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PRODUCTION PLANNING AND CONTROL IN THE ELECTRICAL INDUSTRY: AN EMPIRICAL STUDY OF DEMAND FORECASTING, SCHEDULING AND OPERATIONAL IMPROVEMENT IN MADHYA PRADESH

***Manish Daryani, Lokendra Vikram Singh**

Department of Management, Madhyanchal Professional University, Bhopal.

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***Corresponding Author: Manish Daryani**
Department of Management, Madhyanchal Professional University, Bhopal.

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ABSTRACT

Production planning and control (PPC) is a critical managerial function in the electrical industry because production decisions must respond to changing customer requirements while maintaining appropriate capacity, resources, inventory, cost and delivery performance. This empirical study examines demand forecasting, production scheduling, bottleneck identification, technology use and operational improvement in the electrical industry in Madhya Pradesh. The analysis is based on survey data from 500 respondents contained in the study dataset. Descriptive statistics and factor-analysis results are used to identify the dominant practices and improvement priorities. The findings show that customer demand is the leading influence on production scheduling and control (70.6%), while demand variability is the most frequently identified factor affecting PPC (43.0%). Market research and analysis is the dominant forecasting practice (52.6%), followed by collaboration with suppliers and customers (39.4%). Process mapping and analysis is the most commonly reported method for identifying bottlenecks (43.2%). The dataset further indicates substantial scope for technology-enabled forecasting and PPC improvement. PPC software is used by 57.8% of respondents, whereas demand-forecasting software is reported by only 2.2%. Adoption of new technologies is the leading recommendation for improving PPC (63.4%). The findings suggest that electrical manufacturers can strengthen operational responsiveness by integrating demand information, forecasting, capacity planning, process analysis and digital PPC tools.

KEYWORDS: Production Planning and Control; Demand Forecasting; Production Scheduling; Electrical Industry; Bottleneck Management; Technology; Madhya Pradesh.

1. INTRODUCTION

Production planning and control connects market requirements with the resources and activities required to produce goods efficiently. In manufacturing environments characterized by product variety, changing demand and pressure on cost and delivery, PPC decisions influence capacity utilization, material availability, production sequencing, inventory and customer service. Classical operations-management literature treats planning and control as an integrated process involving forecasting, aggregate planning, scheduling, inventory and shop-floor control (Stevenson, 2021; Slack et al., 2022).

The electrical industry presents a particularly relevant setting for examining PPC because technological change, customer requirements and production constraints can change rapidly. The present study focuses on the empirical evidence contained in a survey of 500 respondents. Rather than treating PPC as a single activity, the study examines the linked areas of demand forecasting, demand management, scheduling decisions, bottleneck identification and technology-supported improvement.

The dataset indicates that customer demand is the strongest reported influence on production scheduling and control. At the same time, rapidly changing technology is reported as the largest industry-level PPC challenge (46.2%), followed by fluctuating demand (24.4%). These findings create a strong empirical basis for examining whether current forecasting and scheduling practices are sufficiently responsive and where operational improvements are required.

2. Review of Literature

Demand forecasting is a foundational input to production planning because production capacity and inventory decisions must be aligned with expected market requirements. Forecasting approaches range from judgmental methods to statistical models and market-based analysis. Hyndman and Athanasopoulos (2021) emphasize that forecasting should be evaluated in relation to the decision it supports and the quality and availability of historical information.

Production scheduling translates plans into time-phased production activities. Scheduling decisions must consider demand, capacity, resources, inventories and sequencing constraints. Operations-management research emphasizes the need to coordinate planning horizons and

shop-floor decisions rather than treating scheduling as an isolated task (Heizer et al., 2020; Stevenson, 2021).

Lean production and just-in-time approaches seek to reduce waste, improve flow and respond efficiently to demand. Lean thinking also highlights the importance of identifying bottlenecks and continuously improving processes (Womack & Jones, 2003). In the present dataset, process mapping and employee interviews are prominent approaches to bottleneck identification, indicating that operational knowledge and process visibility remain important.

