

NORTHEASTERN UNIVERSITY

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# School of Engineering

MECHANICAL & INDUSTRIAL ENGINEERING DEPARTMENT

IE7200 Supply Chain Engineering

## 2nd Partial Exam Project

Instructor: Dr. Cesar Martinez Olvera

Members

Aaditya Gupta      002831774



## **Abstract:**

The comprehensive overview provided explores the utilization of tools like anyLogistix for optimizing and simulating supply chain networks, specifically in the context of Axe Body Spray. This model aids in devising optimization strategies for various aspects such as cost reduction, minimizing lead times, and enhancing service standards. The use of simulation techniques is highlighted as crucial for testing the supply chain under different scenarios, thereby ensuring efficient management and operational processes.

The discussion further deepens into specific elements of the supply chain model for Axe Body Spray, including consumer demand and, supply chain networks. Moreover, the choice of the United States, particularly focusing on smaller cities for distribution, is rationalized by targeted market penetration, distribution efficiency, and opportunities for market expansion and community engagement.

In conclusion, the document offers a deep dive into the strategic planning and continuous improvement required for an efficient supply chain network for Axe Body Spray, emphasizing the importance of data-driven decision-making, optimization, and simulation. It suggests improvements in distribution center expansion, adaptive inventory allocation, and logistics optimization to enhance service speed, reduce costs, and cater to evolving consumer demands and market conditions. This approach aims to strengthen the supply chain's efficiency, resilience, and competitiveness in the product industry.

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## 1. INTRODUCTION TO SUPPLY CHAIN MANAGEMENT

Supply chain management (SCM) is the extensive coordination of activities involved in planning, controlling, and executing the flow of goods and services. It consists of all steps required to transform raw materials into finished products for the consumer.

The primary components of SCM are:

- **Procurement:** This involves acquiring the raw materials, components, and other inputs needed to produce goods and services. Procurement also involves suppliers negotiating prices, establishing contracts, and ensuring timely and quality delivery of supplies.
- **Operations Management:** This focuses on organizing and overseeing the activities that convert raw materials into final products. Operations managers handle production processes, maintain inventory levels, and ensure efficient manufacturing that meets customer demand.
- **Logistics:** This involves the organized movement and storage of goods and resources. Logistics personnel design and manage transportation routes, operate warehousing facilities, and ensure proper and punctual delivery of items to their destinations.
- **Marketing Channels:** This involves controlling the pathways used to sell products to customers. Marketing professionals determine effective strategies to reach potential buyers, create promotional campaigns, and implement pricing and distribution tactics.

The importance of supply chain management is that businesses need to be successful. An efficient and effective supply chain can help businesses to:

- **Operational cost savings:** By streamlining processes and optimizing inventory levels, businesses can lower costs associated with production, transportation, and storage.
- **Enhance productivity:** By coordinating activities across the supply chain, businesses can enhance overall efficiency and productivity.
- **Elevate customer experience:** By delivering products on time and in good condition, businesses can boost customer satisfaction and loyalty.
- **Establish superior capabilities:** By having a more efficient and effective supply chain, businesses can gain an edge over their competitors.

## 2. INTRODUCTION TO FACILITY LOCATION

Tools like anyLogistix for supply chain network optimization and simulation involve a comprehensive process of analyzing, designing, and managing the flow of goods, data, and resources across the entire supply chain network. The goal is to maximize operational efficiency and effectiveness while reducing costs and ensuring customer satisfaction. Here's an overview of how such tools can facilitate supply chain optimization and simulation:

**Data Gathering and Analysis:** Collecting extensive data related to the supply chain, such as inventory levels, demand forecasts, transportation costs, manufacturing capabilities, lead times, and more. This data serves as the foundation for building a supply chain model that is in its prototype phase.

**Supply Chain Model Development:** Utilizing anyLogistix, a digital representation of the supply chain network is constructed. This model encompasses all relevant entities, including suppliers, production facilities, distribution centers, and retail outlets.

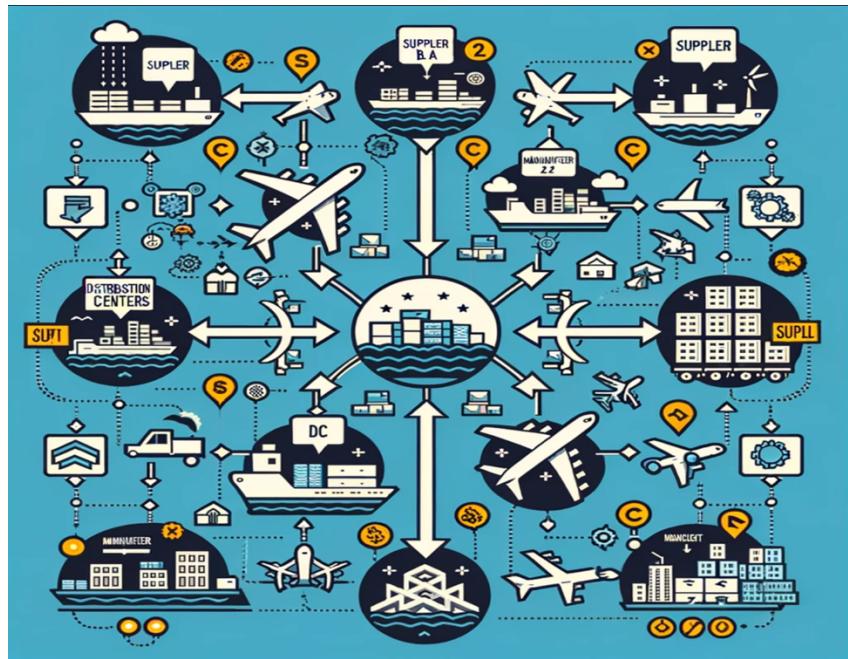
**Optimization Strategies:** The model is used to identify the most efficient and cost-effective methods for managing the supply chain network. Optimization efforts can target certain aspects, such as cost reduction, minimizing lead times, inventory level optimization, or improving service standards.

