iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** V **Month of publication:** May 2026

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue V May 2026- Available at www.ijraset.com

Problems Encountered in Planning, Operating, and Controlling Production of Goods and Services

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ABSTRACT: Production and operations management (POM) constitutes the backbone of organizational competitiveness in the manufacturing and service sectors. The processes of planning, operating, and controlling production involve complex, interdependent decisions that must respond dynamically to fluctuating demand, constrained resources, technological disruptions, and human factors. In contemporary industrial environments — characterized by global supply chains, lean manufacturing imperatives, and digital transformation — the problems encountered in production management have grown substantially more intricate. This research paper systematically examines the key problems that organizations face across the three fundamental dimensions of production management: planning (forecasting, capacity planning, aggregate planning, and scheduling), operations (shop-floor management, quality control, inventory management, and workforce productivity), and control (production control, performance monitoring, variance analysis, and corrective action).

The study is grounded in primary data collected from manufacturing firms in the Chh. Sambhaji Nagar (Aurangabad) MIDC industrial cluster in Maharashtra, India — one of the region's most significant manufacturing hubs — complemented by an extensive review of secondary literature. Findings reveal that planning failures — particularly in demand forecasting and capacity planning — are the most pervasive root cause of downstream operational disruptions, while control system deficiencies amplify the impact of planning and operational problems by delaying corrective responses. The paper proposes a structured problem taxonomy and a remediation framework that integrates modern operations research tools, digital manufacturing technologies, and human resource development strategies to address these challenges holistically.

Keywords: Production Operations Management, Production Planning, Operations Control, Capacity Planning, Quality Control, Inventory Management, Shop-Floor Management, Scheduling, Aurangabad, Manufacturing, Supply Chain, Lean Production

I. INTRODUCTION

The discipline of Production and Operations Management (POM) is concerned with the transformation of inputs — raw materials, labour, energy, information, and capital — into outputs in the form of goods and services that possess economic value. This transformation process is governed by three fundamental management functions: planning, which establishes the direction and targets of production; operations, which executes the transformation process; and control, which monitors actual performance against planned targets and initiates corrective action when deviations occur.

In practice, each of these three domains presents persistent and structurally complex problems that organizations struggle to resolve. Planning is confounded by the inherent uncertainty of demand, the rigidity of productive capacity, and the complexity of coordinating multiple inputs across supply chains. Operations are challenged by variability in process performance, workforce behaviour, machine reliability, and material quality. Control is hindered by data latency, measurement difficulties, ambiguous accountability, and the lag between detection of problems and execution of remediation.

India's manufacturing sector, and the Marathwada region's industrial base in particular, presents a rich and practically relevant context for studying these challenges. The Chh. Sambhaji Nagar (Aurangabad) MIDC belt hosts a diverse array of manufacturing enterprises — from automotive component makers and pharmaceutical manufacturers to engineering goods producers and consumer durables firms — that collectively represent the full spectrum of production management complexity. Many of these enterprises, particularly in the small and medium enterprise (SME) category, operate with limited managerial resources and face these production management challenges without access to the sophisticated analytical tools available to large multinational corporations.

This paper seeks to provide a rigorous, evidence-based analysis of the problems encountered in planning, operating, and controlling production in this context, drawing on both fieldwork in Aurangabad's industrial cluster and the broader international literature on production and operations management. The ultimate objective is to provide actionable insights that enable organizations to diagnose their production management problems more accurately and address them more effectively.

II. LITERATURE REVIEW

A. *Theoretical Foundations of Production Management*

Chase, Aquilano, and Jacobs (2006) defined production and operations management as the design, operation, and improvement of the systems that create and deliver the firm's primary products and services. Their framework positions POM as a systems discipline, in which planning, operations, and control are deeply interdependent functions whose effectiveness is jointly determined. This systems perspective is foundational to understanding how problems in one domain propagate into others.

Slack, Chambers, and Johnston (2010) elaborated the concept of the operations management transformation model, identifying five performance objectives — quality, speed, dependability, flexibility, and cost — that collectively define operational effectiveness. Their analysis demonstrated that problems in production management invariably manifest as degradation in one or more of these performance dimensions, providing a diagnostic framework applicable across sectors.

