Digital Supply Chain and Operations Analytics SoSe-2024
Global Supply Chain and Operations Management M.A.

Prof. Dr. Dimitri Ivanov

CASE STUDY: ANALYZING THE SUPPLY CHAIN NETWORK OF A DOOR CONSULTING COMPANY

By:

Alfredo Jose Alvarez Santiago 77211948967

Mukhammad Marksov 77211948967

Tram Nguyen 77212005139

Shahin Babaei 77211825514

Metallic Door

Fancy Door

Pet Door

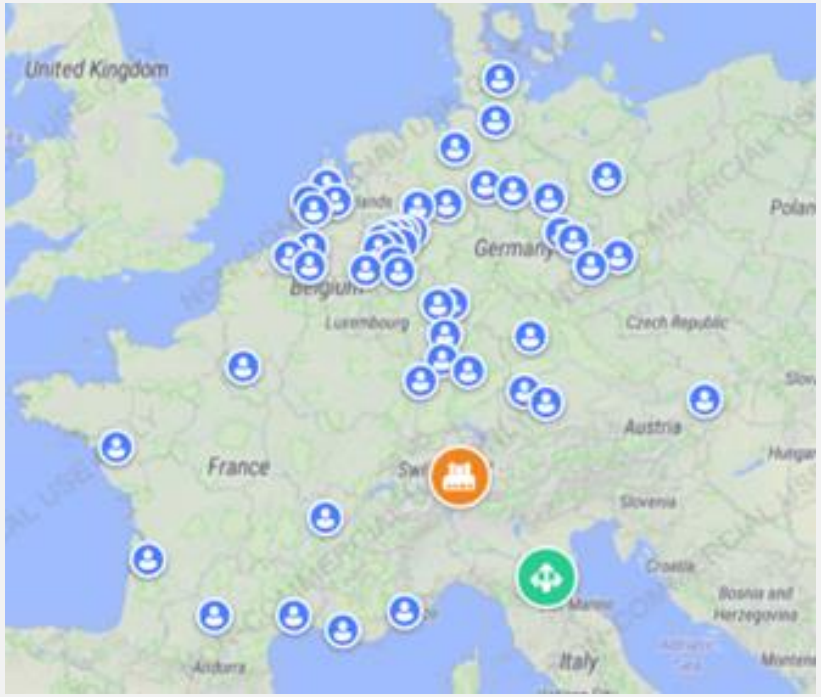
Source: https://www.glenviewhaus.com/wood-door.php?GD=H002_2SL_CST_Mahogany-Walnut&Type=Front&DoorStyle=Heritage

Table of Content:

1. Introduction and case overview to Doors Inc.

Doors Inc. Is a door manufacturing and distribution company, with a focus on Western Europe namely (Germany, France, Austria, Netherlands & Belgium) The company serves a substantial customer base of 50 clients

Currently, Door Consulting manufactures various door types, including Fancy, Metallic, and Pet Doors, in Curaglia (Medel), Switzerland. Raw materials are transported by truck from Italy. Picture illustrates the existing supply chain network.



2. Problem Statement

Door Consulting faces several critical challenges that must be addressed to maintain and enhance its market position and operational efficiency.

- **1) Limited Supply Chain Infrastructure**: Currently, Door Consulting operates with only one supplier and a single production facility.
- **2) Intense Competition in the German Market**: The German door market is highly competitive, leading to a decline in door production.
- **3) Long Delivery Routes and Supply Chain Disruptions**: Extended delivery routes result in inflexibility in meeting customer demands, causing delays and dissatisfaction.

3. Data parameters and Assumptions

To facilitate the analysis and streamline the complexity of the problem, several assumptions and data parameters have been established:

Category	Parameter	Value
Currency and Unit Measures	Costs and Profits	USD
	Unit of Product Status	Pieces (pcs)
Transportation Specifications	Capacity of a Single Truck Load	50 pieces
	Type of Shipment	Truck
	Average Speed	50 km per hour
	Transportation Cost (Supplier to Factory)	0.05 USD per pcs
	Transportation Cost (Factory to DC)	1 USD (fixed delivery cost)
	Transportation Cost (DC to Customer)	0.02 USD per pcs
Production Costs	Fancy Door Model	50 USD per pcs
	Metallic Door Model	25 USD per pcs
	Pet Door Model	5 USD per pcs
Seasonal Demand Periods	Summer Period	January 1, 2024, to August 31, 2024
	Winter Period	September 1, 2024, to April 9, 2025
	Demand Coefficient (Summer)	1.35
	Demand Coefficient (Winter)	1.0

4. Experiment and Results
a) Green Field Analysis (GFA)

Why GFA?

To find the optimal number of distribution centers as well as for defining the approximate locations for the supply chain sites, Greenfield analysis is used.

GFA help us to Analyse following data:

- Locations of the customers/sites
- List of products
- Aggregated demand for each customer and product
- Direct distance between customers and DCs/Warehouses or number of facilities we need to find

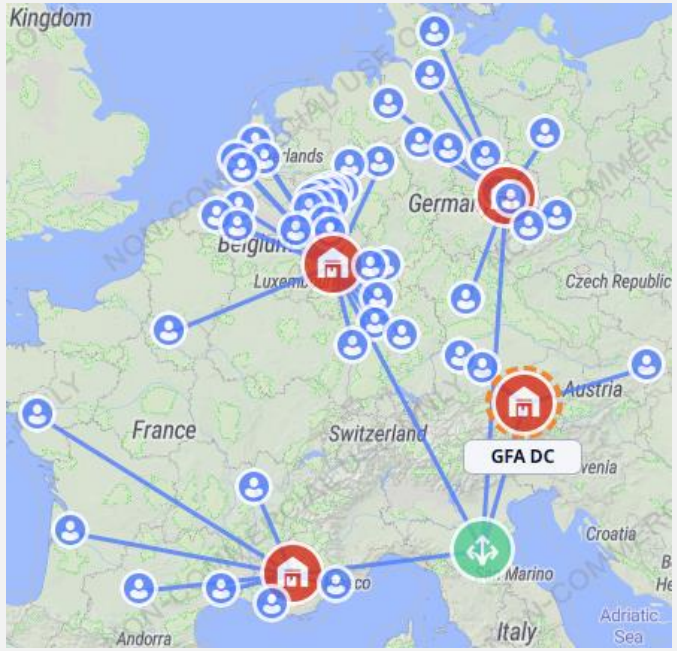
https://www.anylogistix.com/features/solving-facility-location-problem-with-greenfield-analysis/

Greenfield Analysis (GFA)Question‘s

- the optimal coordinates of the new DCs
- the maximum & minimum distance from an optimal DC location to a customer
- The total costs of the SC
- Do we satisfy all customer demand from the optimal DC locations?
- The costs, relevant for choosing an optimal DC location, but not considered in this GFA analysis