**Scenario Simulations:** Simulation plays a crucial role in evaluating how the supply chain will perform under diverse scenarios. This can involve stress-testing the supply chain against potential disruptions, fluctuations in demand, or variations in supply.

**Scenario Evaluation:** Various scenarios are analyzed to comprehend the potential outcomes of different strategic decisions. This could involve changes in supplier selection, transportation modes, inventory policies, or expansion plans.

**Implementation and Continuous Improvement:** The insights gained from optimization and simulation exercises are utilized to make informed decisions about the supply chain network. Continuous improvement is an integral part of this process, where the supply chain model is regularly updated with new data and re-optimized to adapt to evolving business environments and market conditions.

Utilizing tools like anyLogistix for supply chain network optimization and simulation provides a powerful platform for data-driven decision-making. It enables businesses to visualize their supply chain network, predict the impacts of different strategies, and optimize their operations for improved efficiency, resilience, and competitiveness.



*Figure 1. Supply Chain Process.*

### 3. DESCRIPTION OF THE PROPOSED MODEL

#### 1. Product Details

In developing a supply chain model for specific items such as Axe body spray (product A and product B as described) multiple aspects are evaluated to justify the selection of these items. The primary attributes of each model are summarized below:

PRODUCT	SPECIFICATION	COST	VOLUME
Product A	Axe Signature Mysterious	\$22	154 ml
Product B	Axe rogue	\$15	154 ml

*Table 1: Table of Product detail*

For Axe Body Spray in the United States, here's a detailed yet concise overview following the structure you provided:

- 1. Consumer Demand:** There is a growing consumer trend towards personal hygiene and grooming products, significantly increasing the demand for Axe Body Spray. This reflects a shift towards self-care and personal expression.
- 2. Complex Supply Network:** The supply chain for Axe Body Spray involves domestic and international sourcing of materials like fragrances and packaging, sophisticated manufacturing processes, and an extensive distribution network, ensuring products meet market demand efficiently.
- 3. Cost Fluctuation Sensitivity:** The pricing of Axe Body Spray can be sensitive to fluctuations in raw material costs, changes in labor costs, and market competition. These factors can influence overall affordability and consumer purchasing decisions.
- 4. Variety of Products:** Axe offers a diverse range of fragrances and body spray types to cater to a wide spectrum of consumer preferences. This range allows consumers to find a fragrance that aligns with their identity and lifestyle.
- 5. Legal and Ecological Considerations:** Axe Body Spray production complies with legal and environmental regulations, focusing on reducing chemical emissions, ensuring product safety, and adopting sustainable production methods.
- 6. Advancements in Product Features:** Axe is committed to innovation in its product line, improvement in spray technology, and efforts to create eco-friendly packaging, responding to consumer demand for advanced and sustainable personal care products.

## 2. SUPPLIERS

Our decision to choose Hogback and Cambridge Road as suppliers within the AXE body spray supply chain framework is grounded on multiple strategic factors:

- 1. Financial Efficiency:** Both Hogback and Cambridge Road are recognized for their cost-effective production methods. The lower labor and production costs at these facilities can significantly reduce the overall cost of Axe Body Spray.
- 2. Production Proficiency:** Cambridge Road is renowned for its advanced manufacturing technologies and expertise in personal care products. Hogback, while smaller, brings innovative approaches and flexibility to the production process, contributing to high-quality output.
- 3. Resource Accessibility:** Hogback and Cambridge Road were selected as they are the most optimal locations for procuring the supplies that are needed for manufacturing the distinct products.
- 4. Mass Manufacturing Capability:** Cambridge Road and Hogback have the capacity for large-scale manufacturing, essential for meeting high demand and ensuring a steady supply. Hogback's specialized production lines allow for customized and limited-edition products.

**5. Geographical Advantage:** Geographically, both Hogback and Cambridge Road are situated near major transportation hubs, facilitating easier and cost-effective shipping to various marketplaces across the USA.

**6. Regulatory Backing and Framework:** The regions where Hogback and Cambridge Road are located benefit from government policies supporting the manufacturing sector, including tax incentives and subsidies, beneficial for keeping operational costs low.

**7. Supply Chain Risk Mitigation:** By choosing suppliers from different locations within the USA, we can mitigate the risk associated with relying on a single source. This diversification can protect against regional disruptions, political instability, or supply shortages.

**8. Expanding Consumer Base:** Both Hogback and Cambridge Road are positioned well to meet the increasing demand for personal care products, especially as trends in men's grooming continue to evolve. Their capabilities align with the market's growing requirement for innovative and environmentally friendly products.

