



Integrating Quality Control and Production Resources for Effective Production Planning and Control: Evidence from the Electrical Industry in Madhya Pradesh

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Abstract

Effective production planning and control (PPC) requires coordination among quality control, production control, resources, scheduling and operational performance. This empirical study examines the integration of quality control and production control and the role of production resources in PPC in the electrical industry in Madhya Pradesh. The study uses survey evidence from 500 respondents contained in the supplied dataset. Descriptive frequency and percentage analysis is used to examine quality-control practices, production-control measures, integration mechanisms, integration challenges, resource allocation, resource efficiency, performance measurement, interdepartmental collaboration and technology-enabled improvement. The findings show that inspection and testing is the most frequently reported quality control measure (63.4%), while 58.6% report using a quality management system to ensure quality standards. Assembly-line balancing (42.2%) and capacity planning (37.4%) are prominent production-control measures. Quality-control plans are the most common integration mechanism (41.4%), followed by quality-control checkpoints (33.2%). Resistance to change is the dominant integration challenge (59.2%), followed by ineffective communication (22.8%). Raw materials are the most frequently reported production resource (75.2%), and 82.2% allocate resources according to production priorities. Production output (52.2%) and profitability (38.6%) are the leading measures of resource effectiveness. Cost management is the largest resource-management challenge (45.8%). Monitoring production performance is the most common use of analytics (46.4%), while increasing automation is the leading recommendation for improving the role of resources in PPC (58.2%). The findings indicate that stronger integration of quality, production and resource information could support more coherent PPC decision-making in the surveyed electrical-industry context.

Keywords: Quality Control; Production Control; Production Planning and Control; Production Resources; Automation; Electrical Industry; Madhya Pradesh

1. Introduction

Production planning and control is concerned with coordinating materials, capacity, people, equipment, processes and information so that production objectives can be achieved efficiently. Quality is not separate from this system: quality requirements influence process design, inspection, scheduling, rework, resource consumption and delivery. Operations-management literature emphasizes that manufacturing performance depends on the coordinated management of quality, capacity, inventory, scheduling and process improvement (Heizer et al., 2020; Stevenson, 2021; Slack et al., 2022).

The electrical industry provides a useful setting for examining these relationships because production activities depend on materials, equipment, energy, labour, capacity and consistent process control. The supplied dataset contains responses from 500 participants and explicitly separates the relationship between quality control and production control from the role of production resources in PPC. The factor-analysis section also reports high extraction values for these dimensions, indicating that the measured items were retained as relevant indicators in the supplied analysis. □filecite□turn2file2□L239-L249□

This article therefore focuses on two connected questions: how quality control and production control are integrated, and how production resources are allocated, monitored and improved within PPC. The objective is not to claim causality from the descriptive survey results, but to identify dominant practices, constraints and improvement priorities reported by respondents.

2. Review of Literature

Quality management has progressively moved from final-product inspection toward prevention, process control and continuous improvement. Total Quality Management emphasizes organization-wide quality responsibility and customer focus, while statistical process control provides methods for monitoring process variation. Deming (1986) and Juran and Godfrey (1999) emphasize systematic process improvement and management responsibility for quality.

Production control complements quality management by determining how production activities are sequenced and resources are utilized. Capacity planning, line balancing, material planning and scheduling are essential to maintaining flow and meeting delivery requirements (Heizer et al., 2020; Stevenson, 2021). When quality control is separated from production control, quality problems may be detected after resources have already been consumed. Integrating checkpoints, procedures and feedback into production processes can therefore support earlier intervention.

Lean production provides another perspective by linking quality, flow and waste reduction. Womack and Jones (2003) describe lean thinking around value, flow, pull and continuous improvement. Six Sigma similarly emphasizes data-based variation reduction. The dataset's innovative-PPC results show that JIT and TQM are the two most frequently reported strategies, while Lean Production and Six Sigma are less frequently reported. □filecite□turn2file9□L912-L929□

Resource management is also central to PPC. Raw materials, equipment, labour and energy must be available in the right quantity and at the right time. Resource allocation may depend on production priorities, capacity, demand, availability and employee skills. Digital monitoring and automation can increase visibility and responsiveness, but successful implementation also requires communication, training and organizational readiness.

