BUSINESS INTELLIGENCE FOR BIA – BIA 5401

CASE STUDY ANALYSIS – 1

Optimizing Supply Chain Efficiency:
A Case Study on Boeing's Dreamliner 787

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Group 8

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INTRODUCTION

Boeing, a global aerospace company has come under the media spotlight due to disparity between the manufacturing rate of Dreamliner 787 and that of industry expectations. This spotlight is due to a host of several concerning issues in the supply chain that have over time affected the aviation industry. The challenges that translate to maintaining strict quality control through enforcement of thorough inspection processes are vital to provide aircraft that have reliability and performance quality that meets Boeing's reputation. Indeed, the 787 Dreamliner is amongst the most technologically advanced planes currently in circulation and boasts remarkably low fuel consumption; it is thus fitting that this airplane remains a truly representative offering of Boeing. (Josephs, L. (2024, April 22), CNBC; The Boeing Company. (n.d.). 787 Dreamliners.)

The disruptions in supply chain around the world are more than simple shortages of materials due to countless reasons ranging from the Covid-19 restrictions to escalating geopolitical risks that have not only affected Boeing in terms of the availability of significant components but also forced the company to change manufacturing approaches. The complexity of supply chain in acquiring materials and parts from suppliers across the globe has brought changes to the current Production Schedules and Processes. (Josephs, L. (2024, April 22), CNBC)

Experts are in the belief that the time taken to build 787 Dreamliner would culminate in various repercussions on the financial books of Boeing. Due to early cancellation and postponement of deliveries for its aircraft, revenue recognition may also be affected and hence retain a negative impact on its cash flow. Also, the company may have higher costs since it pressures workers to work faster and try to obtain parts to ensure that the production schedule is met. Information obtained from the recent order suggests that there continues to be a strong market for advanced and fuel-efficient airplane which is exemplified in the 787 Dreamliner. This trend emphasizes the fact that existing manufacturing bottlenecks must be effectively managed by Boeing as soon as possible. Thus, the firm will have a chance to not only meet the needs and demands of contemporary consumers, but also to design new strategies that will help to expand a limited market area in terms of the Market Saturation. Overcoming these supply chain obstacles is not merely about sustaining manufacturing activity: it is high time for Boeing to keep on embracing its technological creativeness ensuring that it meets the constantly changing needs of aerospace customers around the world. (Josephs, L. (2024, April 22), CNBC)

EXECUTIVE SUMMARY

Since Boeing is going through a slower than expected rate of manufacturing for its commercial 787 Dreamliner because of insufficient supply of one of the parts used in making the aircraft that is bottleneck, it raises a concern of inefficient supply chain management faced by the company. This issue can be one of the adverse effects of Covid-19 epidemic and the geopolitical tensions going on between several countries all over the world (Josephs, L. (2024, April 22), CNBC; The Boeing Company. (n.d.). 787 Dreamliners.). A dataset has been captured from Kaggle which supports our case and depicts the company's historical data from 1958 regarding the orders and deliveries by various airlines and customers for certain aircrafts which is used to develop a predictive model which is helping in suggesting optimal solutions to curb the intensity of the inefficient supply chain management of the company. (Jalalian, S. (n.d.). Boeing airplane orders EDA (Exploratory Data Analysis), Kaggle)

To sum up, Boeing's experience with the 787 Dreamliner emphasizes the difficulties involved in producing contemporary aircraft and the vital significance of effective supply chain management. To continue leading the aerospace sector and satisfying the needs of its stakeholders and consumers, the firm must continue to work towards resolving these issues. Several optimized solutions have been discussed to reduce various kinds of supply chain inefficiencies that Boeing has in production of the Dreamliner 787 aircraft. The concept of improving demand forecasting improves the evaluation of the company's future orders by considering past orders and then inputting real-time information, which optimizes production and utilization of resources and time hence reducing or eradicating unproductive time. In this way, the firm might come out of its present problems and establish itself for further expansions as the aviation industry develops and the need for new airplanes increases.

Implementing these solutions collectively enhances efficiency, reduces costs, and improves responsiveness in Boeing's supply chain, ensuring better performance and reliability in delivering the Dreamliner 787 aircraft.

PROBLEM STATEMENT

Boeing has been the premier manufacturer of commercial jetliners for decades. However, the company is facing a serious misalignment between deliveries and orders for manufacturing airplanes resulting in significant delays and system inefficiencies affecting the company's market stand and operational stability.