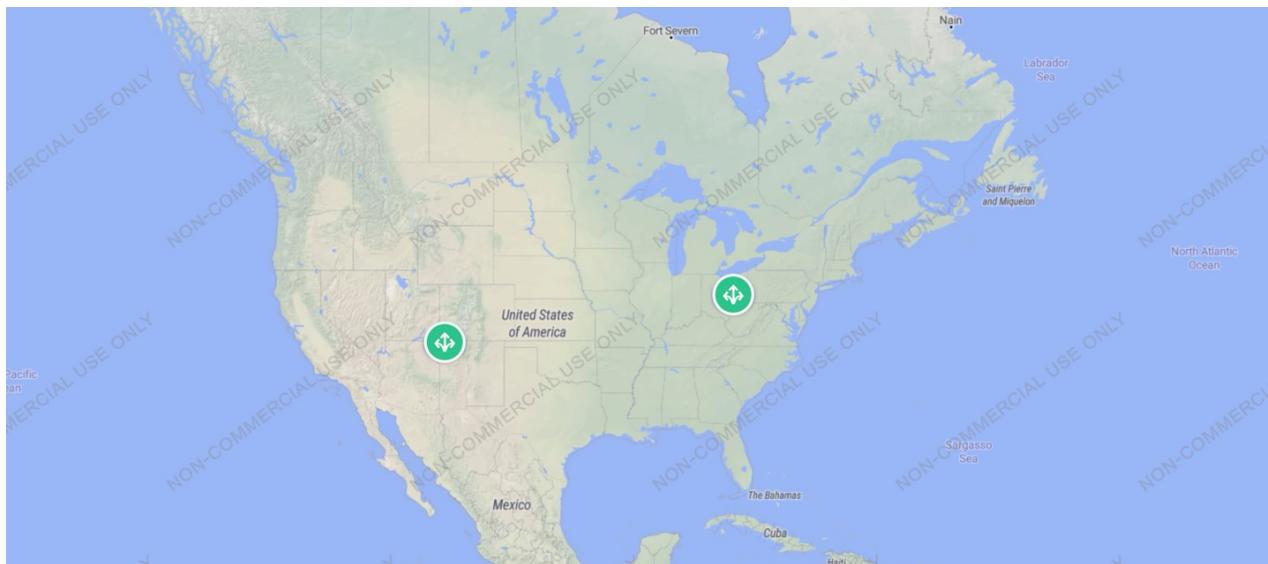


Figure 2: Map view of the suppliers

### 3. CUSTOMER

Choosing the United States as the primary market for our Axe body spray supply chain, with a focus on the 45 populous cities, is driven by several strategic reasons:

**1. Targeted Market Penetration:** Targeting cities like San Angelo, Redcliff, Boulder, Martinsville, and Mount Pleasant allows for focused marketing efforts and direct engagement with markets that are typically underserved by major brands.

**2. Consumer Dynamics:** These areas represent a diverse landscape, enabling Axe to tailor marketing strategies to various consumer preferences and lifestyles prevalent in different regions.

**3. Distribution Efficiency:** Focusing on these towns and cities ensures a more manageable and efficient distribution network. This can lead to lower transportation costs and faster delivery times, improving overall customer satisfaction.

**4. Market Expansion Opportunities:** By establishing a presence in these smaller markets, Axe can build brand loyalty and pave the way for future expansion into adjacent regions or larger urban areas.

**5. Competitive Advantage:** Many larger competitors may overlook smaller cities and towns, providing Axe with an opportunity to dominate these markets and establish a strong local presence.

**6. Customer Feedback and Innovation:** Direct interaction with customers in these markets can provide valuable feedback for product improvement and innovation, aligning product offerings more closely with consumer needs.

**7. Localized Marketing Strategies:** Each market, such as San Angelo, Redcliff, and Boulder, can benefit from localized marketing strategies that resonate with the local culture, values, and consumer behaviors, increasing the relevance and appeal of Axe Body Spray.

**8. Retail Partnerships:** Establishing partnerships with local retailers in these areas can enhance distribution efficiency and market penetration, leveraging existing retail networks and relationships.

**10. Cultural and Event-Based Marketing:** Leveraging local events, traditions, and community programs can provide unique marketing opportunities for Axe, aligning the brand with community values and interests.

#### **4. Distribution Centre (DC's)**

Selecting San Angelo, Red Cliff, Boulder, Martinsville, and Mount Pleasant as distribution centers for our Axe Body Spray supply chain in the United States involves strategic considerations based on logistics, accessibility, and scalability:

**1. Central Location and Reachability:** - San Angelo: Serves as a strategic point for distributing to the southwestern United States, including Texas, and neighboring states, offering better reach to rural and suburban areas.

- Red Cliff: Located in a unique position, it offers access to the northern central United States, advantageous for reaching remote areas and complementing urban distribution.

- Boulder: Positioned to efficiently serve the Rocky Mountain region and surrounding states, providing a pivotal point for both urban and extensive rural distribution.
- Martinsville: Acts as an eastern hub, offering excellent access to the south-eastern and eastern United States, enhancing reach to dense populations.
- Mount Pleasant: Strategically placed to optimize logistics in the northern United States, acting as a central point for both the Midwest and North-eastern distribution corridors.

**2. Logistics Infrastructure:** All chosen locations are connected through significant transportation networks, including highways and local transport routes, essential for the efficient and flexible distribution of Axe Body Spray.

**3. Expandability:** Each location provides the potential for scalable operations, accommodating growing demand and the opportunity to serve as a template for future expansion in strategic locations across the country.

**4. Economic Advantages:** Operating in these diverse locations allows for cost benefits in terms of land, and operation, and potentially lower transportation costs due to proximity to key markets, while maintaining effective distribution capabilities.

**5. Risk Mitigation through Diversification:** Utilizing multiple geographic locations helps in diversifying risk. Should there be disruptions in one area, the other centers can help maintain the supply chain's continuity.

**6. Local Market Servicing:** - Each DC can focus on serving its regional market more effectively, understanding and catering to local demand patterns and distribution challenges.

