A&D Edge

Supply chain management in aerospace and defense

February 2018
Why is supply chain management important for A&D?

A supply chain is at the heart of any aerospace and defense (A&D) organization’s success. Effective and efficient supply chains enable A&D organizations to meet their strategic and financial goals.

The A&D supply chain is a complex ecosystem of different tiers of suppliers; original equipment manufacturers (OEMs); maintenance, repair and overhaul (MRO) providers; and customers including airliners and armed forces. With customers from across the globe, the supply chains of major A&D players are also very much global and diversified in nature. Not only do companies need to deal with suppliers and customers across different geographies, they also need to deal with an entire ecosystem of data, created by the digital disruption in the industry. Using supply chain data effectively and protecting it against cybercrimes are imperative for successful A&D players.

This document looks at the challenges A&D companies face in managing the ever-evolving supply chain and discusses the strategies that they can adopt to address their supply chain challenges. It also envisions how the key elements of the A&D supply chain – customers, suppliers, shop floors and businesses – will look like in the future.

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<table>
<thead>
<tr>
<th>Key supply chain considerations and challenges for different functions of an A&amp;D organization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design and engineering</strong></td>
</tr>
<tr>
<td>• Timeline</td>
</tr>
<tr>
<td>• Cost</td>
</tr>
<tr>
<td>• Quality</td>
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<tr>
<td>• Margin</td>
</tr>
<tr>
<td>• Intellectual property</td>
</tr>
<tr>
<td>• Efficiency</td>
</tr>
<tr>
<td><strong>Planning</strong></td>
</tr>
<tr>
<td>• Forecast accuracy</td>
</tr>
<tr>
<td>• Supply disruption</td>
</tr>
<tr>
<td>• Demand shift</td>
</tr>
<tr>
<td>• Inventory</td>
</tr>
<tr>
<td>• Supply chain visibility</td>
</tr>
<tr>
<td>• Lead times</td>
</tr>
<tr>
<td><strong>Procurement</strong></td>
</tr>
<tr>
<td>• Supplier performance</td>
</tr>
<tr>
<td>• Price volatility</td>
</tr>
<tr>
<td>• Cost and prices</td>
</tr>
<tr>
<td>• Lead times</td>
</tr>
<tr>
<td>• Supplier due diligence</td>
</tr>
<tr>
<td><strong>Manufacturing</strong></td>
</tr>
<tr>
<td>• Quality</td>
</tr>
<tr>
<td>• Stock-outs</td>
</tr>
<tr>
<td>• Waste</td>
</tr>
<tr>
<td>• Capacity</td>
</tr>
<tr>
<td>• Cost</td>
</tr>
<tr>
<td>• Contract</td>
</tr>
<tr>
<td>• Safety</td>
</tr>
<tr>
<td><strong>Aftermarket</strong></td>
</tr>
<tr>
<td>• Ground time</td>
</tr>
<tr>
<td>• On-time delivery</td>
</tr>
<tr>
<td>• Network</td>
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<tr>
<td>• Safety</td>
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**Key challenges**

- Dependence on a large number of sole-source suppliers
- Long lead time
- Financial challenges across the supply chain for new A&D programs
  - Large inventory for commercial aerospace and diversified A&D
  - Management of collaboration across a complex supply chain
- Cyber threats
Supply chain challenges in A&D

Dependence on a large number of sole-source suppliers

A&D companies follow sole-sourcing arrangements for different parts and subassemblies, such as composite components, wing skins, seat track assemblies and aircraft engines, which are business-critical and niche in nature. Depending on a trusted sole-source supplier has its advantages in terms of ensuring quality, minimizing risk downtime, leveraging the brand value of a renowned supplier, fostering trust and optimizing cost. However, when a supply delay or quality issue occurs at the end of the sole-source supplier, it poses a greater risk in terms of production halt, delayed delivery and cost overrun.