Due to a massive helmet order backlog, Boeing has found it difficult to keep up with the number of incoming orders. Customers have been adversely affected by this mismatch due to protracted delays in the delivery of their orders. This has posed a challenge to Boeing in meeting the needs of the customers and solving the problems related to the organization’s planning results to financial issues.

The company suffers from severe supply chain delays that are impacting production. These obstacles might appear during any number of stages of the process, from obtaining raw materials to producing and assembling components. When vital supply chain elements cannot grow quickly enough, production delays are expected, making it harder to meet order requirements and lowering overall efficiency.

Additionally, Boeing's planning and forecasting methods vary significantly from market demand, they are lacking. This disparity could be caused by outdated forecasting techniques, insufficient data, or a lack of integration with current market trends. As a result, Boeing struggles to forecast fluctuations in demand, and adjust production schedules, leading to delays and client dissatisfaction.

Resource allocation is an additional problem the company is confronting because of the excessive pressure of growing order quantities placed on manufacturing resources including people, facilities, and equipment. In this case study, the difficulties faced by the company will be highlighted for better understanding and covering the key issues to be solved for the company’s growth and market brand.

INTRODUCTION TO THE DATASET

Country	Customer Name	Delivery Year	Engine	Model Series	Order Month	Order Year	Region	Delivery Total	Order Total	Unfilled Orders
Afghanistan	Ariana Afghan Airlines	1968	PW	727	Mar	1968	Central Asia	1	1	
Afghanistan	Ariana Afghan Airlines	1970	PW	727	Apr	1969	Central Asia	1	1	
Afghanistan	Ariana Afghan Airlines	1979	GE	DC-10	Sep	1978	Central Asia	1	1	
Afghanistan	Ariana Afghan Airlines		CF	737-700	Nov	2005	Central Asia	0	4	

The dataset that is used to tackle the supply chain inefficiency faced by Boeing represents detailed information of the orders and deliveries of Boeing's aircraft, which is also depicted in figure above. This data covers 9073 records of several years starting 1958 to 2022 and represents certain attributes that affect the supply chain dynamics and inefficiency of Boeing (Jalalian, S. (n.d.). Boeing airplane orders EDA, Kaggle). Information about the variables are as follows:

- Country: The country who placed the order for the aircraft.
- Customer Name: Name of the Airlines/Customer placing a particular order.
- Delivery Year: The year representing the delivery of the aircraft.
- Engine: The type of engine used in a particular aircraft ordered by the customer.
- Model Series: The model of the aircraft ordered by customer.
- Order Month: The month representing the placement of order for the aircraft.
- Order Year: The year representing the placement of order for the aircraft.
- Region: The geographical region to which the aircraft was delivered.
- Delivery Total: The total number of aircraft delivered in each period.
- Order Total: The total number of aircraft ordered in each period.
- Unfilled Orders: The number of orders that have not been fulfilled.

OPTIMIZATION SOLUTION

Based on the predictive model and the analysis of the delivery trends for the Dreamliner 787 aircraft, optimized solutions are hereby proposed to curb supply chain inefficiencies:

1. **Enhanced Demand Forecasting:** Boeing can know when to expect future orders to arrive for it, to project when to produce more of a certain product or when to increase the inventory. Analyzing past orders and integrating real-time data helps identify patterns and refine forecasts. This in turn enhances production planning to allocate manufacturing resources efficiently, minimizing downtime and maximizing productivity.

2. **Inventory Optimization:** Just-In-Time (JIT) system for Boeing's 787 Dreamliner can significantly mitigate supply chain inefficiencies. By ensuring that the raw materials arrive on time precisely when needed, JIT minimizes excess inventory; thus, cuts down the storage charges and improves the organizational cash flow. This results in improved resource utilization, reduced operating expenses, and better financial returns. Additionally, this approach leads to a more responsive and agile production system.
3. **Production Scheduling:** It uses sophisticated techniques of demand forecasting, which enables it to produce goods and services that the customer is likely to demand and not the other way around. Advanced Planning and Scheduling (APS) systems ensure that the production schedules are harmonized with resource availability including labor, equipment, and material hence ensuring that materials and components flow through the process with little interruption, thus increasing throughput. It also minimizes operation costs in the sense that it does not encourage unnecessary or uneconomical usage of resources. APS systems meet Boeing's issues with coordination and effectiveness within its international supply chain.
4. **End-to-end Supply Chain Visibility:** This involves integrating data from various sources into a centralized platform that allows real-time tracking of component movements, monitoring of quality control, and detection of the areas of congestion in specific parts or stages of production. By strengthening relationships with overseas suppliers and ensuring that Boeing has open lines of report, it can effectively address problems, avoid disruption, and enhance cooperation.

