[G0R72A] Data Visualisation Project Report

Part 1. Metadata

- **Version**: Implementation (10/5/2024)
- **Students:**
  - Ali Lamine, 2365040, Hasselt University
  - Andrea Maza León, 2365080, Hasselt University
  - Charles Muiruri, 2365043, Hasselt University
- **Group number**: group_37
- **Dataset:** Suncharge

Part 2. Project description

This project focuses on creating data visualizations to enhance the visibility of SunCharge's supply chain for eco-friendly car batteries. The project involves analyzing datasets related to materials, inventory, sales, purchases and plant operations, aiming to help in detecting potential issues and facilitate the identification of areas for improvement within the supply chain framework. Through this data analysis, the project will provide data-driven insights to assist SunCharge in making informed decisions and logistical optimization.

Key Features:

In our project, we track different stages from the inflow of materials and the outflow products to the market:

Key Identifiers: These cover Vendors, Plants, Distribution Centers, and Customers, essential for tracking, analysis, and understand the complexity of the supply chain's various entities.

1. Inflow part (Supply and Purchases stages):

- **Material, Product Category, Finished Product:** These categorical variables classify SunCharge's products and materials, helping us to analyze the product mix in different stages of the supply chain.
- **Vendors:** We consider VendorCountry to identify geographical patterns**.**
- **Purchases:** PurchaseOrderCreationDate, PlannedGoodsReceiptDate, and ActualGoodsReceiptDate, to compare scheduled and actual material receipt times, identifying potential delays or inefficiencies. PurchaseOrderQuantity, is also considered for its role in inventory planning and meeting demand.
- MaterialPlantRelation, highlights the link between materials and production, crucial for tracking the flow within the company and identifying bottlenecks or inefficiencies in production processes.

2. Outflow part (Sales stage):

- **Sales:** We consider SalesOrderCreationDate, RequestedDeliveryDate, and ActualDeliveryDate, to trace the timeline from order placement to delivery. OrderQuantity, for assessing market demand.
- **Customers:** CustomerCountry provides a categorical overview of the market distribution.
- **CustomerPlantRelation:** This connects customer locations with plant operations, which helps to understand the distribution network.

Guiding Questions:

1. Q1: How can we assess whether to boost or reduce sales efforts in specific countries by analyzing order quantity trends by customers' countries, and its annual variations?
2. Q2: How does actual production and delivery times across suppliers affect supply chain efficiency in terms of time, and where can we identify potential areas for improving supply chain efficiency?
3. Q3: How does the sale of finished products compare across our different plants, based on the number of customers served as well as orders across each quarter for the past few years?

Part 3. Visual design

3.1 Description Process

Our design process followed a Diverge-Emerge-Converge framework, with an evolutionary design methodology to explore the design space. The process started with a brainstorming session where team members individually made >10 sketches, laying the groundwork for our divergent phase. These initial sketches, focusing on distinct variables, were collectively shared on Miro for comprehensive team evaluation and discussion.

Diverge phase: Each team member created > 10 sketches, applying techniques like 'glue dissimilar ideas together' and 'reworking existing visuals' for diverse approaches. These methods helped generate a broad range of ideas by merging unrelated concepts and adapting existing chart types to our project needs. After completing our sketches, we shared them on Miro for team viewing and discussion of concepts and their potential to illustrate supply chain complexities.

Emerge phase: After reviewing 42 sketches, we did a detailed review of each, grouping them by form and attributes, then categorizing by themes like Forecasting, Sales, or Inventory Management. We identified 2-3 guiding questions and marked sketches with color-coded dots (green for Q1, purple for Q2, yellow for Q3) for relevance to these questions. Employing 'evolutionary design', we refined sketches to better answer these questions. Focused on three main questions, we divided tasks, and the team used the SCAMPER method to enhance sketches by substitution, adaptation and modification, aiming for visuals that closely matched our guiding questions. Through regular meetings, we reached consensus on the most suitable visualizations.

