



Adaptive Planning and Optimization for Supply Chain Networks

White Paper

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EXECUTIVE SUMMARY

Compressed cycle times, increasing uncertainty in the business environment, and supply chain network-based competition are putting the spotlight on adaptive planning and optimization as a way to generate dynamic efficiencies.

Compression of product lifecycles and time to market, margin erosion, and increased outsourcing are driving the shift from advanced planning to adaptive planning. This transition requires integration across demand planning, supply chain network optimization, and execution planning. IT-enabled global optimization eliminates pockets of inefficiencies and creates top and bottom line value. Federated governance and appropriate value metrics must be established as part of adaptive planning initiatives.

SAP possesses the necessary expertise, experience, and technology to support your company's strategic shift toward adaptive planning and optimization of your supply chain network.





BUSINESS DRIVERS OF ADAPTIVE PLANNING AND OPTIMIZATION

Dynamic efficiency shapes sustained performance in today's hyper-competitive environments. Companies must stage, commit and release capacity and materials, and execute plans across the supply chain network in order to meet replenishment objectives. Shortened product lifecycles and rapid margin erosion, coupled with demand and supply uncertainty, require stellar planning.

Increased outsourcing to improve asset utilization and efficiency, requires that planning and optimization of resources must be managed across globally distributed supply chain networks. Original equipment manufacturers (OEMs) must coordinate planning and execution with contract manufacturers so as to flexibly source, allocate, and deploy both capacity and materials to meet shifting replenishment requirements. Limited collaborative planning between OEMs and contract manufacturers was a major reason for the inventory glut that occurred in the high technology sector during the 2001 economic slowdown.

Companies continue to accumulate excess inventory or lose significant sales due to stock outs. These opportunity costs must be proactively managed by improved strategic, tactical, and operational planning. Inefficient utilization of capacity and materials, and poor exception handling are unacceptable to stakeholders and unforgiven by competition.

Business success is shaped by the agility with which companies respond to demand and supply changes as well as execution exceptions. This agility is impacted by the strategic alignment of resources, and the real-time tactical and operational coordination across the supply chain network. The business drivers mandate that supply chain network planning must (see Table 1):

- Configure globally optimal solutions across the supply chain network.
- Recognize interdependent constraints across the supply chain processes.
- Dynamically cascade shifts in objectives and constraints across the planning process.

Business Driver		Impact on Planning and Optimization
Product lifecycle compression	➔	Dynamic demand-supply planning
Global distribution of supply chain networks	➔	Global optimization
Agility	➔	Coordination across supply chain network planning processes

Table 1: Impact of Business Drivers on Planning and Optimization





THE ADAPTIVE PLANNING CONCEPT

Advanced planning and adaptive planning is differentiated by five key concepts in supply chain networks (see Table 2).

- **Continuous constraint management.**

Adaptive planning supports the real-time adjustments of plans based on emergent constraints or old constraints that are softened. In advanced planning, the focus on batch planning does not allow for real-time adjustments to previously developed execution models. This inability to adjust to changes results in long lead times, inability to fill customer orders, and inventory stockpiles.

- **Global synchronization scope.**

Adaptive planning enables continuous adaptation through real-time plan calibration, supply chain network optimization, and synchronization of execution plans. Under the advanced planning concept, plans for demand, materials, procurement, production, distribution and transportation are dynamically optimized. Advanced planning with its batch cycle orientation does not make use of continuous cycles of feedback.

- **Interdependency coordination.**

Adaptive planning enables coordination of interdependences between the various planning and execution functions across enterprises. The era of pure vertically integrated companies with absolute control over all planning and execution functions is over. Now, the value for companies is in partnering with other companies across the supply chain network. Adaptive planning accommodates both previously nonexistent and constantly changing dependencies emerging across these partner networks. Advanced planning leads to locally optimized but globally suboptimized plans that cause process variations across the supply chain network.

- **Resource reallocation.** Adaptive planning supports real-time monitoring and interpretation of exceptions, and adjustment to existing plans in response to these exceptions. The adaptive model focuses on near real-time sensing of exceptions, visibility of the occurrence of exceptions throughout the supply chain network, a shared awareness of changing resource requirements caused by exceptions, and a strategy of reallocation and release of resources in response to the exception. The rigid nature of advanced planning severely impairs exception sensing and adjustment.

