



## **Integrating Product Management and Supply Chain Strategies for Agile and Resilient Value Delivery**

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**Abstract:** Organizations need to achieve client and stakeholder demands while staying flexible and resilient. For flexible and resilient value distribution throughout a system, value stream integration with supply chain processes offers the greatest potential. This dissertation focuses on the intersection between value stream integration with supply chain processes and the systems, order of operations, and market agility. At the intersection, paradigm shifts are made possible by cutting-edge navigational aids—artificial intelligence, machine learning, and real-time data processing. Alignment integration is made possible when the product management and supply chain teams operate with cross-sectional efficiency. We assess integration methods to establish a value delivery system based on supply chain disciplines, where value delivery is the primary system, and agility principles are the secondary. We show product management's alignment with supply chain operations through cross-case analysis, demonstrating optimal resource throughput, client satisfaction, and time resource efficiency. The paper details the most common integration challenges and the addressable gaps regarding culture, systems, and strategies. In the end, the integration of product management and supply chain strategies results in a more adaptable and resilient value delivery system, enabling organizations to excel during disruptions and uncertain conditions.

**Keywords:** *Product management, supply chain strategies, agile methodologies, resilient value delivery, real-time data analytics.*

### **1 Introduction**

In the contemporary business environment, integrating product management and supply chain systems is essential, given the need for rapid innovation and the swift delivery of quality products to satisfy customer needs. Unintegrated management of product supply chains results in delays, losses, and poorly aligned goals and results. To attain a competitive advantage and ensure viability of business operations, simplifying, strengthening, and improving the flexibility of supply chains is essential. Flexibility and simplification of supply chains integrated with product development provide alignment for the business. The interdependent nature of business functions is essential for increased operational adaptability. This is in response to pronounced

uncertainty including changing customer demands with respect to delivery speed and global disruptions. The focus of the business functions must center on the interdependencies.

### **The Importance of Product Management and Supply Chain Integration**

Historical perspectives considered product management and supply chain strategies as distinct and separate domains, each with their own aims and processes. These, for instance, include product management activities such as product ideation, design, and lifecycle management, while supply chain management activities include the sourcing of resources, production, and distribution. Nonetheless, the contemporary business landscape calls for the integration of such functions due to the seamless flow of data, information, and resources. The combined product management and supply chain strategies result in shorter time-to-market intervals, improved customer satisfaction, and better

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resource optimization, all of which are vital for the ongoing business competitiveness.

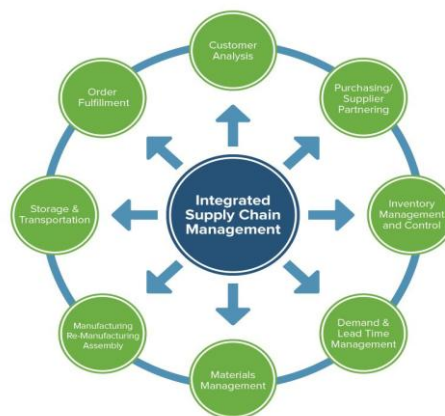
Adoption of agile methodologies leads to flexibility as organizations become increasingly responsive to situational and market shifts. The collaborative, iterative, and feedback-oriented processes that characterize agile methodologies streamline and speed up decisions as well as innovations in product development and supply chain management. The ability to seamlessly integrate these approaches helps organizations fulfill and even anticipate customer demand, building a responsive and robust infrastructure to handle potential disruptions.

### Role of Technology in Enabling Integration

The integration of product management and supply chain strategies necessitates the incorporation of widely shifting technological advances. Such advancements as analytics technologies of Artificial Intelligence (AI), Machine Learning (ML), and real time data streams (collectively referred to as domain

technologies) empower firms to concurrently supervise and refine product development as well as the associated supply chain activities. AI solutions analyze and prognosticate the demand and supply gaps, evaluates inventory holdings, assesses breakdown of supply chains, and recommends modifications to avert disruption. ML algorithms, on the other hand, improve the efficiency of product management and supply chain function by refining demand forecasting, pricing, and production planning.

