# **Product Requirements Document (PRD)**

## **Digital Twin for Supply Chain Resilience**

### **1. Overview**

#### **1.1 Product Name:**

Digital Twin for Supply Chain Resilience

#### **1.2 Document Owner:**

Team TAL

#### **1.3 Last Updated:**

[Date]

#### **1.4 Status:**

Draft / In Development

### **2. Executive Summary**

The Digital Twin for Supply Chain Resilience is an AI-powered platform that enables organizations to visualize, simulate, and proactively mitigate supply chain disruptions. Designed for **nonprofits, enterprises, logistics providers, governments, and financial institutions**, the platform integrates **Miro-style visual modeling with Databricks-style analytics**, allowing users to **map their supply chains, simulate disaster scenarios, and generate AI-driven response plans**.

### **3. Objectives & Success Metrics**

#### **3.1 Objectives:**

1. Provide **an intuitive, visual modeling tool** to map supply chain dependencies.
2. Offer **AI-driven predictive analytics** to forecast disruptions and suggest mitigations.
3. Enable **real-time scenario testing** to improve resilience against supply chain shocks.
4. Support **collaborative decision-making** for supply chain teams.
5. Ensure **scalability and integrations** with existing supply chain systems (ERP, logistics APIs, etc.).

#### **3.2 Key Metrics for Success:**

* **User adoption:** Number of organizations onboarded (nonprofits, enterprises, logistics firms, governments).
* **Engagement:** Number of simulations run per month.
* **Accuracy:** AI’s ability to predict disruptions vs. actual events.
* **Response efficiency:** Reduction in response time to supply chain issues.
* **Business impact:** Cost savings from proactive disruption mitigation.

### **4. Target Users & Personas**

#### **4.1 Primary Users:**

1. **Nonprofits & Humanitarian Organizations** – Optimize logistics for disaster relief.
2. **Enterprises & Manufacturers** – Ensure supply chain continuity for production lines.
3. **Logistics & Transportation Companies** – Prevent bottlenecks in global shipping networks.
4. **Governments & Defense Agencies** – Secure critical infrastructure supply chains.
5. **Financial & Insurance Firms** – Assess risks for investment & policy pricing.

#### **4.2 User Needs:**

* **Nonprofits:** Need cost-effective ways to plan aid distribution.
* **Enterprises:** Need to identify supply chain risks & maintain efficiency.
* **Logistics:** Require AI-driven rerouting for better delivery performance.
* **Governments:** Must ensure national preparedness for supply chain disruptions.
* **Financial firms:** Need predictive risk assessments for underwriting policies.

### **5. Features & Functionality**

#### **5.1 Core Features**

##### **1. Interactive Supply Chain Mapping**

* Drag-and-drop interface to visually model suppliers, warehouses, transport routes.
* Graph-based network representation (powered by Neo4j for relationship mapping).
* Collaboration tools for multiple users to edit and comment in real-time.

##### **2. AI-Powered Early Warning System (Predict & Prevent)**

* Real-time data ingestion from **trade, logistics, weather APIs**.
* **Machine Learning models** to forecast supply chain risks.
* AI-generated **early alerts** for potential disruptions (e.g., port shutdowns, raw material shortages).

##### **3. Disaster Impact Simulation**

* Run ‘What-If’ disaster scenarios (e.g., extreme weather, supplier failure, geopolitical risks).
* AI predicts the impact on supply chains and suggests alternative routes/suppliers.
* Compare different mitigation strategies and their effectiveness.

##### **4. Data Hosting & AI-Powered Analysis**

* Users can **upload supply chain data** securely.
* AI analyzes past disruptions and **recommends risk-reduction strategies**.
* Custom dashboards with **real-time insights & predictive analytics**.

##### **5. API Integrations for Enterprise Adoption**

* **ERP & logistics system integration** (SAP, Oracle, IBM Watson, etc.).
* **Open API** for third-party tool integrations.
* Export data to **custom reports & dashboards**.

### **6. Non-Functional Requirements**

* **Scalability:** Cloud-based infrastructure to handle large datasets.
* **Security:** Role-based access control (RBAC) for user permissions.
* **Compliance:** Adheres to GDPR, SOC 2, ISO 27001 security standards.
* **Performance:** AI-driven simulations complete within **30-60 seconds**.
* **User Experience:** Intuitive UI/UX with minimal learning curve.

### **7. Tech Stack & Architecture**

#### **7.1 Tech Stack**

* **Frontend:** React.js (for Miro-style UI)
* **Backend:** Python (FastAPI for API layer)
* **Database:** Neo4j (graph-based supply chain representation)
* **AI Models:** Time-series forecasting (LSTMs, ARIMA, Reinforcement Learning)
* **Data Processing:** Apache Spark / Snowflake (for large-scale data analysis)
* **Cloud:** AWS/GCP/Azure (for deployment & scalability)
* **Security:** OAuth2, JWT-based authentication

#### **7.2 System Architecture**

* **Data Layer:** Ingests trade, logistics, and weather data from APIs.
* **AI Engine:** Processes real-time data for early warning detection.
* **Simulation Engine:** Runs disaster scenarios & predicts impact.
* **Visualization Layer:** Displays results in an interactive dashboard.

### **8. Competitive Landscape & Differentiation**

| **Feature** | **Digital Twin for Supply Chain** | **Traditional ERP Tools (SAP, Oracle)** |
| --- | --- | --- |
| **AI-Driven Risk Prediction** | ✅ Yes | ❌ No |
| **Real-Time Supply Chain Mapping** | ✅ Yes | ✅ Yes |
| **Disaster Impact Simulation** | ✅ Yes | ❌ No |
| **Collaboration-Friendly** | ✅ Yes | ❌ No |
| **Open API for Integrations** | ✅ Yes | ✅ Yes |

**Key Differentiation:** Combines the best of **ERP analytics, AI-driven forecasting, and visual collaboration** into a single, easy-to-use platform.

### **9. Timeline & Roadmap**

#### **Phase 1 (0-3 months) - MVP Development**

✅ Build interactive supply chain visualization module.  
✅ Develop AI-powered early warning system.  
✅ Integrate API for real-time data ingestion.

#### **Phase 2 (4-6 months) - Beta Testing & Refinements**

✅ Implement disaster impact simulation engine.  
✅ Run pilot programs with nonprofits & enterprise partners.  
✅ Gather user feedback & refine UI/UX.

#### **Phase 3 (7-12 months) - Full Market Launch**

✅ Expand API integrations with major ERP systems.  
✅ Introduce pricing tiers (Nonprofit free tier + Enterprise subscription model).  
✅ Onboard commercial clients & scale platform adoption.

### **10. Risks & Mitigation Strategies**

| Risk | Mitigation Strategy |
| --- | --- |
| Data inaccessibility | Partner with data providers & use alternative datasets |
| AI model inaccuracy | Implement human-in-the-loop validation & feedback loops |
| Adoption resistance | Offer freemium model for nonprofits to demonstrate value |

### **11. Conclusion**

The Digital Twin for Supply Chain Resilience is a first-of-its-kind platform that empowers organizations to **predict, plan, and prevent** supply chain disruptions. Combining **visual modeling, AI-driven forecasting, and disaster simulations**, it offers a scalable solution for industries facing increasing volatility.

🎯 **Next Steps:** Finalize MVP requirements & begin development!