Supply chain planning and inventory management | Aerospace and defense | Inventory management / control | Classifiers

Optimizing Raw Wire Inventory Management: A Data-Driven Approach to Demand Forecasting and Supply Chain

BUSINESS PROBLEM

The main problems that the business aims to solve raw are wire inventory management issues to prevent shortages and achieve a 100% service rate. Key influences include COVID-19 supply chain disruptions, high production variability from customization, and expertise loss from retirements. Late bundle designs and long lead times (26-52+ weeks) complicate forecasting, causing shortages or overstocking. Traditional methods fail in this complex environment. The goal is to use data-driven tools to predict demand, optimize inventory, and ensure production efficiency, minimizing costs and delays. Improving communication is a parallel effort.

APPROACH

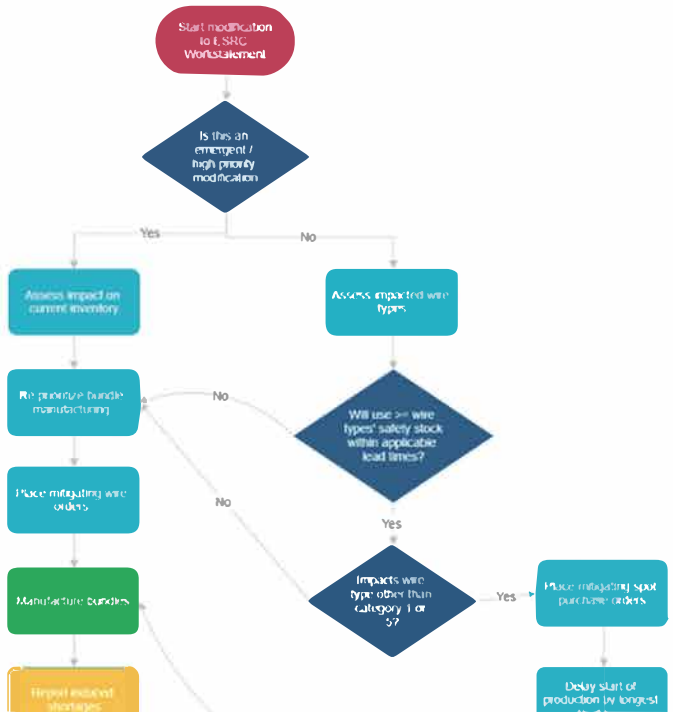
The thesis tackles Boeing's ESRC inventory issues with a data-driven approach: analyzing production data for demand patterns, using K-means clustering to categorize wire types, developing demand and inventory simulation models, and creating a decision support tool. It aims to improve forecasting accuracy and communication, despite data gaps, to optimize inventory and achieve a 100% service rate.

DATA SOURCES

The thesis used live production & supply chain data: consumption from cutting machines (69% of 814 wire types), demand from production rates and work statements, inventory from off-site warehouse reports, and supply data from interviews. Spanning 2020-June 2024, it was collected from manufacturing systems, normalized for confidentiality, and analyzed to improve raw wire inventory management.

Data Types and Format

Data included consumption (time series, numeric, database records), demand (time series, numeric, rates/statements), inventory (snapshot, numeric, reports), and supply (qualitative, text, interviews),



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IMPACT

The solutions proposed, though not fully predictive, impacts the business positively. The demand and inventory simulations underperformed, but the research offers insights and tools to boost supply chain resilience. The data analysis conducted clarifies demand patterns and waste (averaging 12%), and informs tailored inventory strategies for different wire types via K-means clustering. This could reduce shortages and optimize stock, cutting costs indirectly. The management decision support tool enhances communication, preempting inventory risks from work statement changes and reducing the bullwhip effect. This may prevent production delays, potentially saving thousands daily, though data gaps limit quantification and validation. While not directly yielding savings, the solution sets a foundation for improvement. Future steps like collecting better data, specifically regarding shortages, and advanced analytics could refine forecasting, aligning the supply chain with the build cycle employed to fulfill the customization needs. This work shifts the organization to proactive, data-driven management, with clearly identified channels of communication, promising efficiency and reliability gains long-term.

DRIVERS

The solution was driven by the facility facing supply chain disruptions from COVID-19 production due to aircraft customization, and expertise loss from retirements. These factors exposed inventory vulnerabilities, with long lead times (26–52+ weeks) and late bundle designs clashing with the need for a 100% service rate, pushing for data-driven tools to predict demand and optimize raw wire inventory.

BARRIERS

Barriers impacting the project included incomplete bundle design data (retained only 6 months), missing consumption records for 25% of wire types, no verifiable shortage data, limited lead time info from interviews, and desynchronized production rates. These gaps hindered accurate demand forecasting and inventory simulation, limiting the ability to validate models and assess shortage risks effectively.

ENABLERS

Boeing's extensive production data (2020–2024) from the ESRC, including consumption and inventory records, enabled analysis. Team support from Boeing staff, access to software (Python, Excel), and the Leaders for Global Operations program facilitated tool development. Qualitative insights from interviews and a data-rich environment helped overcome gaps, supporting the creation of actionable inventory management solutions.

ACTIONS

I analyzed ESRC data using Python, developed a demand simulation model in excel, and built an inventory simulation tool. I applied K-means clustering to categorize wire types, created a decision support flowchart, and built a Tableau dashboard with the IEs for visibility. I conducted interviews, validated findings qualitatively, and recommended data improvements and pilot studies to refine forecasting and inventory management at Boeing.

INNOVATION

Innovative aspects include a data-driven demand simulation surpassing baseline methods, K-means clustering for wire categorization, and a decision support tool with a Tableau dashboard for real-time visibility. Integrating qualitative insights with quantitative models to address customization challenges and proposing future machine learning enhancements offer novel ways to tackle Boeing's complex inventory issues.

IMPROVEMENT

The solution didn't quantify savings due to data gaps, but it improved demand understanding and waste quantification (12% average). The decision support tool enhances communication, potentially reducing shortages. Simulations, though inaccurate, laid groundwork for future accuracy. Qualitatively, it promises fewer delays, saving thousands daily, pending better data and pilot studies for measurable impact.

BEST PRACTICES

Ensure comprehensive data collection (e.g., shortage records, full design specs), integrate qualitative insights with quantitative models, use clustering for demand patterns, and develop interpretable tools like dashboards. Validate with pilot studies, leverage team expertise, and iterate models with real-time data. Address data gaps early and align with business goals for effective inventory management replication.

OTHER APPLICATIONS

The solution could apply to other high-mix manufacturing (e.g., automotive, electronics) for inventory optimization, aerospace suppliers for demand forecasting, or any supply chain with customization challenges. The decision support tool and clustering approach could enhance logistics in healthcare (e.g., medical device