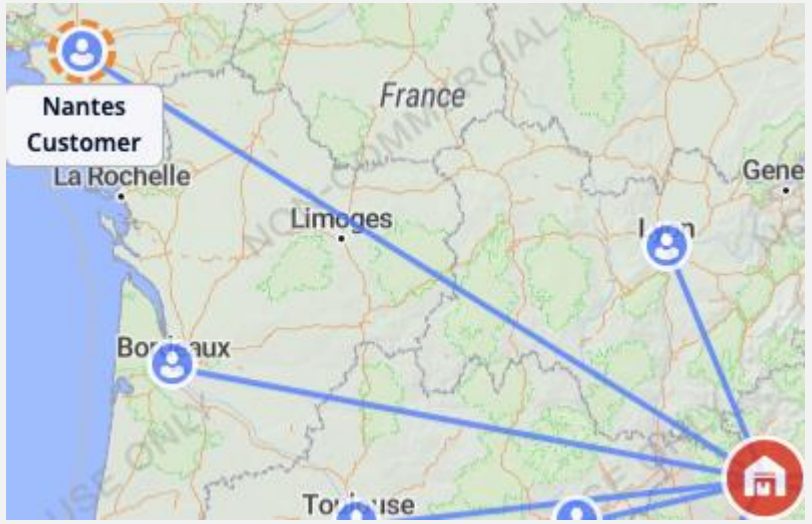
https://blog.hwr-berlin.de/ivanov/wp-content/uploads/2017/06/ALX-2017_Full.pdf

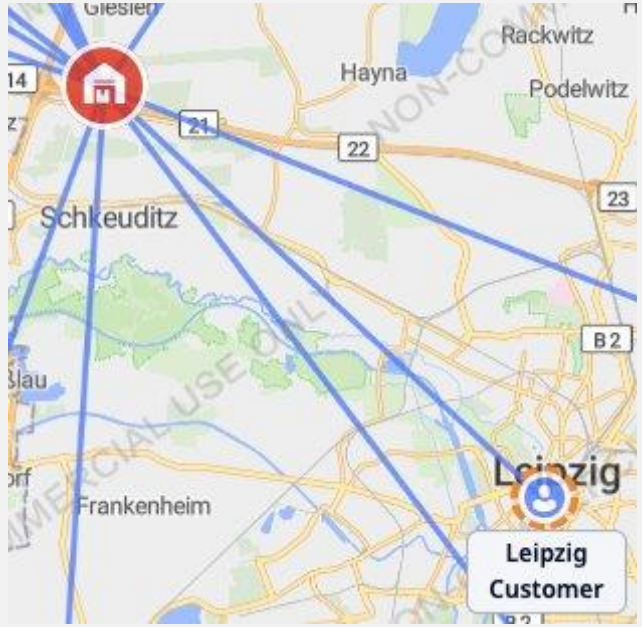
What are the optimal coordinates of the new DC's?



NAME	LATITUDE	LONGITUDE
DC Austria	47.445	12.749
DC Germany	51.428	12.22
DC Belgium	50.155	7.139
DC France	43.965	5.915

What is the maximum and Minimum distance from an optimal DC location to a customer in Kilometer?

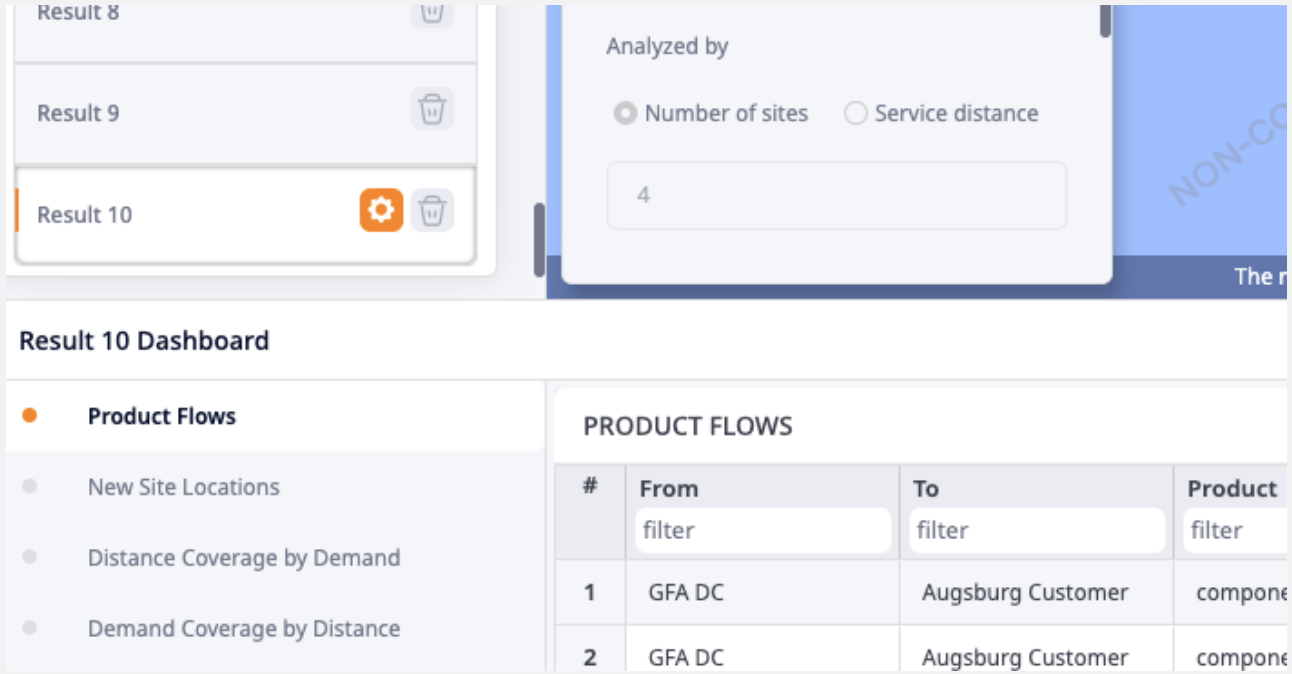




Name	Costumer	Maximum Distance	Minimum Distance
DC Germany	Leipzig Costumer		14.39
DC France	Nantes Costumer	684.756	

https://anylogistix.help/experiments/gfa-parameters.html & app Anylogistix

What are the Total costs of the SC?
What is the most efficient number of Site's?



Number Of Site	Total cost
GFA DC 1	$ 75,001,851,364
GFA DC 2	$ 69,014,120,094
GFA DC 3	$ 65,452,476,908
GFA DC 4	$ 59,656,866,677
GFA DC 5	$ 93,784,423,135

https://blog.hwr-berlin.de/ivanov/wp-content/uploads/2017/06/ALX-2017_Full.pdf

We Compare the data in statistics “Flows” and table “Demand” to understand, Do we satisfy all customer demand from the optimal DC locations?

GFA DC 2	components	Winter Perio	9886492	777.576	3843750529
GFA DC	components	Winter Perio	5792732	345.902	1001857929
GFA DC 4	components	Summer Per	24334135	714.58	8694345907
GFA DC 4	components	Winter Perio	21851060	714.58	7807167753
GFA DC 2	Fancy Door M	Summer Per	6883520	777.576	2676230724
GFA DC 3	components	Winter Perio	5044160	450.014	1134971375
				Total	=SUM(R[-113]C:R[-2]C

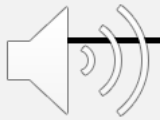
Total Product Flow	Total Demand
222.411.546	611.631.752

GFA DC 4	30	16301830.5	145
GFA DC 4	40	21735774	151
GFA DC 4	50	27169717.5	205
GFA DC 4	60	32603661	213
GFA DC 4	70	38037604.5	258
GFA DC 4	80	43471548	293
GFA DC 4	90	48905491.5	376
GFA DC 4	100	54339435	376
	Total	611631752	

https://blog.hwr-berlin.de/ivanov/wp-content/uploads/2017/06/ALX-2017_Full.pdf

Which costs, relevant for choosing an optimal DC location, were not considered in this GFA analysis?

