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# IMPACT OF PREDICTIVE ANALYTICS ON AUTOMOTIVE SUPPLY CHAIN OPTIMIZATION

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**Abstract:** The automotive spare parts industry plays a critical role in ensuring the continuity, efficiency, and resilience of global vehicle operations. As the industry faces increasing complexity due to fluctuating demand, global disruptions, and technological advancements, predictive analytics has emerged as a strategic tool for supply chain optimization. This study explores the impact of predictive analytics on key areas of the automotive supply chain, including demand forecasting, inventory management, risk mitigation, and cost efficiency. Using secondary data from the Interplex Inventory Sales Report (Oct 2024 – Mar 2025), the research applies analytical techniques such as time-series forecasting, treemaps, and box-and-whisker plots to uncover trends and performance insights. The findings reveal that predictive analytics enables more accurate demand forecasting, reduces inventory imbalances, and supports proactive decision-making in the face of potential disruptions. High-performing products like Battery Terminal – B show strong alignment between sales and inventory strategies, while underperforming items highlight opportunities for improvement. The study also discusses how companies like TI Fluid Systems can leverage predictive tools for better supplier coordination and strategic planning. Overall, the results affirm that predictive analytics is a valuable enabler of supply chain agility, operational efficiency, and competitive advantage in the automotive sector. Future implications suggest that greater integration of real-time data and AI-driven models can further enhance supply chain resilience and sustainability.

**Keyword:** Predictive Analytics, Automotive Supply Chain, Inventory Optimization, Demand Forecasting, Supply Chain Resilience

## I. INTRODUCTION

The automotive spare parts industry is a vital component of the global automotive sector, supporting vehicle safety, performance, and longevity. Driven by rising vehicle numbers, aging fleets, and the growth of electric vehicles, the industry spans OEM and aftermarket segments, with key markets in Germany, Japan, the U.S., China, and India. India, with major hubs in Chennai and Pune, is a growing global player, supported by government initiatives like Make in India and PLI. The sector faces challenges such as supply chain disruptions, counterfeit parts, and evolving vehicle technology. This study explores how predictive analytics can address these issues by improving forecasting, enhancing inventory management, and optimizing supply chain operations. Using tools like Tableau and Excel, and techniques such as time-series analysis and trend forecasting, the research aims to provide actionable insights to drive digital transformation and strategic efficiency across the automotive supply chain

## II. REVIEW OF LITERATURE

**Beinabadi et al. (2024) proposed a** data-driven AI model using CNN, RNN, and MFO to predict automotive component demand with over 90% accuracy. The study used DEA to evaluate suppliers on economic, social, and environmental factors, and BWM to rank them. The model helped improve production planning and supplier selection. It highlights the power of AI in achieving sustainable supply chains in the automotive sector.

**Pawar and Bhasin (2024) explored** how predictive analytics enhances supply chain functions like forecasting, inventory control, and risk management. The study highlights how AI, big data, and blockchain improve decision-making and operational efficiency. It emphasizes the role of real-time data and sustainability in modern supply chains. The paper positions predictive analytics as a key driver for competitive advantage and long-term success.

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**Joel Paul (2022)** explores predictive analytics revolutionizes the automobile industry by enabling real-time forecasting, smarter decision-making, and proactive maintenance. By integrating big data, IoT, and machine learning, automakers enhance efficiency, customer satisfaction, and sustainability. Predictive analytics also supports green technologies and connected car innovations. The study emphasizes its growing role in optimizing production, vehicle lifecycle, and overall industry transformation.

**Arshad and Pasha's study highlights** how predictive analytics significantly improves supply chain performance in the automotive industry. It enables accurate forecasting, reduces inventory by 20–30%, and enhances service levels. Companies like Google and Amazon leverage these tools to optimize operations. The research underscores how predictive analytics helps supply chain leaders reduce costs, spot trends, and improve planning efficiency.