**7. Employment and Resource Utilization:** These locations can provide access to a diverse local workforce and resources, potentially reducing labor costs and benefiting from local expertise

In conclusion, the choice of San Angelo, Red Cliff, Boulder, Martinsville, and Mount Pleasant as distribution centers is informed by their geographic advantages, transportation infrastructure, scalability potential, cost efficiency, risk diversification, and ability to effectively penetrate regional markets. This strategic placement ensures comprehensive coverage and efficient distribution to the diverse customer base across the U.S. for Axe Body Spray.

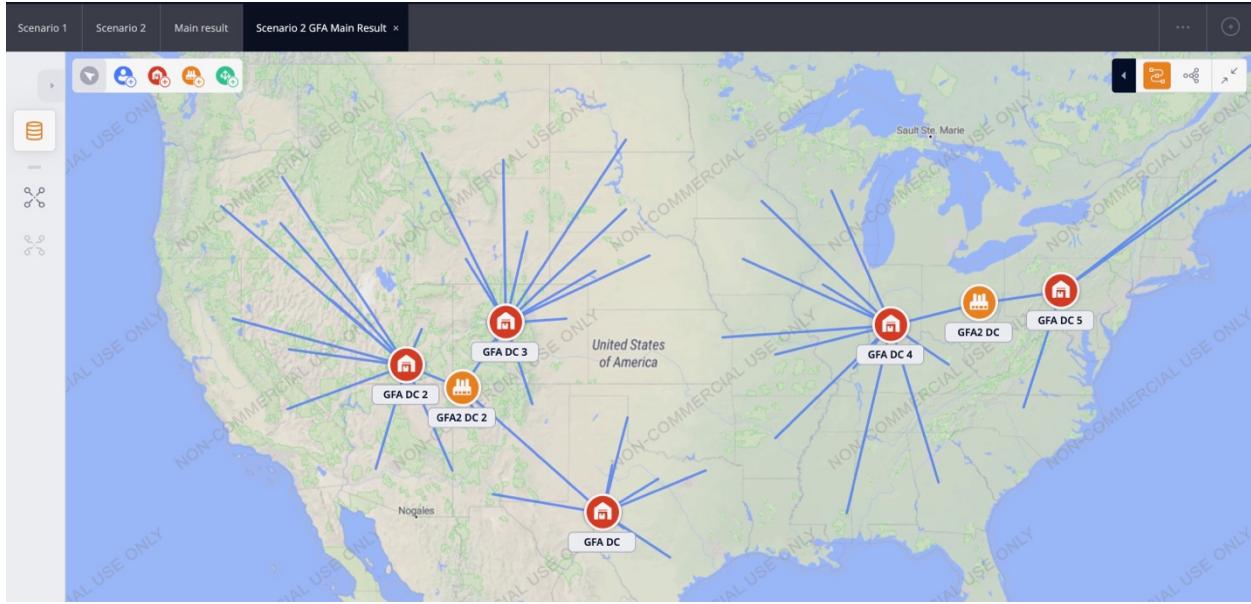


Figure 3: Map view of the Distribution Center

## 5. Transportation

The decision-making in selecting varied transportation methods — air, sea, rail, and different truck classes — plays a pivotal role in establishing effective supply chain frameworks under various logistical scenarios. Here's the rationale behind each chosen transport mode:

Vehicle type	Capacity(m <sup>3</sup> )	Cost per mile (Variable cost) per route
Road	4000 tons	\$2

Table 2: Table of Transportation

### 1. Road:

We have solely utilized road transport from our manufacturing plant to our distribution centers as we have only conducted a Green Field Analysis (GFA). We will be able to explore additional modes of transport once we undertake network optimization.

## GENERAL ASSUMPTION:

Name	Assumption/ Comment/Description
Supplier	Suppliers Hogback and Cambridge Road are chosen for their cost-effectiveness, manufacturing expertise, and strategic location. They provide a reliable and diverse supply of essential oils and fragrances
Export Sites	We don't have proper export sites as our market is mostly in US, so we don't have to use export.

Path	The distribution path involves direct shipment from manufacturing plants to distribution centres, then to retailers or customers. Primary transportation is by road.
Facility Expenses	10% of the product value as inventory holding cost.
No. of D. Cs	On performing the GFA we obtained 5 distribution centres
No. of Customers	For the customers we have used advanced scenario and placed 45 customers and was placed randomly by the software

Table 3: Table of general assumptions

## 4. DESCRIPTION OF THE SCENARIOS TO BE ANALYSED

### Introduction:

The described scenario outlines the supply chain flow for Axe Body Spray, tracing its journey from sourcing raw materials from suppliers to production at the manufacturing facility, and subsequently to the distribution center (DC)