- Fixed facility costs
- Inventory holding costs
- Processing costs



https://blog.hwr-berlin.de/ivanov/wp-content/uploads/2017/06/ALX-2017_Full.pdf

b. Network Optimization

OBJECTIVE

Determine the most efficient combination of factories, distribution centers and their connections within the supply chain

CONFIGURATION

01
Carrying cost

02
Processing cost (Inbound and Outbound shipments)

03
Transportation cost

04
Production cost

05
Other costs

06
Other factors

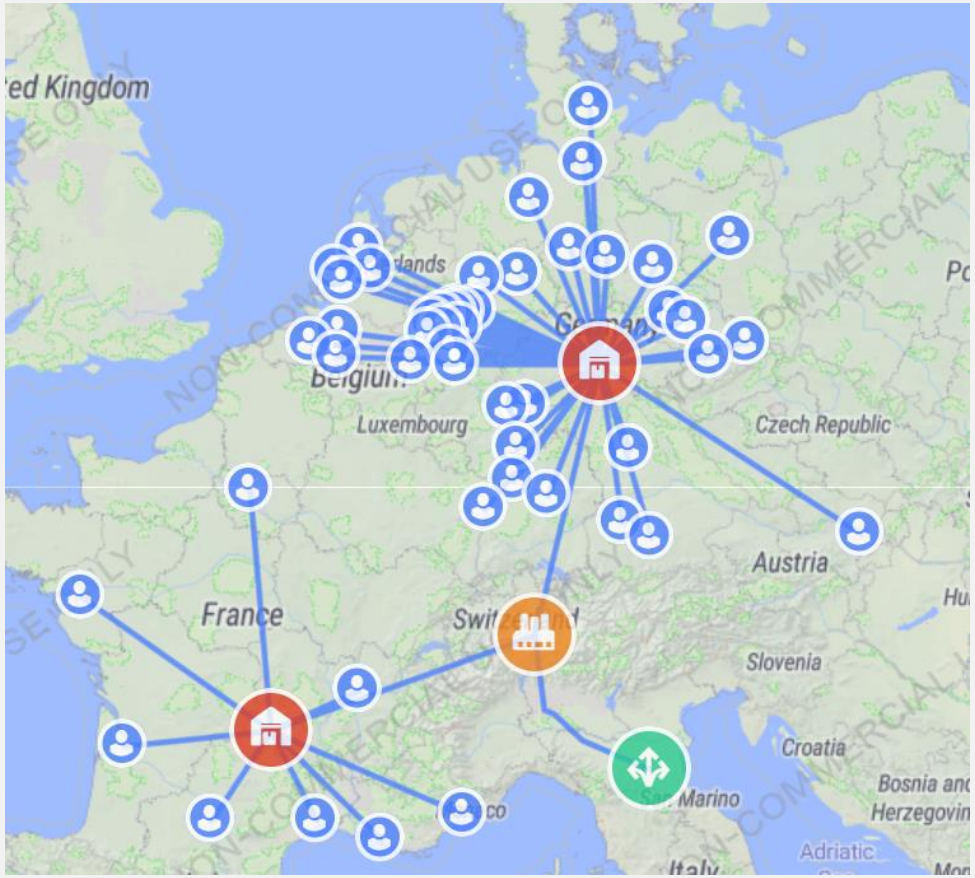
Running Network Optimization

Description	Flow amount	Profit ((NetOpt)
Iteration 1: Site, Site 2, Site 3, Site 4, Site 5	199,415,009.25	2,193,483,550.443
Iteration 2: Site, Site 2, Site 3, Site 5	199,415,009.25	2,186,982,955.616
Iteration 3: Site, Site 2, Site 4, Site 5	199,415,009.25	2,178,719,683.582
Iteration 4: Site, Site 2, Site 5	199,415,009.25	2,172,219,087.755

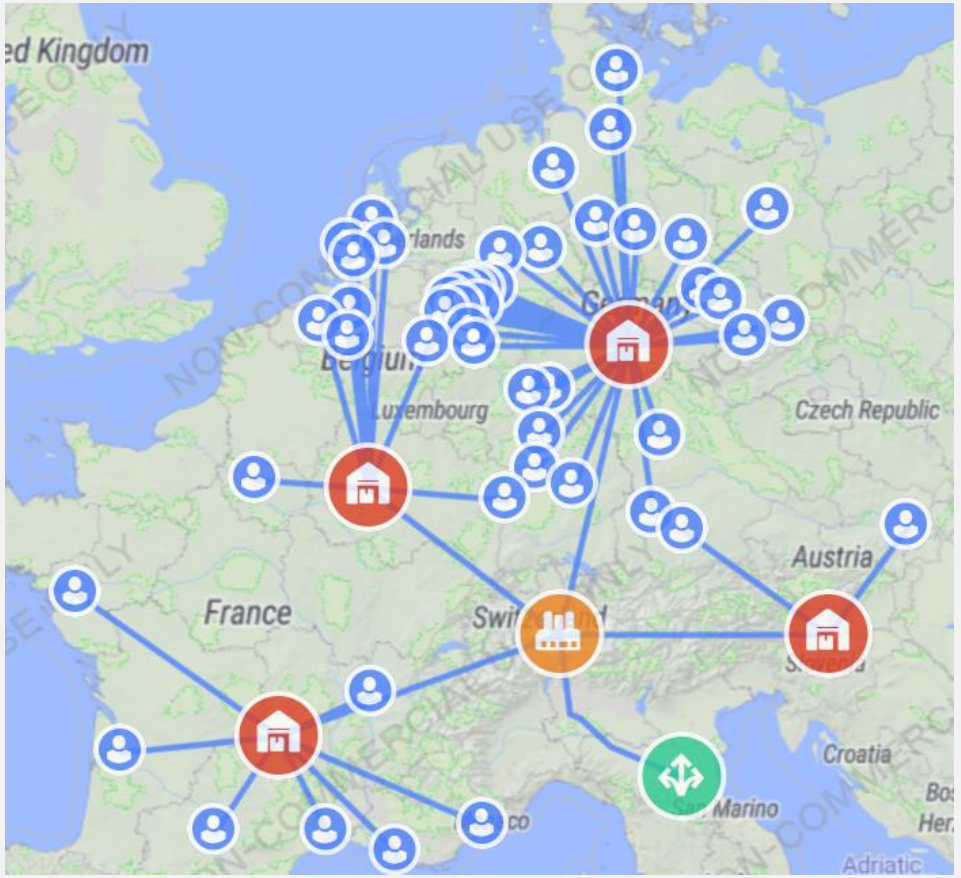
Description	Transportation cost	Other costs
Iteration 1: Site, Site 2, Site 3, Site 4, Site 5	-1,680,612,741.557	-25,575,000
Iteration 2: Site, Site 2, Site 3, Site 5	-1,689,986,336.384	-22,720,000
Iteration 3: Site, Site 2, Site 4, Site 5	-1,698,028,608.418	-22,923,000
Iteration 4: Site, Site 2, Site 5	-1,707,402,204.245	-20.050,000