**Adewusi et al. (2024) reviewed** predictive analytics strengthens supply chain resilience by improving agility, responsiveness, and flexibility. The study highlights integration challenges such as data privacy, talent gaps, and system compatibility. Despite barriers, predictive analytics is seen as a key driver of innovation and efficiency. It recommends developing data governance, training, and ethical standards for wider adoption in supply chain management.

**Aljohani (2023) emphasizes** on predictive analytics and machine learning improve real-time supply chain risk management and agility. Unlike traditional methods, this approach uses time series, anomaly detection, and NLP for proactive disruption handling. It enables faster responses, enhanced visibility, and adaptable risk frameworks. Case studies show its success across industries in minimizing uncertainty and boosting supply chain responsiveness.

**Pradhan, Sarwar, and Hosseinian-Far (2022)** study explores how predictive analytics transforms strategic business models in supply chain management. It shows that PA improves decision-making, process optimization, and profitability across sectors. The research highlights its value for startups and large firms in creating new, efficient models. Overall, it positions predictive analytics as vital for competitive advantage and strategic growth.

**Yu et al. (2021) investigated** how big data analytics enhances supply chain finance (SCF) integration. The study found that big data capabilities significantly improve internal SCF processes, which in turn support collaboration with suppliers and customers. A strong data-driven culture further boosts this integration. The findings offer practical guidance for managers to build efficient SCF strategies in data-intensive

**Kamble, Sachin S. (2023)** examined how blockchain technology (BT) impacts supply chain integration (SCI) and sustainable supply chain performance (SSCP) in the automotive industry. The study found that BT positively affects SSCP and that SCI plays a strong mediating role. Blockchain helps reconfigure supply chain relationships for better collaboration and sustainability. The research confirms BT's potential to drive sustainable outcomes through enhanced integration

**Han, Lu, et al. (2024) study on** examines supply chain digitization in Industry 4.0, focusing on challenges in dynamic and decentralized environments. It addresses issues in data acquisition, fusion, and decision-making. Optimization models are proposed to improve efficiency, quality, and timeliness. Empirical analysis from Chinese automotive firms confirms positive impacts.

**OBJECTIVES OF THE STUDY**

- To analyse how predictive analytics enhances forecast accuracy and inventory optimization in supply chain management
- To explore the practical implementation of predictive models in real-world automotive companies, specifically TI Fluid Systems.
- To investigate the role of predictive analytics in early identification and mitigation of supply chain risks.
- To assess the cost-efficiency benefits resulting from the adoption of predictive tools.

## III. RESEARCH METHODOLOGY

This study relies on secondary data from the Interplex Inventory Sales Report (Oct 2024 – Mar 2025), which offers valuable insights into historical trends, sales performance, and inventory management. Secondary data, being pre-collected for different purposes, enables time- and cost-efficient analysis. However, the study assumes the data's completeness, accuracy, and relevance, acknowledging potential limitations due to its original context.

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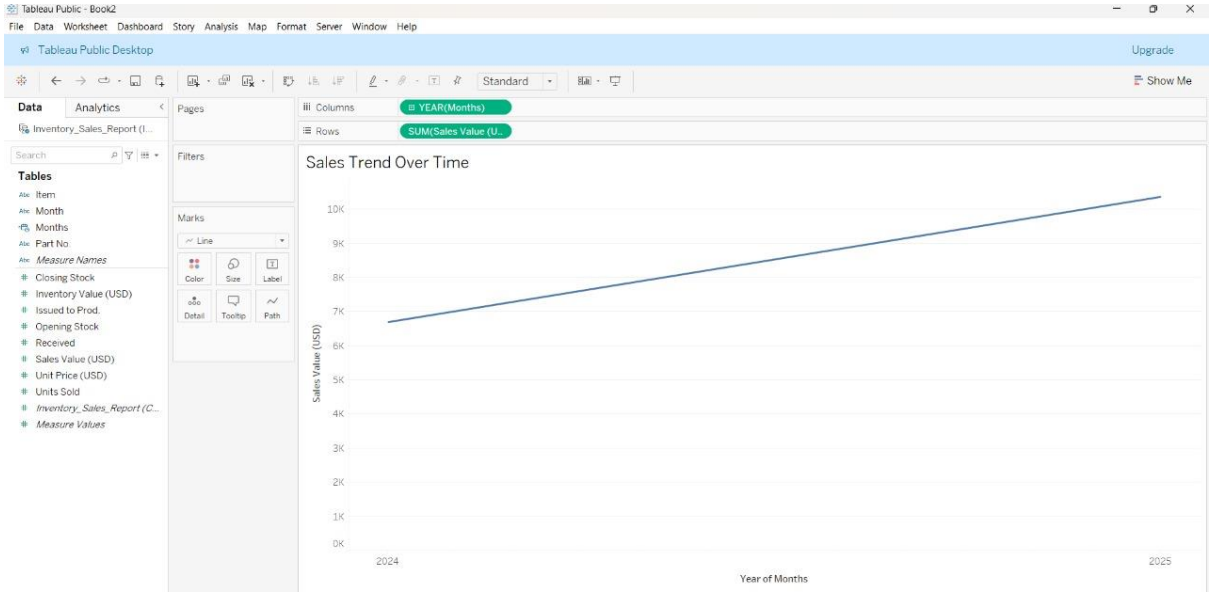
## ANALYSIS