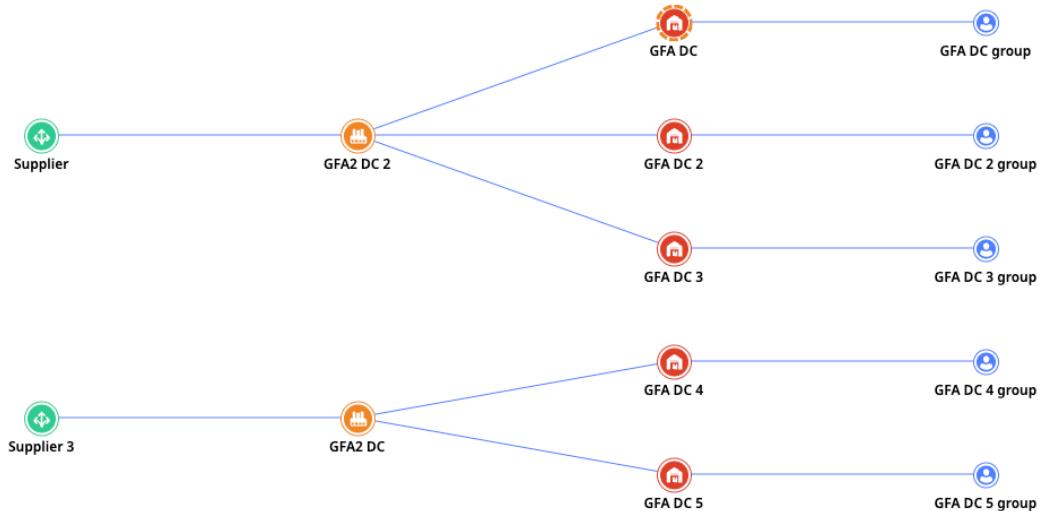


Figure 4 The structure of product supply

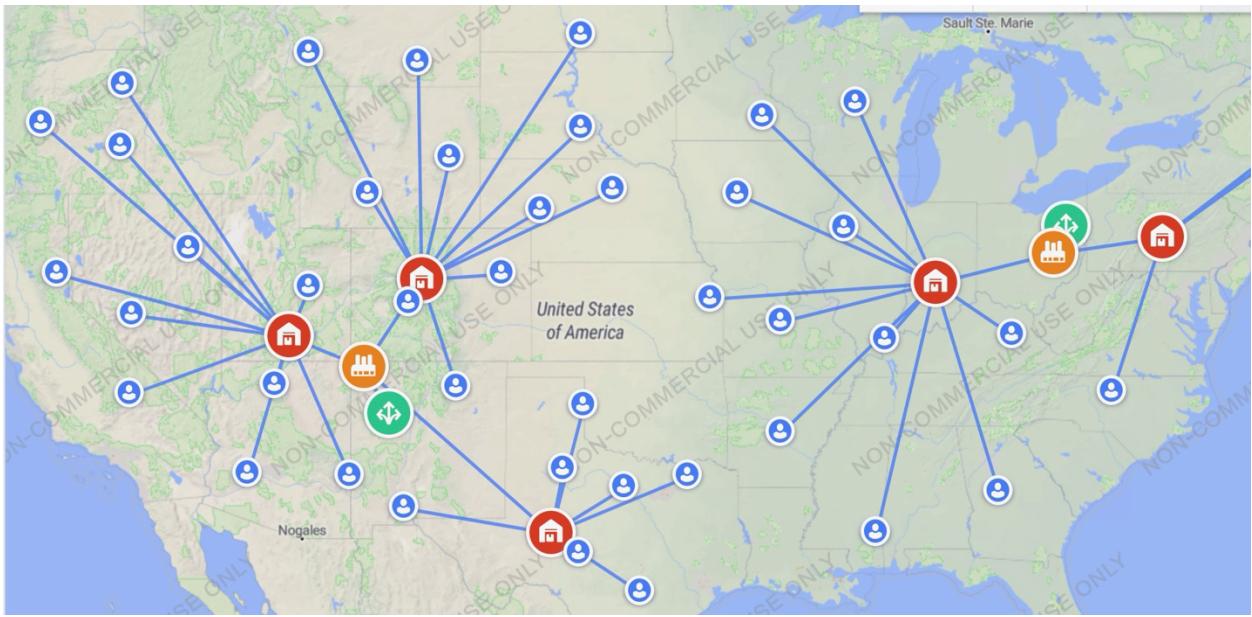


Figure 5: Map view of the Distribution Center

## Product Flow:

PRODUCT FLOWS						
#	From filter	To filter	Product filter	Period filter	Flow, pcs filter	Dist filter
1	Supplier	GFA2 DC 2	AXE BODY SPRAY 1	Time Period	21,460	18
2	GFA2 DC	GFA DC 4	AXE BODY SPRAY 1	Time Period	8,140	40
3	GFA2 DC	GFA DC 5	AXE BODY SPRAY 1	Time Period	2,960	36
4	Supplier 3	GFA2 DC	AXE BODY SPRAY 1	Time Period	11,100	96
5	GFA2 DC 2	GFA DC	AXE BODY SPRAY 1	Time Period	5,180	89
6	GFA2 DC 2	GFA DC 3	AXE BODY SPRAY 1	Time Period	8,140	35
7	GFA2 DC 2	GFA DC 2	AXE BODY SPRAY 1	Time Period	8,140	27
8	GFA2 DC	Customer 24	AXE BODY SPRAY 1	Time Period	740	51
9	GFA2 DC	Customer 9	AXE BODY SPRAY 1	Time Period	740	30
10	GFA2 DC 2	Customer 19	AXE BODY SPRAY 1	Time Period	740	52
11	GFA2 DC 2	Customer 37	AXE BODY SPRAY 1	Time Period	740	33
12	GFA2 DC 2	Customer 7	AXE BODY SPRAY 1	Time Period	740	38

Figure 6: image of product flow table

## Conclusion:

After conducting the Greenfield Analysis (GFA), we've identified the best locations for our distribution center and manufacturing plant for our suppliers.

Additionally, we've calculated the inventory holding costs for both Axe Signature and Axe Rogue from our manufacturing plant to our distribution center.

Moving forward, we need to evaluate the most efficient mode of transportation. Although we've initially chosen road transport, further analysis is necessary to draw definitive conclusions and accurately estimate the costs for the entire supply chain network.