A European aircraft OEM and its US-based engine supplier had to incur significant expenses toward payout to an Indian airline on account of the delayed delivery of a critical part of the airline’s narrow-body aircraft fleet. The OEM also foresees delivery delays in its new generation aircraft program due to a slowdown in production. The slowdown can largely be attributed to issues with the engines supplied by a US-based engine supplier, which is a sole supplier of engines for a significant share of the OEM’s order backlog.

Financial challenges across the supply chain for new A&D programs

To support the huge capital requirements for new A&D programs, OEMs partner with their suppliers where the latter co-fund the programs in exchange for access to long-term production contracts. Development costs are recouped on volume production. However, participation in such programs leads to reduced margins for the suppliers in the short to medium term.

Additionally, operational disruptions affect the liquidity available for suppliers, leading to misalignment of their capital structure. Such financial challenges can also flow down the supply chain and affect the OEMs. As a last resort, in some cases, OEMs are forced to be the lender, so that the supply chain continues to meet delivery contracts with the end customers. Given the lengthy lead times and the requalification efforts required, the problem becomes even more magnified with fewer options available to address the issue in the short term.

Long lead time

The lead time in A&D manufacturing, especially for aircraft and warships, is longer compared with that of other industries. From the time when an aircraft part is manufactured at a tier-3 supplier level to when it becomes part of the final aircraft and is delivered to the customer, it can take up to a few months to pass through different stages of the supply chain. Furthermore, the designing of a new aircraft model can take up to five years. As a result of longer lead time, A&D companies have to carry large levels of inventory and are exposed to an increased risk of supply shortage.

A&D companies depend on their supplier network to meet the delivery schedule of the products and services. As a result, disruption at any part of the supply chain might lead to a cascading effect on the entire supply chain. Supply disruptions and subsequent delivery failures can lead to severe consequences including imposition of penalties, cost overruns and order cancellations.
A&D players, especially commercial aerospace players and diversified A&D companies, have to maintain high inventory levels due to the long-cycle nature of the business. On an average, the inventory days for commercial aerospace players remained more than six times greater than that of defense primes in 2017, while the inventory days for diversified A&D players remained over three times higher than that of defense primes. However, the average inventory days for defense primes grew at 11% annually during 2015-17.

<table>
<thead>
<tr>
<th>Category</th>
<th>Average Inventory Days (2017)</th>
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<tbody>
<tr>
<td>Commercial aerospace players</td>
<td>188</td>
</tr>
<tr>
<td>Diversified A&amp;D companies</td>
<td>106</td>
</tr>
<tr>
<td>Defense primes</td>
<td>31</td>
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</tbody>
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Source: CapitalIQ, EY Analysis

¹Average of top five players by revenue under each category

It becomes difficult for A&D players to swiftly respond to market changes due to the high level of inventory in the supply chain pipeline. Furthermore, maintaining such high inventory levels also means a huge amount of working capital getting stuck on the factory floor.

Collaboration across all parts of the complex supply chain is crucial in order to ensure efficient and effective operations. Smooth information flow across the supply chain facilitates transparency of transactions and enables players at each stage of the supply chain to respond to changes in any other part of the network. This contributes to the agility of the overall supply chain.

As companies increasingly integrate their supply chain network, different parts of the supply chain become well-connected with one another. As a result, disruption in any part of the supply chain might lead to a cascading effect on the entire supply chain.

A leading commercial aircraft manufacturer adopted a strategy to outsource a portion of its supply chain for a wide-body program. However, limited control on the supply chain led to quality issues. Poor quality of components sourced from subcontractors led to a number of electrical system flaws on the aircraft, resulting in several airlines across the globe grounding the aircraft.

A&D players routinely exchange confidential data on product specifications, technology and performance of equipment or services with the objective of enhancing collaboration across all parts of the supply chain.

As major A&D companies increasingly implement integrated supply chain management platforms to better manage their supplier network, any data theft or cyber-attack on any part of the platform can potentially cause a threat to the entire supply chain network, creating a multiplier effect.