Converge phase: Through several meetings, we selected sketches that best answered our research questions. Repeating the Diverge-Converge-Emerge cycle, we revisited sketches, added new ones, and merged them. Using the NUF test (New, Useful, Feasible), sketches were critically evaluated on a 10-point scale for innovation, utility and feasibility. We collaborated to determine scores, asking critical questions to make sure we were making the best choices. In the end, we chose three final sketches that best addressed our main questions.

3.2 From Divergence to Convergence: 8 Top Sketches

Here are the key sketches selected by research question, showcasing our design evolution:

For question 1, during the "Emerge" phase, the team identified an underexplored supply chain aspect. Imagining as CEOs, we assessed customer countries' performance over time for targeted promotions. We selected two heatmaps (CM10, AM9), two bar plots (AL17, AL23), a network diagram (AM6), and a flag-inspired diagram (AL16) for further exploration (See Miro). The flag graph, classifying customer countries by "Order Quantity" and "Plants" with color-coded categories, highlighted order quantity trends. This led us to focus on key sketches that were refined to directly address our first research question. First, a barplot (Fig1 AL17) showing order quantity trends by country over years, integrated with the flag graph (Fig2 AL16) for comprehensive insights. A line chart per country (Fig3 AL20), excluding incomplete 2024 data, provided temporal analysis, merged with the bar graph for clarity. This process, using monochrome to avoid clutter, resulted in the final flag graph design, synthesizing our insights.

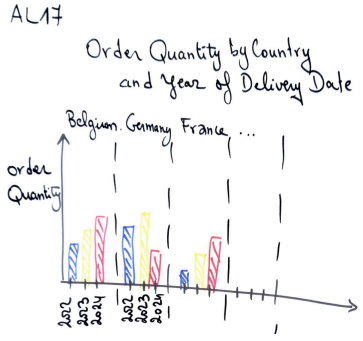


Fig 1. Sketch AL17

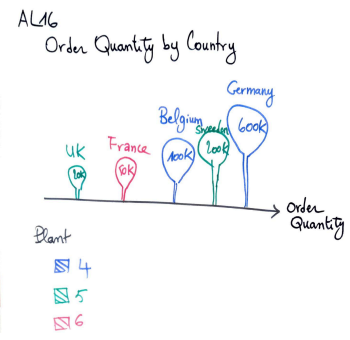


Fig 2. Sketch AL16

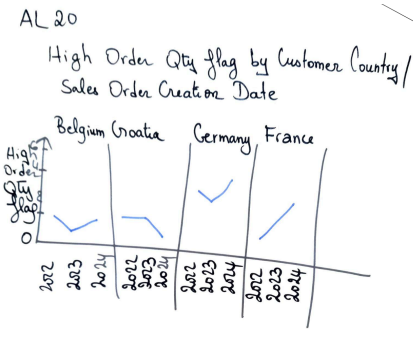


Fig 3. Sketch AL20

For question 2, we aimed to map the entire supply chain over time, starting with AL5 and AM6 sketches, linking supply chain actors from vendors to customers, with Time playing a crucial role in answering this question. Also we used sketch AM11, where a new variable emerged: the deviation in time, allowing us to identify delays. This new variable allowed us to assess vendor performance by comparing actual goods receipt dates against planned ones, identifying the most efficient vendors. We also used sketch AM3 that shows the time spent on production, transportation, and goods receipt for each vendor. Merging these ideas led to a new sketch (Fig 4 AM18), our first attempt to visualize the network's connections. Additionally, the ideas evolved into new sketches (Fig 5 AM15 and Fig 6 AM16), focusing on monthly sales quantities and distribution centers' order processing times, respectively. These sketches were planned to enhance the network with more information. The goal of this approach was to create a comprehensive network (Final Design) that identifies efficiencies and delays, thereby becoming a key tool for SunCharge's logistic optimization.