## 5. DISRUPTION SCENARIO

We are facing two disruption scenarios and have considered two different cases. Due to technical difficulties, we are required to shut down one of these. Consequently, the new network configuration directs the need to the nearest distribution center. Theoretically, this results in the demand for the closest DC increasing to more than double its original demand.

### SCENARIO 1:

In this case, we have opted to shut down distribution center 1 due to some technical reasons.

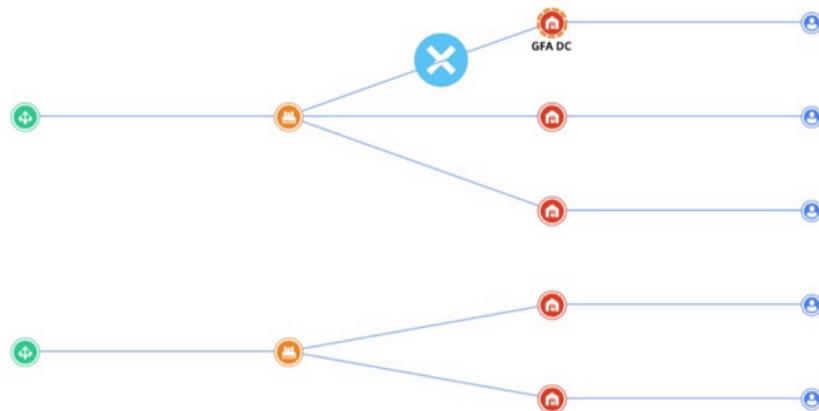


Figure 7: Image of one of the DCs being closed.

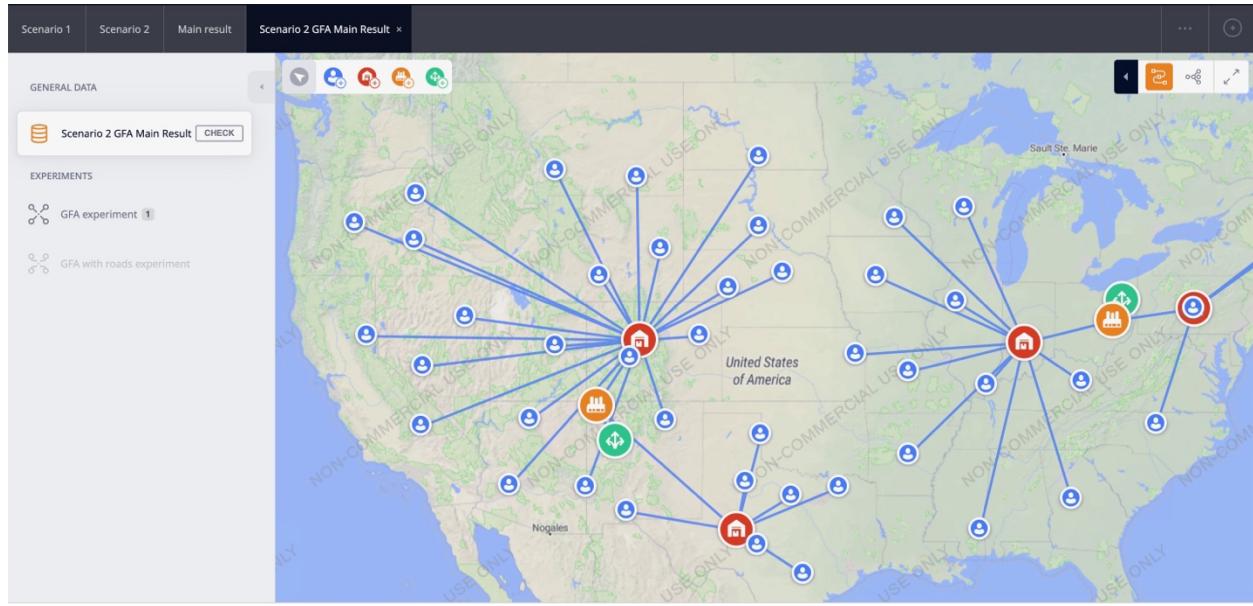


Figure 8: The image of new nodes connected to the nearest DC.