Furthermore, A&D companies possess vast proprietary data that could benefit a hostile country's military and commercial capabilities. Such data can be quickly monetized and, hence, A&D programs have consistently been targeted by cybercriminals. Cyber terrorists can share proprietary data with unethical customers, who use stolen data to forge products and undercut prices to outperform competition.

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A&D supply chain management strategies

Leading A&D players are undertaking a number of initiatives to overcome the challenges they face while managing their complex supply chain network. Effective supply chain strategies not only help companies improve efficiency, control costs and mitigate risks, but also enable them to deliver value to the customers. The following table lists down some of the key supply chain strategies adopted by leading A&D players to address their major supply chain challenges. Long lead time and management of collaboration across a complex supply chain emerge as the most important issues to be addressed. In response to the wide number of challenges, adoption of digital technologies, vertical integration and localization seem to be the most relevant strategies adopted by A&D companies.

<table>
<thead>
<tr>
<th>Major challenges</th>
<th>Key strategies</th>
<th>Dependence on sole-source suppliers</th>
<th>Long lead time</th>
<th>Financial challenges</th>
<th>Large inventory</th>
<th>Management of collaboration across the supply chain</th>
<th>Cyber threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependence on sole-source suppliers</td>
<td>Adoption of digital technologies</td>
<td>Low importance</td>
<td>High importance</td>
<td>Low importance</td>
<td>Low importance</td>
<td>Moderate importance</td>
<td>Low importance</td>
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<tr>
<td>Long lead time</td>
<td>Risk-sharing partnerships</td>
<td>Moderate importance</td>
<td>Low importance</td>
<td>High importance</td>
<td>High importance</td>
<td>Moderate importance</td>
<td>Moderate importance</td>
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<tr>
<td>Financial challenges</td>
<td>Vertical integration</td>
<td>Low importance</td>
<td>Moderate importance</td>
<td>High importance</td>
<td>Low importance</td>
<td>Moderate importance</td>
<td>High importance</td>
</tr>
<tr>
<td>Large inventory</td>
<td>Monitoring of the network security of suppliers</td>
<td>Low importance</td>
<td>Moderate importance</td>
<td>High importance</td>
<td>Low importance</td>
<td>Moderate importance</td>
<td>High importance</td>
</tr>
<tr>
<td>Management of collaboration across the supply chain</td>
<td>Shared supply chain across common platforms</td>
<td>Low importance</td>
<td>Moderate importance</td>
<td>High importance</td>
<td>Low importance</td>
<td>Moderate importance</td>
<td>High importance</td>
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<tr>
<td>Cyber threats</td>
<td>Multiple sourcing</td>
<td>Low importance</td>
<td>Moderate importance</td>
<td>High importance</td>
<td>Low importance</td>
<td>Moderate importance</td>
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<td>Sales and operations planning and manufacturing readiness assessment</td>
<td>Inclusion of local players in the global supply network</td>
<td>Moderate importance</td>
<td>High importance</td>
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Legend:
- **High importance**
- **Moderate importance**
- **Low importance**
Adoption of digital technologies

Digital technologies and new business models are disrupting the aerospace supply chain. While connected devices and sensors together optimize operations of various functional units, common data platforms for information sharing and adoption of 3D printing technology have increased the overall efficiency of the supply chain. Digitally driven new operational models such as joint innovation centers and flexible production sites are further driving evolution of the aerospace ecosystem.

On one hand, advanced analytics and cloud technology enable tier 2 and 3 suppliers to act efficiently and connect with tier 1 suppliers to optimize the supply chain. On the other hand, 3D printing helps aerospace suppliers in rapid prototyping, facilitating innovation and responding to dynamic market demands in real time. 3D printed parts and fixtures are produced with minimal material wastage and are lighter in weight, enabling overall cost savings. Furthermore, the internet of things (IoT) is enabling collection and analysis of vast amount of operational data from shop floor assets and critical components. This data is analyzed and leveraged to track and predict maintenance needs of critical assets on the shop floor and prevent unscheduled maintenance stoppages.