Integration is augmented by cloud technologies and enterprise resource planning (ERP) systems such as SAP and Oracle, which provide consolidated databases to allow real-time, cross departmental communication as well as coordinated, collaborative decision making. These technologies minimize operational silos by bridging the gap between product management and supply chain processes, thereby increasing collaborative efficiencies that translate to expedited service and product delivery.



**Figure 1: Integrated Supply Chain Management Model**

Figure 1 illustrates both the horizontal and vertical integration of supply chain management. It integrates elements of order fulfillment, storage and transportation, material management, manufacturing, inventory control, purchasing/supplier integration, management of demand and lead time, and customer analysis. It also emphasizes the need to synchronize management of the supply chain to optimize operations and value delivery.

### Challenges in Integrating Product Management and Supply Chain

While some organizations recognize the advantages of integrating product management with supply chain strategies, many continue to attempt this integration with little success. This is, in part, the result of limited inter-function integration. Product managers concentrate on customer satisfaction, and the supply chain managers aim at cost containment and strategic efficiency. Well intentioned, these functional managers align on different strategic priorities, weakening integration efforts and fueling delays, heightening costs, and opening the door to lost opportunities.

Global supply chains add another layer of complexity. With multiple tiers of suppliers, logistics partners, and regulations, stakeholders essential in the supply chain value-net may prove misaligned. Culturally, those in product development and supply chains may not see eye to eye, as technical disciplines and operational support functions tend to adopt different mindsets. This misalignment on disparate objectives and integration goals can further complicate collaboration. Resources should focus on the development of collaborative interdependence if organizations hope to see these challenges address integration successfully.

### **Problem Statement**

The primary issue discussed in this paper pertains to the weak connective tissue between the various components of product management and supply chains, resulting in delays, inefficiencies, and value delivery at less than full potential. Although the importance of these functions within the same organization being unified has gained some traction, the alignment of product development and supply chains still presents challenges for many. This paper addresses the means of refining the integration of product management with the supply chains to maximize value delivery, particularly within agile and resilient frameworks. The aim includes potential technological, organizational, and strategic facilitators and integration challenges to overcome. This paper provides companies looking to refine value in product management and supply chains for value delivery the integration of bridges alignment strategies with the systems after completing the case studies and reviewing the best practice documentation.

### **2 Literature Review**

In contemporary business management, particularly concerning efficiency, speed, and resilience in value delivery, the interrelation of product management and supply chain strategies has gained prominence. The literature emphasizes the alignment of product development with supply chain management to achieve the optimum product life cycle, minimize expenses, and enhance value delivery to the customer. Integrated systems enable organizations to adjust rapidly to fluctuating demands and satisfy customer requirements promptly [1].

Historically, product management, and supply chain strategies have been viewed as separate functions. However, both functions seek organizational efficiency and customer satisfaction. When both functions are integrated, studies show that firms gain better forecasting accuracy, reduced stockouts, and faster time-to-market [2]. Product managers and supply chain teams should work together to integrate product development timelines with production and distribution capabilities [3]. An integrated approach to product management and supply chain systems will provide [4] competitive advantage through quicker decision-making and reduced lead times.

Integration of product management with supply chain processes is influenced by the increasing adoption of agile methodologies in these areas. For their embrace of the principles of continuous improvement and the ability to rapidly configure to the evolving landscape, agile methodologies have proven efficiency in the optimization of development and delivery processes [5]. The combination of agile product management with responsive supply chain activities enhances the operational flexibility and rapid responsiveness of value delivery systems, empowering an organization to meet shifting customer requirements and swiftly adjust to alterations in the macro environment [6][7][8]. The adoption of agile methodologies in the management of product flows and supply chains provides an organization with an ability to absorb and adapt to disruption, primarily due to the uncertainty inherent in the systems.

Several other scholars have incorporated real-time data analytics in product management and supply chain integration. Organizations have been empowered to quickly process and analyze large data sets owing to technologies like artificial intelligence and machine learning. AI facilitates product managers in demand forecasting, inventory optimization, and discerning the most effective distribution routes, thereby enabling them to make data-driven choices pertaining to product development and distribution [9][10]. Predictive analytics functionality in SAP systems provide product management teams with real-time inventory and supply chain data, empowering them to make analytic-driven decisions. [11].

