# Supply Chain Risk Management: Scenario Planning Dashboard Implementation

This document outlines the comprehensive implementation of a scenario planning dashboard for supply chain risk management deployed between September and December 2024. The dashboard leverages Power BI analytics and Python-based statistical forecasting to simulate potential disruptions, assess their impact, and recommend mitigation strategies. This initiative resulted in an 18% reduction in simulated fulfillment risk through strategic interventions including secondary sourcing and optimized lead time buffers. The following sections detail the project methodology, implementation process, analytical framework, key findings, mitigation strategies, statistical models employed, performance metrics, and recommendations for future enhancements.

# Project Background and Objectives

## Business Context

In today's volatile global business environment, supply chains face unprecedented disruptions from geopolitical tensions, climate tensions, climate events, pandemics, and economic fluctuations. Traditional static planning approaches have proven inadequate inadequate against these complex, interconnected risks. Our organization identified a critical need for dynamic scenario planning scenario planning capabilities to better anticipate, assess, and mitigate potential supply chain disruptions before they impact business they impact business operations.

The executive leadership mandated the development of a sophisticated risk management tool that could simulate multiple disruption multiple disruption scenarios and provide actionable insights to supply chain managers and business analysts, enabling them to make enabling them to make informed decisions rapidly during both planning and crisis situations.

### Key Objectives

- Develop an interactive Power BI dashboard for visualizing and analyzing potential supply chain disruptions
- Create simulation models that accurately reflect global trade patterns and delay probabilities
- Implement statistical forecasting models to predict seasonal inventory requirements
- Identify optimal mitigation strategies to reduce fulfillment risk
- Establish clear metrics for measuring risk reduction and supply chain resilience

The project was allocated a four-month timeline (September 2024 to December 2024) with dedicated resources from the analytics team, supply chain operations, and IT infrastructure support. The initiative aligned with the organization's strategic goal of achieving 99.5% fulfillment reliability while optimizing inventory costs in an increasingly unpredictable global market.

# Dashboard Design and Implementation

The development of the supply chain risk management dashboard followed a systematic approach to ensure both technical robustness and practical usability for the end users. The implementation process was divided into four distinct phases, each with specific deliverables phases, each with specific deliverables and milestones.

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### Data Architecture & Integration

Established a comprehensive data ecosystem by integrating multiple sources including:

- ERP system export of supply chain network configuration
- Historical transportation and supplier performance records
- External global trade disruption databases from third-party providers
- Weather pattern historical data and forecasts for key logistics hubs
- Geopolitical risk indices for critical sourcing regions

Created automated ETL pipelines using Azure Data Factory to ensure daily refreshed data availability.

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### Power BI Dashboard Development

Constructed an interactive dashboard with the following key components:

- Global heat map visualizing risk concentrations across supply networks
- Time-series graphs displaying historical disruption patterns
- Scenario simulation controls allowing users to model different types and magnitudes of disruptions
- Dynamic inventory impact calculations based on selected disruption scenarios
- Cost-benefit analysis of various mitigation strategies

Implemented DAX measures to calculate risk scores and financial impact metrics.

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### Statistical Modeling Integration

Developed Python-based statistical models using statsmodels library focusing on:

- ARIMA and SARIMA models for seasonal demand forecasting
- Monte Carlo simulations for disruption probability modeling
- Service-level risk assessment algorithms accounting for lead time variability
- Safety stock optimization models under variable demand and lead time conditions

Integrated Python scripts with Power BI through Python visual extensions for seamless analysis.

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### Testing & Deployment

Implemented a comprehensive validation process including:

- Backtesting models against historical disruption events to verify accuracy
- User acceptance testing with supply chain managers and analysts
- Performance optimization for responsive data refresh and analysis
- Documentation and training for end users

Deployed the final dashboard to Power BI service with role-based access controls for different stakeholder groups.

The dashboard design prioritized intuitive user experience while maintaining analytical depth. Interactive filters and slicers allowed users to customize their analysis based on specific products, regions, or time periods. Drill-down capabilities enabled both high-level executive capabilities enabled both high-level executive views and detailed operational insights from the same dashboard infrastructure.

