**NORTHEASTERN UNIVERSITY**

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# School of Engineering

MECHANICAL & INDUSTRIAL ENGINEERING DEPARTMENT

## IE7200 Supply Chain Engineering

# 2nd Partial Exam Project

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# Abstract

Effective supply chain management is crucial for businesses of all sizes. It involves efficiently coordinating the flow of goods and services from raw materials to the end customer. This report analyzes a proposed distribution network model designed using greenfield analysis (GFA) within AnyLogistix software. GFA helps optimize the initial design of a supply chain network, considering factors like product types, supplier and customer locations, and potential distribution center placements.

This report analyzes a proposed distribution network model designed using greenfield analysis (GFA) within AnyLogistix software. The model considers product types (sweatshirts, t-shirts), supplier and customer locations, and potential distribution center (DC) placements. GFA, a core functionality of AnyLogistix, assists in optimizing the initial design of a supply chain network.

By leveraging GFA principles and AnyLogistix's simulation and optimization capabilities, the report identifies potential challenges associated with three key disruption scenarios:

Transportation Cost Disruptions: This scenario explores situations like fuel price fluctuations, driver shortages, and congestion that can significantly increase transportation costs and impact profitability.

Supplier Relocation: This scenario investigates the potential impact of a key supplier relocating to a new geographical area, leading to increased transportation distances, extended lead times, and potential quality control concerns.

Customer Location Variations: This scenario examines situations like new market expansion, seasonal demand fluctuations, and changing customer service expectations that can impact delivery routes and distribution strategies.

**The report utilizes AnyLogistix to analyze the potential impacts of each scenario and recommends mitigation strategies, including:**

- Multi-modal Transportation Options: Exploring alternative transportation modes like rail or barge to potentially reduce costs and improve efficiency.
- Supplier and Transportation Diversification: Utilizing AnyLogistix to evaluate local sourcing opportunities and diversifying transportation modes to mitigate risks associated with supplier relocation or disruptions.
- Strategic Inventory Management: Utilizing AnyLogistix to re-evaluate safety stock levels and improve inventory forecasting accuracy to address potential lead time extensions due to disruptions.
- Route Optimization with TMS Integration: Implementing a Transportation Management System (TMS) to optimize routes, track shipments, and improve decision-making based on real-time data.

By implementing these recommendations, the GFA model can be further optimized to create a more efficient, cost-effective, and resilient supply chain network from its inception.

## INDEX

# I Introduction to Supply Chain Management

**Supply Chain Management (SCM)** is a critical discipline within the field of business and operations management that focuses on the design, planning, execution, control, and monitoring of activities involved in the flow of goods, services, information, and finances from the point of origin to the point of consumption.

At its core, supply chain management aims to optimize the entire supply chain network to enhance efficiency, reduce costs, improve customer satisfaction, and gain a competitive advantage in the marketplace. This involves the coordination and integration of various functions, processes, and stakeholders across multiple organizations, including suppliers, manufacturers, distributors, retailers, and customers.

**Key Components of Supply Chain Management:**

**Procurement and Sourcing:** Procurement involves the acquisition of raw materials, components, and services required for production or resale. Sourcing involves identifying and selecting suppliers based on criteria such as cost, quality, reliability, and sustainability.

**Production and Manufacturing:** Production involves the transformation of raw materials and components into finished products through manufacturing or assembly processes. Effective production management ensures optimal resource utilization, quality control, and production efficiency.

**Inventory Management:** Inventory management involves the control and optimization of inventory levels to balance supply and demand while minimizing carrying costs and stockouts. This includes inventory planning, forecasting, replenishment, and optimization techniques.

**Logistics and Transportation:** Logistics encompasses the movement and storage of goods throughout the supply chain network. Transportation involves the physical movement of goods between suppliers, manufacturers, warehouses, distribution centers, and customers using various modes of transportation such as trucks, ships, trains, and airplanes.

**Warehousing and Distribution:** Warehousing involves the storage, handling, and management of inventory within warehouses and distribution centers. Distribution focuses on the efficient delivery of products to customers through various channels, including direct sales, retailers, wholesalers, and e-commerce platforms.

**Information Systems and Technology:** Information systems play a crucial role in enabling visibility, coordination, and decision-making across the supply chain. Technologies such as Enterprise Resource Planning (ERP), Supply Chain Management (SCM) software, and advanced analytics help organizations streamline processes, improve collaboration, and optimize supply chain performance.

**Importance of Supply Chain Management:**

**Cost Reduction:** Effective supply chain management helps reduce operating costs by eliminating waste, improving efficiency, and optimizing resource utilization throughout the supply chain.

**Customer Satisfaction:** SCM enables faster response times, accurate order fulfillment, and better communication with customers, leading to higher levels of customer satisfaction and loyalty.

**Competitive Advantage:** Companies with well-managed supply chains can gain a competitive edge by offering superior products, faster delivery, and lower prices compared to their competitors.

**Risk Mitigation:** SCM practices help mitigate risks such as supply disruptions, quality issues, and market fluctuations by implementing contingency plans, diversifying suppliers, and improving supply chain resilience.

**Sustainability:** SCM contributes to sustainability initiatives by promoting ethical sourcing, reducing carbon emissions, minimizing waste, and optimizing supply chain operations for environmental and social responsibility.

## II Introduction to Facility Location

Facility location analysis is a crucial aspect of operations management, logistics, and supply chain management that involves determining the optimal placement of facilities within a network. Anylogistix, a powerful simulation software, provides tools and capabilities to model and analyze facility location problems effectively.

