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Integration of Demand Forecasting, Production Planning and Control, Production Execution, and Quality Assurance through Cross-Functional Coordination for Operational Performance Improvement: A Case Study on Manufacturing Companies

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Abstrak: *Integrasi fungsi operasional merupakan isu yang sangat penting dalam manajemen manufaktur karena ketidaksinkronan informasi mengenai permintaan, perencanaan, pelaksanaan produksi, dan kualitas dapat menurunkan kinerja. Penelitian ini bertujuan untuk menganalisis pengaruh koordinasi lintas fungsi terhadap integrasi proses operasional dan kinerja operasional pada salah satu perusahaan manufaktur di Surabaya. Penelitian ini menggunakan metode campuran eksplanatori sekuensial berbasis data sintetis, yang melibatkan 180 responden, 12 informan kunci, 96 jawaban wawancara, dan 72 observasi operasional selama 24 bulan pada tiga keluarga produk. Data kuantitatif yang diperoleh dalam penelitian dianalisis melalui korelasi, data operasional melalui perbandingan KPI, dan data kualitatif dianalisis secara tematik. Hasil penelitian menunjukkan hubungan positif antara koordinasi–integrasi (r=0.444), integrasi–kinerja (r=0.627), dan koordinasi–kinerja (r=0.396). MAPE menurun dari 10.51% menjadi 8.20%, kepatuhan jadwal meningkat dari 88.27% menjadi 92.45%, dan pengiriman tepat waktu meningkat dari 89.69% menjadi 93.57%. Wawancara menekankan pentingnya sinkronisasi informasi, koordinasi keputusan, dan umpan balik kualitas. Temuan menunjukkan bahwa koordinasi lintas fungsi memperkuat integrasi proses dan mendukung peningkatan kinerja operasional.*

Kata Kunci: *Koordinasi Lintas Fungsi, Integrasi Proses Operasional, Peramalan Permintaan, Manajemen Produksi, Kinerja Operasional*

Abstract: Integration of operational functions is an important issue in manufacturing management because the missynchronization of information on demand, planning, production implementation, and quality can reduce performance. This study aims to analyze the effect of cross-functional coordination on the integration of operational processes and operational performance in one of the manufacturing companies in Surabaya. The study used a mixed-method explanatory sequential based on synthetic data, involving 180 respondents, 12 key informants, 96 interview answers, and 72 operational observations for 24 months on three product families. Quantitative data were analyzed through correlation, operational data through

KPI comparison, and thematic qualitative data. The results showed a positive relationship between coordination–integration (r=0.444), integration–performance (r=0.627), and coordination–performance (r=0.396). MAPE decreased from 10.51% to 8.20%, schedule adherence increased from 88.27% to 92.45%, and on-time delivery increased from 89.69% to 93.57%. Interviews emphasized the importance of information synchronization, decision coordination, and quality feedback. Findings show that cross-functional coordination strengthens process integration and supports improved operational performance.

Keyword: cross-functional coordination, integration of operational processes, demand forecasting, production management, operational performance

INTRODUCTION

The manufacturing industry is facing an increasingly dynamic operating environment due to changing demand patterns, cost pressures, technological acceleration, and supply chain disruptions arising from geopolitical tensions, climate change, and changes in consumer behavior. These conditions make companies no longer rely enough on efficiency on a single function, but need to ensure that demand information can be translated consistently into planning, production execution, and quality control. Polater (2025) point out that various global megatrends have increased pressure on supply chain resilience and demand organizations to build more adaptive capabilities. At the production level, Stauder et al. (2025) also emphasized that changing product and component requirements increase uncertainty in manufacturing planning so that production flexibility needs to be aligned with demand. Thus, the ability to integrate demand forecasting, production planning and control, production execution, and quality assurance are important issues in modern operations management.

This urgency is also relevant for Indonesia's manufacturing industry. Data from the Central Statistics Agency shows that the processing industry contributes around 19.07% to Indonesia's Gross Domestic Product in 2025 and grows by around 5.30%, so it remains one of the main sectors in the national economy. The large role of this sector increases the need for companies to maintain productivity, quality, schedule accuracy, and service to customers at the same time. In practice, operational problems can arise when forecasts change without being immediately translated into production plans, when production schedules do not fully consider capacity and material availability, when actual production data is received late by the planning department, or when quality findings do not immediately become feedback for the production process. Conditions like this show that operational performance is not only determined by the technical capabilities of each function, but also by the organization's ability to coordinate information and decisions across functions.

Theoretically, these needs are in line with the concept of Sales and Operations Planning (S&OP) and process integration in operations management. Kreuter et al. (2022) explain that S&OP aims to balance demand and supply by aligning the decisions of various functions into an integrated plan, while Bhalla et al. (2023) emphasize that cross-functional planning plays a role in connecting day-to-day operational decisions with broader organizational goals. From a resource-based perspective, cross-functional coordination can be viewed as an organizational capability that allows resources, information, and knowledge from different parts to be used in an integrated manner. Özkanlısoy (2024) found that integration plays a positive role in supply chain performance, while Ganbold et al. (2021) showed that information-enabled integration is related to improving various dimensions of operational performance, including quality, delivery, production costs, inventory levels, and flexibility. Therefore, cross-functional coordination can be positioned as a mechanism that allows the forecasting, planning, execution, and quality processes to work as a single operational system.

