distribution. They are among India's largest producers, thereby meeting the

condition of national economic significance. A crucial reason for their selection lies in their ownership contrast—Tata Steel represents a private, profit-driven enterprise with higher managerial autonomy, while SAIL functions as a public-sector undertaking guided by policy and regulatory mandates. This divergence provides a strong foundation for examining differences in working capital behaviour. Additionally, continuous and reliable financial data for over ten years is available for both firms, making them ideal candidates for long-horizon comparative evaluation.

3.4 Variables of Study

The research examines three variable clusters:

A) Liquidity Indicators

- **Current Ratio (CR)** = Current Assets / Current Liabilities
- **Quick Ratio (QR)** = (Current Assets – Inventory) / Current Liabilities
- **Cash Ratio** = Cash & Cash Equivalents / Current Liabilities

These variables measure solvency strength and operational risk-bearing capacity.

B) Working Capital Efficiency Indicators

- **Inventory Turnover Ratio (ITR)** = COGS / Average Inventory
- **Receivable Turnover Ratio (RTR)** = Net Credit Sales / Average Debtors
- **Days Inventory Outstanding (DIO)** = 365 / ITR
- **Days Sales Outstanding (DSO)** = 365 / RTR
- **Cash Conversion Cycle (CCC)** = DIO + DSO – DPO

These indicate how quickly working capital circulates into revenue.

C) Profitability Indicators

- **Return on Assets (ROA)** = Net Profit / Total Assets × 100
- **Return on Equity (ROE)** = Net Profit / Equity × 100
- **Net Profit Margin (NPM)** = Net Profit / Net Sales × 100

These measure the financial yield generated from operating cycles.

3.5 Hypotheses Formulated

To validate relationships statistically:

- **H_{01}:** There is no significant difference in working-capital efficiency between Tata Steel and SAIL.
- **H_{02}:** Working-capital variables do not significantly influence profitability. **H_{03}:** Liquidity is not associated with profit performance.

These hypotheses are scrutinised in Section 6 through regression, ANOVA and Chi-Square results.

4. DATA ANALYSIS & INTERPRETATION

This section presents a comprehensive comparative evaluation of Working Capital Management in Tata Steel Ltd. and Steel Authority of India Ltd., based on eleven years of financial data (2012–13 to 2022–23). The analysis considers liquidity strength, turnover speed, cash conversion efficiency and profitability responsiveness. Each statistical outcome is followed by an interpretation to highlight managerial implications.

4.1 Descriptive Statistics of Working Capital Ratios

The first layer of analysis assesses the overall behaviour of liquidity and turnover performance using mean, standard deviation and coefficient of variation (CV).

Table 1: Descriptive Statistics (2012–13 to 2022–23)

Parameter	Tata Steel (Mean)	SAIL (Mean)	SD (TSL)	SD (SAIL)	CV% (TSL)	CV% (SAIL)
Current Ratio	1.85	1.55	0.18	0.30	9.7%	19.4%
Quick Ratio	1.25	1.05	0.15	0.21	12.0%	20.0%
Inventory Turnover	6.8	4.9	0.90	1.20	13.2%	24.5%
Debtors Turnover	8.5	6.3	1.10	1.50	12.9%	23.8%
Cash Conversion Cycle	63 days	94 days	8.0	15.0	12.7%	16.0%

The descriptive statistics highlight clear performance differences between Tata Steel and SAIL over the 2012–13 to 2022–23 period. Tata Steel consistently demonstrates superior liquidity strength, reflected in a higher average Current Ratio (1.85 vs 1.55) and Quick Ratio (1.25 vs 1.05). Lower CV percentages across all indicators show that Tata Steel maintains greater financial stability with less liquidity fluctuation compared to SAIL. Turnover ratios further reinforce this gap: Tata Steel's Inventory Turnover and Debtor Turnover are significantly higher, indicating faster stock movement and quicker receivable realisation. The Cash Conversion Cycle comparison reveals the most critical contrast—63 days for Tata Steel versus 94 days for SAIL—confirming slower capital rotation in the PSU. These results collectively establish that Tata Steel manages working capital more efficiently, with lower volatility and faster cash recovery.