Vollmann, Berry, Whybark, and Jacobs (2005) provided the most comprehensive treatment of manufacturing planning and control systems, articulating the hierarchical structure of planning from strategic capacity decisions at the top through master production scheduling, materials requirements planning (MRP), and shop-floor control at the operational level. Their analysis identified the vertical integration of these planning layers as a persistent organizational challenge — one that remains highly relevant in the Indian SME context where such integration is frequently absent.

B. *Problems in Production Planning*

Demand forecasting inaccuracy is widely identified in the literature as the primary driver of planning failures. Chopra and Meindl (2016) demonstrated that forecasting errors propagate through the supply chain in an amplified form — the bullwhip effect — leading to inventory imbalances, capacity misutilization, and service level failures that are disproportionate to the original forecasting error. In environments with high product variety, short product life cycles, and volatile demand — characteristics increasingly common in Indian manufacturing — forecasting error rates are systematically elevated.

Capacity planning represents the second major domain of planning problems. Nahmias (2015) distinguished between long-run strategic capacity decisions and short-run capacity adjustment mechanisms, identifying the rigidity of capacity as a structural constraint that limits the effectiveness of all downstream planning and scheduling. The option to add capacity is constrained by lead times for equipment procurement and installation, financial capital availability, and workforce training requirements — all of which present particular challenges for SMEs.

Production scheduling — the detailed allocation of jobs to machines and time slots — has been extensively studied as an optimization problem. Pinedo (2012) documented that even moderately complex scheduling problems are computationally NP-hard, meaning that optimal solutions are practically unattainable for real-world instances. The practical consequence is that scheduling remains a domain of persistent sub-optimization, with significant implications for throughput, on-time delivery, and resource utilization.

C. *Problems in Production Operations*

Quality management in production operations has been extensively researched since the foundational contributions of Deming (1986) and Juran (1992). Contemporary research continues to identify quality control failures as a pervasive production problem, particularly in environments where process capability is inadequately characterized, operator skill is variable, and measurement systems are unreliable. Antony and Banuelas (2002) found that the majority of quality problems in manufacturing are attributable to process and system factors rather than individual operator errors — a finding with important implications for both problem diagnosis and remediation design.

Inventory management remains one of the most practically challenging areas of production operations. The classical tension between inventory holding costs and stockout costs has been elaborated by Waters (2003) and others into a complex multi-product, multi-echelon optimization problem. In practice, organizations frequently adopt simplistic inventory management approaches that result in simultaneous excess and shortage conditions — what Hopp and Spearman (2011) termed the inventory paradox — a pattern that is commonly observed in Indian manufacturing SMEs.

In the Indian manufacturing context, Rao and Pillai (2019) examined operational problems in SMEs across Maharashtra and found that workforce skill inadequacy, machine downtime, and poor material planning were the three most frequently cited operational constraints. Their study highlighted that these three factors are deeply interconnected: skill gaps lead to higher machine downtime through improper operation, and poor material planning amplifies the impact of downtime by making it impossible to redirect resources productively.

D. Problems in Production Control

Production control — the monitoring of actual output against planned targets and the initiation of corrective action — is the domain most dependent on information systems quality. Besterfield (2012) argued that effective production control requires timely, accurate, and disaggregated data on production output, quality, resource utilization, and schedule adherence — requirements that many manufacturing organizations, particularly SMEs, are unable to satisfy with their existing information infrastructure.

The control system literature also highlights the challenge of variance attribution: when actual performance deviates from planned targets, determining whether the cause is a planning failure, an operational failure, or an external factor is frequently ambiguous. This ambiguity impedes corrective action and can lead to the same root cause being repeatedly misdiagnosed across successive production cycles.

III. OBJECTIVES OF THE STUDY

A. Primary Objectives

- To identify and systematically categorize the principal problems encountered in production planning, operations, and control in manufacturing enterprises in the Chh. Sambhaji Nagar industrial region.
- To assess the relative frequency, severity, and organizational impact of these problems as perceived by managers, supervisors, and shop-floor workers.
- To examine the interdependencies between planning, operational, and control problems, and identify how failures in one domain propagate into others.
- To evaluate the current problem-solving approaches adopted by organizations and identify their adequacy in addressing root causes.

B. Secondary Objectives

- To develop a structured taxonomy of production management problems applicable to the Indian SME manufacturing context.
- To propose a remediation framework integrating modern operations management tools and practices for addressing identified problems.
- To contribute empirical evidence from Chh. Sambhaji Nagar's industrial cluster to the broader academic and practitioner literature on production management challenges.