**Key Components of Facility Location Analysis with AnyLogistix:**

**Simulation Modeling:** AnyLogistix enables users to create simulation models representing the entire supply chain network, including suppliers, manufacturing facilities, warehouses, distribution centers, and customers. These models can capture complex interactions and dynamics to evaluate different facility location scenarios.

**Agent-Based Modeling:** AnyLogistix uses an agent-based modeling approach, allowing users to represent entities (agents) such as suppliers, manufacturers, and customers as autonomous decision-making entities. This enables the modeling of realistic behaviors and interactions within the supply chain network.

**Geographic Information Systems (GIS) Integration:** AnyLogistix integrates GIS capabilities, allowing users to incorporate geographic data such as maps, transportation networks, and spatial analysis into facility location models. This enables users to visualize and analyze location-based data effectively.

**Optimization and Decision Analysis:** AnyLogistix provides optimization tools and algorithms to help users find optimal facility locations based on predefined objectives and constraints. Users can perform sensitivity analysis and scenario testing to evaluate the robustness of location decisions under different conditions.

**Discrete Event Simulation:** AnyLogistix supports discrete event simulation, enabling users to model and analyze the flow of entities (e.g., products, orders) through the supply chain network. This allows users to identify bottlenecks, evaluate system performance, and assess the impact of facility location decisions on overall operations.

**Scenario Analysis and Sensitivity Testing:** AnyLogistix allows users to conduct scenario analysis

and sensitivity testing to evaluate the impact of different factors (e.g., demand fluctuations, transportation costs, disruptions) on facility location decisions. This helps users make informed decisions and develop robust location strategies.

**Benefits of Using AnyLogistix for Facility Location Analysis:**

**Comprehensive Modeling Capabilities:** AnyLogistix provides a comprehensive set of modeling tools and techniques to represent complex supply chain networks and evaluate facility location decisions effectively.

**Integration of Geographic Data:** By integrating GIS capabilities, AnyLogistix enables users to incorporate geographic data into facility location models, enhancing the realism and accuracy of analyses.

**Optimization and Decision Support:** AnyLogistix optimization tools and algorithms help users find optimal facility locations based on predefined objectives and constraints, providing decision support for strategic planning.

**Visualization and Analysis:** AnyLogistix offers powerful visualization and analysis capabilities, allowing users to visualize location-based data, analyze simulation results, and gain insights into the performance of different location strategies.

In summary, AnyLogistix software provides advanced modeling, simulation, and optimization capabilities to support facility location analysis in supply chain management. By leveraging AnyLogistix features, users can effectively evaluate location decisions, optimize supply chain networks, and enhance overall operational efficiency and performance.

## III Introduction to anyLogistix Software:

AnyLogistix is a powerful and versatile simulation software platform that is widely used for modeling and analyzing complex systems across various industries, including manufacturing, logistics, transportation, healthcare, and supply chain management. Developed by The Anylogistix Company, Anylogistix provides a unique combination of three simulation modeling methods: discrete event simulation, agent-based modeling, and system dynamics.

**Multi-Method Modeling:**

- Anylogistix's unique feature is its ability to combine three different modeling paradigms: discrete event, agent-based, and system dynamics. This allows users to create highly detailed and realistic models that accurately represent complex systems.
- Discrete event modeling is used to simulate processes where events occur at specific points in time, such as manufacturing processes, transportation systems, and queuing systems.
- Agent-based modeling focuses on simulating the behavior of individual entities within a system, such as customers, vehicles, or machines. Agents can interact with each other and their environment, allowing for the modeling of complex social and behavioral dynamics.

- System dynamics modeling is used to represent the feedback loops and interactions between different components of a system over time. It is particularly useful for modeling dynamic systems such as supply chains, healthcare systems, and environmental systems.

**Graphical User Interface (GUI):**

- Anylogistix's GUI is designed to be intuitive and user-friendly, allowing users to easily create, modify, and visualize simulation models.
- The drag-and-drop interface makes it easy to add and connect model components, define parameters, and set up experiments.
- Users can customize the appearance of their models, add annotations, labels, and animations, and create interactive simulations for presentations and demonstrations.

**Library of Objects and Components:**

- Anylogistix comes with a comprehensive library of pre-built objects and components that represent common entities and processes in various industries.
- Users can choose from a wide range of objects such as conveyors, machines, vehicles, agents, warehouses, and more, and customize them to suit their specific modeling needs.
- The library also includes specialized modules for modeling specific domains such as manufacturing, logistics, healthcare, and transportation.

**Optimization and Experimentation:**

- Anylogistix includes powerful optimization algorithms and experimentation capabilities that allow users to optimize model parameters, perform sensitivity analysis, and find optimal solutions to complex problems.
- Users can define optimization objectives, constraints, and search algorithms, and run experiments to explore different scenarios and evaluate the impact of changes on system performance.
- Anylogistix's optimization tools can be used to find optimal solutions for a wide range of problems, including facility location, production scheduling, resource allocation, and supply chain optimization.

**Integration with Geographic Information Systems (GIS):**

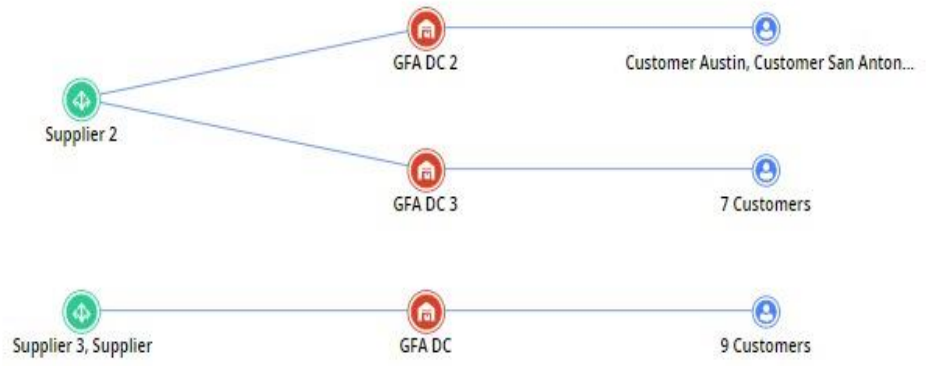
- Anylogistix seamlessly integrates with geographic information systems (GIS), allowing users to incorporate geographic data such as maps, road networks, and spatial datasets into their simulation models.
- Users can import GIS data directly into their models, visualize geographical features, and analyze spatial relationships to support location-based analysis, routing optimization, and facility planning.