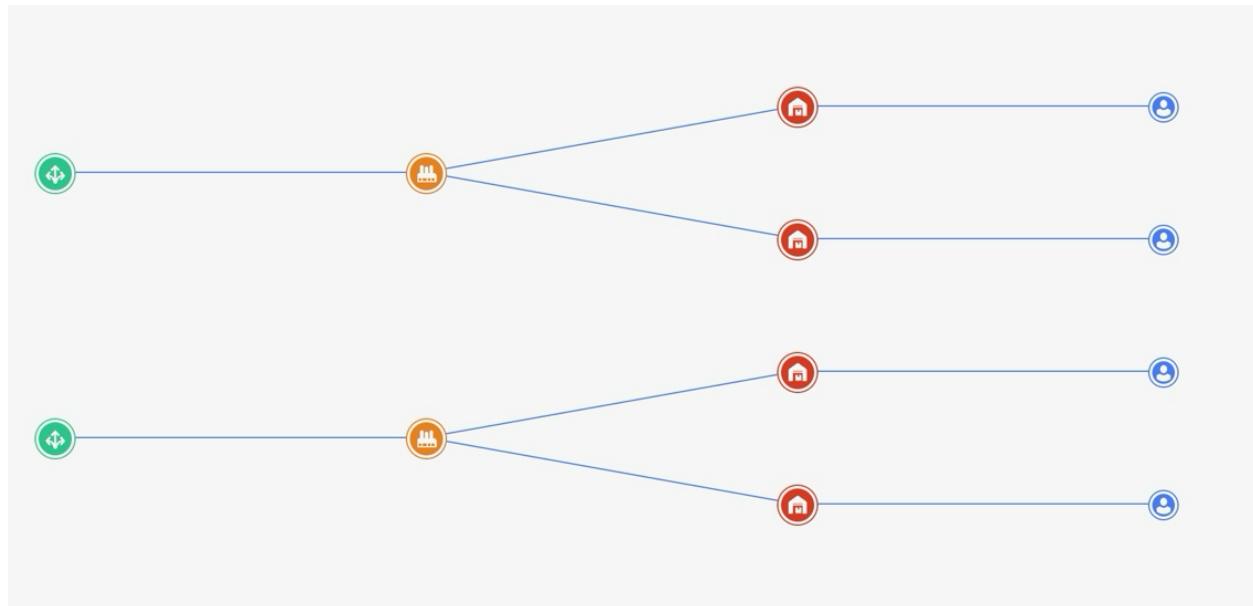


Figure 9: The map view of the updated DC.

Therefore, in this scenario, GFA Distribution Centre 2 was determined to be closed, and the 10 customers previously served by GFA DC 2 were rerouted to GFA DC 3, the closest distribution center.

## SCENARIO 2:

We opted to close the facility as it was serving only three customers. Subsequent analysis using the software indicated that these three customers were reallocated to the closest distribution node. Based on our assumptions, it was determined that the inventory holding costs at the now-closed GFA Distribution Centre 5 were significantly higher than the transportation costs from GFA DC 4 to GFA DC 5.

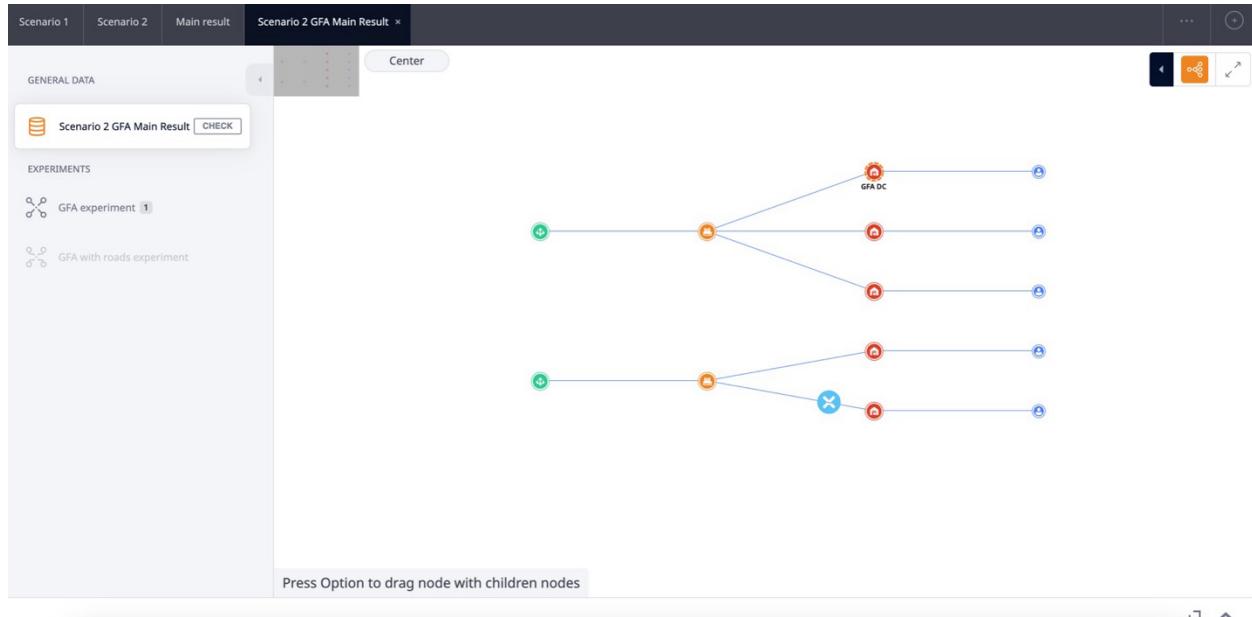


Figure 12: Image of one of the DC locations being closed.