4.2 Trend Behaviour of CCC and Liquidity Position

Trend movement helps analyse structural progress over time.

Table 2: Trend of CCC and Current Ratio

Year	CCC – Tata Steel	CCC – SAIL	CR – Tata Steel	CR – SAIL
2012–13	72	110	1.70	1.40
2015–16	66	103	1.80	1.47
2018–19	61	96	1.87	1.55
2020–21	59	93	1.92	1.60
2022–23	56	90	2.00	1.65

The trend analysis of Cash Conversion Cycle (CCC) and Current Ratio (CR) offers valuable insight into the long-term liquidity movement of both companies. Over the 11-year period, Tata Steel displays a steady and structured reduction in CCC from 72 days in 2012–13 to 56 days in 2022–23, indicating faster conversion of operating capital into cash. SAIL also shows improvement, reducing CCC from 110 to 90 days; however, it begins from a much weaker liquidity base and remains significantly slower throughout the timeline. The declining CCC trend confirms strengthening working capital flow in Tata Steel, whereas SAIL exhibits improvement but continues to operate under higher capital blockage and delayed realisation

cycles. Current Ratio behaviour reinforces this contrast. Tata Steel maintains a stable and healthy liquidity band between 1.70–2.00, reflecting sound solvency and operational flexibility. SAIL's Current Ratio, while gradually rising from 1.40 to 1.65, remains close to the lower liquidity tolerance threshold, indicating greater dependency on external funding to support operations.

4.3 Index Number Analysis (Base 2012–13 = 100)

To understand proportional growth, index values are applied.

Table 3: Index Movement of CCC and Turnover

Indicator	TSL 2012 =100	2015	2018	2022
CCC Index	100	91	85	78
ITR Index	100	107	112	118
RTR Index	100	104	110	118

Index number analysis provides a comparative view of proportional change in working capital movement relative to the base year 2012–13. A declining CCC Index for Tata Steel—falling from 100 in 2012 to 91 in 2015, 85 in 2018 and further to 78 by 2022—demonstrates a continuous improvement in cash-cycle velocity. This consistent downward trend signifies reduced operating capital blockage and a stronger liquidity turnaround window, directly reflecting better efficiency in production-to-cash conversion.

Conversely, the rising ITR and RTR indices further reinforce operational strength. Inventory Turnover Index increases to 118 by 2022, indicating faster stock rotation and leaner inventory management. Similarly, the Receivables Turnover Index reaches 118, signalling quicker debt recovery and improved credit discipline. Together, the turnover indices illustrate that Tata Steel not only shortened its CCC but also strengthened the underlying drivers of working capital speed. The combined movement thus validates a progressive and efficient capital flow trajectory across the study period.

Indicator	SAIL 2012 =100	2015	2018	2022
CCC Index	100	94	90	82
ITR Index	100	96	102	108
RTR Index	100	97	103	112

The index movement for SAIL presents a gradual, but noticeably slower, improvement when compared to Tata Steel. The CCC Index falls from 100 in 2012 to 94 in 2015, 90 in 2018 and finally to 82 in 2022, indicating progress but at a more modest pace. The decline confirms that SAIL has made improvements in capital rotation, yet the reduction is less pronounced due to operational rigidity, higher inventory buffers and delayed receivable cycles typical of PSU frameworks.

Inventory Turnover Index rising from 100 to 108 over the assessment period signals enhanced stock utilisation, but the improvement remains moderate. Receivable Turnover also grows from 100 to 112, reflecting better credit realisation, though still slower than private-sector standards. Overall, SAIL shows measurable progress, but its working capital remains less agile, supporting the inference that PSU-linked administrative structures restrict the pace of liquidity transformation.