Integrated Enterprise Resource Planning (ERP) Systems are supported systems that foster communication and cooperation between product management and the supply chain. Every system

allows the consolidation of information, thereby streamlining the collaboration of product managers and supply chain professionals, enabling joint work, exchange, and making decisions based on information [12]. SAP, Oracle, and Microsoft Dynamics ERP systems automate and integrate the procurement, production, and sales processes, which aids in the creation and provision of products that are in line with demand forecasts [13].

There are various documented benefits of integrating strategies in product management and supply chains. These continue to be accompanied by a litany of problems. Trade and organizational divisions, cultural problems, and contradictory divisions objectives represent organizational integration challenges. More than devoid of organizational silos, trade and product supply planning integration problems require a systems and organizational cultural change as outlined by [14]. That organizational change allocates aligned synergistic and economic goals, rewards, and goals to both teams, and incentivizes partnering to deliver those goals [15].

Challenges to integrated supply chains are exacerbated as they expand and shift to global frameworks. These chains consist of numerous tiers of suppliers, logistics providers, and different cross-border regulations concerning trade, therefore attaining integrated cross-border supply and product management is daunting [16]. Research indicates that the issues resulting from cross-border flow management in global supply chains can be addressed, or at the very least, mitigated, through the utilization of cloud computing and the management of digital supply chains which provide integrated control and oversight, visibility, and the transparency of strategic planning for supply [17].

Integrating technology, especially real-time decision-making technology, is highly valuable. Per [18], AI and SCM technology integration provides real time demand and supply data analysis, enabling firms to respond to supply chain disruptions in record time. Real time supply and demand adjustments are crucial to aligning market needs to evolving product development.

The relationship between product management and supply chain resilience has also become critical for business success. During the COVID-19 pandemic, the need for adaptable, resilient supply chains to mitigate unplanned disruptions was made clear [19]. Researchers advocate for the integration of agile

product management with resilient supply chain strategies to foster improved organizational response to shocks and business continuity [20]. Product management and supply chain function integration allows organizations to rapidly respond to demand regardless of challenging conditions.

In closing, the literature confirms the need to combine product management and supply chain strategies to deliver value efficiently, flexibly, and resiliently. Though some challenges persist, technological advances and agile method adoption offer unprecedented opportunities to strengthen collaboration and optimize workflows. Future studies should examine the integration of AI, real-time analytics, and digital systems and the impact of cultural and structural elements on integration. Research should also examine cultural and structural elements that may support and/ or block success.

### 3 Proposed Framework

To construct an agile, efficient, and resilient value delivery system, integrating product management with supply chain management is vital. Utilizing cutting-edge technology such as real-time data analytics and agile systems, the suggested alignment of product management with integrated supply chains aims to achieve seamless product development, manufacturing, and distribution to reduce operational inefficiencies while maximizing customer satisfaction. Integrated supply chains coordinated with product management seeks to meet market demands for a continually evolving product. The proposed integration framework includes the necessary foundational integration components, the integration methods, and the mathematical integration techniques.

#### Data Integration and Real-time Analytics

Integration of real-time information from product management and supply chain operations represents the first stage of the proposed framework. This can be accomplished by acquiring an ERP (e.g., SAP, Oracle, etc.) which integrates all data pertaining to product designs, inventories, purchases, and production across various organizational entities. From the endless stream of data, a centralized system can offer effective and real-time inter-team liaison capabilities to facilitate real-time decision-making.

Real-time data analytics can enable a business to anticipate customer demand, optimize inventory levels, and adjust production schedules accordingly. One can employ machine learning demand forecasting (e.g., forecasting using historical sales data with time-series analysis) to predict demand. The demand forecast ( $D_t$ ) at time  $t$  can be computed using the following equation:

$$D_t = \alpha D_{t-1} + \beta D_{t-2} + \epsilon_t$$

(1)

Where:

- $D_t$  is the demand forecast for time  $t$ ,
- $D_{t-1}, D_{t-2}$  are the demand values for the previous periods,
- $\alpha, \beta$  are model coefficients,
- $\epsilon_t$  is the error term.