Monitoring and analysis of products and their components can be used to improve productivity and reliability.

A leading aircraft engine manufacturer is using 3D-printed fuel nozzles for one of its next-generation engines. As a result, the number of parts needed to make the nozzle has come down from 20 to 1, leading to a much shorter supply chain for fuel nozzle manufacturing.

Other major digital technologies, such as artificial intelligence, blockchain, augmented reality and social media analytics, also find applications in different stages of the A&D supply chain.

Such digital technologies not only help the companies address their business challenges, but also open up numerous opportunities for them to become increasingly efficient and effective.

A US-based defense manufacturer incorporates blockchain technology into its developmental processes, enabling more efficient and assured offerings. The company uses the blockchain infrastructure to improve the efficiency and security of its software platforms and supply chain, enhance data integrity, increase speed of problem discovery and mitigation, and reduce risks.
“Some years back, OEMs chose to outsource a significant portion of their work to the global supply chain rather than doing all the work internally, the way it was being done historically. This trend is now reversing and the pendulum is swinging back the other way. The OEMs are looking for more control over the manufacturing process to better control quality and more importantly, to improve their financial metrics. They have been increasingly leaning on their supply chains in an effort to improve their own margins. As such, the supply chain is under an increasing pressure as vertical supply chain integration of these OEMs takes hold. While suppliers have navigated the challenges of highly concentrated customers with OEMs for years, recent activities suggest the pressure is about to ramp up significantly.

Our Investment Banking Group provides sector-specific advice on M&A, debt capital markets, equity capital markets and capital restructuring transactions. Our investment banking professionals are focused on the middle-market and bring deep industry knowledge to each transaction.”

— Hisham Barghout, A&D Investment Banking Leader, US

**Risk-sharing partnerships**

Leading companies engage in collaborative agreements through which development and production are executed by a risk-and-revenue-sharing arrangement between the OEMs and its suppliers. Such arrangements are not only limited to production and manufacturing stages, but also include aftermarket activities.

Risk-and-revenue-sharing partnerships provide OEMs the opportunity to distribute risk across the supply chain and reduce cost. On the other hand, despite a higher risk exposure, tier 1 or tier 2 companies engage in such arrangements in order to have a broader portfolio of contracts and gain a share in the revenue generated by the overall program. Risk-and-revenue-sharing partnerships help them maintain technical rights over their supplies and allow them to incorporate the newly developed technologies into similar products to be sold to other OEMs.

A European engine manufacturer entered into a risk-and-revenue-sharing partnership with two Japanese suppliers for the supply of intermediate pressure compressor (IPC) modules, components for combustion modules and all stage low-pressure turbine (LPT) blades to support the production of a new engine.

**Vertical integration**

A&D players adopt vertical integration to gain control over critical processes in the supply chain. Vertical integration helps companies in reducing their operating costs by eliminating supplier margin. It also provides them with the agility to swiftly respond to changes in product specifications as well as market demand, reducing the effective cost and time impact of the changes.

Leading players are focusing on bringing back some of their outsourced business processes in-house. They are investing in new production facilities for manufacturing the previously outsourced components.

Through vertical integration, A&D companies are aiming to capture additional margins from tier 1 and tier 2 supply stages. OEMs are also providing post-sale MRO services to their customers to get benefits from the high-margin aftermarket business.

A leading commercial aircraft manufacturer adopted the strategy by establishing a new avionics and electronics unit to insource key technology and reduce costs. The company also aims to pursue more vertical integration of its aircraft manufacturing business by stepping up its capabilities in advanced materials, propulsion systems and actuators.
Monitoring of the network security of suppliers

Given that all parts of the A&D supply chain are vulnerable to cyber attacks, large A&D players not only focus on building a robust cybersecurity framework for their own systems and networks, but also ensure that their key suppliers are protected from cyber risks.