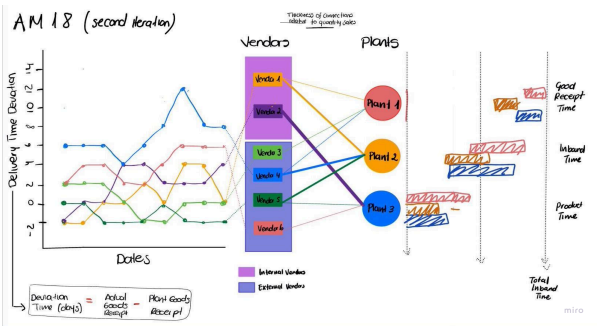


Fig 5. Sketch AM18

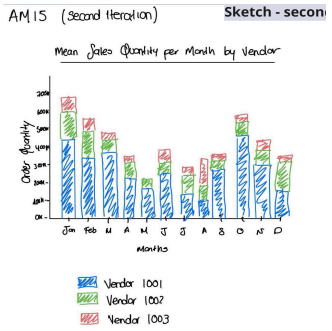


Fig 5. Sketch AM15

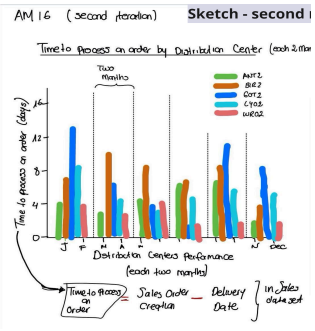


Fig 6. Sketch AM16

For question 3, 16 sketches were selected for the second diverge phase iteration to identify the plant serving the most customers and doing the most sales. AL1, AL2, AL8, AL14, AM5, and AM13 emerged as the top visuals for reworking. AL1 and AL8 showed similar trends in order quantity across a timeline, with AL1 (Fig 8) displaying quantities as bars representing orders for two products. These were merged with AL2 (Fig 7), featuring various plants. AM13, similar to AL2, was discarded in favor of it. AM5's (Fig 9) map idea was deemed feasible and included in the final sketch. Filters would handle the various variables in the final design, incorporating main ideas from AL1, AL2, and AM5.

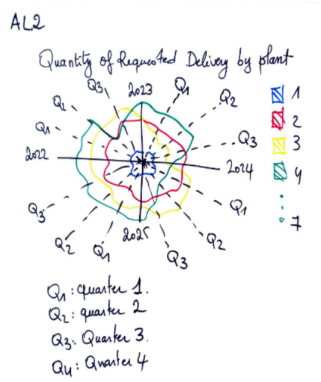


Fig 7. Sketch AL2

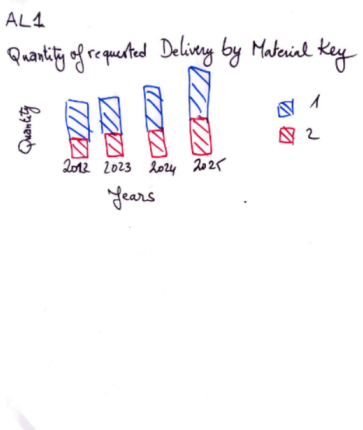
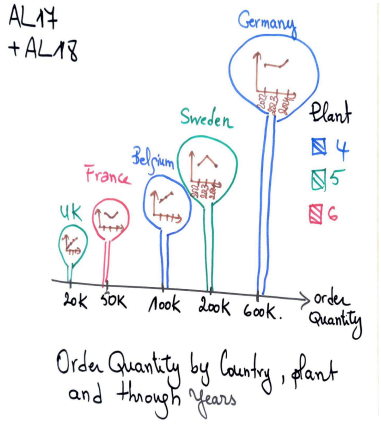


Fig 8. Sketch AL1

Fig 9. Sketch AM15

3.3 Choosing Final Reworked Sketches: Implementation with an Expert Programmer



The first final sketch, Figure 10, presents a flag-inspired diagram that is a graphical representation that mimics the appearance of a flag. It involves using elements resembling flagpoles or beams to represent different categories (countries). The size and the position of the beams encode for the "Order Quantities". The color of the beams encodes for the plant, and the line chart inside the flags encodes for the evolution of Order quantities from 2021 to 2023. With a professional programmer, we'd enhance this flag-inspired diagram with interactive features. This visualization would feature a flag-inspired design where users can click regions or countries for detailed order insights and customer demographics. Additionally, the diagram would incorporate movement in the beam to reflect changes over time. This interactivity simplifies data exploration and insight discovery.