3. Research Objectives

- To examine the quality-control practices used in production processes.
- To identify the major production-control measures used by respondents.
- To examine how quality control and production control are integrated.
- To identify the major challenges to integrating quality and production control.
- To examine the types, allocation and efficient use of production resources.
- To assess how production-resource effectiveness is measured.
- To identify the role of analytics, technology and automation in improving production resources within PPC.

4. Research Methodology

The study follows a quantitative cross-sectional survey approach. The analysis is based on 500 respondents represented in the supplied research dataset. The questionnaire covers demographic variables and five broad PPC areas: factors for improving PPC, demand forecasting and demand management, the relationship between quality and production control, the role of production resources, and innovative PPC strategies. The supplied factor-analysis output reports extraction values between .895 and .949 for the quality-control/production-control section and between .932 and .977 for the production-resources section, indicating that the analyzed items were retained as relevant indicators. □filecite□turn2file2□L239-L249□

Frequency and percentage distributions are used for the empirical results. Because the supplied evidence is primarily categorical and descriptive, the article does not introduce unsupported regression coefficients, significance tests or causal effects. Findings are interpreted as patterns reported by the surveyed respondents.

5. Results and Analysis

Table 1. Quality Control Measures Used in Production

Quality-control measure	Frequency	Percentage
Statistical process control	93	18.6
Inspection and testing	317	63.4
Quality audits	59	11.8
Root cause analysis	31	6.2
Total	500	100.0

Inspection and testing is the dominant reported quality-control measure, selected by 63.4% of respondents. Statistical process control accounts for 18.6%, while quality audits and root cause analysis account for 11.8% and 6.2%, respectively. This indicates a stronger reliance on inspection and testing than on formal statistical or root-cause-oriented approaches. These figures are directly reported in the supplied dataset. □filecite□turn3file0□L53-L81□

Table 2. Methods Used to Ensure Production Quality Standards

Method	Frequency	Percentage
Quality management system	293	58.6
Regular inspections and audits	141	28.2
Clear quality standards	37	7.4
Employee training	29	5.8
Total	500	100.0

A quality management system is the most frequently reported method for ensuring quality standards (58.6%), followed by regular inspections and audits (28.2%). Employee training is reported by only 5.8%. □filecite□turn3file2□L230-L263□

Table 3. Production Control Measures Used in Production Processes

Production-control measure	Frequency	Percentage
Capacity planning	187	37.4
Material planning	16	3.2
Assembly-line balancing	211	42.2
Batch production	86	17.2
Total	500	100.0

Assembly-line balancing is the most frequently reported production-control measure (42.2%), closely followed by capacity planning (37.4%). Material planning is reported by only 3.2%. □filecite□turn3file2□L264-L285□

Table 4. Methods for Monitoring and Controlling Production Quality

Method	Frequency	Percentage
Key performance indicators	17	3.4
Standard operating procedures	274	54.8
Quality control system	91	18.2
Clear quality standards	118	23.6
Total	500	100.0

Standard operating procedures are the dominant mechanism for monitoring and controlling production processes (54.8%), whereas only 3.4% report using KPIs for this purpose. □filecite□turn3file7□L798-L834□

Table 5. Integration of Quality Control and Production Control

Integration approach	Frequency	Percentage
Establishing a quality management system	113	22.6
Developing a quality control plan	207	41.4
Implementing quality-control checkpoints	166	33.2
Using data to inform decision-making	14	2.8
Total	500	100.0

Developing a quality-control plan is the most common reported integration approach (41.4%), followed by quality-control checkpoints (33.2%). Only 2.8% report using data to inform decision-making as the integration mechanism. □filecite□turn3file3□L299-L330□