**Customization and Extensibility:**

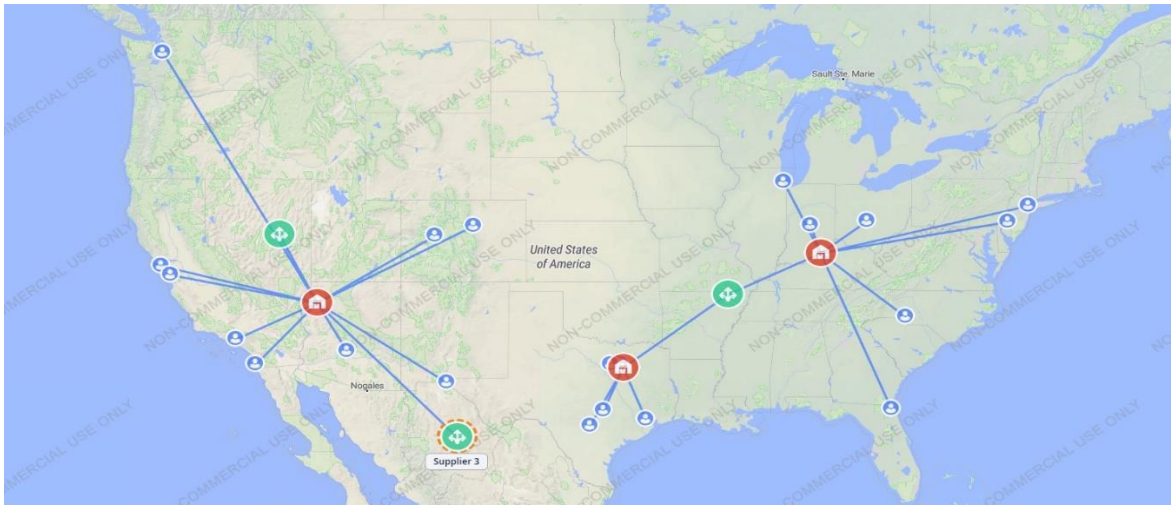
- Anylogistix provides extensive customization and extensibility options, allowing users to develop custom simulation models, add custom logic, create custom user interfaces, and integrate external data sources and software tools.
- Users can write custom code in Java, Python, or other programming languages to extend the functionality of Anylogistix and create highly specialized models and simulations.

Overall, Anylogistix is a comprehensive simulation software platform that offers a wide range of features and capabilities for modeling, simulating, and analyzing complex systems across various domains. Its multi-method modeling approach, intuitive GUI, extensive library of objects, optimization tools, GIS integration, and customization options make it a powerful tool for researchers, engineers, analysts, and decision-makers alike.

## IV Description of the Proposed model:




1. Optimal Distribution Centre Location




**2. Distribution Networks**

This report analyzes the optimal distribution network identified using anyLogistix software for distributing two products: sweatshirts and t-shirts. The analysis considers the configuration of suppliers, ports (if applicable), distribution centers, and the customer base, incorporating the latest information.

**1. Product:**

Two products are included in the model:

- Sweatshirts (potentially bulkier than t-shirts)
- T-shirts

**2. Suppliers:**
The model includes three confirmed suppliers with the following locations:

Supplier 1: Nevada
Supplier 2: Arkansas
Supplier 3: New Mexico

- Maintain relationships with three geographically dispersed suppliers (Nevada, Arkansas, New Mexico) to leverage potential cost benefits and mitigate risks associated with relying on a single source.
- Continuously evaluate supplier performance based on factors like cost efficiency, manufacturing expertise, raw material availability, and responsiveness.
- Negotiate pricing and order quantities to optimize total landed cost, considering transportation expenses and potential bulk discounts.

**When selecting suppliers, various factors can be considered, including:**

**Cost Efficiency:**

**Production Costs:** Evaluating the per-unit cost of producing sweatshirts and t-shirts from each supplier.

Transportation Costs: Considering transportation costs from each supplier location to your distribution centers, especially given the geographically dispersed suppliers. The model likely factors in potential cost savings for bulk orders and minimizes long-distance transportation of bulkier sweatshirts.
Total Landed Cost:Analyzing the total cost delivered, which includes the production cost, transportation cost, import duties (if applicable), and other landed charges.

**Manufacturing Expertise:**
Assessing the experience and capabilities of each supplier in producing high-quality garments that meet your specifications for sweatshirts and t-shirts. This might involve evaluating factors like:

- Ability to handle specific materials (cotton, fleece, etc.)
- Quality control processes
- Capacity for customization (logos, embroidery)

**Raw Material Availability:**

- Considering each supplier's access to necessary raw materials (fabric, thread, trims) and their reliability in securing these materials at consistent quality and pricing.

**Large Scale Production:**

- Evaluating the capacity of each supplier to meet your production needs, especially if you anticipate high demand for sweatshirts or t-shirts. This ensures the supplier can handle your order volume without compromising quality or delivery timelines.