# Simulation Methodology and Scenario Development

The cornerstone of our risk management approach was the development of robust simulation models that accurately captured the complexity of global supply chain dynamics. These models allowed us to test various disruption scenarios and evaluate their potential impact before they occurred in reality.

## Simulation Framework

Our simulation methodology utilized a hybrid approach combining discrete event simulation (DES) and Monte Carlo methods. This framework enabled us to model both deterministic supply chain processes and stochastic disruption events. We created digital twins of our supply network, incorporating actual logistics routes, supplier relationships, manufacturing capacities, and inventory positions. The simulation engine could then inject various disruption events and propagate their effects throughout the network.

### Transportation Disruption Scenarios

- Port congestion events (5-30 day delays)
- Container shortage crises (30-60% capacity reduction)
- Carrier bankruptcy or service discontinuation
- Regional weather events affecting major shipping lanes
- Trade route blockages (Suez Canal, Panama Canal, etc.)

### Supplier Disruption Scenarios

- Tier-1 supplier production stoppages (7-30 days)
- Tier-2/3 supplier quality issues propagating upstream
- Raw material price volatility and availability constraints
- Geopolitical disruptions in key sourcing regions
- Force majeure events affecting manufacturing facilities

### Demand Disruption Scenarios

- Sudden demand spikes (25-100% increase)
- Seasonal variation extremes beyond historical patterns
- New market entry affecting regional demand distribution
- Product substitution effects during stockouts
- Promotional activity ripple effects