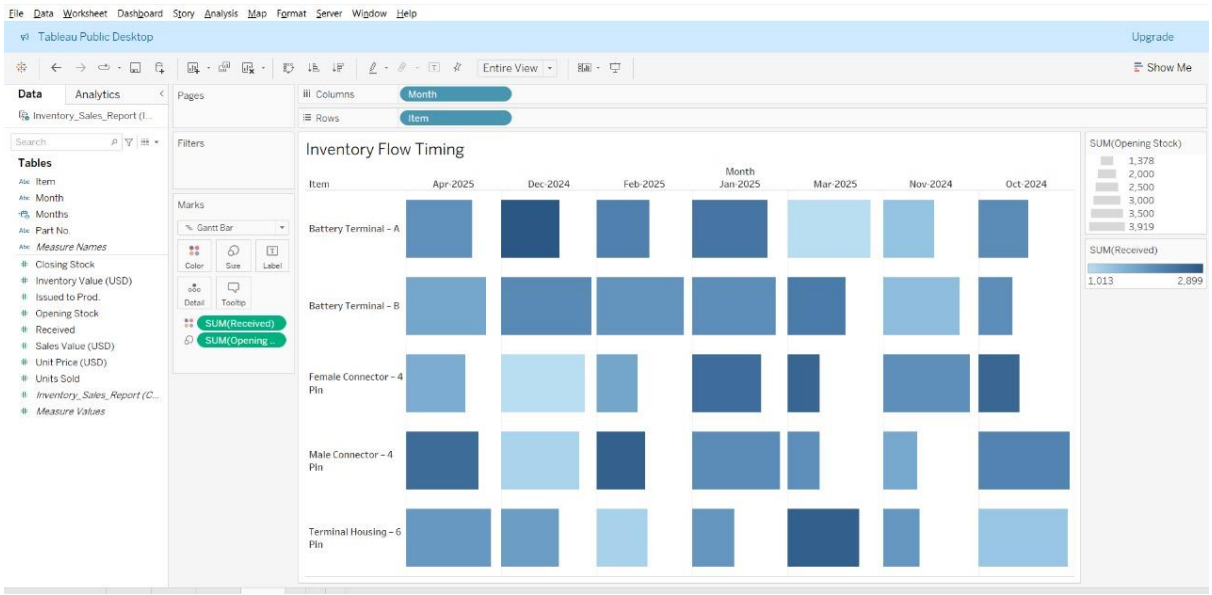
### SALES TREND OVER A TIME




**INTERPRETATION:**

The line chart titled "Sales Trend Over Time" illustrates a consistent upward trend in sales value (measured in USD) from the year 2024 to 2025. This indicates that the company has experienced steady growth in its sales performance over this period. The continuous increase in the sales value suggests effective sales strategies, growing customer demand, or improved market conditions contributing to the positive performance. Overall, the visualization reflects a healthy and progressive sales trajectory year over year