- **Managing the unexpected.** Adaptive planning depends on heuristics and models to adjust plans based on exception patterns. As events lead to outcomes that trigger exceptions, adaptive planning heuristics to manage both expected and unexpected exceptions must be in place. In contrast, advanced planning models are only able to deal with predictable exceptions.

Characteristic	Advanced Planning	Adaptive Planning
Constraint management	Batch	Real-time
Synchronization scope	Local	Global
Coordination plans	Rigid	Flexible
Resource deployment	Allocated	Reallocated
Exception management scope	Predictable	Unpredictable

Table 2: Key Characteristics of Advanced Planning versus Adaptive Planning





CHARACTERISTICS OF ADAPTIVE PLANNING

There are five key characteristics that define adaptive planning.

- **Customer value focus.** For adaptive planning to succeed, the driver of strategy must refocus from firm efficiency (supply-driven) to customer value (demand-driven). Adaptive planning allows companies to be proactive to changes in the environment and resilient to changes in demand.
- **Global synchronization.** Instead of focusing on optimizing local supply chain network activities, adaptive planning emphasizes dynamically synchronizing activities across the supply chain network. This continuous synchronization closes the loop between planning and execution.
- **Integrated planning and execution cycles.** Adaptive planning views planning and execution as interdependent activities based on developing business rules and policies in response to changes in the external environment. Batch planning and execution that is constrained by a sole reliance on future predictions of demand is eliminated.
- **Responsive planning cycles.** Adaptive planning occurs in dynamic, networked supply chain configurations that are based on responsive planning cycles rather than constrained by traditional fixed planning cycles. Planning cycles optimize supply chain network plans by integrating past, present, and future data to come up with real-time replenishment requirements.
- **Feedback.** Adaptive planning is firmly footed in the present while remaining cognizant to the past and sensitive to the future. It uses continuous rather than sporadic cycles of feedback throughout the supply chain network.
- **Pattern discovery.** Adaptive planning mines supply chain network wide data leading to discovery of patterns of exceptions and their causes. Alerts and distributed process controls can be implemented to enhance coordination in distributed supply chain network planning and execution.





THE ADAPTIVE PLANNING PROCESS

An integrated end-to-end planning process, from demand plans to execution plans, is essential to dynamically align demand with supply (see Figure 1). The complementary processes that must be implemented to achieve this alignment include:

- **Demand plan calibration**, which is used to formulate and revise real-time replenishment requirements based on complementary components of the demand signal.
- **Supply network plan optimization**, which is used to reconfigure supply chain network resources and optimally allocate replenishment orders to sites across the supply chain network.
- **Execution plan synchronization**, which is used to dynamically optimize finite capacity, production facilities, and transportation resources.

DEMAND PLAN CALIBRATION

Fine-grained calibration of demand plan with market requirements requires a shift from individual companies developing long-term product forecasts to companies generating real-time replenishment requirements collaboratively with their customers and suppliers. These replenishment requirements are derived from complementary information streams, which include:

- **Current** order and inventory status across the supply chain based on point-of-sale and sell-through data. Data generated by radio frequency identification (RFID) tags provide near real-time information about product flow for demand planning.

- **Future** trends in demand, which include market intelligence reports, information collected from environmental scanning, and expected demand spikes due to promotional activity. These activities are discretely and explicitly considered because they create swings in orders and inventory levels across the supply chain network.
- **Historical** order patterns, which are used to establish baseline demand forecasts.

SUPPLY NETWORK OPTIMIZATION

To generate dynamic efficiencies, real-time replenishment requirements must be optimally sourced across the supply chain network to internal manufacturing facilities or contracted manufacturers. Efficient sourcing requires visibility of available resources across the supply chain network, and the application of algorithms for their simultaneous optimization. Changes in resource availability or priorities of replenishment requirements must be sensed so that adjustments to replenishment order allocation plans can be made.

EXECUTION PLAN SYNCHRONIZATION

Efficiently executing and filling replenishment orders requires the simultaneous optimization of materials and capacity for production, transportation and distribution. Departures from scheduled plans are sensed and dynamic adjustments are made to achieve replenishment objectives with minimal performance deviations. Information about supplier execution performance provides feedback about supplier capability that can be used in future cycles of supply network plan optimization.