**Strategic Location:**

- Considering the supplier's location relative to your distribution centers. While the geographically dispersed suppliers might introduce some complexity, the model likely factors this in to optimize transportation efficiency. Ideally, suppliers closer to your DCs can potentially reduce lead times and inbound transportation costs.

**Market Demand:**

- Aligning supplier selection with your target market. For instance, if you focus on organic or sustainable materials, a supplier with a proven track record of using eco-friendly practices might be a priority.

### 3. Customers:

| From | To | Product | Period | Flow,pcs | Distance,km | Flow Cost Estimation, pcs*km |
|---|---|---|---|---|---|---|
| GFA DC | Customer | Tshirt | Time Period | 740 | 621.436 | 459862.48 |
| GFA DC | Customer Denver | Tshirt | Time Period | 740 | 814.047 | 602394.925 |
| GFA DC | Customer Los Angeles | Tshirt | Time Period | 740 | 543.455 | 402156.661 |
| GFA DC | Customer Phoenix | Sweatshirt | Time Period | 740 | 465.984 | 344828.505 |
| GFA DC | Customer San Diego | Sweatshirt | Time Period | 740 | 600.607 | 444449.317 |
| GFA DC | Customer San Francisco | Tshirt | Time Period | 740 | 757.82 | 560787.114 |
| GFA DC | Customer San Jose | Sweatshirt | Time Period | 740 | 712.405 | 527179.564 |
| GFA DC | Customer Seattle | Tshirt | Time Period | 740 | 1333.013 | 986429.551 |
| GFA DC 2 | Customer Austin | Sweatshirt | Time Period | 740 | 286.958 | 212348.658 |
| GFA DC 2 | Customer Dallas | Sweatshirt | Time Period | 740 | 7.316 | 5413.59 |
| GFA DC 2 | Customer El Paso | Sweatshirt | Time Period | 740 | 917.645 | 679057.417 |
| GFA DC 2 | Customer Fort Worth | Tshirt | Time Period | 740 | 48.436 | 35842.284 |
| GFA DC 2 | Customer Houston | Sweatshirt | Time Period | 740 | 356.273 | 263642.047 |
| GFA DC 2 | Customer San Antonio | Tshirt | Time Period | 740 | 400.432 | 296319.348 |
| GFA DC 3 | Customer Charlotte | Tshirt | Time Period | 740 | 553.246 | 409401.743 |
| GFA DC 3 | Customer Chicago | Sweatshirt | Time Period | 740 | 419.243 | 310239.566 |
| GFA DC 3 | Customer Columbus | Tshirt | Time Period | 740 | 281.806 | 208536.205 |
| GFA DC 3 | Customer Indianapolis | Tshirt | Time Period | 740 | 157.072 | 116232.921 |
| GFA DC 3 | Customer Jacksonville | Sweatshirt | Time Period | 740 | 970.785 | 718380.583 |
| GFA DC 3 | Customer New York City | Sweatshirt | Time Period | 740 | 1025.825 | 759110.839 |
| GFA DC 3 | Customer Philadelphia | Tshirt | Time Period | 740 | 915.465 | 677444.185 |
| Supplier 3 | GFA DC | Tshirt | Time Period | 3700 | 918.907 | 1699977.457 |
| Supplier 2 | GFA DC 3 | Tshirt | Time Period | 2960 | 514.47 | 761414.909 |
| Supplier | GFA DC | Sweatshirt | Time Period | 2220 | 278.186 | 308786.129 |
| Supplier 2 | GFA DC 2 | Tshirt | Time Period | 1480 | 683.192 | 505561.981 |
| Supplier 2 | GFA DC 3 | Sweatshirt | Time Period | 2220 | 514.47 | 571061.182 |
| Supplier 2 | GFA DC 2 | Sweatshirt | Time Period | 2960 | 683.192 | 1011123.962 |

### 4. Customers

**The model considers a total of 21 customers located across the United States, with the following distribution:**

- GFA DC 1 (with 9 customers)
- GFA DC 2 (with 5 customers)
- GFA DC 3 (with 7 customers)

### 5. Distribution Center:

**The model identifies a network of three strategically positioned distribution centers (DCs) for optimal distribution:**

- GFA DC 1 (with 9 customers)
- GFA DC 2 (with 5 customers)
- GFA DC 3 (with 7 customers)

- Utilize a network of three strategically located DCs (GFA DC 1, GFA DC 2, GFA DC 3, GFA DC 4, GFA DC 5, GFA DC 6) to serve the geographically dispersed customer base.

- **Employ a Transportation Management System (TMS) to optimize inbound and outbound transportation, considering factors like:**
    - Product characteristics (bulkier sweatshirts might require specific handling).
        - Distance between suppliers, DCs, and customers.
    - Transportation mode costs (truck, rail) depending on distance and urgency.
- **Implement inventory management strategies at each DC to ensure sufficient stock levels for both sweatshirts and t-shirts, considering:**
    - Seasonal demand variations (higher demand for sweatshirts in winter)
        - Lead times from suppliers.
    - Storage capacity limitations (potential bulk storage needs for sweatshirts).

**Customer Allocation:**

- **Assign customers to the most efficient DC based on factors like:**
    - Customer location (minimize transportation distance).
    - Historical order history (understanding customer demand patterns for sweatshirts vs. t-shirts).
        - Special requirements (expedited shipping needs).