Running Network Optimization

The current design



The most optimized design



Running Network Optimization

DEMAND FULFILLMENT

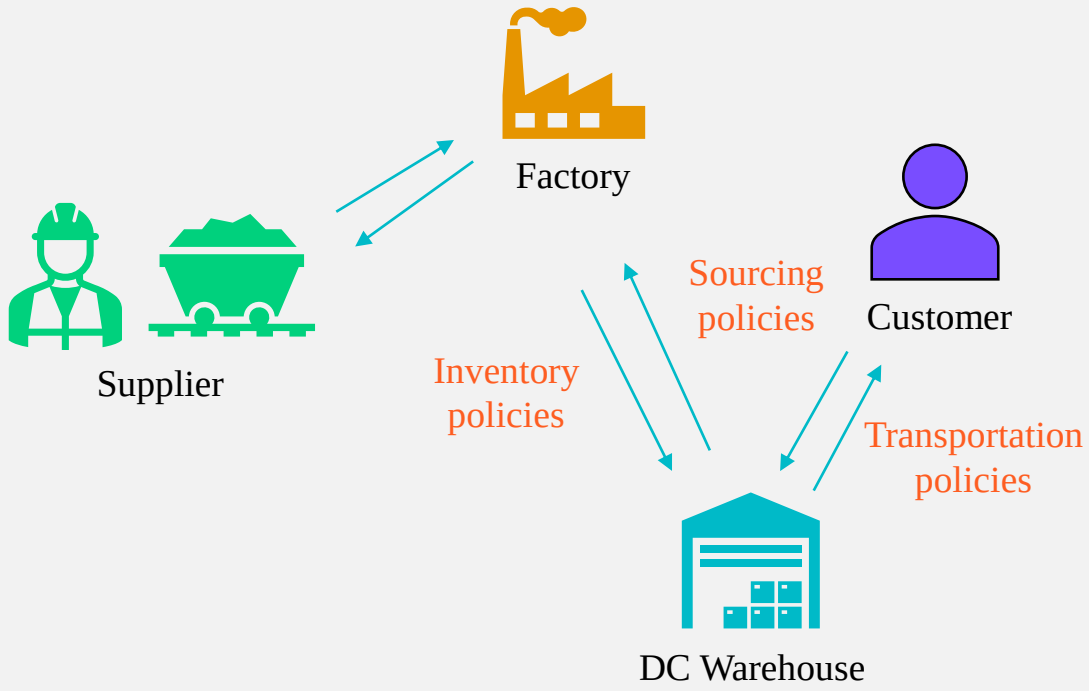
Customer	Product	Unit	Satisfied	Percentage
filter	filter	filter	filter	filter
Hannover Customer	Fancy Door Model 1	pcs	232,848	100
Hannover Customer	Pet Door Model 1	pcs	232,848	100
Hannover Customer	Metallic Door Model 1	pcs	232,848	100
Lyon Customer	Fancy Door Model 1	pcs	213,488.1	100
Lyon Customer	Pet Door Model 1	pcs	213,488.1	100
Lyon Customer	Metallic Door Model 1	pcs	213,488.1	100
Halle (Saale) Custom...	Fancy Door Model 1	pcs	105,817.95	100
Halle (Saale) Custom...	Pet Door Model 1	pcs	105,817.95	100
Halle (Saale) Custom...	Metallic Door Model 1	pcs	105,817.95	100
Aachen Customer	Fancy Door Model 1	pcs	119,874.825	100
Aachen Customer	Pet Door Model 1	pcs	119,874.825	100
Aachen Customer	Metallic Door Model 1	pcs	119,874.825	100

100% customers' demand are satisfied

3) Simulation (SIM)

Simulation is imitating the behaviour of one system with another. By making changes to the simulated SC, one expects to gain an understanding of the dynamics of the physical SC.

In the case of Door consulting as a result of GFA and NO we can establish that we have a Singular supplier (Supplier1) in Italy and a manufacturing facility (Factory) in Switzerland, and four different DCs (Site, Site 2, Site 3 and Site 4) in France, Germany, Belgium and Austria, respectively.