### INVENTORY FLOW TIMING




**INTERPRETATION:**

The "Inventory Flow Timing" chart visualizes monthly stock movement for various items from October 2024 to April 2025. It uses color intensity to show received quantities and block size to represent opening stock levels. Darker shades indicate higher receipt, while larger sizes reflect greater opening stock. Items like Battery Terminal – A and Male Connector – 4 Pin show consistent activity, highlighting regular usage or demand. Some months show lighter shades and smaller blocks, suggesting lower inventory inflow or stock availability. This chart helps in understanding supply timing and inventory planning across different components.

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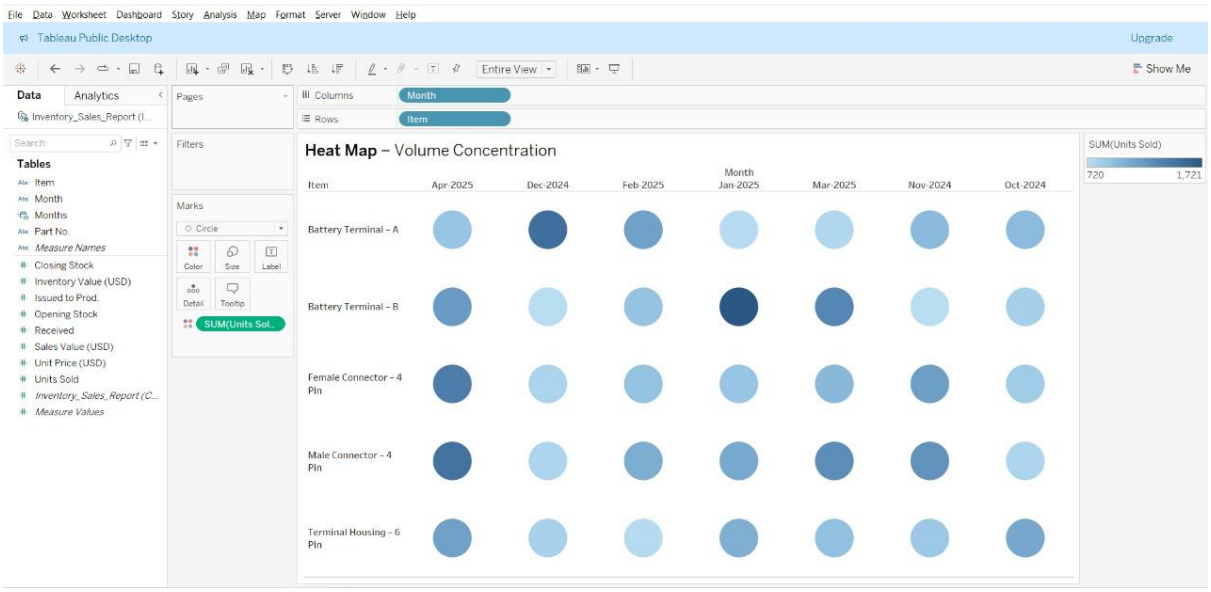
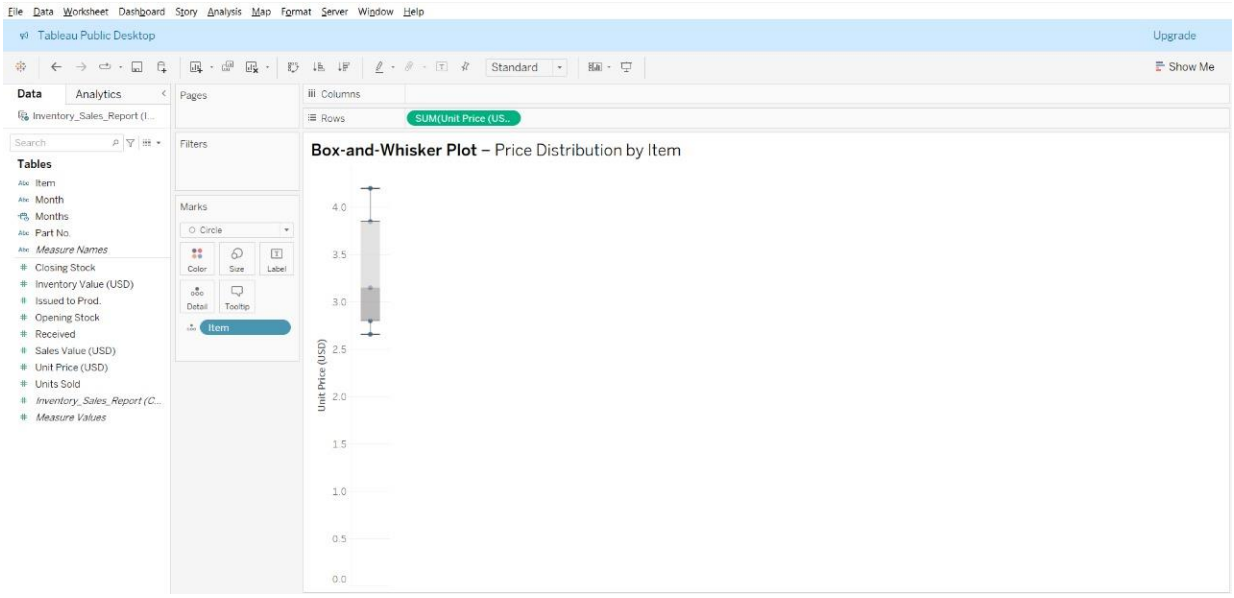
## HEAT MAP-VOLUME CONCENTRATION