Digital technologies increasingly support planning, inventory management, production monitoring and analytics. However, technology adoption is useful only when information is integrated with planning processes and managerial decision-making. The present study therefore considers the gap between general PPC software use and the relatively limited reported use of demand-forecasting software.

3. Research Objectives

- To examine the major factors affecting production planning and control in the electrical industry.
- To analyze current demand forecasting practices and their relevance to production planning.
- To identify the major factors influencing production scheduling and control decisions.
- To examine the methods used to identify PPC bottlenecks.
- To assess the role of technology and analytics in improving PPC processes.
- To identify the major operational changes recommended for improving PPC in the electrical industry.

4. RESEARCH METHODOLOGY

The study uses a quantitative, cross-sectional survey design. The empirical analysis is based on the supplied dataset containing responses from 500 participants. The questionnaire covers demographic characteristics and multiple PPC dimensions, including factors affecting PPC, bottleneck identification, scheduling decisions, demand forecasting, technology use, performance indicators and recommended improvements.

Frequency and percentage distributions are used to summarize categorical responses. The supplied analysis also contains factor-analysis outputs. The extraction values reported for the PPC-improvement items are high, ranging from 0.940 to 0.977, while demand-forecasting and demand-management items range from 0.818 to 0.979. The total-variance results show

that the first component explains 75.979% of variance and the first three components together explain 89.314%. These results support the internal relevance of the measured dimensions, although they should not be interpreted as causal relationships.

Because the supplied tables are primarily categorical frequency distributions, the article does not introduce unsupported regression coefficients, p-values or causal claims. The conclusions are therefore restricted to the patterns actually represented in the supplied data.

5. RESULTS AND ANALYSIS

Table 1. Major Factors Affecting PPC.

Factor	Frequency	Percentage
Demand variability	215	43.0
Production capacity	122	24.4
Resource availability	107	21.4
Quality issues	56	11.2
Total	500	100.0

Demand variability is the most frequently reported factor affecting PPC (43.0%), followed by production capacity (24.4%) and resource availability (21.4%). The pattern indicates that PPC effectiveness is strongly connected with the ability to respond to changing demand while maintaining adequate capacity and resources.

Table 2. Methods Used to Identify Production Bottlenecks.

Method	Frequency	Percentage
Process mapping and analysis	216	43.2
Simulation software	23	4.6
Collecting and analyzing data	87	17.4
Employee interviews	174	34.8
Total	500	100.0

Process mapping and analysis is the leading bottleneck-identification method (43.2%), followed by employee interviews (34.8%). Simulation software is reported by only 4.6% of respondents, suggesting relatively limited use of simulation for operational bottleneck analysis within the surveyed group.

Table 3. Factors Influencing Production Scheduling and Control Decisions.

Factor	Frequency	Percentage
Customer demand	353	70.6
Production capacity	67	13.4
Resource availability	54	10.8
Inventory levels	26	5.2
Total	500	100.0

Customer demand is by far the most frequently reported scheduling influence (70.6%). This reinforces the central role of demand information in PPC decision-making and supports a demand-responsive planning perspective.

Table 4. Current Demand Forecasting Practices.

Forecasting practice	Frequency	Percentage
Statistical forecasting methods	27	5.4
Market research and analysis	263	52.6
Collaboration with suppliers and customers	197	39.4
Expert opinion and judgment	13	2.6
Total	500	100.0

Market research and analysis is the dominant forecasting practice (52.6%), while collaboration with suppliers and customers accounts for 39.4%. Statistical forecasting methods account for only 5.4%, and expert judgment for 2.6%. This distribution suggests that organizations rely more heavily on market-oriented and collaborative approaches than formal statistical forecasting.

Table 5. Technology Used to Improve PPC.

Technology	Frequency	Percentage
PPC software	289	57.8
Inventory management software	163	32.6
Quality control software	37	7.4
Demand forecasting software	11	2.2
Total	500	100.0

Table 6. Recommended Changes to Improve PPC.