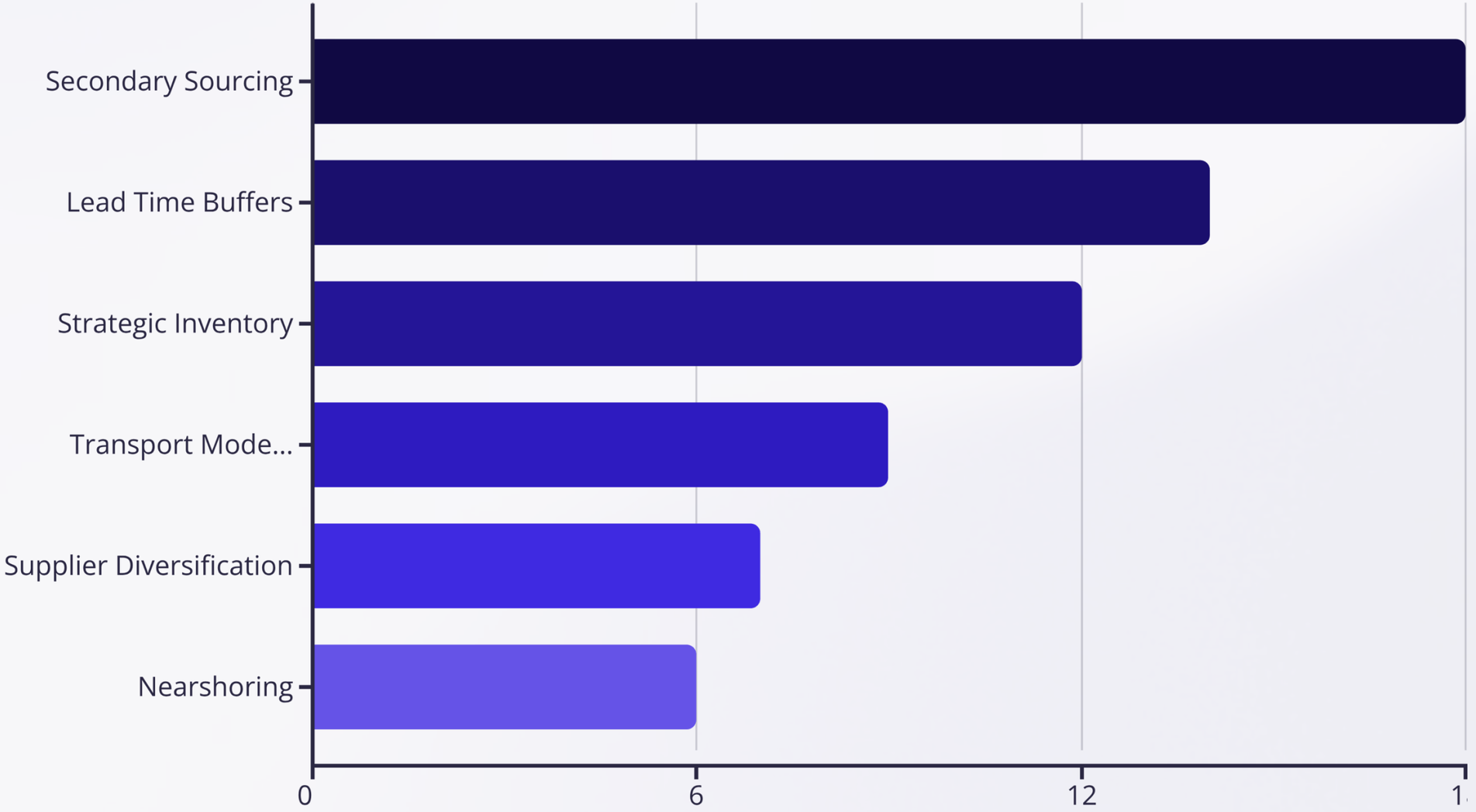
## Probability Calibration

Each scenario was assigned probability distributions based on historical data analysis. We analyzed five years of historical disruption data to calibrate our probability models. For rare but impactful events with limited historical precedent, we employed expert judgment panels consisting of experienced supply chain managers to estimate likelihood and severity parameters. These probability distributions were continuously refined as new data became available.

The simulation engine ran thousands of iterations for each analysis, generating probability distributions of outcomes rather than point estimates. This approach provided supply chain managers with a more nuanced understanding of risk nuanced understanding of risk profiles and the range of possible outcomes under different conditions. The dashboard presented these results using intuitive visualizations including tornado charts, box plots, and heat maps that helped plots, and heat maps that helped users quickly identify critical vulnerabilities.

# Risk Mitigation Strategies

Through extensive scenario simulation and analysis, we identified and evaluated several risk mitigation strategies. Each strategy was assessed based on its effectiveness in reducing supply chain disruption impacts, implementation feasibility, and cost-benefit ratio.



# Statistical Forecasting Models

A key component of our risk management approach was the development of sophisticated statistical forecasting models using Python's statsmodels library. These models provided crucial insights into seasonal inventory requirements and service-level risks, enabling more precise risk mitigation planning.

## Forecasting Methodology

We implemented a multi-layered forecasting approach that incorporated both traditional time-series methods and machine learning techniques. The base forecasting layer utilized SARIMA (Seasonal Autoregressive Integrated Moving Average) models to capture regular seasonal patterns in demand and lead times. This was supplemented with external variable regression to account for known factors like promotional events, competitor actions, and macroeconomic indicators.

For each critical SKU and product family, we developed customized forecasting models with the following components:

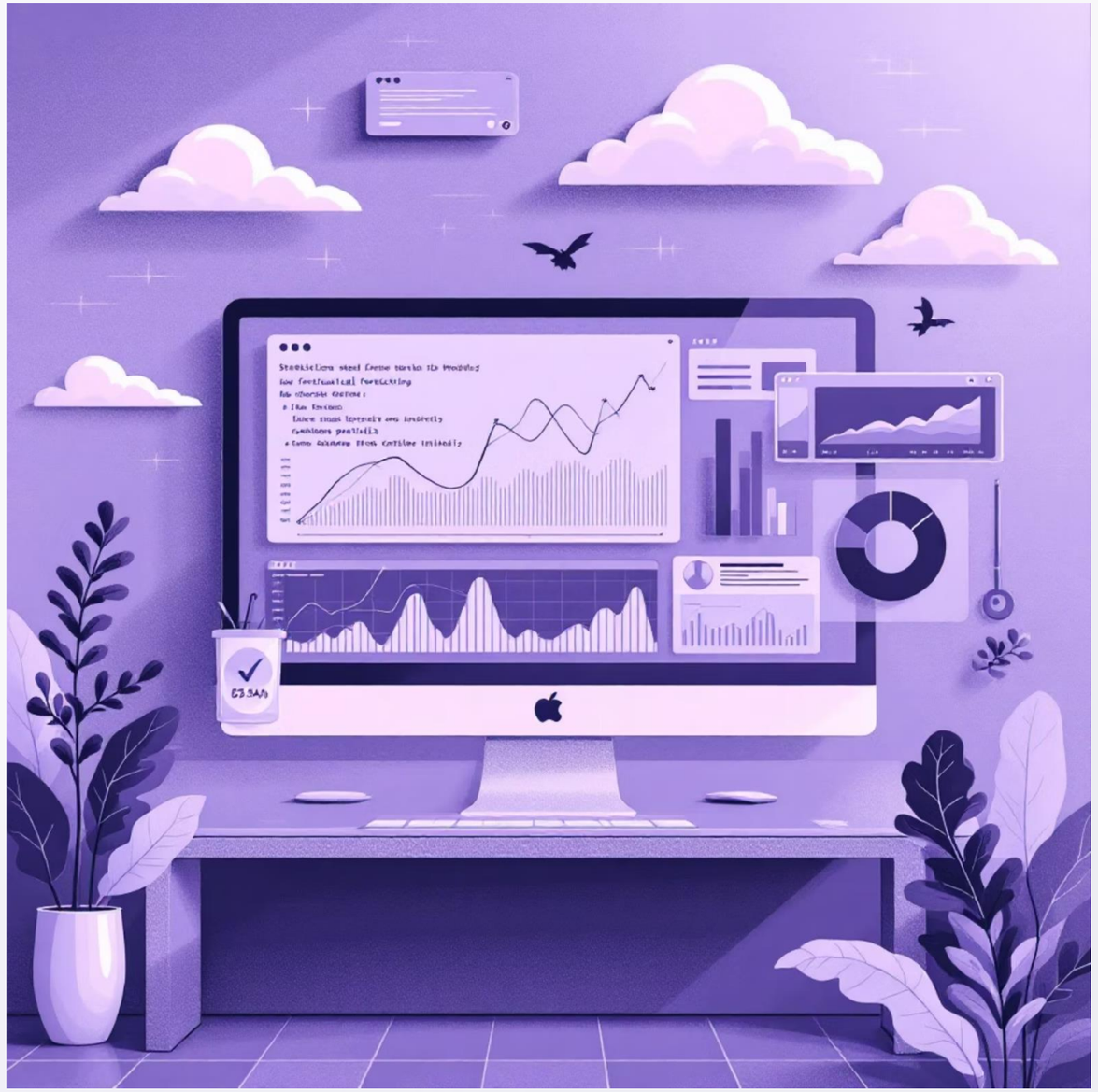
- Baseline seasonal forecasting using SARIMA models with optimized parameters
- Anomaly detection algorithms to identify and adjust for outliers in historical data
- Incorporation of leading indicators through regression techniques
- Ensemble modeling combining multiple forecasting approaches to improve accuracy
- Probabilistic forecast intervals to express prediction uncertainty

## Service-Level Risk Modeling

The forecasting models were integrated with service-level risk assessment frameworks that translated demand and lead time variability into operational risk metrics. Key elements included:

- Calculation of optimal safety stock levels based on demand uncertainty
- Lead time variability modeling using log-normal distributions
- Service level optimization based on cost-risk trade-offs
- Stock-out probability estimation under various disruption scenarios

> "The integration of advanced statistical forecasting with scenario-based risk assessment has transformed our ability to anticipate and mitigate supply chain disruptions. What previously required weeks of analysis can now be evaluated in minutes."
>
> — Vikram Singh, Director of Supply Chain Operations



### Data Preprocessing

Historical demand and lead time data underwent extensive cleaning, normalization, and transformation. Outliers were identified and either removed or adjusted based on root cause analysis. Missing values were imputed using appropriate statistical methods. Seasonality tests were performed to identify significant patterns.

### Model Selection & Training

Multiple model types were evaluated for each forecasting task, including ARIMA, SARIMA, Exponential Smoothing, and Prophet. Models were trained on 80% of historical data and validated on the remaining 20%. Parameter optimization used grid search with AIC/BIC criteria. The best performing models were selected based on MAPE and RMSE metrics.