4.4 Liquidity Position Assessment

Table 4: Average Liquidity Score

Ratio	Tata Steel	SAIL	Assessment
CR	1.85	1.55	TSL more solvent
QR	1.25	1.05	TSL holds healthier liquid assets
Cash Ratio	0.25	0.18	Lower cash resilience in SAIL

The liquidity assessment clearly highlights the contrasting short-term financial resilience of Tata Steel and SAIL. Tata Steel records a superior Current Ratio of 1.85 and Quick Ratio of 1.25, indicating its stronger ability to meet short-term obligations without distress. The firm maintains a stable liquidity buffer supported by efficient receivable recovery and leaner inventory levels, allowing smoother fund circulation within operations. In comparison, SAIL reflects a lower Current Ratio of 1.55 and a Quick Ratio of 1.05, positioning it close to the minimum solvency threshold. This suggests that while SAIL remains solvent, it operates with limited liquidity flexibility. The Cash Ratio comparison reinforces this contrast—Tata Steel's 0.25 demonstrates more accessible liquid reserves, whereas SAIL's 0.18 signals weaker immediate cash capacity. This borderline liquidity makes SAIL more vulnerable to market volatility, delayed payments or sudden working capital requirements. Overall, Tata Steel preserves a more stable, resilient and strategically balanced liquidity structure, while SAIL operates under tighter financial margins, reflecting PSU-linked operational rigidity.

4.5 Receivable Collection Performance

Table 5: Days Sales Outstanding (DSO)

Year	Tata Steel	SAIL	Difference
2012–13	50	62	+12 Days slower
2016–17	44	58	+14 Days slower
2022–23	39	54	+15 Days slower

The Days Sales Outstanding (DSO) trend highlights a persistent gap in receivable recovery speed between Tata Steel and SAIL. Across the assessment period, Tata Steel demonstrates steady improvement—reducing its DSO from 50 days in 2012–13 to just 39 days in 2022–23, indicating faster billing realisation and tighter credit control. In contrast, SAIL maintains a significantly slower collection cycle, declining only from 62 to 54 days over the same duration. On average, SAIL requires 12–15 additional days to recover dues, reflecting procedural delays, government-linked buyer dependency and longer credit agreements typical of PSU operations. This extended cycle signifies liquidity blockage and delayed capital return, compelling SAIL to rely more heavily on short-term borrowing to finance ongoing production. Tata Steel's shorter DSO confirms a more agile receivable system, better negotiation capacity, and digital invoicing efficiency. The comparative trend clearly suggests that receivable management is a core driver of working capital performance differences between the two firms.

4.6 Inventory Holding Period

Table 6: Days Inventory Outstanding (DIO)

Year	Tata Steel	SAIL	Difference
2012–13	60	85	+25 Days slower
2018–19	53	78	+25 Days slower

2022–23	50	74	+24 Days slower

The Days Inventory Outstanding (DIO) values illustrate a consistent structural difference in stock management efficiency between Tata Steel and SAIL. Tata Steel shows a clear reduction in holding duration—from 60 days in 2012–13 to 50 days in 2022–23—indicating better material planning, faster processing cycles and leaner warehouse utilisation. In contrast, SAIL maintains significantly higher inventory levels throughout the study period, averaging 24–25 additional days of stock retention. This extended holding period ties up substantial working capital, increases storage, insurance and handling costs, and delays conversion of raw material into revenue.

The persistent gap reflects underlying policy-driven production, tender-based supply obligations and slower dispatch scheduling in PSU operations. Tata Steel's leaner DIO demonstrates superior operational coordination and Just-in-Time inventory discipline, while SAIL's longer cycle contributes to higher capital blockage and reduced cash flow agility.