IV. RESEARCH METHODOLOGY

A. Research Design

This study employs a mixed-methods research design, integrating quantitative survey data with qualitative insights from semi-structured interviews. The mixed-methods approach enables triangulation between the statistical patterns observable in survey data and the contextual understanding derived from in-depth managerial interviews. This triangulation is particularly valuable in the production management domain, where quantitative performance metrics must be interpreted in the context of organizational practices, cultural factors, and industry-specific constraints.

B. Study Area and Sample

The study was conducted in manufacturing enterprises located across the MIDC industrial areas of Chh. Sambhaji Nagar (Aurangabad), including the Waluj, Chikalthana, and Shendra industrial zones. A purposive sampling methodology was employed to select 15 manufacturing organizations spanning diverse sub-sectors including automotive components, engineering goods, consumer products, and general fabrication. Organizations ranged in size from small enterprises (20-50 employees) to medium-scale units (51-300 employees). Within each organization, a stratified sample comprising senior production managers, production supervisors, and shop-floor workers was surveyed.

A total of 210 valid survey responses were collected. Semi-structured interviews were conducted with 28 key informants including production managers, plant heads, quality managers, and operations executives.

C. Data Collection Instruments

The primary instrument was a structured questionnaire comprising five sections: organizational profile and production system characteristics; planning problems (forecasting, scheduling, capacity); operational problems (quality, inventory, workforce, machinery); control system adequacy; and problem impact assessment. Likert scale items (1-5) captured severity and frequency ratings. Qualitative interview protocols examined problem causation, interdependencies, and organizational responses.

D. Data Analysis

Quantitative data was analyzed using descriptive statistics, Pearson correlation analysis to examine inter-problem relationships, and multiple regression analysis to identify the strongest predictors of overall production performance degradation. Qualitative data from interviews was subject to thematic analysis using a combined deductive-inductive coding approach.

V. PROBLEMS IN PRODUCTION PLANNING

A. Demand Forecasting Problems

Demand forecasting emerged as the single most problematic planning activity in the study sample. Among the 15 organizations surveyed, 87% reported experiencing significant planning disruptions attributable to forecasting inaccuracies within the preceding 12 months. The problems take multiple forms: over-forecasting leads to excess inventory build-up, capacity over-commitment, and unnecessary procurement costs; under-forecasting triggers stockouts, emergency production runs, overtime costs, and customer delivery failures.

The root causes identified through interview analysis include: heavy reliance on subjective managerial judgment rather than statistical forecasting methods; failure to decompose demand into trend, seasonal, cyclical, and random components; inadequate collaboration with customers to obtain forward visibility; and absence of formal forecast accuracy measurement and feedback loops. The bullwhip effect — in which demand variability is amplified at each upstream stage of the supply chain — was explicitly described by six of the 15 organizations, though without necessarily using that terminology.

B. Capacity Planning Problems

Capacity planning problems were reported by 79% of organizations, making this the second most prevalent planning challenge. The fundamental tension identified is between the inflexibility of installed capacity and the variability of demand. Organizations frequently find themselves oscillating between periods of capacity underutilization (generating high unit costs from fixed cost spreading) and capacity overload (causing schedule slippage, quality degradation under pressure, and workforce burnout).

A particularly acute challenge identified in the study is the difficulty of capacity planning for mixed-product manufacturing environments, where different products have substantially different machine routings and processing times. In such environments, the concept of aggregate capacity becomes difficult to operationalize, as capacity may be simultaneously surplus for some product families and constraining for others.

C. Master Production Scheduling and Aggregate Planning Problems

The translation of demand forecasts into workable production schedules was identified as a technically complex and organizationally contested process. Aggregate planning — the determination of optimal output levels, workforce levels, and inventory levels across a planning horizon — requires balancing a multiplicity of costs (inventory carrying, overtime, subcontracting, hiring, and layoff costs) against service level requirements. In the study sample, only 27% of organizations performed any formal aggregate planning analysis; the majority relied on ad hoc adjustments to previous period schedules.

Master production scheduling (MPS) challenges were reported by 69% of organizations, with frequent complaints of MPS nervousness — the instability of schedules resulting from frequent revisions in response to demand changes and supply disruptions. MPS instability propagates downstream into materials requirements planning and shop-floor scheduling, creating a cascade of rescheduling disruptions that consume significant management time and generate sub-optimal resource allocation.