Table 6. Challenges in Integrating Quality and Production Control

Challenge	Frequency	Percentage
Resistance to change	296	59.2
Misalignment of goals and objectives	71	14.2
Lack of leadership	19	3.8
Ineffective communication	114	22.8
Total	500	100.0

Resistance to change is the largest reported challenge (59.2%), followed by ineffective communication (22.8%). Misalignment of goals and objectives accounts for 14.2%, while lack of leadership accounts for 3.8%. □filecite□turn3file3□L331-L369□

Table 7. Production Resources Used in Production Processes

Production resource	Frequency	Percentage
Raw materials	376	75.2
Equipment	28	5.6
Labour	31	6.2

Energy	65	13.0
Total	500	100.0

Raw materials are the dominant reported production resource (75.2%), followed by energy (13.0%), labour (6.2%) and equipment (5.6%). □filecite□turn2file5□L493-L514□

Table 8. Allocation of Production Resources

Allocation approach	Frequency	Percentage
Priority of production activities	411	82.2
Availability of resources	47	9.4
Requirements of production process	15	3.0
Monitor and adjust allocation	27	5.4
Total	500	100.0

Production-resource allocation is overwhelmingly based on the priority of production activities (82.2%). This indicates that respondents generally allocate resources according to production importance or urgency. □filecite□turn2file5□L515-L552□

Table 9. Factors Considered When Allocating Production Resources

Factor	Frequency	Percentage
Production demand	93	18.6
Capacity	263	52.6
Availability of resources	54	10.8
Employee skill level	90	18.0
Total	500	100.0

Capacity is the most frequently reported resource-allocation factor (52.6%), followed by production demand (18.6%) and employee skill level (18.0%). □filecite□turn2file8□L770-L804□

Table 10. Methods Used to Ensure Efficient Use of Production Resources

Method	Frequency	Percentage
Monitoring production processes	194	38.8
Identifying and eliminating waste	83	16.6
Lean manufacturing techniques	54	10.8
Optimizing production schedules	169	33.8
Total	500	100.0

Monitoring production processes is the leading reported method of ensuring efficient resource use (38.8%), followed by production-schedule optimization (33.8%). Lean manufacturing techniques are reported by 10.8%. □filecite□turn2file4□L411-L442□

Table 11. Measures of Production-Resource Effectiveness

Measure	Frequency	Percentage
Machine utilization	27	5.4
Production output	261	52.2
Employee productivity	19	3.8
Profitability	193	38.6
Total	500	100.0

Production output is the most frequently reported measure of resource effectiveness (52.2%), followed by profitability (38.6%). Machine utilization and employee productivity are reported much less frequently. □filecite□turn2file4□L443-L475□

Table 12. Challenges in Managing Production Resources

Challenge	Frequency	Percentage
Limited availability of resources	143	28.6
Unexpected equipment breakdowns	106	21.2
Scheduling conflicts	22	4.4
Cost management	229	45.8
Total	500	100.0

Cost management is the most frequently reported production-resource challenge (45.8%), followed by limited resource availability (28.6%) and unexpected equipment breakdowns (21.2%). □filecite□turn2file6□L590-L617□

Table 13. Cross-Departmental Collaboration in Resource Management

Collaboration method	Frequency	Percentage
Establishing clear communication channels	283	56.6
Building strong relationships	24	4.8
Sharing data and information	176	35.2
Aligning incentives	17	3.4
Total	500	100.0

Clear communication channels are the dominant reported collaboration mechanism (56.6%), followed by sharing data and information (35.2%). □filecite□turn2file6□L618-L650□

Table 14. Data and Analytics Used to Manage Production Resources

Analytics use	Frequency	Percentage
Optimize production schedules	166	33.2
Predict equipment maintenance needs	16	3.2
Monitor production performance	232	46.4
Predictive analytics	86	17.2

Total	500	100.0
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Monitoring production performance is the most common analytics application (46.4%), followed by production-schedule optimization (33.2%). Predictive analytics accounts for 17.2%, while predicting equipment-maintenance needs is reported by only 3.2%. □filecite□turn2file1□L115-L148□