Although the relationship between integration and performance has been widely discussed, the literature still shows mixed results and focuses. Ganbold et al. (2021) place more emphasis on the capabilities of information technology as a driver of supply chain integration, while Özkanlısoy (2024) examine the relationship between Industry 4.0, supply chain integration, and performance. El Mokadem & Khalaf (2023) show that the relationship between integration and operational performance can change according to the supply chain strategy used, which means integration does not always yield the same benefits in every organizational condition. These findings are reinforced by Wong et al. (2025) , who show that higher integration does not automatically always result in better performance because its effect depends on the combination and configuration of integration dimensions. Meanwhile, modern manufacturing studies focus heavily on technology. Arcidiacono & Schupp (2024) , for example, point out the contribution of smart manufacturing to cost, quality, and delivery performance, while Mahin et al. (2024) place quality assurance within the framework of Quality 4.0 and emphasize the importance of integration between technology, quality management, and leadership to achieve operational excellence.

Cross-functional coordination refers to aligning information, activities, decisions, and objectives across departments. In manufacturing, it is essential because sales, planning, production, quality, inventory, and logistics decisions are interdependent. Li et al. (2022) show that system, process, and team coordination improve information processing and operational performance, consistent with the S&OP emphasis on cross-functional alignment of demand and supply (Kreuter et al., 2022). Demand forecasting supports capacity, material, inventory, and production decisions, while S&OP integrates demand and operations through cross-functional planning (Kreuter et al., 2022; Bhalla et al., 2023). Khannan et al. (2025) further emphasize integrated production planning in collaborative manufacturing environments. Therefore, cross-functional coordination is expected to strengthen integration across demand–planning–execution–quality processes through effective communication, information sharing, and decision alignment (Li et al., 2022; Kreuter et al., 2022; Bhalla et al., 2023), leading to the first hypothesis, H1: Cross-functional coordination has a positive effect on the integration of operational processes.

Operational integration connects demand forecasting, production planning and control, production execution, and quality assurance. Battesini et al. (2021) highlight the interconnectedness of manufacturing decisions, while Arcidiacono & Schupp (2024) and Mahin et al. (2024) emphasize the contribution of smart manufacturing and Quality 4.0 to operational performance and quality. Ganbold et al. (2021) found that integration improves quality, delivery, cost, inventory, customer service, and flexibility. Özkanlısoy (2024) also found a positive relationship between integration and performance, although El Mokadem & Khalaf (2023) showed that its benefits may depend on supply chain strategy and operating conditions. Operational performance includes quality, cost, timeliness, delivery, inventory, flexibility, and responsiveness. Therefore, greater integration among operational processes is expected to improve operational performance, leading to the second hypothesis, H2: Integration of operational processes has a positive effect on operational performance.

Cross-functional coordination may also directly improve operational performance by enabling faster responses to demand changes, material constraints, production delays, and quality issues. Li et al. (2022) and Ganbold et al. (2021) demonstrate the importance of coordination and information integration for operational performance. Despite these findings, previous studies generally examine supply chain integration, technology, S&OP, or quality management separately. This study addresses this gap by integrating demand forecasting, production planning and control, production execution, and quality assurance within one operational process integration framework. Effective cross-functional coordination is therefore also expected to directly support operational performance, leading to the third hypothesis, H3: Cross-functional coordination has a positive effect on operational performance.

Overall, the literature supports a model in which cross-functional coordination strengthens operational process integration, which subsequently supports operational performance, while also examining the direct relationship between coordination and performance.

Based on these studies, there is still room for research that needs to be developed. The literature referenced earlier generally looks at integration at the supply chain, technology, S&OP, or quality management levels separately, while the interconnectedness of internal processes from demand forecasting, production planning and control, production execution, to quality assurance has not been widely placed in a single operational integration framework that has been tested together. In addition, previous research has positioned technology, supply chain strategy, or integration configuration as an explanatory factor, while cross-functional coordination as a managerial mechanism that connects the entire set of internal processes still requires further testing. This is important because the existence of systems, data, or procedures does not necessarily guarantee that information from demand planning will be consistently translated to the implementation and quality stages. Thus, this study fills the gap by placing the integration of operational processes as a construct that includes four main dimensions—demand forecasting, production planning and control, production execution, and quality assurance—and tests cross-functional coordination as a factor that drives integration and operational performance.

Based on these gaps, this study aims to analyze the influence of cross-functional coordination on operational process integration, the effect of operational process integration on operational performance, and the direct influence of cross-functional coordination on operational performance in one of the manufacturing companies in Surabaya. This research is expected to make a theoretical contribution by expanding the study of operations management through the explanation that performance comes not only from the effectiveness of each function, but also from the ability of the organization to unify a series of demand–planning–execution–quality through cross-functional coordination. Practically, this study provides a framework for management to evaluate the quality of coordination, information synchronization, and decision connectivity between departments as the basis for improving forecasting accuracy, adherence to production schedules, equipment effectiveness, product quality, and delivery accuracy. With this approach, the study not only assesses whether integration is related to performance, but also explains how cross-functional coordination can be the foundation for the creation of a more integrated and responsive operational process.

METHODS

Research Design

This study uses a mixed-method approach with a sequential explanatory design (QUAN → qual → integration) in the framework of a case study at a manufacturing company in Surabaya. The quantitative stage is used to analyze the relationship between cross-functional coordination, operational process integration, and operational performance, then followed by the qualitative stage to explain the mechanisms underlying the quantitative results. The sequential explanatory design was chosen because it allows statistical findings to be explained through the experiences and views of actors directly involved in organizational processes (Toyon, 2021; Othman et al., 2020). The integration of the two types of data is carried out at the interpretation stage through joint display. According to the status of the research dataset, all data used in the preparation of this manuscript are synthetic/simulative and are used as a research analysis model.