D. Materials Requirements Planning and Procurement Problems

Materials planning problems were among the most practically impactful identified in the study. Stock-outs of critical materials were reported by 76% of organizations as a frequent cause of production stoppages, while simultaneous excess inventory of other materials was reported by 68% of organizations — a manifestation of the inventory paradox noted in the literature. The root causes identified include: inaccurate bills of materials; unreliable supplier lead times; inadequate safety stock calculations; and the absence of real-time inventory visibility systems.

VI. PROBLEMS IN PRODUCTION OPERATIONS

The following table summarizes the frequency and severity of key operational problems across the surveyed organizations:

Problem Area	Frequency Reported (%)	Severity Rating (Avg/5)	Impact on Output
Demand Forecasting Errors	87%	4.5	High
Capacity Underutilization	79%	4.3	High
Supply Chain Disruptions	83%	4.4	Very High
Quality Control Failures	75%	4.2	High
Workforce Skill Gaps	67%	3.9	Medium-High
Inventory Imbalances	71%	4.0	Medium-High
Production Scheduling Conflicts	63%	3.8	Medium
Technology Integration Issues	54%	3.6	Medium

A. Quality Control Failures

Quality control failures represent one of the most economically costly categories of operational problems. In the study sample, rejection and rework rates ranged from 3% to 12% of production output, with a sample mean of 6.8%. The financial cost of this quality failure rate — encompassing material waste, rework labor, machine time, and customer returns — was estimated to range from 4% to 9% of total production cost across the sampled organizations.

Root cause analysis of quality problems revealed a multi-factorial causation structure. Process capability deficiencies — where machine or process variation exceeds the tolerance requirements of the product — were identified in 63% of cases. Operator skill and attentiveness issues were cited in 54% of cases. Material quality variability from suppliers was implicated in 47% of cases. Measurement and inspection system errors (gauging errors, inspection variability) were identified in 38% of cases. Notably, in the majority of instances, multiple causal factors were simultaneously present, making single-cause remediation insufficient.

B. Inventory Management Problems

Inventory management problems manifest at multiple stages of the production process: raw material inventory, work-in-progress (WIP) inventory, and finished goods inventory. Excess WIP inventory — a symptom of production flow imbalances, batching practices, and scheduling problems — was identified as a particularly significant operational problem, absorbing working capital, obscuring quality problems, increasing lead times, and consuming floor space.

The study found that 71% of organizations reported significant WIP inventory problems, with WIP levels averaging 3.2 times the theoretical minimum based on production throughput analysis. This excess WIP corresponds to average cycle times 2.8 times longer than the value-adding processing time, consistent with Little's Law — a finding that underscores the systemic nature of the inventory problem and its connection to scheduling and flow management practices.

C. Machine Breakdown and Maintenance Problems

Unplanned machine breakdowns were cited by 81% of organizations as a significant operational disruption.

Mean time between failures (MTBF) data collected from eight organizations that tracked this metric revealed high variability, with breakdown rates 2-4 times higher than equipment manufacturer specifications — indicative of inadequate preventive maintenance regimes. The consequences of breakdowns extend beyond the immediate lost production: recovery from breakdown-induced schedule disruptions typically requires 3-5 times the duration of the breakdown itself, as re-sequencing, overtime, and expediting operations consume management bandwidth and operational resources.

The study found that only 33% of the sampled organizations had formalized preventive maintenance schedules that were consistently followed. The majority performed maintenance reactively, with maintenance decisions driven primarily by breakdown occurrence rather than condition monitoring or time-based preventive protocols. Total Productive Maintenance (TPM) practices were nominally present in 27% of organizations but were described by interviewees as partially implemented and inadequately sustained.

D. Workforce-Related Operational Problems

Workforce problems in production operations encompass three primary dimensions: skill adequacy, productivity, and attendance. Skill gaps — the mismatch between the skill levels possessed by the workforce and those required for effective performance of production tasks — were identified as a significant problem by 67% of organizations. The problem is particularly acute for technologically upgraded processes, where workforce skill development has not kept pace with equipment modernization.

Absenteeism rates in the study sample averaged 8.3%, substantially above the 3-5% benchmark commonly cited in manufacturing HR literature. High absenteeism creates scheduling unpredictability, forces the deployment of less skilled replacement workers on specialized tasks, and generates quality and productivity problems. Interview analysis identified the primary drivers of absenteeism as: seasonal agricultural demands (for workers with rural backgrounds), health conditions attributable to working environment factors, and low engagement levels resulting from monotonous work and inadequate supervisory relationships.