Table 15. Recommended Changes to Improve the Role of Production Resources in PPC

Recommendation	Frequency	Percentage
Implementing new technologies	133	26.6
Increasing automation	291	58.2
Improving communication	29	5.8
Collaboration between departments	47	9.4
Total	500	100.0

Increasing automation is the leading recommendation (58.2%), followed by implementing new technologies (26.6%). Together, these technology-oriented recommendations account for 84.8% of responses. □filecite□turn2file9□L868-L911□

6. Discussion

The findings show that quality control and production control are present as related but not fully data-integrated activities. Inspection and testing dominates quality-control practice, while assembly-line balancing and capacity planning dominate production control. The strong use of standard operating procedures also suggests that process standardization is an important mechanism for maintaining production quality.

However, the integration results reveal an important organizational issue. Quality-control plans and checkpoints are common, but the use of data to inform integration decisions is very limited (2.8%). At the same time, resistance to change is reported by 59.2% of respondents. This combination suggests that the challenge is not simply technical; organizational acceptance and cross-functional communication may be important conditions for deeper integration.

The production-resource findings show a strongly priority-based allocation system. Capacity is the most frequently reported allocation factor, while raw materials are the dominant resource. Resource effectiveness is mainly judged by production output and profitability rather than machine utilization or employee productivity. This may indicate that resource evaluation is focused on immediate production and financial outcomes, with less emphasis on detailed resource-level efficiency measures.

Technology provides a clear improvement opportunity. Monitoring production performance is the most common analytics use, but predictive maintenance is rare. The dataset also shows that increasing automation is the leading recommendation for improving resource management. These results are consistent with the broader logic of data-driven operations: better visibility can support faster identification of deviations, while automation can reduce repetitive work and improve process consistency. The survey data, however, does not establish that automation itself causes better performance.

7. Managerial Implications

- Integrate quality-control checkpoints with production schedules and resource plans rather than managing quality as a separate activity.
- Strengthen the use of production data in quality and resource decisions, especially because only 2.8% reported data-informed integration.
- Develop cross-functional mechanisms to reduce resistance to change and ineffective communication.
- Use capacity, demand, resource availability and employee skills together when allocating production resources.

- Expand performance measurement beyond production output and profitability to include machine utilization and employee productivity where appropriate.
- Increase the use of predictive analytics and equipment-maintenance monitoring to reduce unexpected breakdowns.
- Prioritize automation and new technologies through phased implementation supported by training and process redesign.
- Combine quality management, JIT, lean and other appropriate improvement approaches according to organizational needs rather than treating any one approach as universally optimal.

8. Conclusion

This study examined the integration of quality control and production control and the role of production resources in PPC using survey evidence from 500 respondents. The findings show that inspection and testing, quality management systems, assembly-line balancing, capacity planning and standard operating procedures are prominent practices. Quality-control plans and checkpoints are the most common mechanisms for integration, but data-informed integration remains limited.

Resource management is strongly priority-driven, with capacity playing the largest role in allocation decisions and raw materials being the most frequently reported resource. Production output and profitability dominate resource-effectiveness measurement, while cost management is the largest reported challenge. The high preference for automation and new technologies indicates strong interest in digitally supported resource management.

Overall, the evidence supports an integrated PPC perspective in which quality, production control and resource decisions are coordinated through common procedures, communication and increasingly data-supported systems. Future improvement should therefore address both technological capability and organizational readiness.

9. Limitations and Future Research

The study is based on the supplied survey dataset and therefore reflects respondent-reported practices. The categorical results are descriptive and do not independently demonstrate causal relationships between quality integration, resource management and PPC performance. Future research could examine firm-level data, defect rates, rework, downtime, machine utilization, delivery performance and cost measures using correlation, regression or structural-equation approaches. Longitudinal studies could also examine whether automation and integrated quality-resource systems produce measurable improvements over time.

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