**INTERPRETATION:**

The "Heat Map – Volume Concentration" visualizes the monthly sales volume (units sold) for each inventory item. Darker and larger circles represent higher sales volumes, while lighter and smaller circles indicate lower sales. Battery Terminal – B saw peak sales in January 2025, and overall, all items show steady movement across months. This visualization makes it easy to spot demand trends and identify high-performing components over time. It helps decision-makers optimize inventory based on sales concentration patterns.

## BOX AND WHISKER PLOT-PRICE DISTRIBUTION BY ITEM




**INTERPRETATION:**

The "Box-and-Whisker Plot – Price Distribution by Item" shows the spread and variability of unit prices for different inventory items. The plot displays the median, interquartile range (IQR), and potential outliers. Most item prices range between approximately $2.7 and $4.1, with a median around $3.2. This visualization helps identify consistency or fluctuations in pricing and is useful for monitoring price stability or detecting anomalies.

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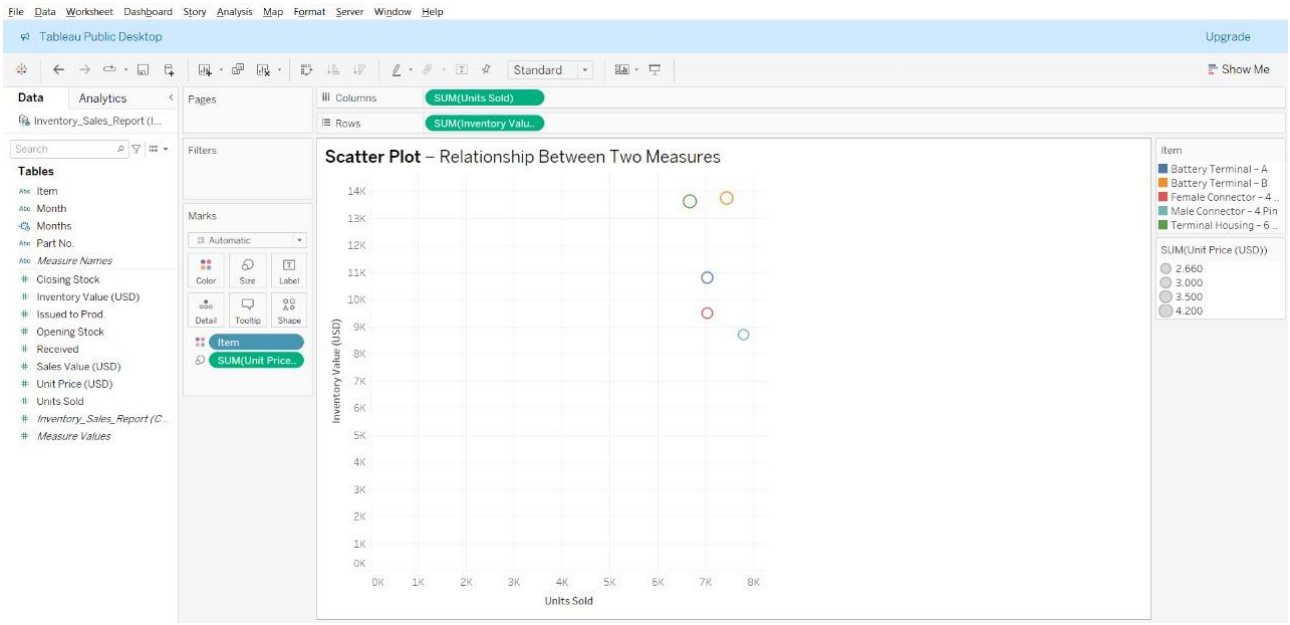
**SCATTER PLOT- RELATIONAL BETWEEN TWO MEASURES**