Population and Sample

The target population of the study is company personnel involved in the demand–planning–execution–quality process flow. The quantitative sample consisted of 180

respondents from eight functions, namely Sales/Demand Planning, PPIC/PPC, Procurement, Warehouse, Production, Maintenance, QA/QC, and Logistics. Respondents included Staff/Specialist, Foreman/Coordinator, Supervisor, Engineer/Planner, Section Head, and Manager with a working period between 1–22 years. The sampling technique used purposive sampling, because respondents were selected based on their involvement in planning, coordinating, implementing, or controlling operations.

The qualitative stage involved 12 key informants who were purposively selected because they were directly involved in the decision-making and flow of demand-plan–execution-quality information and had cross-functional exposure. The informants consisted of Sales/Demand Planning, PPIC/PPC, Production, QA/QC, Warehouse, Procurement, Maintenance, Logistics, and Operations personnel with a working period of 6–18 years. The composition allowed for perspective to be obtained from the planning level to operational decision-making.

Research Variables and Instruments

Quantitative data were collected using a questionnaire of 23 items with a Likert scale of 1–5. The Cross-Functional Coordination construct was measured by five items (CFC1–CFC5) which included the accuracy of information exchange, the effectiveness of coordination meetings, the involvement of functions in decisions, the resolution of priority conflicts, and the alignment of KPIs. The conceptualization of this construct follows the thinking about cross-functional coordination and organizational information processing as discussed by Li et al. (2022).

The Operational Process Integration construct consists of 12 items and is treated as a multidimensional construct that includes: Demand Forecasting (DF1–DF3), Production Planning and Control (PPC1–PPC3), Production Execution (PE1–PE3), and Quality Assurance (QA1–QA3). The development of the dimensions refers conceptually to the study of planning and S&OP integration (Kreuter et al., 2022) , process integration and operational performance Ganbold et al. (2021) , and quality integration in modern manufacturing (Mahin et al., 2024) . The items were not adopted verbatim from a previous scale, but were structured contextually based on the constructs used in the research. Operational Performance constructs are measured through six items (OP1–OP6) that represent delivery accuracy, output achievement, defect and rework control, lead time efficiency, schedule adherence, and flexibility to changes in demand.

In addition to the questionnaire, the study used operational documentation data for 24 months, January 2025–December 2026, on three product families, resulting in 72 observations. The indicators analyzed included actual demand, forecast, MAPE, production plan, actual production, schedule adherence, OEE, defect rate, rework rate, on-time delivery, inventory days, and downtime.

Validity and Reliability

Evaluation of quantitative instruments was carried out through a measurement model. Convergent validity was assessed based on outer loading ≥0.70 and Average Variance Extracted (AVE) ≥0.50, while construct reliability was assessed using Cronbach's alpha and composite reliability ≥0.70. Discriminant validity was evaluated using the Heterotrait–Monotrait Ratio (HTMT). The evaluation followed the latest practice of PLS-SEM which emphasizes testing measurement models before interpretation of structural relationships (Hair & Alamer, 2022; Sarstedt et al., 2022).

Qualitative Data Collection

Qualitative data was collected through semi-structured interviews with 12 informants. Each informant answered eight questions that addressed: demand information flow, constraints in translating forecasts into production plans, communication of schedule changes, actual production monitoring, quality feedback, effectiveness of cross-functional coordination,

changes in performance indicators, and integration improvement priorities. This stage resulted in 96 units of interview answers. From the data, 48 main citations were used for the structured coding process. The analysis was directed at the themes of demand information synchronization, production planning alignment, execution visibility, quality feedback, coordination and decision-making, as well as shared KPIs and operational performance. The thematic analysis procedure follows the principles of data introduction, coding, theme formation, theme review, and interpretation as described by Byrne (2022).

Research Procedure

The research was carried out through five stages. First, the constructs and research indicators were determined based on conceptual models and literature review. Second, the quantitative stage was carried out through the collection of questionnaire data from 180 respondents and the processing of operational data for 24 months. Third, quantitative results were used to identify key relationships and operational issues that required further explanation. Fourth, interviews were conducted with 12 key informants and analyzed thematically. Fifth, survey results, operational data, and interview results were integrated through joint displays to identify convergence and explanation of the relationship between cross-functional coordination, operational process integration, and performance.

Data Analysis

Quantitative analysis was carried out in several stages. Descriptive statistics were used to describe respondent characteristics and the distribution of answers. Pearson correlation was used as an initial analysis to see the direction and strength of the relationship between cross-functional coordination, operational process integration, and operational performance. Further structural model testing was carried out with Partial Least Squares–Structural Equation Modeling (PLS-SEM) as the model includes latent constructs and integration constructs that are multidimensional in nature. PLS-SEM is also suitable for research oriented towards explaining and predicting relationships between variables (Hair & Alamer, 2022; Sarstedt et al., 2022). The structural analysis is geared towards testing the following three hypotheses:

H1: Cross-functional coordination has a positive effect on the integration of operational processes.

H2: Integration of operational processes has a positive effect on operational performance.

H3: Cross-functional coordination has a positive effect on operational performance.

PLS-SEM is conducted using SmartPLS 4, while Microsoft Excel is used for dataset management, calculation and comparison of operational KPIs, and the preparation of joint displays. Qualitative data analysis is carried out through thematic coding in a structured manner with spreadsheets. In the final stage, quantitative results, operational KPI data, and interview themes are compared to obtain meta-inference on how cross-functional coordination strengthens process integration and supports operational performance.