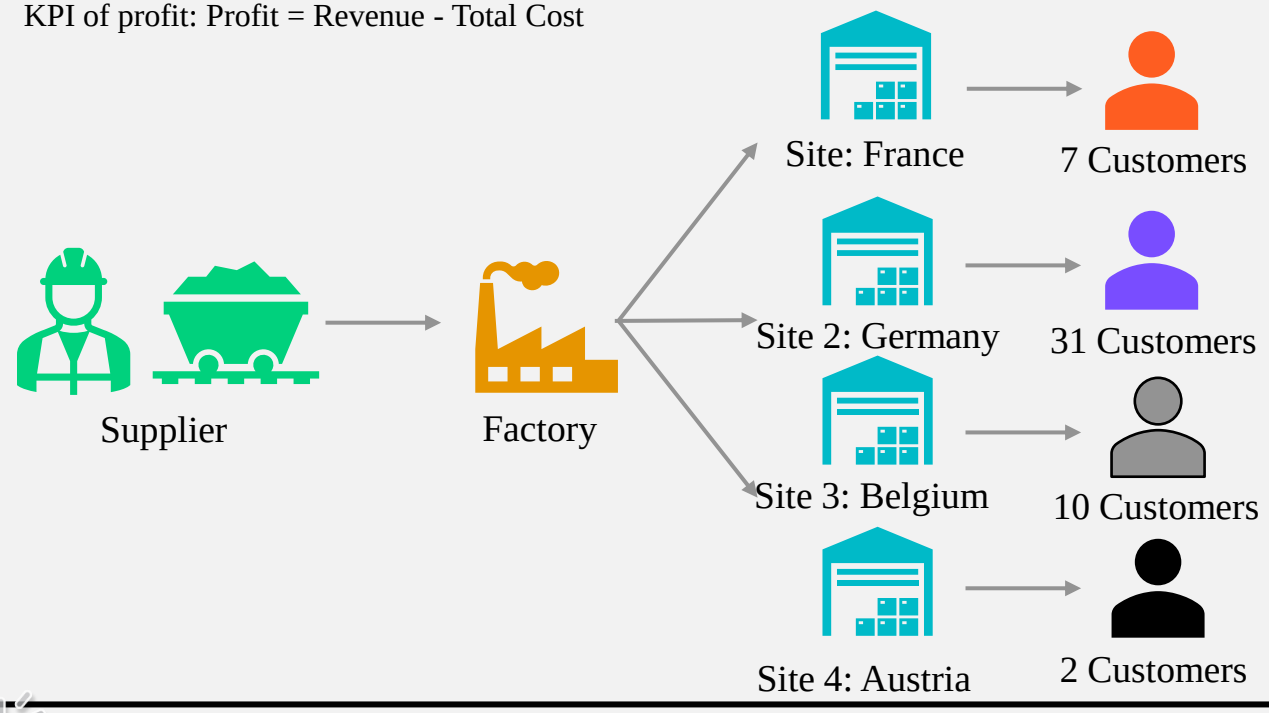


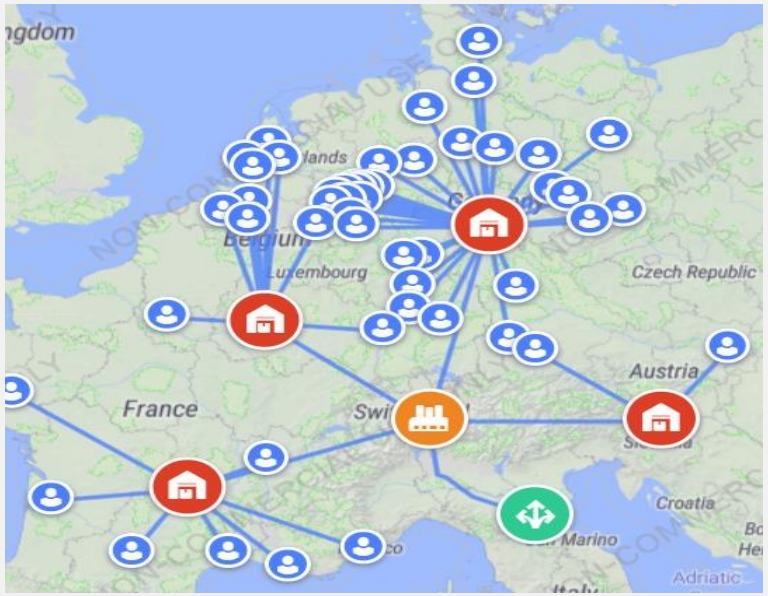
Case 1: All DC's

Statistics	Value	Unit
Revenue	6,647,166,975	USD
Total Cost	6,251,708,818	USD
Profit	395,457,156	USD

SCM hierarchy: 4 Sites: Germany, France, Austria, Belgium

KPI of profit: Profit = Revenue - Total Cost



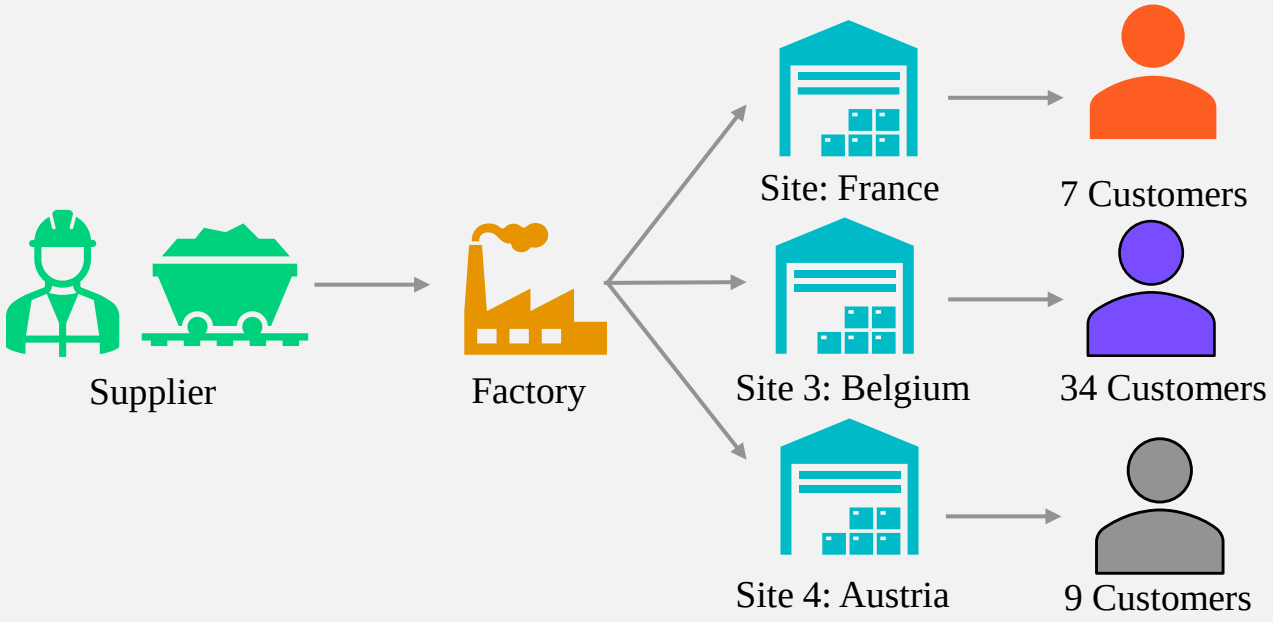


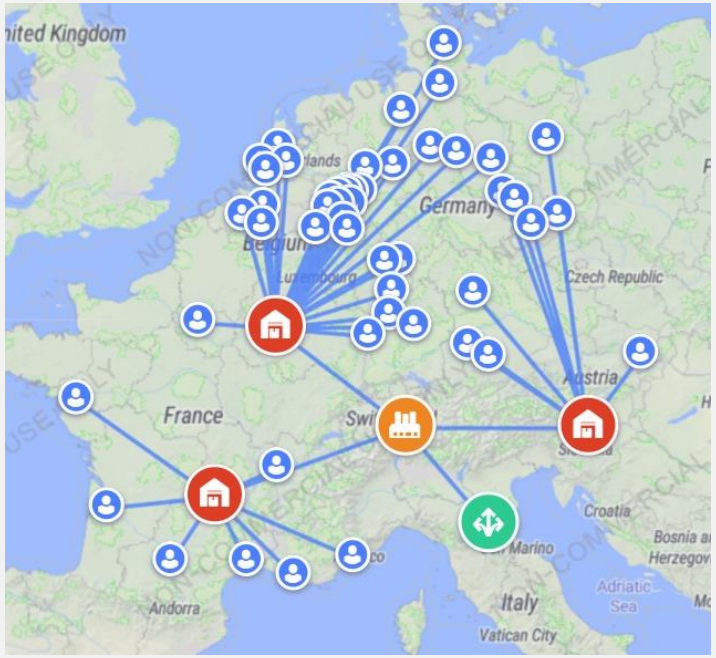
Case 2 (Without Germany)

Statistics	Value	Unit
Revenue	6,647,166,975	USD
Total Cost	5,679,425,608	USD
Profit	967,741,361	USD

SCM hierarchy: 3 Sites: France, Austria, & Belgium

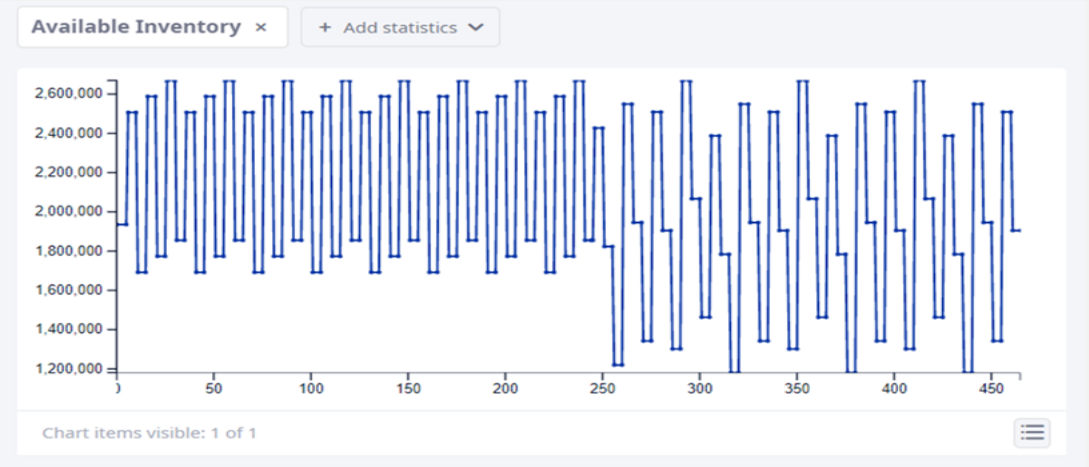
KPI of profit: Profit = Revenue - Total Cost