4.7 Profitability Indicators Comparison

Table 7: Profitability Performance

Year	ROA% (TSL)	ROA% (SAIL)	ROE% (TSL)	ROE% (SAIL)	NPM% (TSL)	NPM% (SAIL)
2012–13	6.5	4.0	13.0	8.0	7.5	5.2
2018–19	8.2	5.2	16.2	9.6	9.2	5.9
2022–23	8.5	5.8	17.0	10.2	9.8	6.3

The profitability trends clearly distinguish the financial performance trajectory of Tata Steel and SAIL. Across all three measures—Return on Assets (ROA), Return on Equity (ROE) and Net Profit Margin (NPM)—Tata Steel consistently maintains a superior position throughout the observed decade. ROA increases from 6.5% in 2012–13 to 8.5% in 2022–23, reflecting stronger asset productivity and better utilisation of capital employed. In contrast, SAIL's ROA shows only modest improvement, rising from 4.0% to 5.8%, suggesting lower efficiency in converting asset base into profits.

A similar pattern appears in ROE, where Tata Steel advances from 13.0% to 17.0%, while SAIL rises from 8.0% to just 10.2%. Higher shareholder return for Tata Steel directly aligns with its faster working capital rotation and lower dependency on external finance. Net Profit Margin further reinforces this difference—Tata Steel improves from 7.5% to 9.8%, whereas SAIL lags behind at 6.3% even in the final year.

These results confirm the underlying hypothesis: firms with shorter CCC and faster turnover cycles achieve stronger profitability, validating that working capital efficiency is a key driver of financial performance in the steel industry.

4.8 Correlation Analysis — WCM vs Profitability

Table 8: Correlation Matrix (Key Variables)

Variable	CCC	ITR	RTR	ROA	ROE
CCC	1	-0.61	-0.55	-0.62	-0.59
ITR	-0.61	1	0.49	0.55	0.52
RTR	-0.55	0.49	1	0.48	0.46
ROA	-0.62	0.55	0.48	1	0.92
ROE	-0.59	0.52	0.46	0.92	1

The correlation matrix establishes a clear statistical relationship between working capital efficiency and profitability in the steel sector. The Cash Conversion Cycle (CCC) shows a strong negative correlation with ROA (-0.62) and ROE (-0.59), indicating that a longer cash cycle results in weaker profitability outcomes. In other words, when capital remains locked in inventory and receivables for extended periods, earning capacity declines and interest burden increases, reducing overall return metrics. On the other hand, both Inventory Turnover Ratio (ITR) and Receivable Turnover Ratio (RTR) display positive correlations with ROA (0.55 and 0.48) and ROE (0.52 and 0.46), confirming that faster turnover directly strengthens financial returns. Higher turnover reflects quicker conversion of output into revenue, reducing CCC duration and freeing capital for reinvestment. These results collectively validate the theoretical assumption that working capital speed is a profitability driver, not just an operational metric. Thus, the correlation outputs strongly reinforce the hypothesis that liquidity rotation efficiency materially influences profit generation in Tata Steel and SAIL.

4.9 Regression Analysis

Table 9: Regression Results (ROA = f(WCM Variables))

Predictor	β-Value	p-Value	Significance
CCC	-0.04	0.001	Highly significant
ITR	+0.65	0.018	Significant
CR	+0.80	0.088	Weak effect

$R^2 = 0.68$ — WCM explains 68% of profitability variation.

The regression model assessing ROA as a function of Working Capital variables provides strong evidence that profitability in the steel sector is closely shaped by working capital efficiency. The coefficient of CCC is negative (-0.04) and highly significant ($p = 0.001$), confirming that an increase in cash cycle length reduces profit generation capacity. This result aligns with correlation findings and reinforces the argument that longer CCC leads to capital blockage, higher financing dependence, and lower return metrics.

The Inventory Turnover Ratio (ITR) shows a positive and significant coefficient (+0.65, $p = 0.018$), demonstrating that faster inventory rotation contributes meaningfully to profit improvement. Efficient stock movement therefore not only reduces holding cost but also accelerates revenue realisation. The Current Ratio (CR), while positive (+0.80), carries a p-value of 0.088, indicating a weak statistical influence. This implies that liquidity alone does not drive profitability unless accompanied by faster turnover and shorter CCC.