RESULTS

Respondent Characteristics

The quantitative analysis used data from 180 respondents from eight organizational functions. The largest proportion came from Production with 40 respondents (22.2%), followed by PPIC/PPC with 30 respondents (16.7%), QA/QC with 24 respondents (13.3%), Sales/Demand Planning with 22 respondents (12.2%), Warehouse with 20 respondents (11.1%), Procurement with 18 respondents (10.0%), Maintenance with 14 respondents (7.8%), and Logistics with 12 respondents (6.7%). Based on position, the respondents consisted of 52 Supervisors (28.9%), 43 Staff/Specialists (23.9%), 25 Foreman/Coordinators (13.9%), 24 Engineers/Planners (13.3%), 21 Section Heads (11.7%), and 15 Managers (8.3%). The respondents' working period ranged from 1–22 years with an average of 6.19 years.

Descriptive Statistics and Measurement Results

Descriptively, all constructs obtained an average score above the midpoint of the scale. Cross-Functional Coordination had an average of 3.47±0.79, while Operational Process Integration reached 3.53±0.67 and Operational Performance 3.54±0.71. Among the four integration dimensions, the highest score was found in Production Planning and Control at 3.55±0.77, followed by Quality Assurance at 3.53±0.74, Production Execution at 3.52±0.76, and Demand Forecasting at 3.51±0.77.

Table 1. Descriptive Statistics, Reliability, and Convergent Validity

Constructs/Dimensions	Mean	SD	Loading Range	Cronbach's α	CR	AVE
Cross-functional coordination	3,47	0,79	0,814–0,877	0,904	0,929	0,723
Demand Forecasting	3,51	0,77	0,837–0,886	0,824	0,895	0,740
Production Planning & Control	3,55	0,77	0,849–0,881	0,830	0,898	0,746
Production Execution	3,52	0,76	0,823–0,862	0,802	0,884	0,717
Quality Assurance	3,53	0,74	0,841–0,868	0,815	0,890	0,730
Operational Process Integration*	3,53	0,67	0,858–0,885	0,899	0,929	0,767
Operational Performance	3,54	0,71	0,798–0,838	0,904	0,926	0,675

Loading Operational Process Integration shows four dimensions of loading: Demand Forecasting, Production Planning and Control, Production Execution, and Quality Assurance.

All outer loading was above 0.70, AVE value was above 0.50, while Cronbach's alpha and composite reliability were above 0.70. The HTMT value between constructs/dimensions ranged from 0.394–0.886, with the highest value in the Production Planning and Control–Production Execution relationship being 0.886; all values were below 0.90.

At the indicator level, the highest average value was found in OP1 or timeliness of delivery (M=3.60), followed by PPC1 or suitability of production plans with forecasts, capacity, and materials (M=3.57). The indicator with the lowest average was CFC4 or speed of resolution of priority conflicts between functions (M=3.43).

Relationship among Research Constructs

Correlation analysis showed that all major constructs had a positive relationship. The relationship between Cross-Functional Coordination and Operational Process Integration resulted in $r=0.444$; $p<0.001$. The strongest relationship was found between Operational Process Integration and Operational Performance, which was $r=0.627$; $p<0.001$. Cross-Functional Coordination was also positively correlated with Operational Performance of $r=0.396$; $p<0.001$.

Table 2. Correlation among Main Constructs

Construct	Cross-functional coordination	Operational Process Integration	Operational Performance
Cross-functional coordination	1,000	0,444	0,396
Operational Process Integration	0,444	1,000	0,627
Operational Performance	0,396	0,627	1,000

All correlations between the main constructs are significant at $p<0.001$.

Hypothesis Testing

Path estimation based on standardized construct scores showed that all three relationships tested had a positive direction. In H1, Cross-Functional Coordination had a positive effect on Operational Process Integration with $\beta=0.444$, $t=6.605$, $p<0.001$, with a 95% bootstrap confidence interval of 0.315–0.557. Cross-Functional Coordination explained 19.7% variation in Operational Process Integration ($R^2=0.197$).

In the Operational Performance model, Operational Process Integration showed the greatest positive influence with β=0.561, t=8.712, p<0.001, so that H2 was supported. After the influence of Operational Process Integration was taken into account, Cross-Functional Coordination still showed a direct positive effect on Operational Performance of β=0.147, t=2.279, p=0.024, so that H3 was also supported. The two predictors together explained the 41.0% variation in Operational Performance (R^2=0.410).

Table 3. Hypothesis Testing Results

Hypothesis	Structural Path	b	t-value	p-value	Bootstrap 95% CI	R^2	Result
H1	Cross-Functional Coordination → Operational Process Integration	0,444	6,605	<0.001	0,315–0,557	0,197	Supported
H2	Integration of Operational Processes → Operational Performance	0,561	8,712	<0.001	0,453–0,664	0,410	Supported
H3	Cross-functional coordination → operational performance	0,147	2,279	0,024	0,027–0,264	0,410	Supported

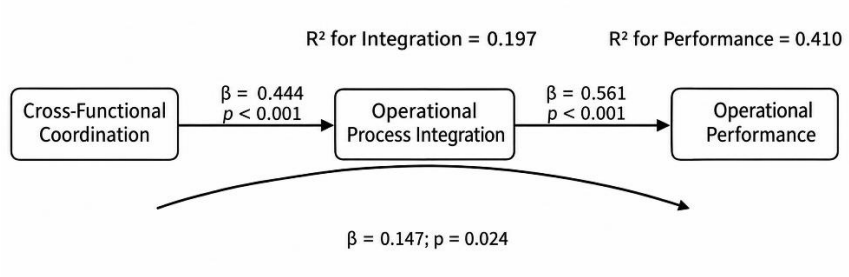


Figure 1. Structural Model Results

Operational Performance Results

The operational data consisted of 72 observations, namely 24 months in three product families. Overall during the observation period, the average MAPE Forecast was 9.35%, Schedule Adherence 90.36%, OEE 75.64%, Defect Rate 2.56%, Rework Rate 1.17%, On-Time Delivery 91.63%, Inventory Days 24.79 days, and Downtime 49.01 hours.