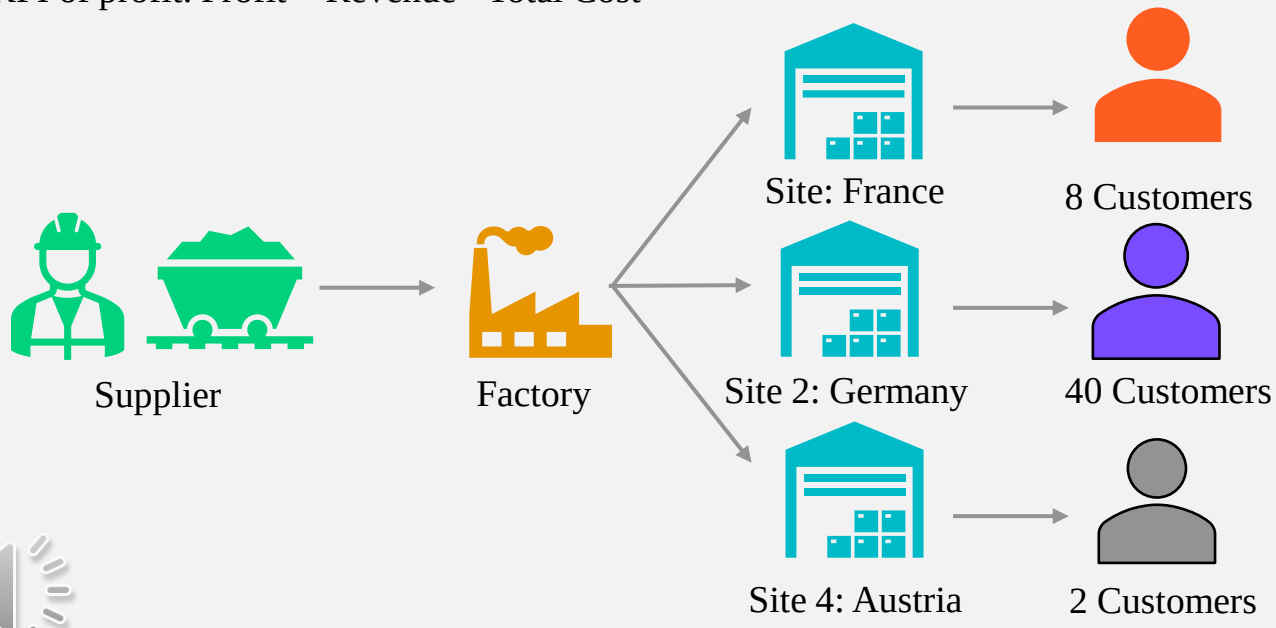
Case 3 (Without Belgium)

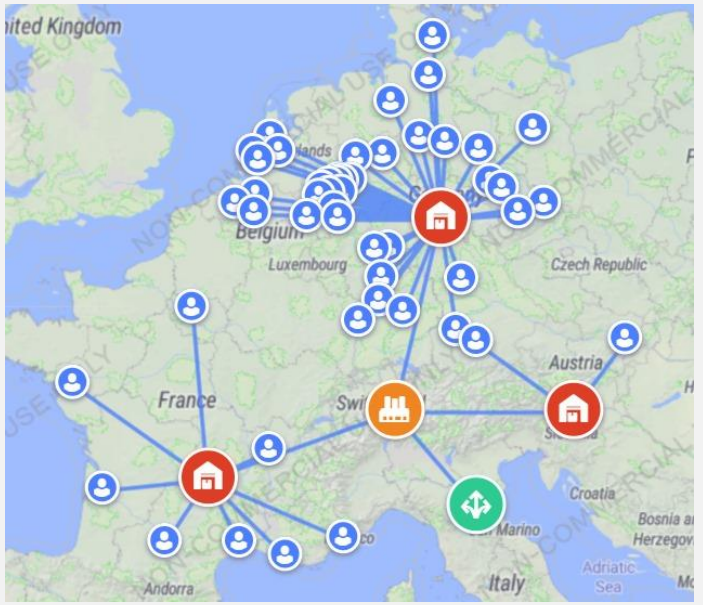
Statistics	Value	Unit
Revenue	6,647,166,975	USD
Total Cost	6,097,393,659	USD
Profit	549,773,315	USD



SCM hierarchy: 3 Sites: Germany, France, & Austria

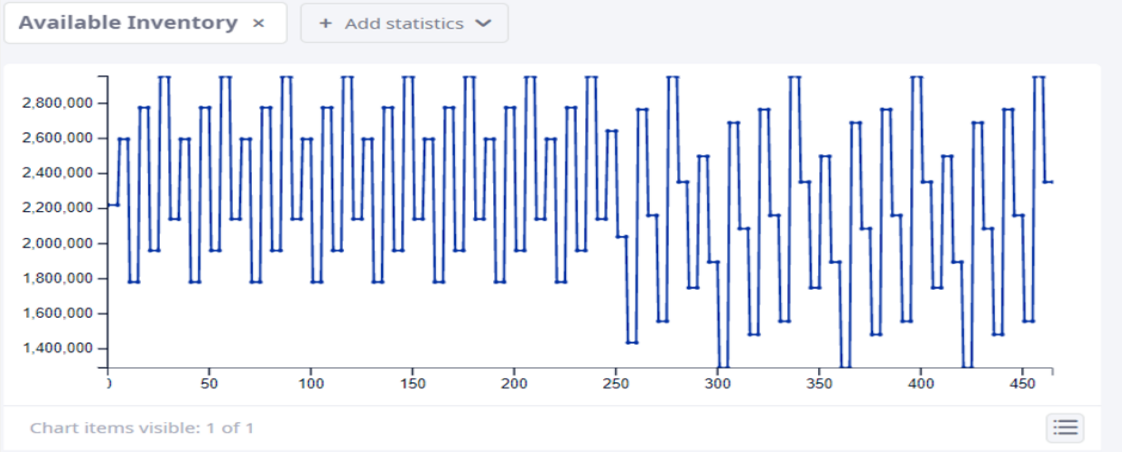
KPI of profit: Profit = Revenue - Total Cost