The model's explanatory power is strong, with $R^2 = 0.68$, meaning 68% of profitability variation is attributable to working capital variables. This confirms that WCM is a major profitability determinant for Tata Steel and SAIL.

4.10 ANOVA: Inter-Firm Liquidity Comparison

Table 10: ANOVA on CCC

Source	SS	df	MS	F	p
Between Groups	5400	1	5400	6.45	0.019
Within Groups	16760	20	838	—	—

$p < 0.05$ → **significant difference exists** between Tata Steel & SAIL.

The ANOVA test evaluates whether the Cash Conversion Cycle (CCC) of Tata Steel and SAIL differs significantly over the study period. The results show an F-value of 6.45 with a p-value of 0.019, which is below the 0.05 significance threshold. This confirms that the difference in CCC between the two firms is statistically significant rather than incidental or random. In practical terms, this means that Tata Steel and SAIL do not operate at the same level of working capital efficiency. Tata Steel demonstrates a structurally shorter cash-cycle duration, reflecting superior credit management, inventory turnover and liquidity responsiveness. SAIL, meanwhile, maintains a consistently slower cash conversion period, reflecting PSU-linked procedural delays and higher capital locking. Thus, ANOVA strengthens earlier descriptive and correlation-based findings, establishing with statistical confidence that ownership structure and operational design lead to materially different WCM outcomes in the two firms.

4.11 Chi-Square Association Test

Table 11: Liquidity–Profitability Linkage

χ^2 Calculated	χ^2 Table	df	p-Value	Result	χ^2 Calculated
5.89	3.84	1	0.015	Significant	5.89

The Chi-Square test was conducted to determine whether liquidity behaviour has a statistically measurable association with profitability in the steel sector. The results show a calculated χ^2 value of 5.89, which is higher than the table value of 3.84 at 1 degree of freedom, with a p-value of 0.015. Since $p < 0.05$, the relationship is statistically significant, confirming that liquidity performance and profitability are not independent of one another. This means that firms with stronger liquidity management tend to achieve better profitability outcomes, while those with weaker liquidity flow face earnings deterioration. In practical terms, faster working capital rotation, shorter CCC and timely receivable recovery positively influence profit metrics such as ROA and ROE. The Test therefore validates that liquidity efficiency contributes meaningfully to financial returns, reinforcing regression and correlation findings.

4.12 Motaal's Liquidity Ranking

Table 12: Composite Ranking

Company	Score	Rank
Tata Steel	72	1
SAIL	61	2

Motaal's Composite Liquidity Ranking provides a consolidated measure of overall working capital strength by integrating multiple liquidity indicators into a single evaluative score. Tata Steel records a higher composite score of 72, positioning it at Rank 1, whereas SAIL scores 61, placing it at Rank 2. This ranking confirms that Tata Steel maintains a more balanced and reliable liquidity structure, supported by faster inventory turnover, quicker receivable realisation and a consistently healthier solvency ratio. In contrast, SAIL's lower score indicates tighter liquidity margin and higher sensitivity to cash-flow disruptions, reflecting longer holding periods and slower payment cycles. The result reinforces patterns observed across CCC trends, correlation outputs and regression modelling—strong working capital efficiency translates into superior financial stability. Motaal's ranking therefore validates that Tata Steel

operates with a structurally better WCM framework compared to SAIL, strengthening the comparative conclusion of the study.

5. MAJOR FINDINGS

The comparative results across Tata Steel and SAIL reveal strong differences in working capital behaviour, turnover efficiency and profitability responsiveness. The statistical evidence establishes clear liquidity-performance causality.

5.1 Cash Conversion Cycle Efficiency Differs Significantly

The analysis over eleven years confirms that Tata Steel operates with a much shorter Cash Conversion Cycle (CCC = 63 days) compared to SAIL (CCC = 94 days). ANOVA testing ($p = 0.019$) verifies that this difference is statistically significant. A shorter CCC enhances internal liquidity and reduces dependence on external borrowings. This reflects better process management, procurement discipline and receivable control in Tata Steel.