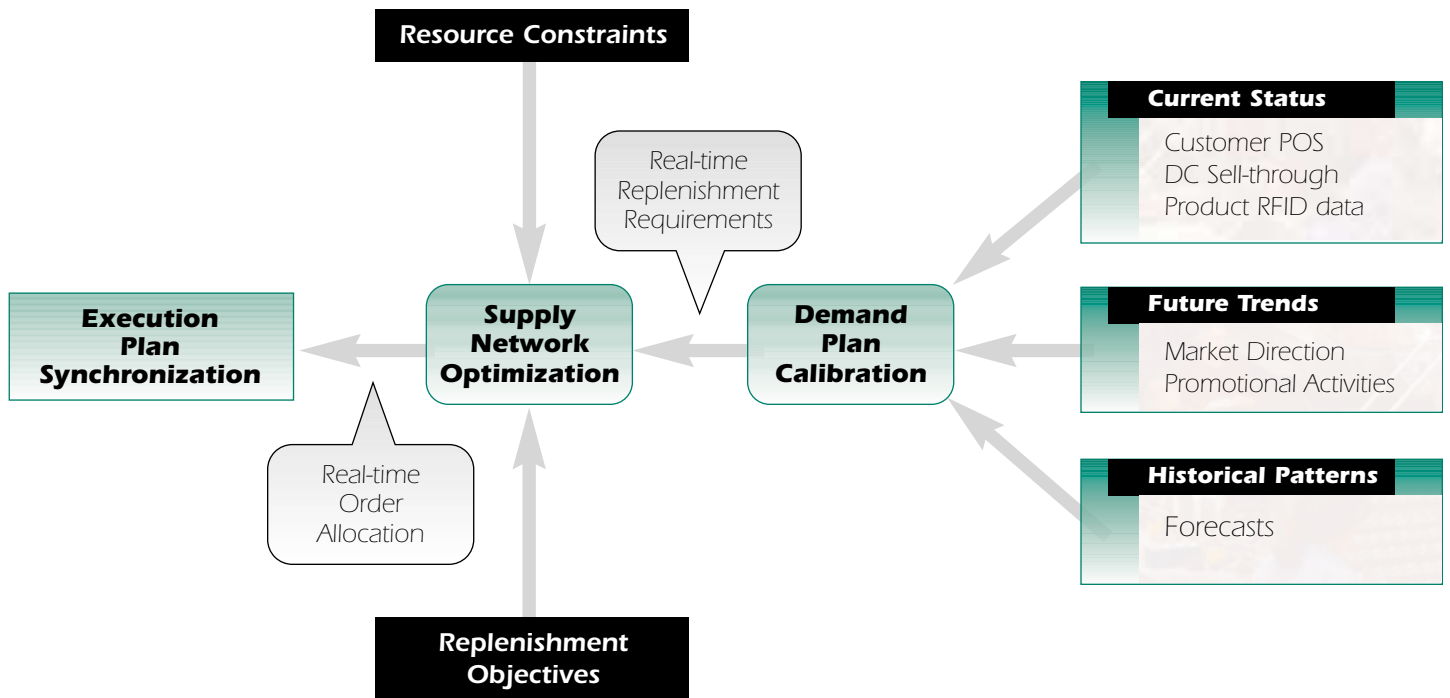


Figure 1. The Adaptive Planning Cycle





DIGITAL CAPABILITIES FOR ADAPTIVE PLANNING

Adaptive planning and optimization depends on the implementation of a digital infrastructure to support key processes.

SPOT- AND MARKET-CONNECTIVITY

Adaptive planning infrastructures must provide interoperability across the proprietary platforms and myriad operating systems used by both spot and long-term partners. Web-based data brokering, transformation, and semantic translation services will simplify integration across enterprises and industries by leveraging open Internet-standards such as XML (eXtended Markup Language) and SOAP (Simple Object Access Protocol).

INTEGRATION OF ACTUAL, PREDICTIVE, AND HISTORICAL DATA

Adaptive planning involves integration of dynamic demand data, promotional information and market forecasts, and historical patterns. Real-time data integration requires access to internal sales systems to track demand information including POS data and distribution center sell-through data. Tagging technologies such as RFIDs make it possible for products to provide continuous data feeds about their location to systems. Industry-specific optimization models must be embedded in the software.

MULTILATERAL PLAN COORDINATION

Adaptive planning infrastructures must support horizontal (similar functions across companies), vertical (different tiers), and diagonal (cross-cutting across functions) coordination across supply chain network partners.