A comparison between the first 12 months and the last 12 months shows consistent changes in all observed operational KPIs. MAPE Forecast decreased from 10.51% to 8.20%, or decreased by 2.31 percentage points. Schedule Adherence increased from 88.27% to 92.45%, while OEE increased from 73.52% to 77.77%. In the quality dimension, Defect Rate decreased from 2.86% to 2.26% and Rework Rate from 1.31% to 1.03%. On-Time Delivery increased from 89.69% to 93.57%. Inventory Days decreased from 26.26 to 23.32 days, while Downtime decreased from 52.70 to 45.32 hours.

Table 4. Comparison of Operational KPIs

Operational KPI	First 12 Months	Last 12 Months	Absolute Change	Relative Change
Forecast MAPE	10,51%	8,20%	−2,31 pp	−22,02%
Schedule Adherence	88,27%	92,45%	+4,18 pp	+4,73%
OEE	73,52%	77,77%	+4,25 pp	+5,78%
Defect Rate	2,86%	2,26%	−0,60 pp	−21,12%
Rework Rate	1,31%	1,03%	−0,28 pp	−21,32%
On-Time Delivery	89,69%	93,57%	+3,89 pp	+4,34%
Inventory Days	26,26 days	23,32 days	−2,94 days	−11,20%
Downtime	52,70 hours	45,32 hours	−7,38 hours	−14,01%

The monthly trend also shows a gradual increase in Schedule Adherence, OEE, and On-Time Delivery during January 2025–December 2026.

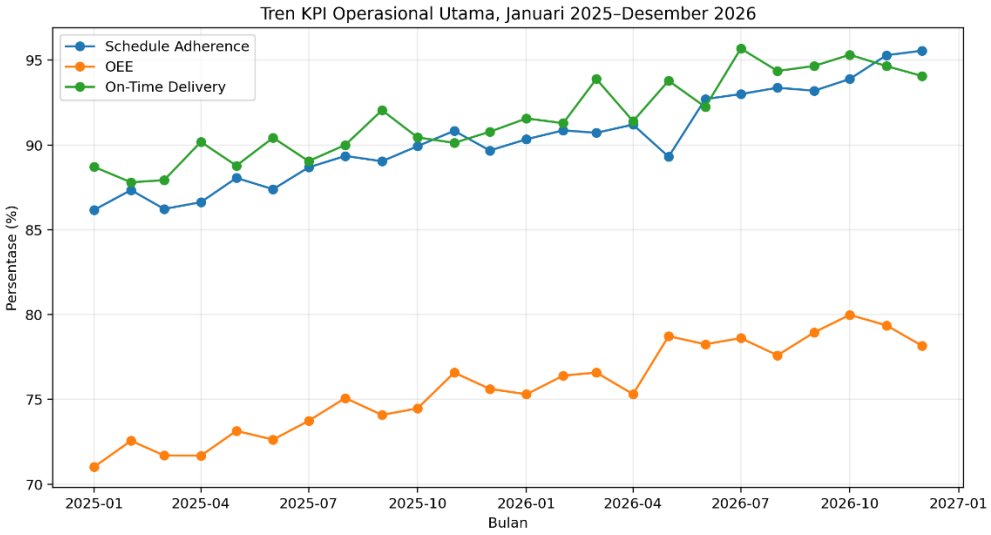


Figure 2. Monthly Trends in Schedule Adherence, OEE, and On-Time Delivery

In indicators that are getting better if the value is lower, the data pattern shows a tendency to decrease in the MAPE Forecast, Defect Rate, and Rework Rate throughout the observation period.