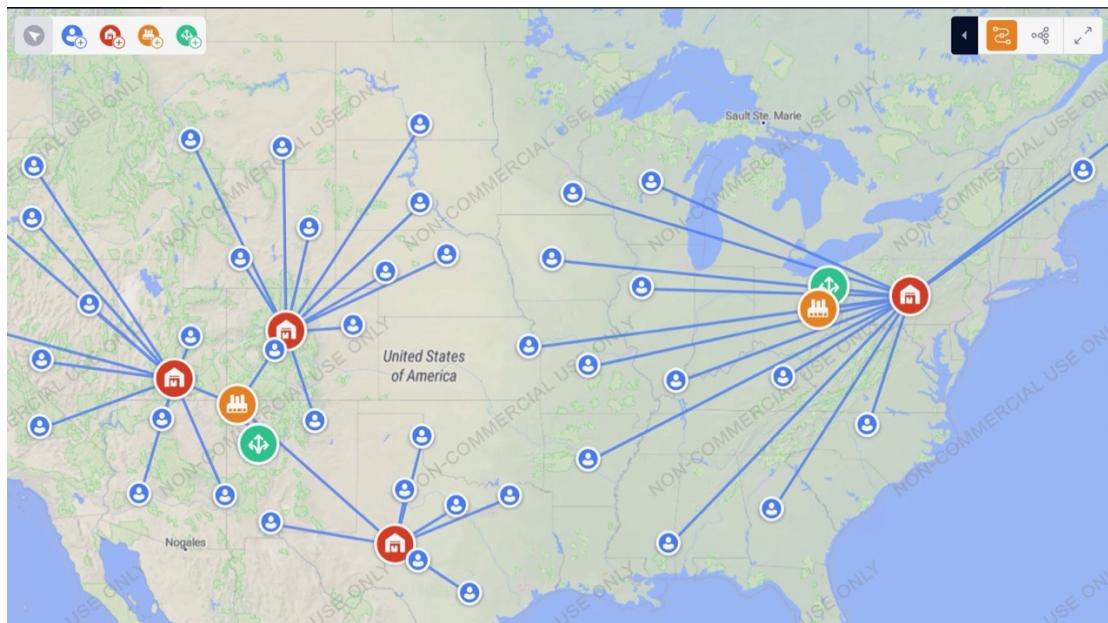
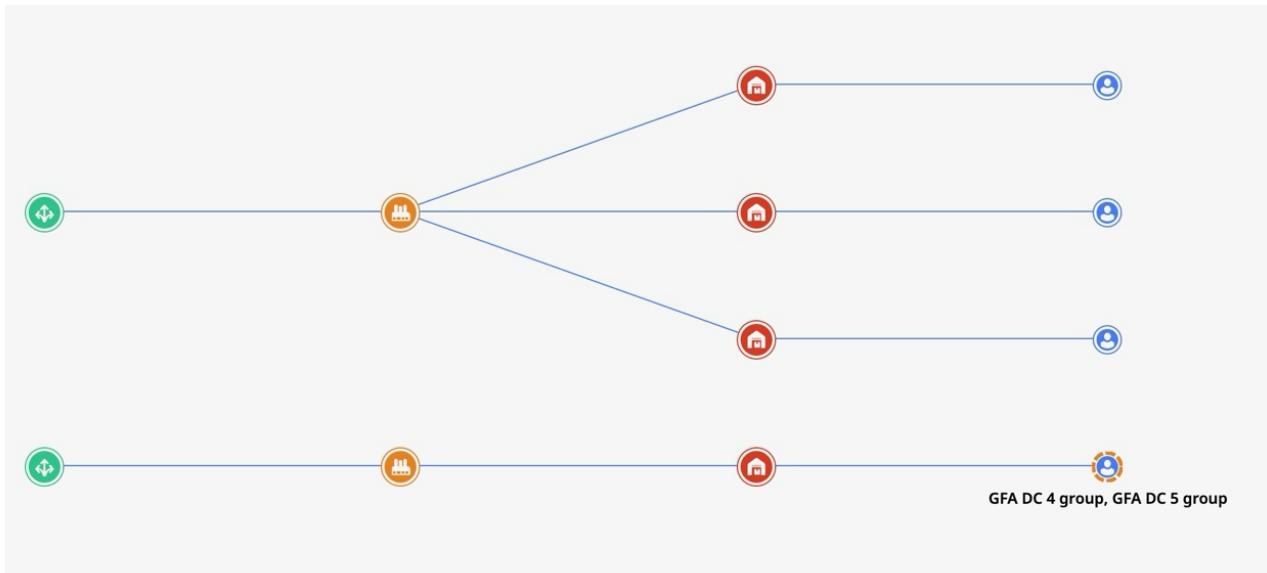


Figure 13: The image of new nodes connected to the nearest DC.



*Figure 14: The map view of the updated DC.*

## CONCLUSION:

In this project, we selected two unique fragrances of Axe body spray to model our supply chain, assuming each product originates from separate suppliers and manufacturing facilities. Additionally, we utilized five distribution centers to facilitate connections to 45 randomly chosen customers.

The GFA conducted is not entirely precise, as it relies on several assumed parameters that may not entirely reflect reality, given that our analysis is conducted using a learning software with specific limitations. To achieve more accurate and definitive results, further analysis through network optimization is necessary. While we have determined the inventory holding costs to gain a clearer understanding of our GFA, it is still premature to definitively conclude that this configuration represents the optimal network.

## 6. PROPOSED IMPROVEMENT RECOMMENDATION

**Distribution Centre Expansion:** Elevate the supply network by introducing additional distribution hubs, particularly in regions with dense customer populations. This action aims to minimize the geographical gap between inventory and consumers, leading to quicker delivery times and decreased freight expenses. Consider future scalability and the capability to cater to an expanding customer base while ensuring consistent quality of service during this expansion.

**Adaptive Inventory Allocation:** Develop a customized inventory approach, allocating stock based on regional consumption trends. Utilize detailed analysis of transaction data and consumer

activities to forecast demand for specific locales. Stocking products nearer to areas with the highest demand aids in enhancing the speed of service, diminishing the chance of product shortages, and boosting overall client satisfaction. This strategy requires an adaptable and resilient inventory management system to respond effectively to fluctuating consumer demands and market dynamics.

**Logistics Optimization:** Overhaul the current transport and logistics structure to remove redundant operations and streamline workflow. This might include amalgamating cargo loads, choosing the best-suited modes of transport, and applying advanced software for enhancing route selection, thus ensuring deliveries are executed via the most direct and cost-effective routes. Streamlining logistics not only aids in decreasing expenses but also promotes more eco-friendly practices by lowering the energy and resource expenditure associated with transportation.

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