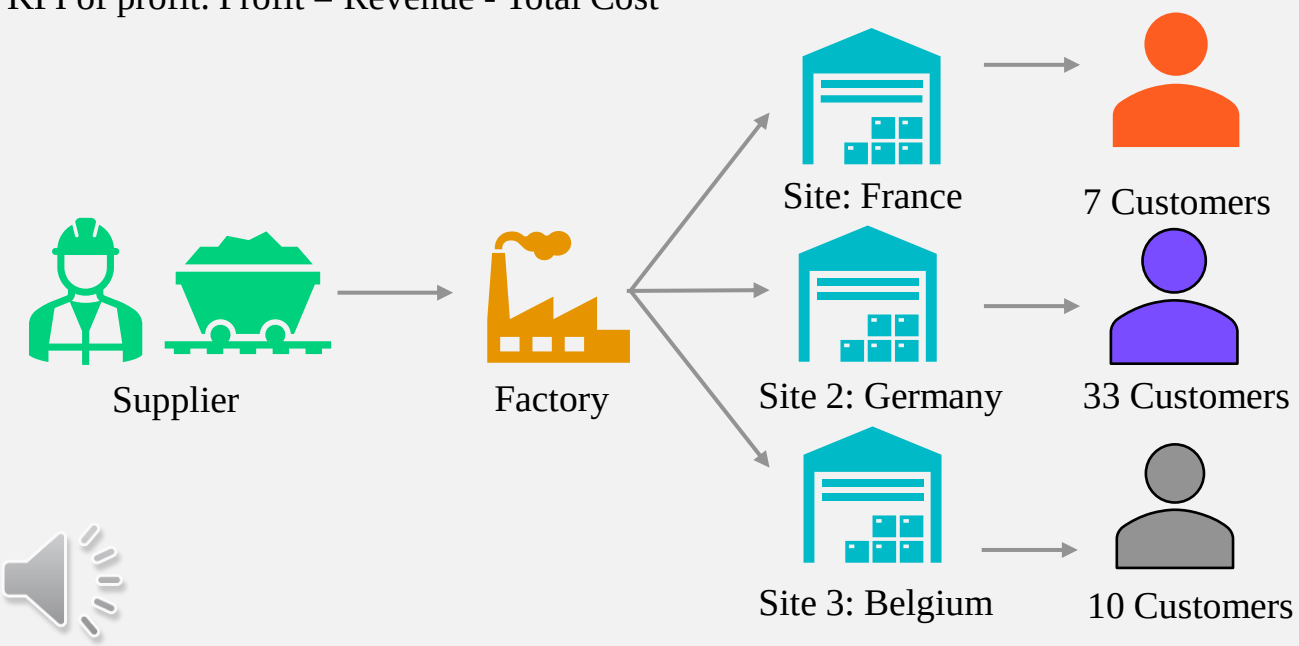
Case 4 (Without Austria)

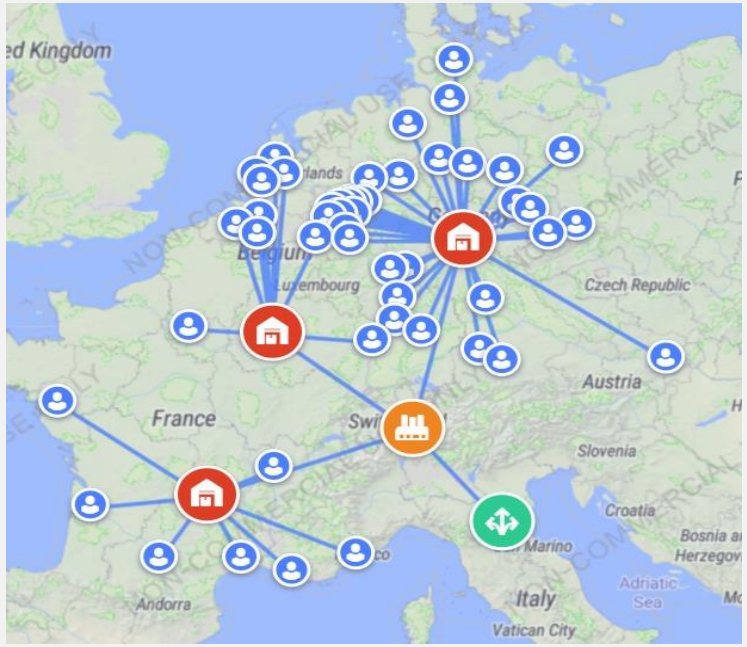
Statistics	Value	Unit
Revenue	6,647,166,975	USD
Total Cost	6,106,727,636	USD
Profit	540,439,338	USD



SCM hierarchy: 3 Sites: Germany, France, & Belgium

KPI of profit: Profit = Revenue - Total Cost

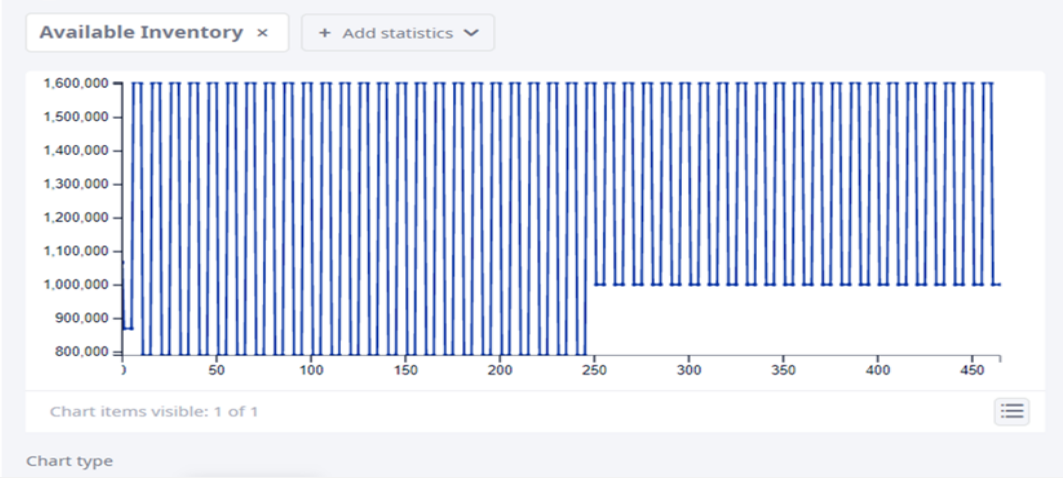




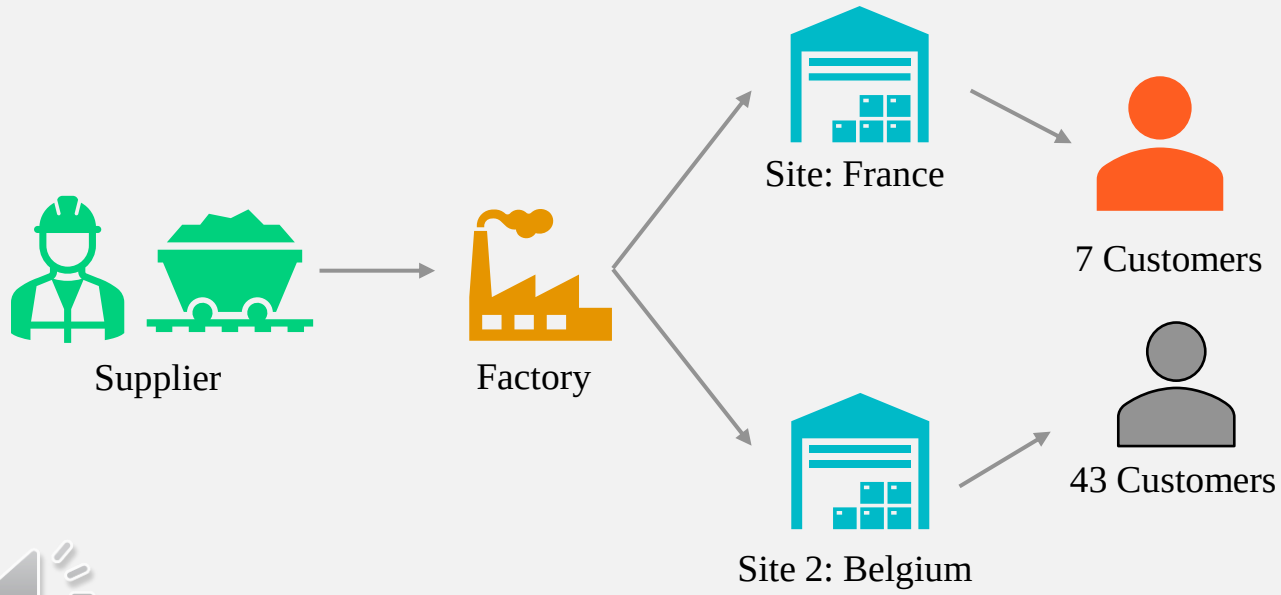
Case 5 (Without Germany & Austria)