Unless the suppliers understand the importance of protecting sensitive information and the consequences of breaches, it is impossible for companies to operate in an environment of trust. Leading A&D companies as well as government customers are working with their suppliers to understand their cybersecurity policies and help them develop their cybersecurity strategies.

A leading OEM initiates its supply chain cybersecurity risk management right from the contract negotiation processes. The company's information security team collaborates with the procurement team to develop the contract requirements and expectations of the supplier base. It also expects its suppliers to pass down the security requirements to sub-tier suppliers. The OEM also uses a cloud platform to continuously monitor, measure and mitigate cybersecurity risk throughout its multi-tier supply chain.

Shared supply chain across common platforms

To leverage maximum possible advantages of the existing supplier base and control costs, A&D players are using a shared supply chain for different platforms. Diversified A&D companies also leverage a common supply chain across similar platforms with applications in different industries. OEMs are using cloud-based supply chain management programs, having a list of all the suppliers that can be leveraged for various common products and materials.

Not only at the company level, the sharing is now at an industry level, where the leading players are collaborating to have a shared platform to manage a supply chain. Such partnerships are seen among the leading players in the North American and European regions. Shared supply chains have resulted in cost efficiencies, operational effectiveness and economic convenience.

Five leading European aerospace manufacturers have collaboratively established an online supply chain hub. These companies have decided to follow their US rivals in launching an electronic platform for managing their supply chain and supplier network. Hosted in the cloud by the supply chain hub, this allows the suppliers to work with all the five establishing partners through a single online portal.
Building an alternative supplier network through multiple sourcing

Leading A&D players have started looking beyond sole-supplier arrangements to dual and multiple sourcing options. Under these arrangements, companies sign contracts with two or more suppliers for the supply of the same material, equipment or part. For instance, OEMs are offering multiple engine options, especially on commercial aircraft, primarily to mitigate supply chain risk.

Multiple sourcing options minimize the risk of supply disruptions by many folds. In case of failure of one supplier to deliver quality supply in due time, the OEMs or their tier 1 suppliers have the option to switch to an alternative supplier network for the supply of critical parts.

In addition to mitigating the supply disruption risks, such arrangements also help in capacity expansion and reducing the risk of failure during product development in the test phase. Theoretically, sole-sourcing helps in achieving economies of scale; however, dual or multiple sourcing increases price competition by increasing the number of suppliers in the long run.

A leading US-based aircraft engine manufacturer has increased multiple contracts (dual and triple) with different suppliers for the supply of aircraft engine nacelle and power system components.

Sales and operations planning and manufacturing readiness assessment

Operating through different business units with a footprint in diverse geographies, A&D companies need to enable their operating units to make faster, better-informed decisions through a unified data modeling solution that incorporates demand, supply and financial data at multiple levels of granularity and dimensions. It is imperative for companies to enable an integrated planning process across different markets having non-uniform processes and IT architecture.

A&D companies are implementing sales and operations planning (S&OP) tools, covering product management review, demand review, supply review, integration, reconciliation and management business review to ensure mid-to long-term demand, supply and financial integration at market level as well as at a global level.

Furthermore, as companies operate in an increasingly competitive environment, they need to ensure their ability to meet delivery schedules and cost targets for key programs. In addition, to support ramp-up programs, it is important to consistently plan how costs and schedules vary at each stage of manufacturing.

Procurement and spend analytics have a huge role in demand assessment. Real-time dashboard management and highly skilled category management are required to ensure that supply meets demand. Companies are also implementing manufacturing readiness assessment programs and tools to make decisions earlier in the life cycle and integrate manufacturing considerations throughout each phase of the life cycle. These programs also allow companies to anticipate risks at an earlier stage and take actions predictively.
Inclusion of local players in the global supply network

A&D players partner with local players in foreign markets as their key suppliers. In some cases, A&D majors make the local players an integral part of their global supply chain.

On the defense side, a primary driver of such an association is the offset obligation on the foreign players that sell equipment to the governments of different countries, especially in emerging economies. Under the offset obligations, the foreign players must plough back a portion of the government sales contract value into the local industry. Working with local suppliers helps them discharge the obligation efficiently in the system.