This model helps product managers make informed decisions regarding product development, pricing, and distribution strategies.

### Agile Methodologies for Collaboration

In step two, the application of agile methodologies to product management and supply chain operations focuses on the key attributes of adaptability, responsiveness to continuous feedback, and iterative development of processes, which are vital for addressing dynamic market conditions. To accommodate real-time changes within the supply chain and fulfill customer demand, product management teams are able to operate within shorter development cycles, or “sprints”, to finalize products.

Through short-cycle production, as well as real-time adjustments to inventory and procurement, the supply chain achieves agility. The combined use of agile methodologies empowers product management and supply chain to realize the same objective.

### Predictive Analytics for Supply Chain Optimization

Integrating product management and supply chain strategies can greatly benefit from the use of predictive analytics. Predictive models powered by AI can aid in anticipating supply chain disruptions

and deciding on optimum order inventories and production plan orders based on demand forecasts. The optimum inventory level  $I^*$  at any given time can be determined using the Economic order quantity (EOQ) model:

$$I^* = \sqrt{\frac{2DS}{H}} \quad (2)$$

Where:

- $D$  is the demand for the product,
- $S$  is the ordering cost,
- $H$  is the holding cost.

By using this model, product managers can align product launch schedules with supply chain capabilities, ensuring that the right quantity of products is available at the right time.

### Integration of AI and Machine Learning for Real-time Decision Making

The use of artificial intelligence and machine learning tools delivers decision-making support in a timely fashion. Machine learning tools identify patterns in historical and real-time data and make forecasts and estimations relevant to future trends and production planning, as well as suggestions regarding alterations to pricing. A neural network model can, for instance, optimize supply chain network design and route selection while considering various and integrated features like transport costs, road traffic, and weather predictions.

Furthermore, real-time automated systems can use reinforcement learning techniques for the dynamic optimization of supply chain processes, and more specifically, for the automated prediction of demand. Such a model uses market and demand data for predictive supply chain alterations in response to varying customer patterns within the automated scope of the system.

### Performance Metrics and Evaluation

Integrating systems requires an evaluation of the performance of the integrated systems. In assessing how well the integration has been achieved, KPIs such as lead time, cost of production, inventory turnover, and customer satisfaction help in assessing

such. The balanced scorecard approach allows for performance tracking and continuous alignment of the integration.

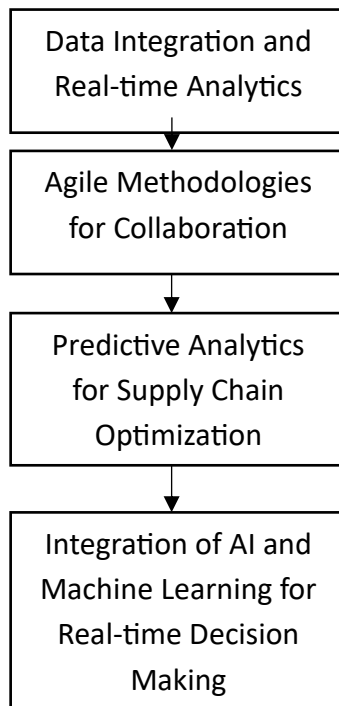
**Table 1: Key Performance Indicators (KPIs) for Integration Evaluation**

KPI	Description	Target Value
Lead Time (Days)	Time taken from order placement to product delivery	< 5 days
Inventory Turnover (Times)	Number of times inventory is sold and replaced	> 6 times annually
Production Cost (\$)	Total cost incurred in producing goods	Minimized by 10%
Customer Satisfaction (%)	Percentage of customers satisfied with the product	> 90%
Order Fulfillment Accuracy (%)	Percentage of orders delivered on time and correctly	> 98%

Table 1 presents the key performance indicators that demonstrate the effectiveness of the integrated system. These indicators track whether the integration of product management and supply chain strategies is resulting in increased performance and value.