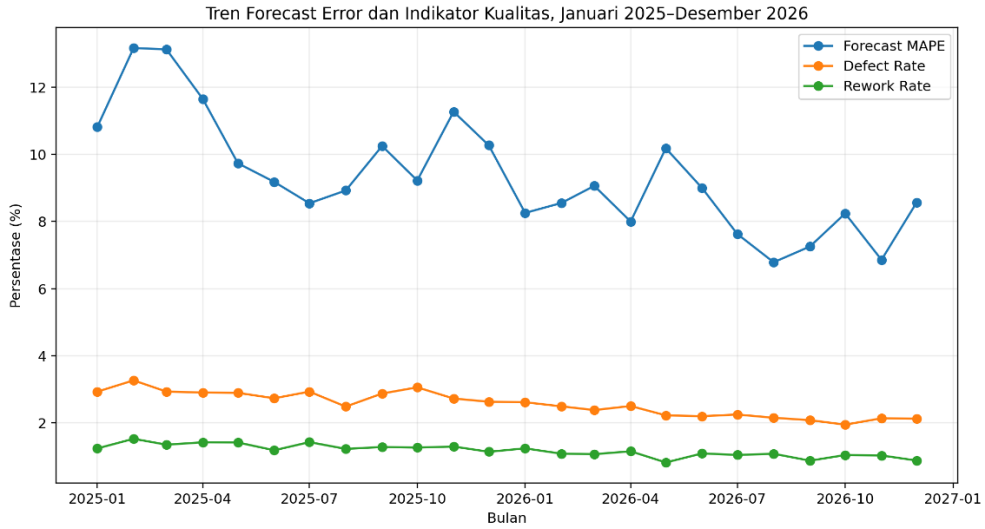


Figure 3. Monthly Trends in Forecast MAPE, Defect Rate, and Rework Rate

When viewed based on product families, the average MAPE Forecast is 9.61% for Product A, 9.56% for Product B, and 8.89% for Product C. Schedule Adherence is 90.31%, 90.21%, and 90.57%, respectively, while the average OEE is 75.41%, 75.50%, and 76.02%. The variation between product families is relatively limited compared to the changes that occur between periods.

Qualitative Findings

The qualitative stage produced 96 interview answers from 12 informants. A total of 48 main quotes were included in a structured coding matrix. The coding resulted in four core themes, with each theme having 12 quotes from all informants.

Table 5. Main Qualitative Findings

Theme	Coded Excerpts	Main Empirical Finding
Request Information Synchronization	12	The forecast has been updated regularly, but sudden changes, changes in customer priorities, and revisions after the frozen schedule still require additional coordination.
Coordination & Decision Making	12	Schedule changes are communicated through daily meetings, coordination groups, and cross-functional confirmations; the speed of confirmation is an important part of the schedule change process.
Quality Feedback	12	Defect information is conveyed through QC reports and daily meetings; recurring problems are passed on to the analysis of the cause and corrective actions together with production.
Shared KPIs & Operational Performance	12	Informants identify changes in schedule adherence, on-time delivery, defects, rework, downtime, production stability, and inventory as coordination improves.

In addition to the four themes in the main coding matrix, the complete answers show two operational domains that also appear in the interview guidelines. In the alignment of production planning, the problems recorded include changes in product mix, material availability, capacity limitations, changes in actual demand, changeovers, and frozen schedule stability. In the visibility of production execution, the informant mentioned monitoring of actual output, downtime, schedule attainment, OEE, plan–actual deviation, and the need for data source integration.

On the question of coordination effectiveness, five informants explicitly stated that daily coordination accelerates decisions related to order priority, material shortages, and quality issues. Six responses highlighted that coordination forums have helped but that cross-functional KPI alignment still needs to be strengthened, including one that specifically emphasizes maintenance involvement. One operations-level informant emphasized that cross-functional meetings are effective when decisions have a clear PIC and deadline.

In the improvement priority, five answers point to the need for an integrated dashboard from demand to quality, five answers emphasize shared KPIs, meeting standardization, and forecast–plan–actual–quality data integration, while two answers emphasize a single source of operational data, escalation rules, and forecast update discipline.

Integrated Results

The integration between quantitative data, operational data, and interview results showed a consistent pattern of findings in the three research relationships. H1 showed a positive relationship between Cross-Functional Coordination and Operational Process Integration ($r=0.444$; $\beta=0.444$; $p<0.001$), while qualitative data showed the existence of a coordination mechanism through daily meetings, update of request information, revision of schedules, and cross-functional confirmations.

For H2, Operational Process Integration had the strongest relationship with Operational Performance ($r=0.627$; $\beta=0.561$; $p<0.001$). In parallel, operational data showed an increase in Schedule Adherence, OEE, and On-Time Delivery as well as a decrease in MAPE Forecast, Defect Rate, Rework Rate, Inventory Days, and Downtime between the two 12-month periods.

For H3, the bivariate relationship between Cross-Functional Coordination and Operational Performance reached $r=0.396$ ($p<0.001$), while the direct effect after Operational Process Integration was incorporated into the model remained positive and significant ($\beta=0.147$; $p=0.024$). The results of the interviews at the same time noted the acceleration of decision-making, coordination of schedule changes, resolution of quality issues, and the need for cross-functional KPI alignment.

Table 6. Joint Display of Main Results

Research Relationship	Quantitative Result	Operational Evidence	Qualitative Evidence	Result
H1: CFC → Operational Integration	r=0,444; β=0,444; p<0,001	Schedule adherence increases throughout the period	Demand synchronization and coordination of schedule changes	Supported
H2: Operational Integration → Operational Performance	r=0,627; β=0,561; p<0,001	MAPE, defect, rework, inventory days, and downtime decrease; OEE and OTD increase	Quality feedback and forecast–plan–actual–quality connectivity	Supported
H3: CFC → Operational Performance	r=0,396; β=0,147; p=0,024	The improvement of several operational KPIs took place during the observation period	Daily coordination and acceleration of cross-functional decisions	Supported

Overall, all three research hypotheses were supported by quantitative relationship estimation. Operational results show KPI changes that are in line with performance improvements, while qualitative results provide data on demand information synchronization, decision coordination, quality feedback, and performance indicators observed during operational processes.