**Factors Influencing Optimal Network Design:**

- Transportation Costs: The model likely minimizes overall transportation costs by considering, especially with the updated supplier locations:
- Product-specific factors: Potential differences in transportation costs for sweatshirts (bulkier) vs. t-shirts.
- Inbound transportation from geographically dispersed suppliers (Nevada, Arkansas, New Mexico) to the optimal DC, considering distance and potentially minimizing long hauls for bulkier sweatshirts.
- Outbound distribution to all 21 customer locations, considering assignment to the most efficient DC based on location and potential seasonal demand variations.
- Distance: Distance between facilities (suppliers, DCs, customers) remains a significant cost driver, and the supplier locations might influence DC selection for minimizing inbound transportation costs.
- **Distribution Center Network Optimization:**
  The model likely considers factors like:
- Capacity: Matching the capacity of each DC with the expected demand for the assigned customer base and product types.
- Inventory Management: Optimizing inventory storage and allocation across the DCs based on product characteristics (e.g., bulk storage for sweatshirts) and customer demand patterns.
- Customer Allocation: Assigning customers to the most efficient DC based on location, product needs, and potential seasonal variations in demand.

**Other Potential Factors (not directly visible):**

- Transportation modes (truck, rail, etc.) and their associated costs, considering potential cost-effectiveness for long hauls from geographically dispersed suppliers.
- Infrastructure capacities at different locations for handling both products.
- Land or facility costs associated with establishing the DCs at different locations.

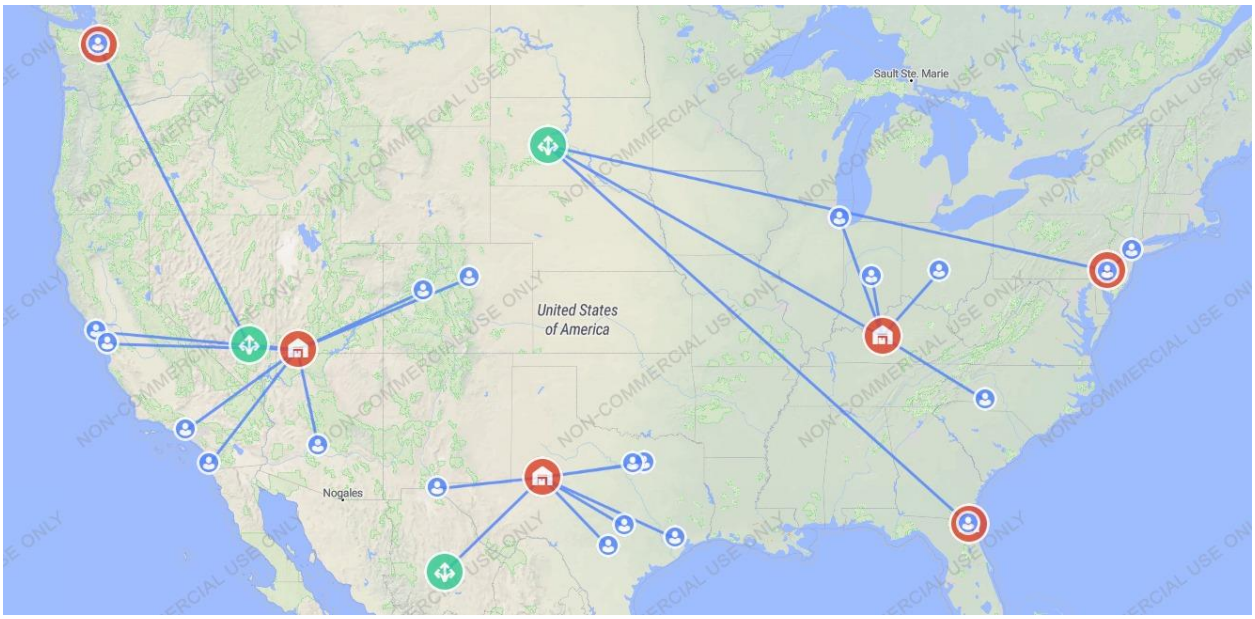
## V Analysis of Described scenarios:

**Scenarios:**

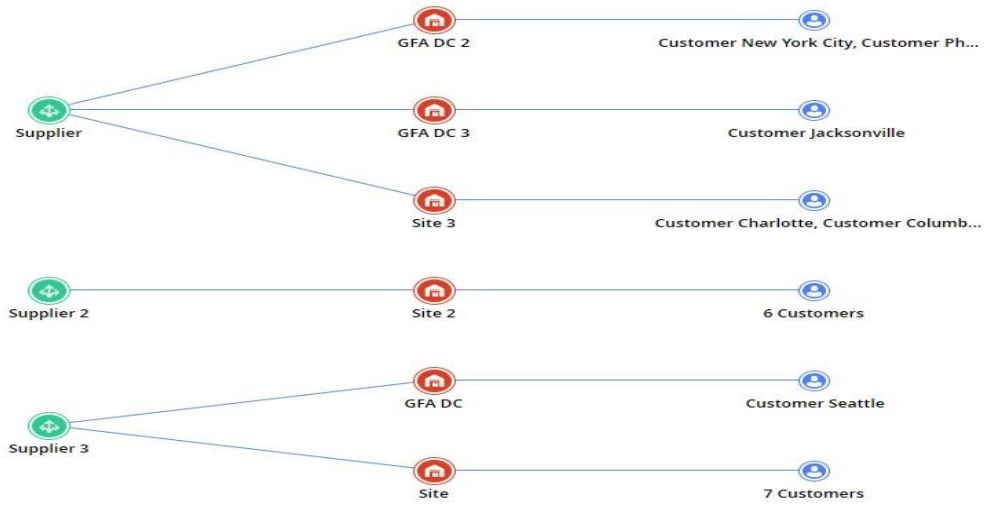
**Customer Location: Midwest** (Transportation Cost Calculation Example)
Information:
**Customer Location: Midwest**
**Supplier 1: Nevada**
Transportation Cost per Kilometer**: $2**