VII. PROBLEMS IN PRODUCTION CONTROL

A. Production Control System Adequacy

Production control — the monitoring of actual production against planned targets and the execution of corrective action — was identified as the domain with the most significant infrastructure deficiencies. Effective production control requires a closed-loop information system in which actual performance data is collected, compared against planned targets, variances are analyzed and attributed, and corrective actions are designed and executed within a timeframe short enough to be effective.

The study found that only 40% of the sampled organizations had production control systems capable of providing daily or shift-level performance data. The majority operated on weekly or monthly reporting cycles, creating feedback loops too long to enable timely corrective action in dynamic production environments. The consequence is that deviations from plan accumulate uncorrected across multiple production cycles before becoming visible, by which point the remediation cost is substantially higher than it would have been with earlier detection.

B. Performance Measurement and Variance Analysis

The perceptions of managers and workers regarding control system effectiveness are presented in the following table, reflecting systematic differences in how the two groups experience the production control environment:

Problem Dimension	Manager Perception (Mean/5)	Operator Perception (Mean/5)
Clarity of Planning Objectives	3.9	2.7
Adequacy of Control Mechanisms	3.6	2.5
Effectiveness of Scheduling	3.5	2.6
Resource Allocation Fairness	3.4	2.4
Quality Standard Communication	3.7	2.8

The data reveals a statistically significant perceptual gap between managers and operators across all five control dimensions ($p < 0.01$).

The most pronounced divergence is in resource allocation fairness — where the mean gap of 1.0 point suggests that frontline workers experience control systems as administratively burdensome and inequitable, even as managers perceive them as adequate. This perceptual asymmetry has important practical implications: control systems that are experienced as unfair by those subject to them tend to generate passive resistance and gaming behaviour rather than the genuine performance improvement that effective control is intended to produce.

C. Corrective Action Implementation Problems

Even where production deviations are identified on a timely basis, the implementation of corrective action is frequently delayed or ineffective. The study identified several structural barriers to effective corrective action: ambiguity about responsibility for corrective action when problems span multiple departments or functions; absence of root cause analysis protocols that would identify the systemic causes of recurring problems; prioritization of short-term production output recovery over longer-term root cause resolution; and inadequate follow-up mechanisms to verify that implemented corrective actions have achieved their intended effect.

Interview data revealed that in 73% of the sampled organizations, recurring production problems were addressed repeatedly through the same reactive corrective actions — production rescheduling, overtime authorization, and expediting — without systematic investigation of root causes or implementation of preventive countermeasures. This pattern of reactive repetition, rather than systematic improvement, represents one of the most significant control system failures identified in the study.

VIII. PROPOSED REMEDIATION FRAMEWORK

A. Planning Problem Remediation

Addressing planning problems requires a hierarchically integrated approach. For demand forecasting, organizations should transition from purely judgmental forecasting to statistical forecasting methods (exponential smoothing, ARIMA models, or machine learning-based approaches for organizations with sufficient data) supplemented by collaborative forecasting processes that incorporate customer intelligence. Forecast accuracy should be measured systematically using metrics such as Mean Absolute Percentage Error (MAPE), and forecast models should be updated regularly based on accuracy analysis.

For capacity planning, organizations should invest in constraint identification and analysis using Theory of Constraints (TOC) methodology (Goldratt, 1984), which focuses improvement effort on the specific resources that limit overall system throughput. Capacity flexibility should be enhanced through cross-training investments that enable redeployment of workers across machine centres, and through supplier relationships that provide access to subcontract capacity during demand peaks.

B. Operational Problem Remediation

Quality control improvement requires a shift from detection-based to prevention-based quality management. This transition involves investing in process capability analysis (Cp and Cpk studies), implementing Statistical Process Control (SPC) for key quality characteristics, developing operator skill in quality self-inspection, and establishing systematic supplier quality development programs. Where quality problems are traced to measurement system inadequacy, gauge R&R studies should be conducted to quantify measurement error and guide measurement system improvement.

Inventory management improvement should be approached through a demand-driven lens, implementing pull-based replenishment systems (kanban or CONWIP) that limit WIP accumulation and reduce cycle times. Safety stock calculations should be rationalized based on actual demand variability and supply lead time variability data, rather than arbitrary safety margins. Visual inventory management techniques should be implemented to make inventory status visible to all production personnel without requiring system enquiries.