Implementation Steps

```
# Prepare features and target variable
features_dreamliner = valid_months_dreamliner[['Order Year', 'Order Month', 'Order Total']]
target_dreamliner = valid_months_dreamliner['Delivery Total']

# Train-test split
X_train_dreamliner, X_test_dreamliner, y_train_dreamliner, y_test_dreamliner = train_test_split(
    features_dreamliner, target_dreamliner, test_size=0.2, random_state=42)

# Model training
model_dreamliner = RandomForestRegressor(n_estimators=100, random_state=42)
model_dreamliner.fit(X_train_dreamliner, y_train_dreamliner)

# Predictions
y_pred_dreamliner = model_dreamliner.predict(X_test_dreamliner)

# Evaluation
mse_dreamliner = mean_squared_error(y_test_dreamliner, y_pred_dreamliner)

# Display the first few predictions
predictions_dreamliner = pd.DataFrame({'Actual': y_test_dreamliner, 'Predicted': y_pred_dreamliner})
mse_dreamliner, predictions_dreamliner.head()
```

Integrating the predictive model into Boeing's existing supply chain management system can provide a robust solution to inefficiencies in the 787 Dreamliner production. The model uses Linear Regression and Random Forest Regression to forecast demand and delivery schedules accurately. The Python code for the model is shown hereby.

The use of the predictive model enables Boeing to get real-time information about the supply chain hence have a chance to fix some problems before they cause major problems with the supply chain. The measures of visibility and forecasting improve the production system to be more sensitive to market conditions and supply chain interruptions and make the necessary changes quickly.

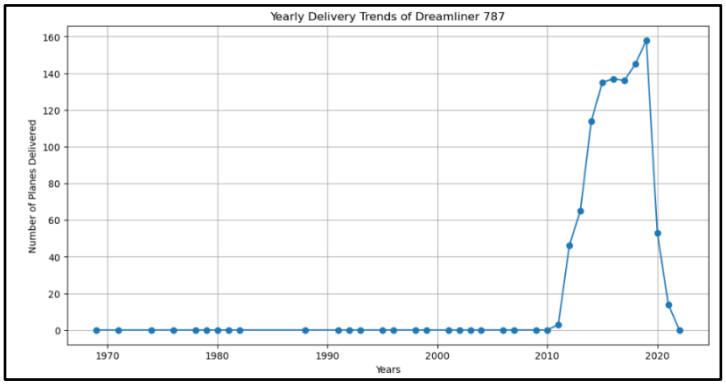

Fig 1.1 - Yearly Delivery Trends of Dreamliner 787

The above Fig. 1.1 is a line graph that displays the number of Dreamliners delivered annually from around 1970 to 2020 and is labeled "Yearly Delivery Trends of Dreamliner 787." The graph shows that until just after 2010, there was a dramatic increase in deliveries, which peaked at around 140 planes delivered around 2015. This pattern points to a sharp increase in production or acquisition in a brief amount of time.

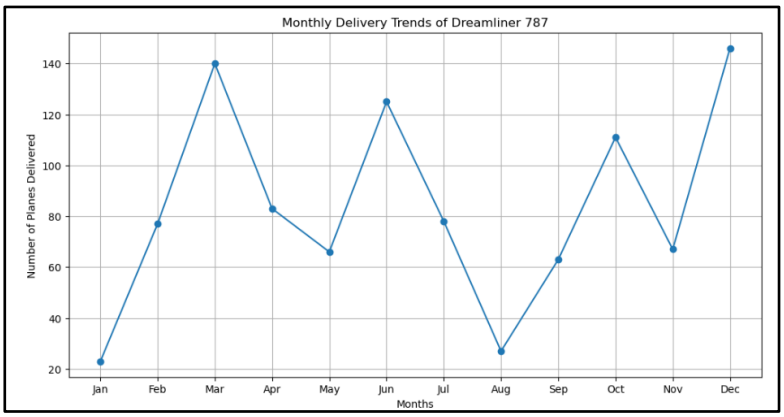

Fig 1.2 - Monthly Delivery Trends of Dreamliner 787

The line chart in the above figure discussed as “Monthly Delivery Trends of Dreamliner 787” indicates the delivery of several Boeing 789 Dreamliners per month. The chart also shows tremendous changes every month, with an all-time high of approximately 140 deliveries in

March and December, suggesting the company has high production and delivery rates. However, there is a significant decline in August where deliveries are at almost zero.