Another main factor for partnering with local suppliers is cost efficiency, driven by suppliers from low-cost countries that have reasonable technological capabilities. Emerging countries, including China and India, are expected to produce a number of tier 1 and tier 2 suppliers in the coming decades while the demand from these countries is likely to grow, driven by increasing specialization in design, manufacturing and assembly of A&D products. Suppliers from these countries, for instance, now manufacture structural components for all leading OEMs. They also provide engineering services to many industry players and produce smaller aircraft parts and component wings, exit doors, landing gear boxes and passenger doors for global manufacturers.

A leading US-based OEM has selected an Indian conglomerate as the exclusive supplier for the fuselage of an attack helicopter program. The Indian player has established a manufacturing facility in the country with an aim to sole-supply fuselages for the helicopter program globally.

Digital disruptions and strategies of A&D companies for “being digital” are leading to an evolution of the A&D supply chain.

Invest in adoption of digital technologies at all stages of the value chain

- Form JVs and partnerships with local players in emerging markets
- Use data analytics to understand customer preferences
- Leverage data captured through sensors for predictive maintenance
- Build infrastructure for real-time information sharing across the value chain
Future of the A&D supply chain

The infographic below highlights how the key participants of the A&D supply chain – customers, suppliers, shop floors and the core businesses – will work in the future. While the entire ecosystem will be supported by enterprise cloud, blockchain platforms will have a crucial role in ensuring the transparency and safety of the large number of transactions in the supply chain.

Key elements of the A&D supply chain of the future

Supported by enterprise cloud

**Customers of the future**

1. Smart data from passengers for enhancing flight experience
2. Data sharing with governments to enable data-driven defense strategies
3. Automated procurement planning

**Suppliers of the future**

1. Automated and integrated system for order placement and tracking
2. Real-time in-transit tracking and product monitoring
3. Data sharing for rapid supply chain configuration
4. Risk-and-revenue-sharing agreements
5. Sharing talent management responsibility with key suppliers

**Shop floor of the future**

1. Simulation enabled by artificial intelligence
2. Collaborative R&D and testing with customers
3. 3D printing of large subassemblies
4. Automated inventory management
5. Smart factories supporting higher customization

**Triggers for evolution of the A&D supply chain**

1. Enhancing customer experience and involvement
2. Redefining products and services
3. Digitalizing business based on customer value
4. Developing workforce of the future
5. Building a value chain ecosystem

**A&D business of the future**

1. Integrated systems - Sensors for predictive maintenance
2. Smart products and services - Remote systems control aircrafts and defense equipment
3. Smart procurement - Automated ordering
4. Workforce of the future - Mobile talent pool, freelancing R&D personnel, shared workforce
5. Smart logistics - Real-time visibility, global tracking, condition monitoring

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The A&D business of the future would be driven by smart customers. As customers become more and more technologically sound, businesses need to look beyond traditional products and service offerings. Availability of in-flight data, real-time weather information and battlefield information will enable A&D players to offer a wide range of value-added and on-demand services to both commercial and defense customers.

Smart factories of the future A&D businesses would be supported by digitalized demand sensing, smart procurement and smart logistics. On the digital shop floor, digital technologies such as IoT, 3D printing, artificial intelligence, sensors and robotics will take a central stage.

On the other hand, the workforce of the future would not only need to strike a balance between technical capabilities and engineering knowledge, but it would also be imperative to constantly upgrade the skills of the workforce to excel in the era of continuous technological evolution. Digitalization will also be at the core of innovation and development programs, leading to smart products and services to support the future of warfare.