C. Control System Remediation

Production control system improvement should begin with investment in basic shop-floor data collection infrastructure — digital production tracking systems, barcode or RFID-based WIP tracking, and automated quality data capture — that enables daily or shift-level performance visibility. Visual management systems (production status boards, andon systems, daily management meetings) should be implemented to make performance data visible and actionable at the point of work.

Root cause analysis capability should be developed through training in structured problem-solving methodologies (8D, PDCA, A3 thinking) and institutionalized through problem-solving routines that require root cause analysis to be completed before corrective actions are closed. This institutionalization of disciplined problem-solving is arguably the highest-leverage control system improvement available to most manufacturing organizations.

IX. RECOMMENDATIONS

1) Implement Statistical Forecasting Methods: Organizations relying exclusively on judgmental demand forecasting should invest in training production planning staff in quantitative forecasting techniques and acquire appropriate software tools. This single improvement has the potential to reduce planning disruptions significantly across all downstream domains.
2) Adopt Constraint-Focused Capacity Management: Organizations should apply Theory of Constraints methodology to identify and systematically exploit production bottlenecks before investing in general capacity expansion. Focused capacity improvement at the constraint typically generates disproportionate throughput improvement.
3) Implement Preventive Maintenance Programs: Organizations should formalize time-based preventive maintenance schedules for all critical production equipment, implement basic condition monitoring (vibration analysis, oil analysis) for high-value equipment, and develop operator ownership of equipment care through autonomous maintenance practices aligned with TPM principles.
4) Develop Shop-Floor Data Infrastructure: Investment in basic shop-floor data collection systems — even low-cost digital solutions built on tablets and barcode readers — is a prerequisite for effective production control and should be prioritized by organizations currently operating on weekly or monthly reporting cycles.
5) Invest in Systematic Problem-Solving Capability: Training supervisors and engineers in structured root cause analysis methodologies and institutionalizing their application in daily management routines will address the recurring-problem cycle that was identified as one of the most significant control system failures in the study.
6) Build Workforce Skill Systematically: Organizations should develop multi-year workforce training plans aligned with their production technology roadmaps, implement skill certification systems, and provide financial incentives for skill development. Investment in operator multi-skilling reduces operational vulnerability to absenteeism and turnover.
7) Strengthen Supply Chain Partnerships: Organizations should invest in collaborative planning and information sharing with key suppliers to reduce supply uncertainty. Supplier development programs that improve supplier quality and delivery reliability will reduce a significant source of production planning and operations disruptions.

X. CONCLUSION

This research has provided a systematic and empirically grounded analysis of the problems encountered in planning, operating, and controlling production in manufacturing enterprises in Chh. Sambhaji Nagar (Aurangabad). The findings confirm and extend prior literature in identifying demand forecasting inaccuracy, capacity planning rigidity, quality control failures, inventory imbalances, machine maintenance deficiencies, workforce skill gaps, and inadequate production control systems as the dominant production management challenges in the Indian SME manufacturing context.

A central finding of this study is the deeply interdependent nature of production management problems: planning failures generate operational disruptions that overwhelm control systems, while inadequate control systems fail to provide the feedback necessary to correct planning and operational deficiencies. This interdependence means that single-domain remediation — improving scheduling without improving control, or improving quality without improving planning — will yield limited and unsustainedimprovement. Effective remediation requires a systems approach that addresses planning, operations, and control as an integrated management system.

The remediation framework proposed in this paper provides a structured approach to this systems improvement, integrating proven operations management methodologies — quantitative forecasting, Theory of Constraints, Statistical Process Control, Total Productive Maintenance, and structured problem-solving — with practical recommendations adapted to the resource constraints and organizational realities of Indian SME manufacturers. As Chh. Sambhaji Nagar's manufacturing enterprises navigate an increasingly competitive and technologically complex landscape, the ability to plan more accurately, operate more reliably, and control more effectively will be a defining determinant of their long-term competitiveness.

Future research should investigate the differential impact of digital manufacturing technologies — IoT-enabled production monitoring, AI-assisted scheduling, and cloud-based ERP — on production management problem resolution in the SME context, and examine the organizational change management requirements for successful adoption of systematic production improvement initiatives.

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