DEMO

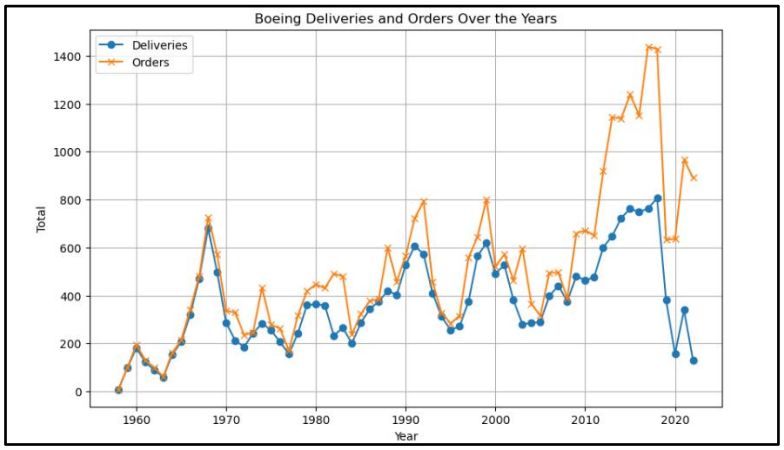

Fig 1.4- Boeing deliveries and orders over the years

The above image presents data on Boeing deliveries and orders from 1960 to 2020. The chart illustrates the annual figures for both deliveries and orders over this period. Notably, there has been a significant demand for Boeing products since the early 2000s. However, the number of deliveries has consistently lagged the number of orders, indicating that the company has struggled to meet the demand for its products.

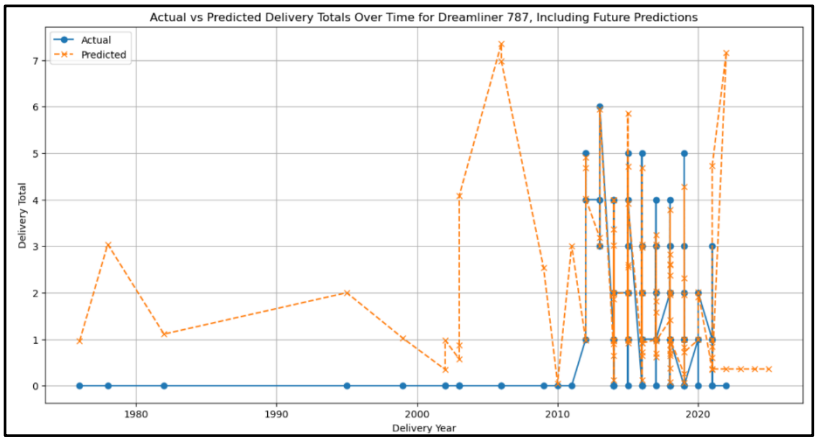

Fig 1.5- Actual vs Predicted delivery totals over time (including future predictions)

The above figure presents delivery over the years including the future predictions from 1958 to 2020 by a line plot that compares the actual and predicted delivery totals over time for the Dreamliner 787. This visualization makes it easier to know how effectively the model predicts future deliveries and captures patterns over several delivery years.

BENEFITS

1. **Enhanced Demand Forecasting**

- Improved Production Planning: When the demand rates are accurately forecasted, then Boeing will be able to schedule the production period of the planes well in advance hence do away with many of the manufacturing hitches, keep off manufacturing idle time, and thus improve productivity.
- Cost Reduction: This results in improved inventory forecasting, minimizing chances of over or understocking of products, thereby minimizing the amount of cash to be invested in storage.
- Customer Satisfaction: If customers' needs are identified and fulfilled better and faster, this results in greater customer satisfaction levels and increased loyalty.
- Competitive Advantage: Reducing variability in demand forecasting may offer some competitive advantage in a business since it will allow Boeing to react to changes in demand and to competitors' actions in a shorter period.

2. **Inventory Optimization (Just-In-Time System)**

- Reduced Inventory Costs: Through JIT acquisition, Boeing will reduce inventories and, in the process, cut expenses incurred in storage and the capital trapped in inventory.
- Improved Cash Flow: Lower inventory translates to reduced inventory holding costs; consequently, the company's cash flow will be better, enabling the company to channel resources to other areas.
- Enhanced Resource Utilization: To summarize, managing inventories is to use available resources more efficiently and minimize wastage.
- Agility and Responsiveness: JIT usually ensures that the production cycle is sensitive to changes in the market, and this is a benefit for Boeing.