Fig 10. Final sketch Q1

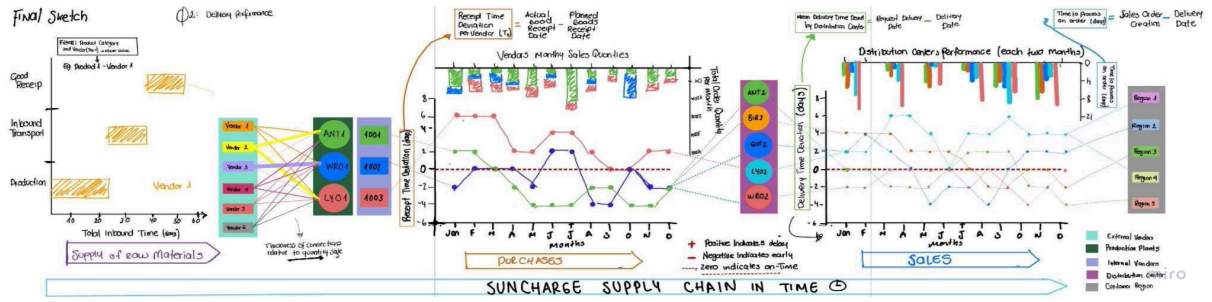
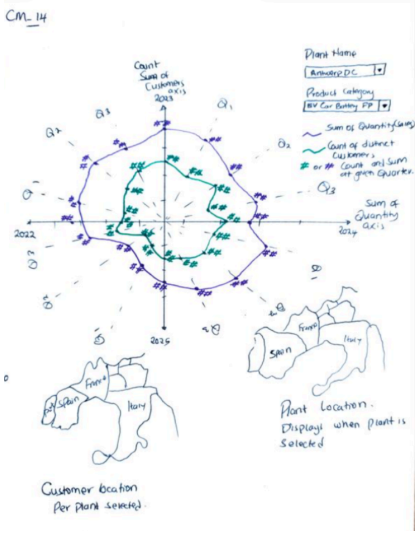


Fig 11. Final sketch Q2

The second final sketch that answers Question 2 (Figure 11), illustrates supply chain dynamics: vendor interactions, production, and delivery times. It provides a multi-layered representation of data, aiming to enhance supply chain visibility. Colored nodes represent entities for easy identification, while line thickness indicates materials movement and potential delays or bottlenecks. Graphs with colored lines map out actual delivery against planned times, showing how reliable each part of the supply chain is. Finally, bar charts represent sales, revealing demand patterns and how well supply matches up over time. Given a professional programmer, we'd make these visualizations interactive, allowing product and vendor-specific exploration. Clicking on elements could present detailed performance insights. Additionally, exploring distribution centers efficiency over periods would be possible, with mouse-over revealing order details and fulfillment rates, providing a view of supply-to-delivery efficiency.



The final sketch for Question 3 (Figure 12) features a radar plot repurposed as a time series plot for two variables with varied measures. It utilizes a dual axis within the radar plot to accommodate the diverse scales of the variables. Filters per plant control the radar plot and two maps: One displaying locations and the other showing customer locations. The intensity of the color on the customer map corresponds to the number of distinct customers in each area(Country). When hovering over each quarter on the radar chart, the color intensity changes to reflect changes in customer numbers, accompanied by text displaying the number of customers for that quarter.