**Challenge:**
An exact transportation cost calculation is impossible without knowing the specific city in the Midwest. However, we can estimate the cost based on two scenarios representing opposite ends of the Midwest region:

**Scenario 1**: Customer in Chicago (Western Midwest)




5. After Adding 3 more DC's




## 6. Optimal Distribution Center after adding 3 DC'S

Estimated Distance: Approximately 1,800 kilometers (using online distance measurement tools)

**Calculation:**
Distance = 1,800 kilometers
Transportation Cost per Kilometer = $2
Total Transportation Cost = Distance x Transportation Cost per Kilometer
Total Transportation Cost = 1,800 km * $2/km = $3,600

**Scenario 2**: Customer in Columbus (Eastern Midwest)

Estimated Distance: Approximately 2,500 kilometers (using online distance measurement tools)

**Important Notes:**

These are just estimated distances based on potential customer locations across the Midwest. The actual distance will vary depending on the specific city.

The $2 per kilometer transportation cost is an assumption. Actual costs can vary depending on factors like mode of transport (truck, rail), shipment size, fuel prices, and negotiated rates with carriers.

Therefore, the estimated transportation cost from Supplier 1 (Nevada) to a customer in the Midwest could range from $3,600 to $5,600, depending on the specific location.

**Scenario 2: Disrupted Transportation Cost (Supplier 1 - Midwest Customer)**

**Original Scenario:**

- Customer Location: Columbus(Eastern Midwest)
- Supplier: Supplier 1 (Nevada)
- Estimated Distance: Approximately 2,500 kilometers (using online distance measurement tools)
- Transportation Cost per Kilometer: $2 (assumed)

**Disruption:**

A major truck driver shortage disrupts the usual transportation methods, causing limited availability and inflated prices for long-haul truck freight.

**Disruption Impact:**

Increased Transportation Cost per Kilometer: We assume a 50% increase due to the disruption, bringing the cost to $2 * 1.5 = $3 per kilometer.

**Calculation:**

- Distance = 2,500 kilometers
- Disrupted Transportation Cost per Kilometer = $3
- Total Transportation Cost with Disruption = Distance x Disrupted Transportation Cost per Kilometer
- Total Transportation Cost with Disruption = 2,500 km * $3/km = $7,500

**Summary:**

Due to the disruption caused by the truck driver shortage, the transportation cost for delivering goods from Supplier 1 (Nevada) to a customer in Colombus (Eastern Midwest) has increased from an estimated $5,000 (original scenario) to $7,500. This represents a significant cost increase of 50%.

**Additional Considerations:**

- The actual cost increase due to the disruption can vary depending on the severity of the shortage and the specific negotiations with carriers.
- This scenario highlights the importance of having a contingency plan for transportation disruptions. This might involve:
- Utilizing alternative transportation modes (e.g., rail) if feasible.
- Negotiating flexible contracts with carriers to account for potential cost fluctuations.
- Diversifying your supplier base to reduce dependence on a single location (potentially a Midwest supplier for Midwest customers).

**The model considers a total of 21 customers located across the United States, with the following distribution:**

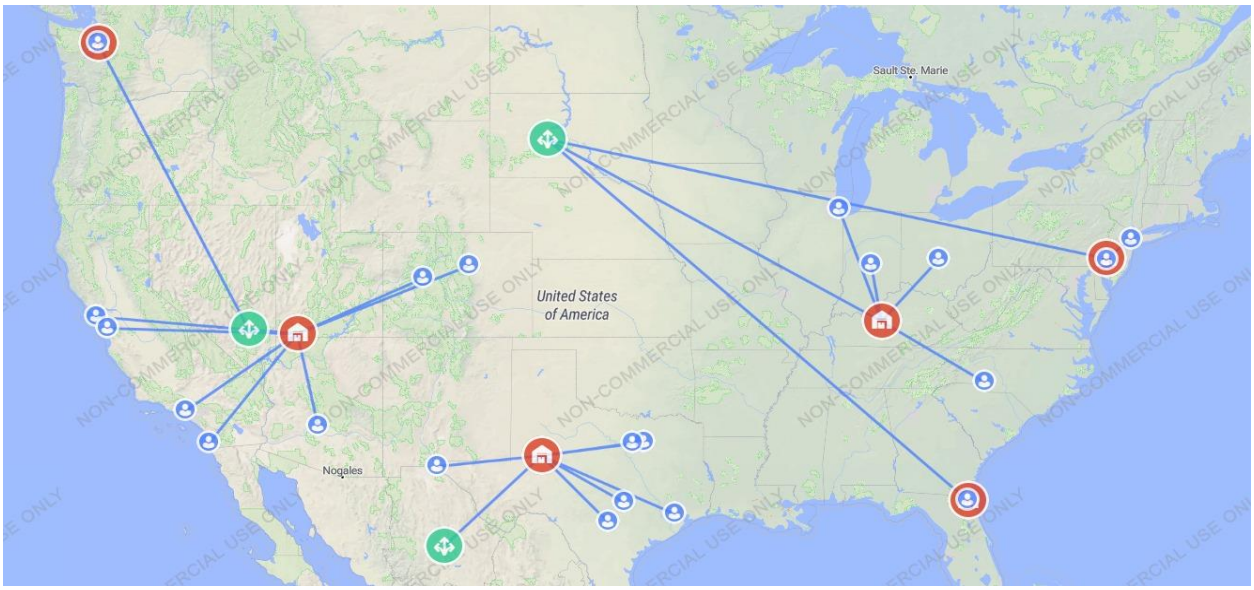
- 1 customers assigned to GFA DC 3
- 1 customers assigned to GFA DC
- The remaining 2 customers assigned to GFA DC 2
- Site 3- 2 customers assigned
- Site 4- 7 Customer
- Site 5- Remaining 6 Customers

**Disruptive Scenario 3**: Increased Costs Due to Supplier Relocation and Fuel Consumption

Disruption: A key supplier to GFA has relocated its operations 2500 km farther from the GFA distribution centers due to unforeseen circumstances. This move, combined with an increase in fuel consumption by around 3000 gallons, significantly impacts transportation costs and efficiency.