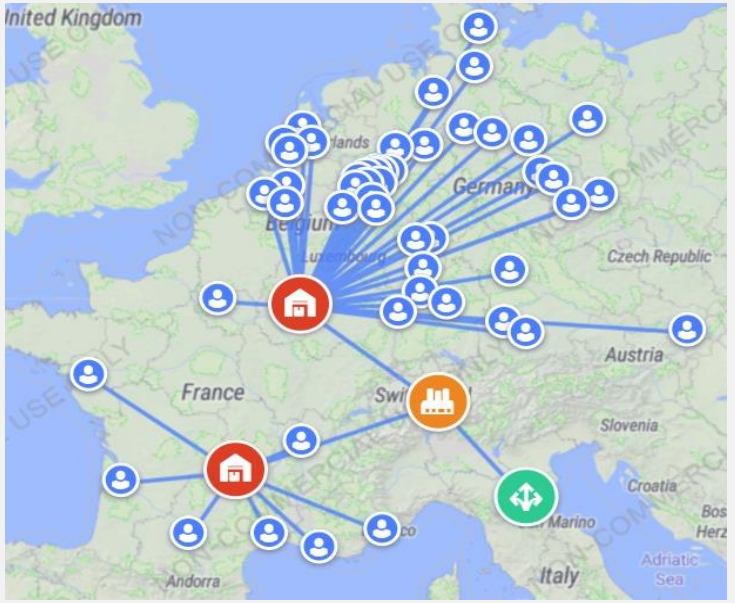
Statistics	Value	Unit
Revenue	6,647,166,975	USD
Total Cost	5,581,173,565	USD
Profit	1,065,993,409	USD

SCM hierarchy: 2 Sites: France & Belgium



KPI of profit: Profit = Revenue - Total Cost





d) Comparison Experiment

Comparison experiment allows us to compare the results of several Simulation experiments.

Comparison experiments can be set up to perform multiple Simulation experiment runs (called replications) during each iteration.

Iteration	Description	Profit	Total Cost	Service level by order
Case 1	Simulation Costs (1)	395,457,156	6,251,708,818	0,99
Case 2	Simulation Costs No Site 2	967,741,361	5,679,425,608	0,84
Case 3	Simulation Costs No Site 3	549,773,315	6,097,393,659	0,97
Case 4	Simulation Costs No Site 4	540,439,338	6,106,727,636	0,99
Case 5	Simulation Costs No Site 2 and 4	1,065,993,409	5,581,173,565	0,73

e) Variation experiment

Variation experiments involve a series of simulations where a single scenario is run by iterating one or more parameters. This process helps in understanding the performance of indices.

Use Cases for Variation Experiments:

1. Parameter Impact Verification
2. Stochastic Parameter Impact

Iteration	Description	Total cost	Service Level by Order
1	Min 100,000	6,141,653,718	0,94
2	Min 105,000	6,141,653,718	0,94
8	Min 135,000	6,251,709,768	0,99
21	**Min 200,000**	**6,240,433,768**	**1**

5. Managerial recommendations

Recommendation based Supply Chain Design:

Green Field Analysis (GFA) Results:

- The GFA results indicated that establishing four distribution centers in Germany, Austria, France, and Belgium leads to the lowest total cost and enhances service delivery times. Implementing these optimal locations is essential for achieving cost efficiencies.

Network Optimization:

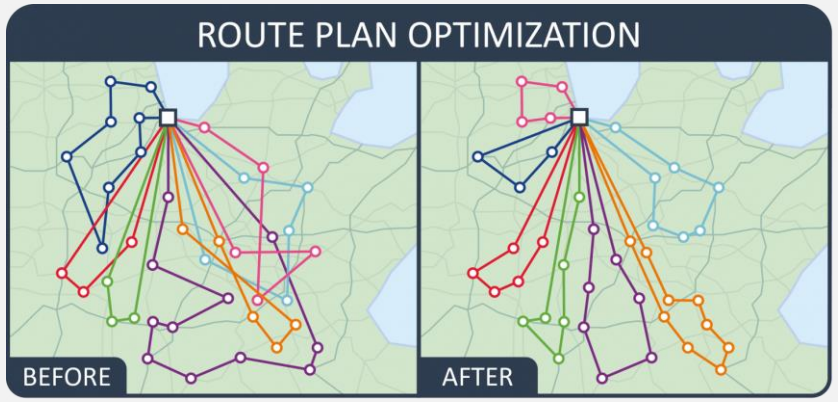
- From our network optimization process, Iteration 1, comprising Sites 2, 3, 4, and 5, has been identified as the most profitable configuration, yielding a net profit of $2,193,483,550.44.
- The detailed cost analysis highlighted the critical impact of transportation and processing costs on overall profitability. By selecting the most cost-effective routes and optimizing the number of distribution centers (DCs), we can substantially reduce operational expenses.

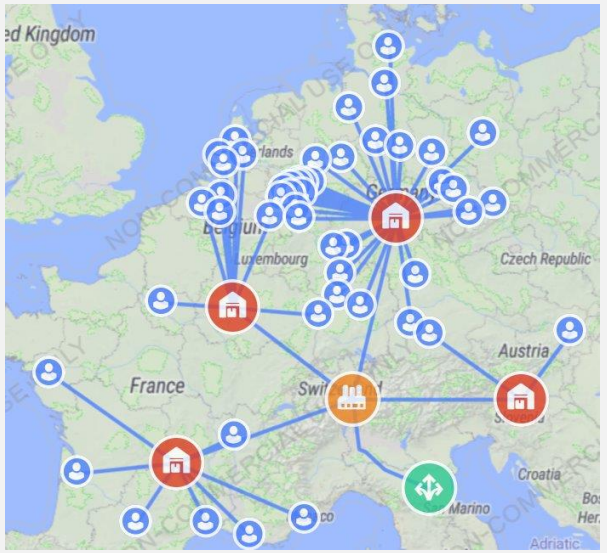
Simulation:

- Simulations across various scenarios have demonstrated that Case 4, which excludes the site in Austria, shows improved inventory management and reduced backlogs.
- This indicates that consolidating operations and minimizing the number of sites can lead to better inventory control and lower holding costs.
- Case 4 also achieves the highest profit when compared to a 0.99 service level by order.

Other Recommendations

- Diversification of Suppliers & Multiple production plants
- Digital Twin Technology
- Improved Transportation Management
  - GPS & Optimal Route planning





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Thank you!