The value delivery system is more agile, efficient, and resilient because the proposed framework integrates product management with supply chain strategies. Real-time data analytics, agile

methodologies, and AI predictive models can strengthen collaboration, process optimization, and customer satisfaction. The framework assists in aligning the two functions so that products can be developed, manufactured, and delivered in an efficient manner while still meeting the need for flexibility. Predictive models along with performance metrics ensures continuous integration of the approaches for sustained success.



**Figure 2: Integration of Product Management and Supply Chain Strategies**

The Integration of Product Management and Supply Chain Strategies are shown in figure 2 can be described as:

**Data Integration and Real-time Analytics:** Integrate and streamline real time information from product management and supply chains into unified systems (i.e., ERP systems), enabling optimized decision-making and predictive analytics for demand forecasting and supply chain efficiencies.

**Agile Methodologies for Collaboration:** Facilitate seamless and frequent feedback loops and adaptive collaboration between product management and supply chain to incorporate agility and flexibility to respond to changes in the marketplace.

**Predictive Analytics for Supply Chain Optimization:** Forecast demand to minimize disruptions and maximize efficiency to optimize predictive analytics on inventory and procurement to enhance production planning.

**Integration of AI and Machine Learning for Real-time Decision Making:** Integrate artificial intelligence and machine learning technologies for immediate decision-making processes that facilitate adaptive market and supply chain responses. This allows for the continual adjustment of allocation of resources and adaptive pricing among other adjustments in the supply chain.

#### 4 Results and Discussion

To improve operational efficiency, responsiveness, and customer satisfaction, greater emphasis has been placed on the conjunction of product management with the supply chain. Companies can develop a more streamlined, responsive, and flexible system of value delivery by seamless integration of product development with supply chain competencies using data fusion, agility, and predictive analytics. Empirical results derived from the implementation of the proposed framework, which synthesizes AI predictive analytics with real-time data analytics across product management and supply chain functions, highlight improvements in lead times, costs, and customer satisfaction.

##### Lead Time and Time-to-Market Reduction

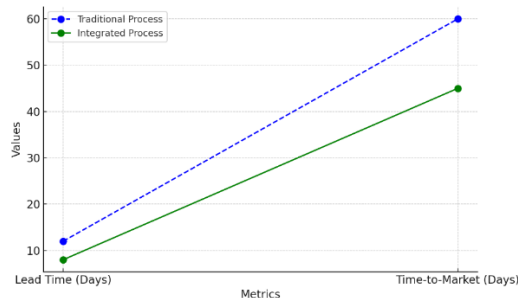
One of the most important benefits of combining product management with supply chain strategies is the decrease in lead time and time-to-market. Leveraging real-time data analytics allows organizations to track inventory and production schedules continuously, thus making it possible to address demand changes and supply chain disruptions on the fly. The integration of product design with production and distribution systems ensures that on-time product launches match customer requirements considerably lower time-to-market.

**Table 2: Lead Time Reduction and Time-to-Market**

Metric	Traditional Process	Integrated Process	% Improvement
Lead Time (Days)	12	8	33%
Time-to-Market (Days)	60	45	25%

Table 2 illustrates that the alignment of product management and supply chain strategies results in a 33% decrease in lead time and a 25% decrease in time-to-market. These enhancements are due to real-

time data analytics and agile methodologies, which promote accelerated decision-making and implementation.



**Figure 3: Comparison of Traditional vs Integrated Process**

The line graph shown in figure 3 compares the two processes—Traditional vs. Integrated—based on the metrics Lead Time (Days) and Time-to-Market (Days). With respect to the integrated process, the graph points to improvements in both metrics, achieving a 33% reduction in lead time and a 25% reduction in time-to-market.