Impact Analysis:
- Increased Transportation Costs: The relocation adds \$3750 per shipment due to the distance increase, and the fuel cost increase adds an additional \$7500 (\$2.5/gallon for 3000 gallons), totaling an increase of \$11250 per shipment.
- Delayed Shipments and Operational Inefficiencies: Longer transit times and increased fuel usage may lead to delays and reduced operational efficiency, affecting supply chain reliability.

Mitigation Strategies:
- Optimization and Efficiency Improvements: Implement route and load optimization to mitigate increased distances and fuel usage.
- Supplier and Transportation Diversification: Explore local supplier options and alternative, more cost-effective transportation modes to reduce dependency on the relocated supplier.
- Strategic Inventory Management: Adjust safety stock levels and re-evaluate inventory strategies to buffer against potential supply chain disruptions




7. Connections

**Challenges:**

- Increased Transportation Costs: The relocation adds a substantial cost of $11,250 per shipment, significantly impacting profitability.
- Delayed Shipments and Operational Inefficiencies: Longer distances and higher fuel usage lead to delays, reduced efficiency, and potential stockouts.
- Supply Chain Vulnerability: Dependence on a single, now-distant supplier increases vulnerability to disruptions.

A multi-pronged approach is crucial to address the challenges presented in this scenario. By implementing a combination of optimization, diversification, and strategic inventory management strategies, GFA can mitigate the impact of increased costs and improve supply chain resilience.

## VI Proposed Improvement Recommendations:

**Elaborate Recommendations for Scenario:1 Truck Driver Shortage Disrupting Transportation Costs (using Anylogistix):**

- This scenario highlights the disruption caused by a truck driver shortage, leading to increased transportation costs for delivering goods from a supplier in Nevada to a customer in Columbus, Ohio (Eastern Midwest). Here are some elaborate recommendations for addressing this scenario using Anylogistix:

1. **Deep Dive into Multi-Modal Transportation Options:**

- Modeling Capabilities: Leverage Anylogistix's ability to model complex transportation networks.
- Alternatives beyond Rail: Explore feasibility of barge transport (if waterways are viable) or short-sea shipping (if the Nevada supplier is located on the coast).
- Detailed Analysis: Consider infrastructure availability, transfer terminal costs, total transit times, and impact on customer service levels compared to truck transport.
- Utilize Anylogistix's visualization features to compare delivery routes and estimated lead times across different modes.
- Analyze potential modal combinations (e.g., truck-barge) for specific scenarios where they might be advantageous.

2. **Spot Market Exploration with Simulation:**

- Simulating Spot Market Opportunities: Utilize Anylogistix to model the potential benefits and risks of using the spot market for truck freight during disruptions.
- Capture the dynamic nature of the spot market by incorporating real-time or historical pricing data (if available).
- Analyze potential cost savings compared to traditional contracts with fixed rates.
- Balancing Cost and Reliability: Model scenarios with different percentages of shipments allocated to the spot market versus traditional contracts.
- Assess the trade-off between potentially lower costs but increased volatility and lack of guaranteed capacity with the spot market.

3. **Collaboration for Regional Optimization:**

- Modeling Inter-company Collaboration: Utilize Anylogistix to model collaborative strategies with other businesses in the region facing similar challenges.
- Explore scenarios for consolidating shipments with neighboring companies to leverage economies of scale and negotiate better rates with carriers.
- Analyze the feasibility of backhauling opportunities where empty trucks returning from deliveries can be utilized for shipments in the opposite direction.

4. **Leveraging Technology for Improved Visibility and Decision-making:**

- Cost-Effectiveness Analysis: Analyze the cost-effectiveness of implementing transportation management systems (TMS) or logistics platforms within Anylogistix.
- Consider functionalities offered by different solutions like route optimization, real-time carrier pricing integration, and shipment tracking.
- Model scenarios with and without TMS to assess potential cost savings and improved operational efficiency.
- Enhanced Visibility and Decision Support: Explore how TMS or logistics platforms can improve overall transportation visibility during disruptions.
- Integrate real-time market data on fuel costs, carrier availability, and spot market pricing into your Anylogistix model.
- Utilize Anylogistix's simulation capabilities to test different strategies based on real-time data for informed decision-making.

**Elaborate Recommendations for Scenario 2: Increased Costs Due to Supplier Relocation & Fuel Consumption (using Anylogistix)**

- This scenario highlights the disruption caused by a key supplier relocating further away, combined with rising fuel consumption, leading to increased transportation costs and reduced efficiency. Here are elaborate recommendations for addressing this scenario using Anylogistix:

**1. Multi-Faceted Optimization with Anylogistix:**

- Route Optimization: Utilize Anylogistix's built-in route optimization functionalities to analyze existing delivery routes for potential improvements.
- Factor in the increased distance due to the supplier relocation and model alternative routes for increased efficiency.
- Consider factors like traffic patterns, road conditions, and potential rest stops for drivers when optimizing routes.
- Load Optimization: Analyze truck loading practices to maximize space utilization and minimize empty miles.
- Explore options like double-stacking trailers for compatible products and model the impact on transportation efficiency in Anylogistix.
- Analyze potential investments in trailer configurations or packaging optimizations to maximize space utilization.