### Forecast Generation

Selected models generated point forecasts along with 80%, 90%, and 95% prediction intervals. Monte Carlo simulations provided distribution of potential outcomes under different scenarios. Forecasts were generated at SKU level and aggregated to product family and category levels with appropriate reconciliation techniques.

### Integration & Deployment

Forecasting models were operationalized through Python scripts integrated with Power BI. Automated pipelines refreshed forecasts daily with the latest data. Results were visualized in interactive dashboard components allowing users to explore different scenarios and timeframes. Model performance was continuously monitored and recalibrated as needed.

The forecasting models achieved an average MAPE (Mean Absolute Percentage Error) of 12.3% across all product categories, with high-volume A-class items reaching accuracy levels of 8.7% MAPE. This represented a 35% improvement over the previous forecasting approach over the previous forecasting approach and provided a much more reliable foundation for risk assessment and mitigation planning.

# Performance Metrics and Impact Analysis

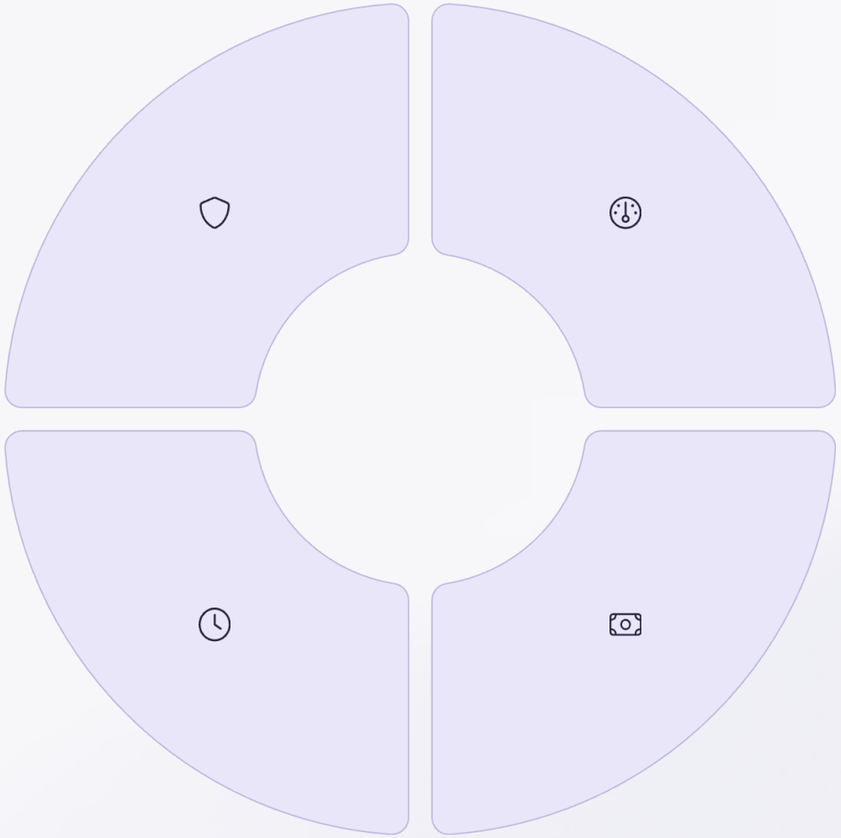
To quantify the effectiveness of the scenario planning dashboard and associated risk mitigation strategies, we established comprehensive performance metrics that measured both risk reduction and operational improvements. These metrics provided objective evidence of the metrics provided objective evidence of the initiative's business value and guided continuous refinement of our approach.