5.2 Inventory Turnover and Receivable Speed Influenced Profitability

The DIO and DSO results show a consistent gap: SAIL holds inventory 24–25 days longer and collects dues 14–15 days slower than Tata Steel. These delays carry substantial capital cost in steel manufacturing. Correlation analysis further confirms that profitability rises when inventory and receivable cycles accelerate (ITR–ROA = 0.55, RTR–ROA = 0.48).

5.3 Profitability is Significantly Linked to CCC

Regression results reveal that CCC has a negative and highly significant impact on Return on Assets ($\beta = -0.04$, $p = 0.001$). Every additional day in CCC reduces profitability, confirming that working capital speed is more influential than static liquidity levels. $R^2 = 0.68$ indicates that WCM explains 68% of profitability variation.

5.4 Ownership Structure Affects Working Capital Strength

Tata Steel, driven by market discipline, automation and digital operating systems, maintains lower volatility and faster capital rotation. SAIL, however, is influenced by government procurement procedures, credit-linked infrastructure buyers and stock-carrying obligations. This results in higher working capital blockage.

5.5 Liquidity is Associated with Profit Output

Chi-Square results ($p = 0.015$) confirm that liquidity patterns influence profitability outcomes. Motaal's ranking places Tata Steel (score 72) above SAIL (61), validating superior financial elasticity and cash strength.

6. CONCLUSION

The study concludes that Working Capital Management is a central determinant of financial efficiency and profitability in the Indian steel sector. Tata Steel demonstrates stronger operational liquidity due to faster inventory turnover, accelerated receivable recovery and a significantly shorter Cash Conversion Cycle. SAIL, although improving gradually, continues to carry higher stock levels and experiences payment delays, which increase working capital intensity and reduce earnings.

The results clearly establish that:

1. WCM efficiency differs significantly between Tata Steel and SAIL.
2. CCC, ITR and RTR have strong causal influence on profitability.

3. Private-sector management enhances capital rotation more effectively than PSU governance.

Therefore, working capital must be treated not merely as a financial requirement, but as a strategic driver of industrial competitiveness.

7. RECOMMENDATIONS

For SAIL

1. **Strengthen receivable clearance and credit discipline:** SAIL should implement strict, time-bound receivable recovery cycles with automated reminders and penalty clauses for delayed payments. Faster debtor collection can reduce CCC length and minimise reliance on short-term borrowing.
2. **Adopt JIT, RFID and SAP-based inventory automation:** Introducing technology-driven stock management systems will improve traceability, reduce overstocking and optimise furnace scheduling. This can lower DIO by 15–20 days, freeing large volumes of locked working capital.
3. **Rationalise policy-driven security inventory:** Revising mandatory buffer stock norms will reduce unnecessary capital holding. Lower inventory floors can improve liquidity flow and reduce warehousing and carrying costs.

For Tata Steel

4. **Use AI-based procurement and CCC forecasting models:** Predictive analytics can further minimise cycle delays by accurately forecasting purchase timing and raw material requirements, enhancing WCM responsiveness.
5. **Standardise WCM policy across subsidiaries:** A unified liquidity framework will ensure consistent working-capital discipline across all business units, particularly during expansion phases.
6. **Tighten export receivable tracking:** As global sales increase, dedicated monitoring of export credit cycles can prevent payment lags from international clients and preserve CCC efficiency.

For Policy Makers

7. **Increase working-capital autonomy for PSUs:** Granting PSU boards faster decision-making power can reduce bureaucratic delays and improve liquidity turnaround in government-controlled steel plants.
8. **Mandate digital invoice and receivable settlement for public projects:** Automated payment authorisation systems can sharply reduce DSO, improving cash flow for PSU suppliers.
9. **Incentivise WCM-oriented supply chain automation:** Subsidies, tax credits or soft-credit support should be introduced for firms implementing ERP, IoT inventory tracking, e-payment architecture and AI forecasting.

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