Recommended change	Frequency	Percentage
Adopting new technologies	317	63.4
Implementing lean production methods	63	12.6
Streamlining communication channels	44	8.8
Enhancing employee training and development	76	15.2
Total	500	100.0

Table 7. Major PPC Challenges in the Electrical Industry.

Challenge	Frequency	Percentage
Fluctuating demand	122	24.4
Environmental regulations	60	12.0
Rapidly changing technology	231	46.2
Quality control	87	17.4
Total	500	100.0

Table 8. Key Performance Indicators Used to Measure PPC Effectiveness.

KPI	Frequency	Percentage
Inventory turnover	86	17.2
On-time delivery	132	26.4
Quality metrics	94	18.8
Cost metrics	188	37.6
Total	500	100.0

6. DISCUSSION

The empirical pattern points to a demand-centered PPC environment. Customer demand is reported as the dominant scheduling influence, and demand variability is the most frequently identified PPC factor. This is consistent with the operations-management view that planning decisions should connect market requirements with capacity and resource decisions (Heizer et al., 2020; Stevenson, 2021).

A notable finding is the relatively limited reported use of statistical forecasting methods and demand-forecasting software. Market research and collaboration are widely used, but only 5.4% report statistical forecasting and 2.2% report demand-forecasting software. This does not establish that statistical forecasting is superior for every firm; rather, it identifies an opportunity for greater use of data-supported forecasting where appropriate. Forecasting methods should be selected according to data quality, demand characteristics and decision requirements (Hyndman & Athanasopoulos, 2021).

The technology findings show a similar pattern. PPC software is relatively common, but demand-forecasting software is much less prevalent. At the same time, 63.4% of respondents recommend adopting new technologies as the most important improvement. The results therefore suggest a transition from general digitization toward more integrated planning intelligence.

The bottleneck results are also significant. Process mapping and employee interviews dominate, while simulation software is rarely reported. This suggests that operational improvement remains strongly dependent on direct process understanding. Combining process mapping with systematic production data and appropriate analytical tools could improve the identification and prioritization of bottlenecks.

7. Managerial Implications

- Integrate demand information more systematically into production scheduling and capacity decisions.

- Develop a structured forecasting process combining market intelligence, customer/supplier information and appropriate statistical methods.
- Increase the use of digital forecasting and analytics where reliable historical and operational data are available.
- Use process mapping together with production data to identify and prioritize bottlenecks.
- Link PPC software with inventory, forecasting and production-performance information rather than using isolated systems.
- Track cost, delivery, quality and inventory indicators together to obtain a balanced view of PPC effectiveness.
- Invest in employee training so that digital PPC systems and analytical tools are converted into better operational decisions.

8. CONCLUSION

This study examined production planning and control in the electrical industry using survey evidence from 500 respondents. The findings demonstrate that customer demand and demand variability are central to PPC decisions. Market research and supplier/customer collaboration are the dominant forecasting approaches, while process mapping and employee interviews are the main methods used to identify bottlenecks. Cost metrics are the most frequently used PPC performance indicator.

The results also identify a clear technology opportunity. Although PPC software is relatively common, demand-forecasting software has very limited reported adoption, and adopting new technologies is the most frequently recommended improvement. The evidence therefore supports a shift toward integrated, demand-responsive and data-supported PPC. Such a shift should combine forecasting, capacity planning, scheduling, bottleneck management and performance measurement rather than implementing technology as a stand-alone intervention.

9. Limitations and Scope for Future Research

The study is based on the supplied survey dataset and its reported categorical responses. The analysis therefore primarily establishes descriptive patterns and does not independently establish causality. The dataset also reflects the surveyed respondents and should not automatically be generalized to every electrical-industry organization. Future research could use firm-level longitudinal data, forecasting-error measures, production lead-time data and multivariate models to test the relationships suggested by the present findings.

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