The smart A&D businesses would be supported by the suppliers of the future, who would be equipped with real-time information sharing platforms so as to ensure an uninterrupted supply for critical parts in real time and with minimal waste. The relationship between OEMs and their suppliers would go beyond buyer-supplier relationship to "being a part of the business," giving rise to a new range of risk-and-revenue-sharing business models.
Supply chain transformation for a diversified A&D manufacturer

The challenge

- A US-based aircraft parts manufacturer, also involved in manufacturing of residential and commercial climate-control equipment, was struggling with gauging demand across the supply chain, which led to production delays and, ultimately, impacted their market share. The client also faced product mix challenges due to a slow response to changes in market demands. This represented an overall lack of visibility to distributor sales in the planning process.

What we did

- Assisted in the creation of a road map for a supply chain transformation, initiated through upgrading the client’s demand planning process
- Proposed a demand-planning enterprise resource planning (ERP) module as the first stage of the larger, comprehensive supply chain ERP solution, with an innovative implementation style to quickly get hands-on feedback from users
- Developed a standardized, company-wide planning process and a method to assess the results by easily measuring and tracking the accuracy of its forecasts
- Delivered the project within the client’s offices and conducted frequent working sessions to demonstrate prototypes and new functionality

Value delivered

- The company could minimize obsolescence in the distributors’ inventory. They were able to reduce “stock-outs” at distributors by maintaining steady product supply through accurate demand forecasts.
- They were also able to increase their revenues by winning more large contracts through dependable component product supply.

Developing an optimized supply chain model for a French defense player

The challenge

- The client needed assistance in designing an optimized supply chain model after having conducted several studies on the subject. It faced challenges related to project management, project communication and data reliability across its supply chain. It also wanted to audit, design and test its supply chain management processes under different environments.

What we did

- Conducted diagnostic analysis on the supply chain management and the physical supply chain, including production logistics, procurement logistics and logistics backup
- Designed the target model for the entire supply chain
- Assisted in adding further level of details in the target models, taking into account the specificities of different military environments

Value delivered

- The client was able to design and implement an optimized supply chain model.
- They could design frameworks for gathering skills in supply chain and applying data analytics in supply chain management and risk mitigation related to the defense supply chain.
### Designing supply chain strategy for an Indian industrial products manufacturer

**The challenge**
- A large Indian diversified industrial products player was involved in the manufacturing and distribution of a wide range of products to thousands of dealers, besides direct supply to OEM customers. Planning and logistics were being handled independently by the different divisions of the company. The company’s forecast accuracy was poor, and they did not have sufficiently granular metrics to monitor demand and supply performance.

**What we did**
- Designed alternative distribution networks and logistics cost reduction opportunities for all consumer product divisions based on demand aggregation and a hub-and-spoke supply chain model
- Planned processes to align different functions and product groups using revised design parameters, metrics and planning calendars
- Designed an inventory management process to improve product availability and synchronize supply with demand
- Proposed multiple organization structure options for supply chain across business units and geographic regions

**Value delivered**
- The client was able to reduce its lost sales opportunities to the extent of around 10% of turnover.
- They were also able to reduce their overall logistics costs by approximately 20% through inventory consolidation, network redesign, consolidation of movements, better truck utilization and freight rate negotiation.

### Supply chain network redesign for a leading wind turbine manufacturer

**The challenge**
- A wind turbine manufacturer, which was also involved in the maintenance and repair services for turbines, had to support service material availability in the markets, due to a market change toward larger customers providing their own services. The company’s existing supply chain network did not provide the right materials in the right place and quantity, slowing the service process down. Furthermore, long downtimes led to penalties that the company had to pay back to its clients.

**What we did**
- Helped in the creation of a network design that comprised the installed base of several thousands of machines, regional warehouses and several hundreds service stores and services cars
- Assisted in identification of warehouse sites for emergency hubs, sizing the hubs based on a defined assortment, calculation of stock levels and replenishment rules, and developing a fast response transportation and service process
- Guided in successful implementation of one pilot emergency hub and definition of the rollout plan

**Value delivered**
- The client was able to reduce critical parts inventory by approximately 30%.
- Service time was significantly reduced from 24 hours to 2 hours.
- The client received the rollout concept for fast implementation of the future emergency hubs.
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