**2. Supplier and Transportation Diversification Strategies:**

- Local Sourcing Exploration: Utilize Anylogistix to model the feasibility and potential cost benefits of identifying and sourcing from local suppliers closer to GFA distribution centers.
- Gather data on potential local suppliers, including lead times, product quality, and minimum order quantities.
- Simulate scenarios with a mix of local and relocated suppliers to find the optimal balance between cost and supply chain resilience.
- Alternative Transportation Modes: Analyze the feasibility and cost-effectiveness of using alternative transportation modes for longer distances**.**
- Explore options like rail transport or intermodal transportation (combining truck and rail) in Anylogistix.
- Consider factors like infrastructure availability, transfer terminal costs, total transit times, and compatibility with product types when evaluating alternatives.

**3. Strategic Inventory Management with Simulation:**

- Safety Stock Re-evaluation: Utilize Anylogistix to model the impact of adjusting safety stock levels for products sourced from the relocated supplier.
- Consider the increased lead time due to the relocation and model scenarios with different safety stock levels to ensure sufficient buffer against potential delays.
- Implement a risk-based approach, focusing on critical items most susceptible to disruption.

**Inventory Forecasting Improvement:**

- Improve inventory forecasting accuracy to anticipate demand fluctuations and ensure sufficient stock levels despite potential delays.
- Integrate forecasting models into your Anylogistix simulation to analyze the impact of improved forecasting on inventory levels and overall supply chain efficiency.

**Vendor Managed Inventory (VMI) Exploration:**

- Simulate the potential benefits of implementing VMI with the relocated supplier in Anylogistix.
- In VMI, the supplier manages inventory levels at GFA distribution centers, ensuring just-in-time delivery even during disruptions.
- Analyze the impact of VMI on inventory holding costs, order lead times, and overall supply chain responsiveness.

## VII Results:

**Supply Chain Analysis and Optimization using Greenfield Analysis with AnyLogistix**
**Executive Summary**

This report analyzes a proposed distribution network model for a greenfield analysis (GFA). It considers product types (sweatshirts, t-shirts), supplier and customer locations, and potential distribution center (DC) placements. Utilizing AnyLogistix software for simulation and optimization, the report identifies potential challenges associated with various disruption scenarios and recommends improvement strategies to create an efficient and cost-effective supply chain network.

**Key Findings:**

The GFA model optimizes DC placement to minimize transportation costs based on supplier and customer locations.
Geographically dispersed suppliers and customers may pose challenges, but strategic DC placement can mitigate them.
Disruption Scenarios Analyzed with AnyLogistix:

The report analyzes three potential disruption scenarios that could impact the proposed distribution network model:

**Scenario 1: Transportation Cost Disruptions**
This scenario considers situations where transportation costs significantly increase, impacting profitability. Causes could include:

- Fuel price fluctuations: Sudden spikes in fuel prices can dramatically increase transportation costs, impacting profit margins.
- Driver shortages: A lack of available truck drivers can lead to higher freight rates and potentially delay deliveries.
- Congestion and infrastructure issues: Traffic congestion and infrastructure problems can lengthen delivery times and increase fuel consumption, driving up costs.

**Scenario 2: Supplier Relocation**
This scenario explores the situation where a key supplier relocates to a new geographical area farther from the distribution centers, leading to:

- Increased transportation distances:Longer hauls mean higher fuel consumption, driver hours, and potentially additional tolls or fees.
- Extended lead times: Moving suppliers farther away can increase the time it takes to receive goods, impacting inventory levels and potentially delaying customer deliveries.
- Potential quality control concerns:Changing suppliers can introduce initial risks related to maintaining consistent product quality.

**Scenario 3: Customer Location Variations**

This scenario explores situations where there's a significant shift in customer demand or demographics, impacting delivery routes and distribution strategies:

- New market expansion:Expanding into new geographical areas with a high concentration of customers could require establishing new distribution centers or adjusting existing routes.
- Seasonal demand fluctuations: If customer demand varies significantly throughout the year in specific regions, it may be necessary to adjust inventory stock levels and delivery schedules at the DCs.
- Changes in customer service expectations: If customers demand faster delivery times or specific delivery windows, the existing distribution model may need adjustment to meet these new expectations.

**Mitigation Strategies and Improvement Recommendations:**

For each disruption scenario, the report leverages AnyLogistix to analyze potential impacts and recommends mitigation strategies:

**Scenario Analysis and Recommendations:**

Transportation Cost Disruptions:

- Scenario Analysis: Simulate different transportation cost structures to understand cost fluctuations' impact on profitability.
- Recommendation: Implement a Transportation Management System (TMS) to optimize routes, track shipments, and improve decision-making.

Supplier Relocation:

- Scenario Analysis: Model the impact of supplier relocation on transportation distances, lead times, and overall efficiency.
- Recommendation: Diversify transportation modes (rail, intermodal) and explore local sourcing opportunities with AnyLogistix.

Customer Location Variations:

- Scenario Analysis: Simulate customer demand variations in different regions using AnyLogistix.
- Recommendation: Utilize AnyLogistix to re-evaluate safety stock levels, improve inventory forecasting accuracy, and consider Vendor Managed Inventory (VMI) with key suppliers.

**Benefits of Implementation:**

- Reduced transportation costs through route optimization, strategic supplier selection, and multi-modal options.
- Enhanced supply chain resilience by mitigating disruptions through diversification, safety stock adjustments, and VMI.
- Improved operational efficiency through real-time visibility with TMS integration and data-driven decision-making.

## Conclusion

By leveraging AnyLogistix for ongoing analysis and optimization following the principles of GFA, this approach can proactively address potential challenges identified through various disruption scenarios. This ensures a more efficient, cost-effective, and resilient supply chain network from the ground up.

## VII References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