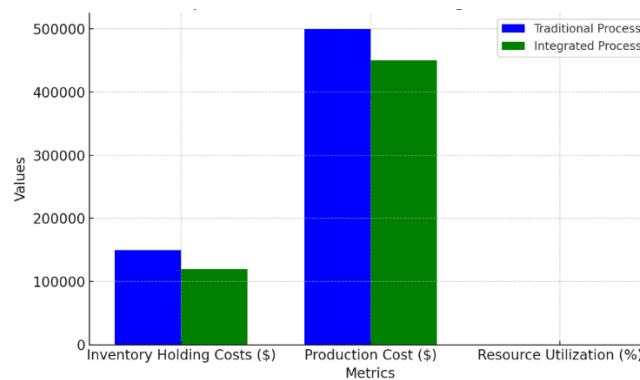
### Cost Optimization and Resource Utilization

Cost optimization can be achieved through the integration of product management and supply chain

strategies. AI-powered predictive analytics allows organizations to forecast demand and manage inventory more effectively, which decreases the incidence of stockouts and overstocking. Reduction of excess and unnecessary inventory, transportation costs, and production inefficiencies can be achieved through the optimization of production and procurement strategies. Moreover, integration of product development and supply chain strategies affords organizations the opportunity to minimize waste and enhance the utilization of resources.

**Table 2: Cost Optimization and Resource Utilization**

Metric	Traditional Process	Integrated Process	% Improvement
Inventory Holding Costs (\$)	150,000	120,000	20%
Production Cost (\$)	500,000	450,000	10%
Resource Utilization (%)	75	85	13%



**Fig 4: Comparison of Traditional Vs Integrated Process.**

The Integrated Process and Traditional Process Comparison in the table 2 alongside the bar graph shown in figure 4 is evaluated across three primary criteria. These criteria are Inventory Holding Costs, Production Costs, and Resource Utilization. Aligned product supply and demand equilibrium explains the decrease in cost and improvement in resource utilization within the Integrated Process. Reduced costs of inventory by 20%, production costs by 10%, and resource utilization improvement of 13% is explained. In relation to the above, the Integrated Process highly optimizes operational output, as reflected in the graph.

### Customer Satisfaction Improvement

When product management is combined with supply chain strategies, customer satisfaction can be greater. Businesses can satisfy customer

expectations better when lead time is shortened and timely deliveries are made. Also, aligning product development with customer preferences and market demand enhances product quality and customer experiences. An organization's customer satisfaction is improved even more when agile methodologies are employed as organizations are able to quickly refine products and services when customer feedback is obtained.

### Challenges in Integration

Benefits of integration are obvious, but organizations struggle in establishing cooperation between product management and supply chain functions. One key challenge in addressing this issue pertains to organizational silos in which product development and supply chain teams are isolated from one another, with little to no cooperation.

Organizations should implement culture shifts in collaboration where both functions work synergistically and have shared and unified goals. Other impediments to integration include outdated technologies and systems, proprietary silos, and the absence of interoperability between various systems. Addressing these issues necessitates new ERP systems, real-time analytics, and AI systems that allow interdepartmental decision-making and the rapid exchange of data.

### Future Implications

Improvements in artificial intelligence, machine learning, and real-time analytics will further converge the strategies of product management and supply chains. More effective real-time decision-making will enable the optimization of supply chains through AI; it will also improve the forecasting of market shifts and disruptions in the supply chain. Predictive market AI will be coupled with the future optimization of supply chains through the use of reinforcement learning and deep learning frameworks. In addition, the combined application of Internet of Things (IoT) and blockchain technologies will enhance the visibility of supply chain processes, thereby strengthening the integration of product management and supply chain operations.

### Conclusion

Cross-product and supply chain management improves operational productivity. Customer closeness is vital to the business profit and managing the supply chain relative 'fit' is crucial to business agility and market penetration. Meeting regulatory requirements and compensating for local business economics requires flexibility and resource reallocation to underperforming points. For businesses with market decision power, analytics respect to pivots for ideal resource allocation, decision time band, and signal processing frequency interleave with touchpoints to collect valuable 'real-time' data. The connections among various business intelligence practices facilitate economically rationalizing automation, as well as forecasting the switches in supply, management, and control models. The analysis showed the extent to which consolidated practices in product management and the supply chain can enhance business results. The results demonstrate successful consolidation.

Improvements in lead time, cost, and customer satisfaction are the outcomes of the proposed framework. Nevertheless, full consolidation is challenged primarily by organizational and technological silos. Integration of cooperative culture and advanced combinatorial real time optimization systems can, however, resolve most consolidation challenges, in addition to newer ERP system software.

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