CONVERGENCE OF PLANNING AND EXECUTION

Initial forecasts imperfectly match needs to resources. Adaptive planning infrastructures support refinement of these forecasts in the following ways:

- **Assumption revalidation.** Adaptive planning systems continuously revalidate the underlying assumptions by automated monitoring of actual, historic, and predictive data from which planning heuristics draw assumptions.
- **Closed feedback loops.** Adaptive planning infrastructures monitor events to ensure compliance with agreed upon objectives. Unlike traditional applications that react in a time-lagged manner, adaptive planning applications cascade deviations through the supply chain network so that interdependent plans can be responsibly adjusted.
- **Contained failure.** Failure is contained when the magnitude and nature of error in a forecast is identified and communicated early, and before it grows into a problem. Adaptive planning infrastructures use digital peer-to-peer networks and software agents to intelligently disseminate such information across the supply chain network.





EVENT MANAGEMENT AUTOMATION

Agents are software programs that can collaborate across companies and are capable of monitoring the environment, autonomously executing a specialized task, and then sharing the results with prespecified entities, including other agents. Because agents can autonomously communicate, collaborate, coordinate, learn, and even negotiate across the supply chain network, they can manage resolution of exceptions and event responses across multiple suppliers. Unlike forecasting and batch processing, such agent-based systems monitor and respond to changes in their environment as they unfold.

KNOWLEDGE DISCOVERY FOR PLANNING

An adaptive planning infrastructure seeks unapparent patterns embedded in routinely collected data. These mechanisms extract the knowledge embedded in yet-undiscovered patterns and apply it to update and create new planning heuristics. For example, data about production plans and transportation constraints can be examined to identify overlooked interdependencies. Two tools play a key role in knowledge discovery for planning.

- **Data mining** tools, which detect complex patterns in large transactional datasets to estimate predictive models and help refine, update, and revalidate existing heuristics.
- **Fuzzy logic** tools, which apply existing rules to predict outcomes and test planning heuristics in the absence of hard, quantitative data.

These tools leverage transactional data to improve models and heuristics for supply chain network planning.





ADAPTIVE PLANNING AT COLGATE-PALMOLIVE

The advantages of adaptive planning are well illustrated by Colgate-Palmolive's experiences, a U.S. \$9.4 billion global consumer products company that manufactures and markets a variety of products, such as toothpaste, soaps, detergents, and pet foods. It has operations in over 200 countries and approximately 70% of its sales come from international operations. The company has set a target to improve its gross profit margin from 54.4% in 2000 to 60% in 2008, leading to an emphasis on initiatives that yield growth and efficiencies.

Colgate has established a digital platform to achieve visibility of information, physical and financial flows, to optimize operations, and to collaborate in the planning process with their customers and suppliers (see Figure 2). Beginning in 1994, Colgate has established standards and improved global operations spanning 49 countries through an SAP R/3 ERP initiative. Companies in the consumer products and goods industry, like other hyper-competitive global industries, can generate significant value by dynamically aligning demand and supply planning across the supply chain network. Realizing the potential value of such adaptive planning and optimization, Colgate embarked on its Global Supply Chain initiative in November 1999.

Colgate focused on three initiatives – vendor-managed inventory (VMI), cross-border sourcing (CBS), and management of promotional demand, to calibrate replenishment orders and commit supply resources at the right time to the production, finishing, and transportation of the right product.

The VMI process is architected on the digital capability to collect daily demand and inventory information from major customer distribution centers (DCs) in North America, and analyze it to compute base demand for about 1,000 SKUs. These functions are performed by Demand Planner (DP) in SAP Adaptive Planning and Optimization (APO), and then transmitted to Supplier Network Planner (SNP) to establish execution plans for order replenishment.

The CBS process is architected on the digital capability to collect daily demand and inventory information from Colgate DCs, which are distributed globally, and analyze the information to compute base demand. As with VMI, these functions are performed by DP in SAP APO, and then transmitted to SNP to establish execution plans for off-shore manufacturing sites. The process obviates the need for multiple, inaccurate monthly forecasts developed by sales subsidiaries that determined replenishment requirements from manufacturing sites.

Promotional demand information is communicated by Colgate sales subsidiaries using DP in SAP APO. Collecting and processing fine-grained information about base demand and promotional demand makes it feasible to synchronize demand and supply and efficiently execute manufacturing, production and distribution.