**INTERPRETATION:**

This scatter plot shows the relationship between Units Sold and Inventory Value (USD) for different items.
Battery Terminal – B and Male Connector – 4 Pin sold the most and have high inventory values.
Battery Terminal – A has the lowest inventory value and unit price.
Bubble size shows Unit Price—larger bubbles mean higher price.
It helps compare sales performance and inventory cost across products quickly.

**FINDINGS AND RECOMMENDATIONS**

Based on the visual analysis, it is evident that Battery Terminal – B and Male Connector – 4 Pin are the top-performing items, showing both high units sold and high inventory value, indicating strong and consistent demand. In contrast, Battery Terminal – A reflects the lowest inventory value and unit price, suggesting it contributes less to overall profitability and may require reassessment. The box-and-whisker plot confirms that item prices are largely stable, with most values falling between $2.7 and $4.1, showing minimal pricing fluctuations and indicating consistency in the pricing strategy. The heat map reveals that Battery Terminal – B experienced peak sales in January 2025, and in general, most items demonstrated steady monthly sales volumes, pointing to balanced demand across the product line.

The inventory flow timing chart highlights that certain items, particularly Battery Terminal – A and Male Connector – 4 Pin, have regular stock movement, which reflects ongoing demand and replenishment. However, lighter shades and smaller blocks in some months indicate periods of lower inventory inflow, which may pose challenges in maintaining consistent availability. The line chart depicting sales trend over time shows a steady and healthy increase in sales value from 2024 to 2025, suggesting improved sales strategies, growing market demand, or better customer engagement.

Based on these findings, it is recommended that the company focuses more on high-performing items to maximize revenue and meet demand efficiently. Underperforming items should be reviewed to determine their strategic relevance or explore ways to improve their sales. Inventory planning should be enhanced using the flow data to prevent shortages and optimize supply timing. Additionally, the company should continue leveraging its current pricing consistency and sales momentum to reinforce growth strategies and maintain a competitive edge in the market.

## IV. CONCLUSION

In conclusion, the analysis of the Interplex Inventory Sales Report (Oct 2024 – Mar 2025) demonstrates the effective application of predictive analytics in understanding and optimizing the automotive spare parts supply chain. The visualizations reveal key insights into sales trends, inventory flow, price consistency, and product performance. High-performing components such as Battery Terminal – B and Male Connector – 4 Pin contribute significantly to sales and should remain a strategic focus.

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The stable pricing and consistent upward sales trend indicate a healthy market response and effective operational strategies. By leveraging these insights, the company can make data-driven decisions to enhance inventory management, streamline supply chain operations, and sustain long-term growth in a competitive market environment.

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