Discussion

The results show that cross-functional coordination is an important factor in shaping operational process integration in the demand forecasting–production planning and control–production execution–quality assurance series. The effect of cross-functional coordination on operational process integration was $\beta=0.444$ ($p<0.001$), with $R^2=0.197$, indicating that the increase in communication, decision-making, and priority alignment between departments is in line with the increasingly integrated operational processes. The qualitative findings clarify the mechanism: demand changes need to be translated through forecast updates, schedule revisions, cross-functional confirmations, and daily coordination before they can become production decisions. This pattern is in line with the information processing view that places cross-functional coordination as an organization's ability to meet increasing information needs when processes become increasingly interdependent. Li et al. (2022) found that cross-functional system, process, and team coordination strengthens information processing capabilities and supports operational performance. Similarly, Kreuter et al. (2022) and Bhalla et al. (2023) explain that S&OP creates alignment between demand and operations through cross-functional decisions. Thus, H1 is not only statistically supported, but also derives an operational explanation that coordination becomes a means to transform information scattered between parts into consistent decisions throughout the process flow.

The strongest finding was found in the relationship between Operational Process Integration and Operational Performance ($\beta=0.561$; $p<0.001$), with a correlation of $r=0.627$. When Operational Process Integration and Cross-Functional Coordination were taken together, the model was able to explain 41.0% variation in Operational Performance. The results showed that the greatest benefit did not simply come from the existence of individual forecasting, planning, execution, or quality assurance, but from the company's ability to connect the four processes. Operationally, the pattern was consistent with changes in KPIs during the observation period: MAPE Forecast decreased from 10.51% to 8.20%, Schedule Adherence increased from 88.27% to 92.45%, OEE increased from 73.52% to 77.77%, and On-Time Delivery increased from 89.69% to 93.57%. At the same time, the Defect Rate decreased from 2.86% to 2.26%, the Rework Rate from 1.31% to 1.03%, the Inventory Days from 26.26 to 23.32 days, and the Downtime from 52.70 to 45.32 hours. Simultaneous changes in forecasting, production, quality, inventory, and delivery show that operational performance is multidimensional, as stated by Battesini et al. (2021) , and cannot be explained through just one production indicator.

These results reinforce the findings of Ganbold et al. (2021) , who showed that integration is related to quality, delivery, cost, inventory, customer service, and flexibility, and Özkanlısoy (2024) , who found that integration contributes positively to performance in the manufacturing context. However, this study expands the focus of the literature. Ganbold et al. (2021) placed integration in the context of supply chain integration and information technology capabilities, while Özkanlısoy (2024) linked it to Industry 4.0. This study focuses on the internal integration of operational processes, i.e. how demand forecasting is translated into production planning and control, passed on to production execution, then controlled and returned through quality assurance. Thus, integration in this study is not only the integration of information or relationships between organizations, but the connection of decision processes and implementation within the manufacturing system. This perspective is also in line with the study of Khannan et al. (2025) , which shows the need for the integration of production planning with broader manufacturing activities.

The quality assurance dimension provides significance in the integration chain. The decrease in the Defect Rate of around 21.12% relative and the Rework Rate of around 21.32% between the two periods shows that the improvement in performance occurs not only in the volume and accuracy of schedules, but also in quality results. Interviews show that defect information is returned through QC reports and daily meetings, while recurring problems are forwarded to cause analysis and corrective actions along with production. This supports the idea of Quality 4.0 that quality needs to be placed as part of the information system and decision-making, not just the final inspection. Mahin et al. (2024) emphasize that the integration of processes, technology, leadership, and quality management are important components in achieving operational excellence. In parallel, Arcidiacono & Schupp (2024) found that improving manufacturing capabilities can contribute to the dimensions of cost, quality, delivery, and flexibility. In this study, the evidence emerged in the form of a relationship between quality feedback and production execution as well as the improvement of several KPIs simultaneously.

H3 also gained support, but provided more nuanced findings. Bivariately, the relationship between Cross-Functional Coordination and Operational Performance reached $r=0.396$ ($p<0.001$). However, after Operational Process Integration was incorporated into the model, the direct effect of coordination on performance dropped to $\beta=0.147$ ($p=0.024$), much smaller than the effect of Operational Process Integration of $\beta=0.561$. This pattern suggests that coordination does have direct consequences for performance, for example through decision acceleration, material shortage resolution, schedule changes, or responses to quality issues, but the benefits of coordination are greater when the coordination is actually realized into process integration. These findings are consistent with Özkanlısoy (2024), who found that integration plays an intermediary role in the relationship between Industry 4.0 capabilities and performance. However, this study did not formally test the mediation hypothesis so the pattern should be understood as an indication of mechanism, not statistical evidence of mediation.

These findings also help explain why the literature does not always have a uniform influence on integration. Wong et al. (2025) show that integration does not universally result in improved performance because each dimension of integration can play a different role and the combination determines the final outcome. El Mokadem & Khalaf (2023) also found that the relationship between integration and operational performance is contingent on supply chain strategies. In this study, there are still a number of barriers that indicate that integration is not yet fully optimal: sudden changes in demand still require manual confirmation, priority changes can occur after frozen schedules, data sources are not fully integrated, and KPIs between departments still need alignment. This may explain why coordination explains only 19.7% of variations in Operational Process Integration. In other words, integration is not determined by coordination alone; material availability, machine capacity, changeovers, equipment reliability,

frozen schedule disciplines, data quality, and information infrastructure also have the potential to contribute to integration variations that the model has not yet explained.