Colgate's initiatives provide it with the digitally enabled process capabilities to collect, share and analyze fine grained information about base demand and promotional demand. They enable the company to establish and refine its replenishment requirements and execution plans collaboratively with its customers and suppliers. Fluctuations in demand are captured as replenishment changes, which are addressed efficiently by simultaneously optimizing resource and capacity constraints across the supply chain network. The performance gains for Colgate and its customers and suppliers are impressive.

VMI initiative has resulted in 98% on-time and order fulfillment rates, and customer replenishment order cycles have been compressed from 5 days to 1 day. CBS has compressed replenishment cycles from 62 to 33 days, reduced inventory by 22%, and increased fill-rates from 94% to 97%.

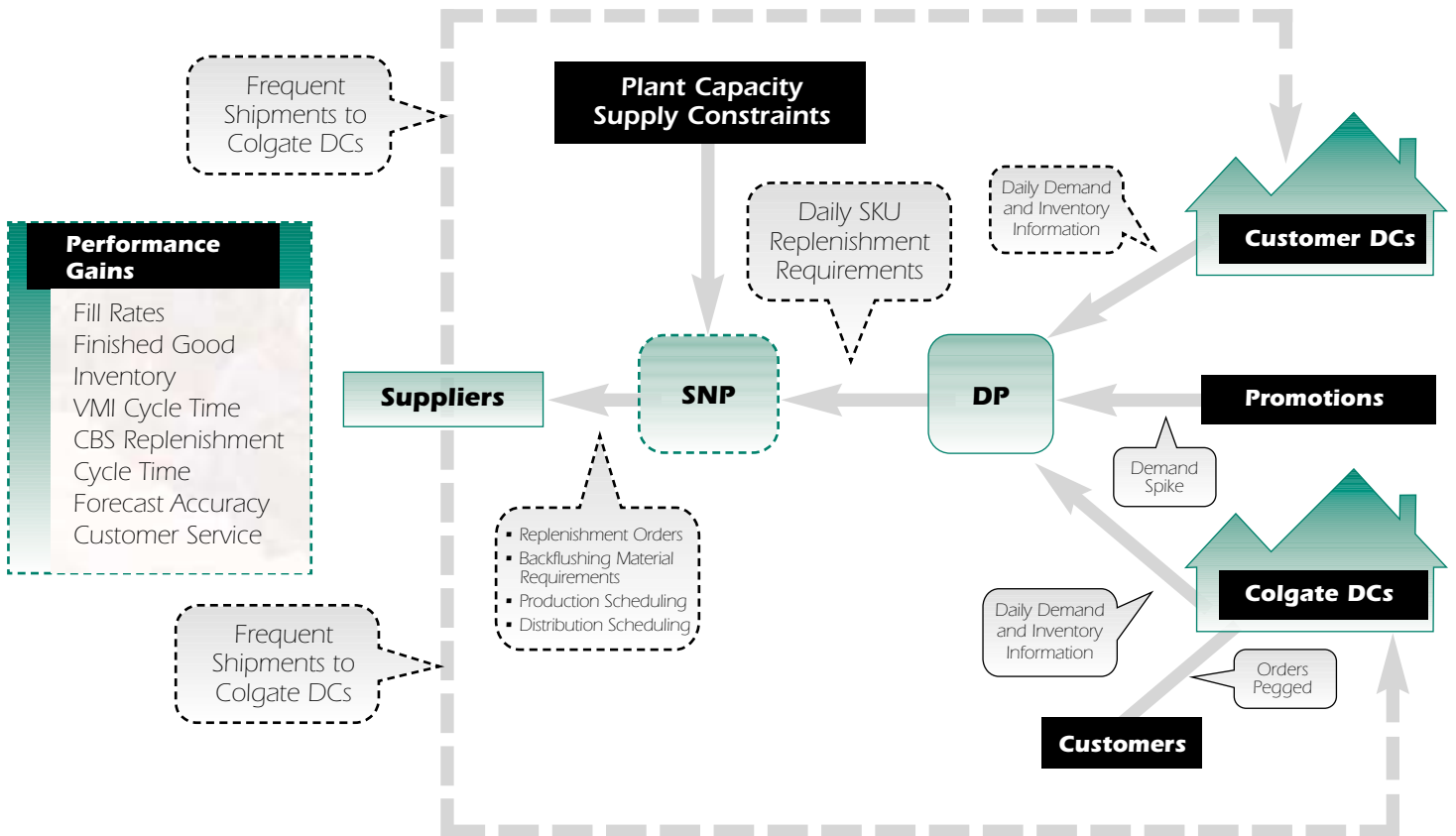


Figure 2. Adaptive Planning at Colgate-Palmolive

----- Physical Flows
 ----- Information Flows





IMPACTS OF ADAPTIVE PLANNING AND OPTIMIZATION

The case study illustrates the capabilities that have been deployed by Colgate-Palmolive to enhance demand planning, supply network optimization, and execution planning, and the coordination of these capabilities so that changes can be cascaded through the supply chain network.