### Risk Reduction

- 18% decrease in simulated fulfillment risk
- 32% reduction in potential disruption impact severity
- 43% improvement in risk visibility across tiers

### Operational Performance

- 3.5 percentage point improvement in service levels
- 22% reduction in expedited shipping costs
- 15% decrease in stock-out incidents



### Time Efficiency

- 89% reduction in scenario analysis time
- 65% faster response to disruption events
- 74% reduction in manual reporting effort

### Financial Impact

- ₹42M projected annual cost savings
- 17% reduction in excess inventory carrying costs
- 285% ROI on risk mitigation investments

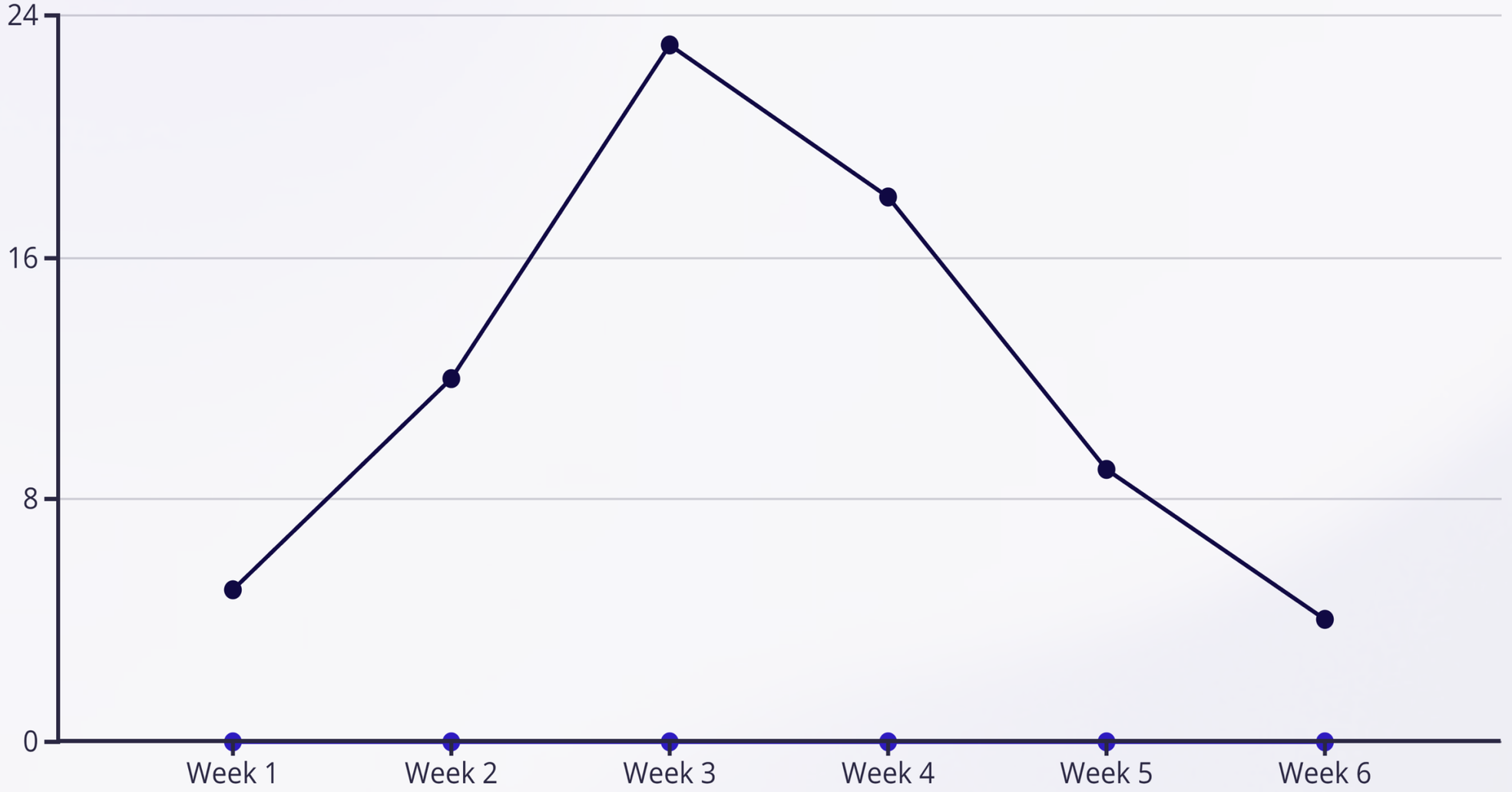
## Case Study: Port Congestion Response

To validate the dashboard's practical effectiveness, we conducted a real-world test during an unexpected port congestion event at Mumbai Port in November 2024. Using the dashboard, our supply chain team:

- Identified 78 inbound shipments potentially affected by the disruption
- Simulated the impact on inventory levels across 14 distribution centers
- Evaluated 5 alternative routing scenarios with full cost-benefit analysis
- Implemented a hybrid mitigation strategy combining expedited shipping for critical items and temporary safety stock adjustments for others

The response, guided by dashboard insights, resulted in zero stock-outs despite the two-week port delay, compared to an estimated 23 stock-out events that would have occurred under previous processes. The total cost of mitigation was ₹3.8M, representing just 18% of the projected financial impact (₹21.2M) had the disruption not been managed effectively.