The qualitative results reinforce this interpretation by showing that the integration problem is cross-process. On the demand side, there is a need for faster forecast updates and communication of priority changes. On the planning side, the stability of frozen schedules, materials, capacity, and changeovers is a concern. In execution, informants emphasize the visibility of actual output, downtime, schedule attainment, and plan–actual deviation. In quality assurance, the effectiveness of feedback defects and corrective actions are key. Five answers explicitly point to the need for an integrated dashboard from demand to quality, the other five emphasize shared KPIs, meeting standardization, and forecast–plan–actual–quality data integration, while two answers emphasize a single source of operational data, escalation rules, and forecast update discipline. Thus, qualitative data show that integration does not stop at information exchange, but requires the same decision-making structure and process visibility across functions. This is in line with the development of collaborative manufacturing, which emphasizes the integration of production and planning as a mechanism to improve the ability to respond to operational needs Khannan et al. (2025).

The novelty of this research lies in the unification of four internal processes—demand forecasting, production planning and control, production execution, and quality assurance—as one construct of Operational Process Integration, then placing Cross-Functional Coordination as a managerial antecedent that is linked to operational performance. The previous literature has tested S&OP, supply chain integration, Industry 4.0, smart manufacturing, or Quality 4.0 separately. This study brings together the upstream process of demand information with the planning, production realization, and quality feedback processes in one demand–planning–execution–quality framework. Another contribution comes from the use of three layers of evidence: the perception of 180 respondents, 72 KPI observations over 24 months, and 96 answers from 12 informants. With this design, changes in operational performance are not only reflected in the perception score, but can also be seen in the patterns of MAPE Forecast, Schedule Adherence, OEE, defect, rework, OTD, inventory, and downtime. Theoretically, the results expand the perspective of integration from mere structural linkage to process-based operational capability, i.e. the ability of organizations to continuously convert demand information into plans, production actions, and quality feedback.

The practical implication of these findings is that management should not improve forecasting, PPIC, production, or quality in isolation. The first priority is to build a single source of truth that connects forecast–plan–actual–quality so that each function uses consistent information. Second, cross-functional dashboards need to display at least Forecast MAPE, schedule adherence, actual versus plan, OEE, downtime, defect/rework, inventory, and OTD. Third, daily operational meetings need to use shared KPIs, clear PICs, completion deadlines, and escalation rules for changes in demand or schedule. Fourth, quality assurance needs to be maintained as a closed feedback loop so that quality findings can influence production execution and subsequent planning. This approach is closer to the principles of S&OP and collaborative manufacturing that emphasizes cross-functional decision alignment rather than simply digitizing individual processes.

This study has several important limitations in interpreting the results. First, the research dataset is synthetic/simulative, so the statistical relationship figures and KPI patterns should be viewed as the result of the developed analysis model and cannot be generalized as empirical evidence in the field. Second, the single-case design limits the heterogeneity of the organizational context. Third, although 24 months of operational data are available, the main structural relationships use cross-sectional perception data, so the causal direction cannot be ascertained longitudinally. Fourth, the model only includes cross-functional coordination and process integration to explain performance, while technological factors, organizational culture, human resource competence, machine reliability, supply uncertainty, and production strategy

have not been analyzed. Fifth, the pattern of decline in the direct coefficient of CFC→performance after integration is included suggests the possibility of an indirect mechanism, but mediation has not been a research hypothesis and has not been formally tested. The next research should use actual field data from several companies, longitudinal design, link the survey with actual ERP/MES/QMS data, compare industry types or manufacturing strategies, and explicitly test the mediating role of Operational Process Integration and the possibility of moderation of environmental uncertainty or digital integration.

CONCLUSION AND RECOMMENDATIONS

Based on the findings and discussion presented above, this study concludes that operational performance in manufacturing companies is strongly influenced by the integration of operational processes and cross-functional coordination.

1. Cross-Functional Coordination has a positive effect on Operational Process Integration ($\beta=0.444$; $p<0.001$), while Operational Process Integration has the greatest influence on Operational Performance ($\beta=0.561$; $p<0.001$). Cross-Functional Coordination also has a smaller but significant direct influence on Operational Performance ($\beta=0.147$; $p=0.024$), with both predictors explaining 41.0% of performance variations. These results are supported by improvements in MAPE Forecast, Schedule Adherence, OEE, Defect Rate, Rework Rate, OTD, Inventory Days, and Downtime.
2. The findings indicate that improving operational performance depends more strongly on the organization's ability to integrate processes than on direct cross-functional coordination alone. Therefore, demand forecasting, production planning and control, production execution, and quality assurance should be managed as a single operational integration capability. Companies are advised to establish a single source of operational data, cross-functional dashboards, shared KPIs, standardized coordination forums, clear PICs and escalation rules, and closed-loop quality feedback.
3. Subsequent research should validate the proposed model using actual, multi-company, and longitudinal field data. Future studies should also formally test the mediating role of process integration and other contextual factors to strengthen the model's generalization and causal capabilities.

Limitation

This study has several limitations that should be considered when interpreting the findings. The use of synthetic data and the focus on a single manufacturing company in Surabaya limit the scope of generalizing the findings to broader manufacturing contexts. In addition, this study does not specifically examine the mediating role of operational process integration or other contextual factors. These limitations provide opportunities for future research to develop a more comprehensive understanding of the relationships examined in this study.

Rcomendation

Future research should validate the proposed model using actual data from multiple manufacturing companies and longitudinal observations. Further studies should also examine the mediating role of operational process integration and relevant contextual factors to strengthen the model's generalizability and causal interpretation.

Authors Contribution

All authors contributed to the conceptualization, methodology, data analysis, interpretation of findings, writing, and revision of the manuscript. All authors approved the final version of the manuscript.

AI Disclosure Statement

Generative artificial intelligence tools were used to support language editing and manuscript refinement. The authors remain fully responsible for the accuracy, originality, interpretation, and final content of the manuscript.

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