3. **Production Scheduling**

- Increased Efficiency: The APS system makes it easy for end products to transverse through the system with little hindrance, hence increasing the flow rate in the production process.
- Cost Savings: The system relieves the process of overscheduling and use of more resources than necessary during an organization's operating cycle, thus cutting operating costs.
- Enhanced Coordination: APS solves the coordination problem in Boeing's global supply chain, keeping various stages of production and key suppliers in harmony.
- Improved Delivery Performance: Better scheduling in production means improved delivery frequency, which contributes to increasing the company's reliability and on-time delivery performance.

4. **End-to-End Supply Chain Visibility**

- Real-Time Tracking: Implementation of the database with other sources promotes node-level tracking in the supply chain and thus the efficiency of the system.
- Quality Control: The assessment ensures quality and consistency by monitoring all the processes and solving a problem immediately when it is discovered.
- Problem Detection and Resolution: Since it is easier to identify congested areas and disruptions on the layouts before implementation, Boeing can avoid complicating factors that could cause disturbances and halt effective production.
- Operational Efficiency: End-to-end visibility also leads to increased efficiency of the supply chain and shortening of lead times, giving greater reliability.

CHALLENGES

1. **Process Integration:** Changes to current procedures and methods are required to integrate new processes and technology. Effective communication, detailed instruction, and overcoming resistance to change are necessary to ensure a smooth transition. Ignoring these components can result in low staff morale, reduced productivity, and disruptions, all of which may impact the optimization strategy's ability to be effective.
2. **Supplier Coordination:** Suppliers may have restrictions that affect their scalability, so it takes significant work to strengthen collaboration with them and make sure they can fulfill

rising needs. Supplier delays can lead to ongoing bottlenecks and reduce the effectiveness of the supply chain. This can cause delays in order fulfillment, manufacturing schedule interruptions, and higher operating expenses. As a result, the company's ability to satisfy consumer expectations is hampered and its competitive position in the market is severely damaged.

3. **Resource Allocation and Scalability:** Adapting resource distribution dynamically to meet changing demand necessitates advanced planning and the ability to make decisions quickly. It might sometimes be complicated to find a balance between the availability of resources and opportunities on the one hand and the need for production and high demand on the other because it presupposes flexible adjustment to changes in demand rates.
4. **Regulatory and Compliance Issues:** There is a need to ensure that optimization strategies are aligned to coincide with the industrial norms and standards because such restraints affect the integration of modern technologies and the implementation of change. Noncompliance with these standards may give rise to legal complications, penalties, and disturbances in operations. These outcomes might erode the efficacy of optimization endeavors and impede the advancement toward enhanced supply chain productivity and efficiency.
5. **Cost Constraints:** Budgetary restrictions may restrict the breadth and pace of execution, which may limit the strategy's efficacy and postpone the benefits realization. Considering this, the lack of sufficient funding to deploy needed technologies and resources to scale up SCM improvement activities may limit the strategies' effectiveness in boosting overall supply chain performance and efficiency as envisioned.
6. **Vendor Reliability and Performance:** This is in as much as there are risks that are associated with the performance and reliability of the external suppliers when one depends on them for critical components or services. This means there is a need to ensure that such vendors are producing goods and services that will enable such operations to continue running equivalently. Unreliable suppliers can hinder delivery of goods and services thereby being a source of time wastage, low quality, and more expenses.

CONCLUSION

To sum it up, issues with Boeing's supply chain in the production of the Dreamliner 787 contribute to the fact that modern aerospace manufacturing is a large-scale process that became even more challenging due to the COVID-19 pandemic and unstable geopolitics. Such problems are caused by delivery disruptions, inadequate planning of market demand, inadequate inventory management, and a general lack of end-to-end supply chain visibility. Thus, there is a need to implement the following recommendations: advanced demand forecasting that analyzes the data and uses machines to enhance forecasting, Just-In-Time inventory control to address the weakness in inventory and cash flow, and lastly, implement production planning that coordinates production with resources and customer requirements. Also, with better, and efficient supplier management and communications, a journey towards the accomplishment of end-to-end supply chain visibility will occur, further augmenting efficiency.

RECOMMENDATIONS

1. Implement Advanced Quality Management Systems (QMS) - This can help identify defects at the initial stages, denying further escalation of time wastage and redoing of works.
2. Leverage Blockchain Technology – It can increase the traceability of products within the supply chain reducing the usage of counterfeit components.
3. Adopt Lean Manufacturing Principles – Helps to minimize waste, streamline production, optimize workflows, and reduce unnecessary inventory.
4. Optimize Logistics and Transportation – This can be achieved by using advanced routing algorithms, real-time tracking, and efficient load planning, thus reducing transportation costs and delivery times.

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