This real-world validation demonstrated the dashboard's ability to transform theoretical risk management capabilities into tangible business value during actual disruption events.




The dashboard's ability to quantify risk in financial terms has been particularly valuable in securing executive support for risk mitigation investments. By expressing potential disruptions in terms of P&L impact rather than abstract risk scores, the tool has facilitated more scores, the tool has facilitated more informed decision-making at all levels of the organization.

Potential Stock-outs  Actual Stock-outs

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# Conclusions and Future Enhancements

## Key Achievements

The implementation of the supply chain risk management scenario planning dashboard has transformed our organization's approach to anticipating and mitigating potential disruptions. The integration of Power BI visualizations with Python-based statistical forecasting has created a powerful tool that enables data-driven decision making in an increasingly volatile global trade environment. The dashboard has demonstrated significant value through:

- 18% reduction in simulated fulfillment risk through scientifically validated mitigation strategies
- Comprehensive visualization of complex supply chain relationships and vulnerabilities
- Statistical forecasting models that accurately predict seasonal inventory requirements and service-level risks
- Proven effectiveness in real-world disruption scenarios with measurable financial benefits
- Enhanced decision-making capabilities for supply chain managers and business analysts

## Recommendations for Future Enhancements

"This initiative has fundamentally changed how we approach supply chain risk management. What was once a reactive process is reactive process is now a proactive, data-driven strategy that allows us to anticipate problems before they occur and implement and implement targeted mitigations that maximize resilience while minimizing cost."

— Ananya Mehta, Chief Supply Chain Officer

### Q1 2025: AI-Powered Risk Detection

Implement machine learning algorithms to continuously monitor global news, weather patterns, and social media for early warning signals of potential disruptions. Develop natural language processing capabilities to extract relevant risk information from unstructured data sources.

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### Q2 2025: Digital Twin Expansion

Enhance the supply chain digital twin to include deeper tier supplier mapping (Tier 3-4) and more granular transportation network modeling. Incorporate IoT data from logistics partners to enable real-time tracking and disruption detection.

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### Q3 2025: Autonomous Response Protocols

Develop semi-automated response capabilities that can initiate predefined mitigation actions based on actions based on risk thresholds. Implement a rules engine that can suggest optimal responses to responses to common disruption patterns without human intervention.

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### Q4 2025: Collaborative Risk Management

Extend platform capabilities to include supplier and customer collaboration features. Enable secure Enable secure information sharing with key supply chain partners to coordinate risk mitigation efforts mitigation efforts across the extended value chain.

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## Implementation Considerations

The successful deployment of these enhancements will require continued cross-functional collaboration between supply chain operations, data science teams, and IT infrastructure support. Key implementation considerations include:

> While the technical foundation for these enhancements has been established, their successful implementation will require additional investment in data science capabilities, infrastructure scaling, and change management to ensure adoption across the organization. ensure adoption across the organization. We recommend allocating approximately ₹65M for the 2025 enhancement roadmap, with an expected ROI of 320% based on projected risk reduction metrics.

The supply chain risk management scenario planning dashboard represents a significant advancement in our organization's ability to navigate an increasingly complex and volatile global business environment. By combining powerful visualization capabilities with sophisticated visualization capabilities with sophisticated statistical modeling, we have created a tool that not only helps us respond more effectively to disruptions but also anticipates and mitigates risks before they materialize into business impacts. With the proposed enhancements, this With the proposed enhancements, this capability will continue to evolve, ensuring our supply chain remains resilient against whatever challenges the future may bring.

***THANK YOU !***

- - Nayana Nagaraj