Adaptive planning and optimization (APO) revises replenishment requirements on a near real-time basis based on current order and inventory information, and changes in anticipated demand. It optimizes supplier sourcing plans and execution plans to efficiently meet recalibrated replenishment requirements. Such proactive adaptation of plans yields efficiency gains with which materials and capacity are procured, staged, committed, and deployed across the supply chain network to achieve replenishment objectives.

APO improves the alignment of supply and demand, and provides the agility to achieve compressed time-to-market capabilities that enhance competitiveness of short lifecycle products. Recalibration of replenishment requirements, dynamic alignment of supply chain network resources, and adjustment of execution plans lower process and outcome variability. This reduces stock outs and stockpiles which in turn reduces lost sales and profits, and inventory carrying costs across the supply chain network. Increased capacity utilization and inventory turns, improved working capital efficiency and reduced material costs are other advantages that are realized.

APO also accelerates the supply chain network's asset conversion velocity and yields improvements in end-to-end cycle time measures, such as cash-to-cash cycle time and the quote-to-cash cycle time. Poster child companies such as Dell have achieved negative cash conversion cycles and continue to compress their quote-to-cash conversion cycle. These measures capture the efficiency with which supply chain network resources are aligned, adjusted, and deployed to meet predictable and unpredictable replenishment requirements.





BUSINESS STRATEGY FOR ADAPTIVE PLANNING AND OPTIMIZATION IMPLEMENTATION

Implementing adaptive planning and optimization requires a shift in overall business strategy. The key points underlying this shift in strategy are:

- **Develop an end-to-end strategy that encompasses the planning spectrum.**

To achieve the full potential of APO, an integrated perspective must be applied to the demand planning, supply network optimization, and execution planning processes. Their interdependencies must be effectively managed so that an efficient and timely response is generated to changes. The integrated planning process enables strategic, tactical and operational improvisation of a company's resources in response to changes in demand and supply, and to exception conditions.

- **Build a shared vision of adaptive planning with key suppliers and customers.**

Network externalities are critical to the success of adaptive planning and will be realized with increased participation from members of the supplier and customer base. Suppliers and customers must share an unambiguous vision of how adaptive planning creates value both for the supply chain network and themselves.

- **Align governance systems with adaptive planning.**

In a centralized planning approach, supply chain network planning is company-specific, and limited information is shared to coordinate supply chain execution across companies. Bureaucratic control that characterizes centralized planning results in information fiefdoms, entrenched decisional structures, and power regimes within and across companies. Adaptive planning requires a transition from hierarchical and bureaucratic structures of centralized planning to federated

and collaborative structures. Strategy should proactively manage distribution of power, information sharing across companies, and inter-firm collaborative decision-making. Governance systems that support such deep collaboration require trust-building and relational commitment of partners to preempt short-term focused opportunistic behavior.

- **Implement an outward and responsive integrated IT infrastructure.**

Traditionally, IT infrastructure implementation has focused on internal information processing with little or no connectivity established between the company and its partners. Such systems are inadequate for global optimization. IT infrastructures must enhance connectivity, visibility, and planning collaboration across the supply chain network.

- **Establish value metrics for supply chain network planning.**

Traditional measures used with advanced planning systems are focused on functional optimization. The value of adaptive planning and optimization can be captured by using inventory efficiency measures such as inventory carrying costs and inventory turns, asset utilization measures such as capacity utilization, and end-to-end velocity-focused measures such as quote-to-cash cycle time and cash-to-cash cycle time. A benchmarking system that tracks the impacts of adaptive planning and optimization solutions must be established.

Implementing Adaptive Planning

- Develop an end-to-end planning strategy
- Build a shared vision for global optimization
- Align governance systems
- Implement IT for connectivity, visibility, and collaboration
- Establish value metrics





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