Fig 12. Final sketch 1 Q3

Part 4. Implementation

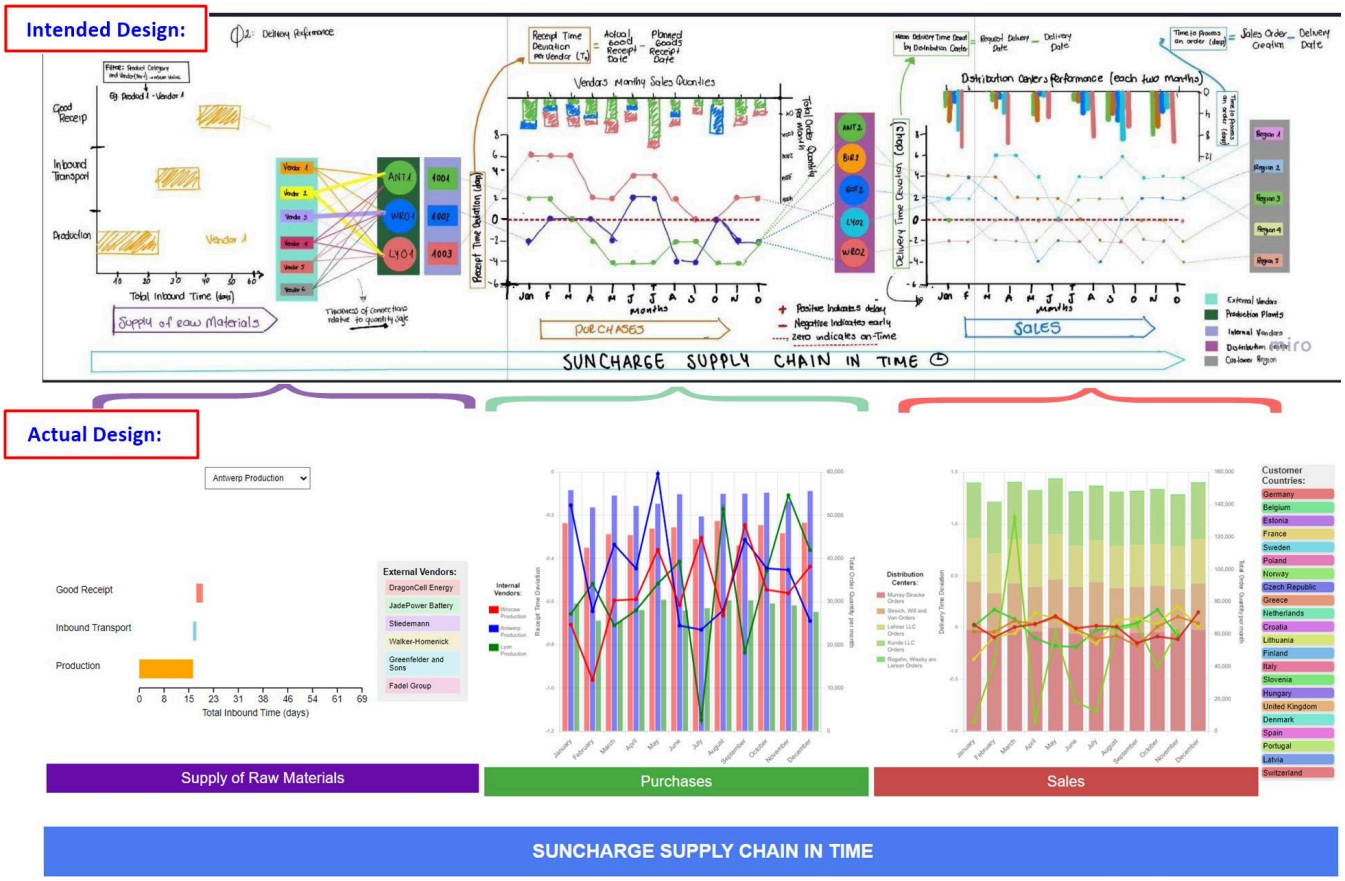
In this section of the report, we describe the implementation of two visualizations: Question 2 - Supply Chain Dynamics and Question 2- Plant Performance Insights. These were selected based on an evaluation process that occurred during the visual design phase (Part 3). Our design process employed a Diverge-Emerge-Converge framework, where we assessed each visualization option using the NUF t (Newness, Usefulness, and Feasibility).

Table 1 presents the NUF scores from our evaluation. As evidenced, both FV1 for Question 2 and FV1 for Question 3 scored the highest. These scores influenced our decision to focus our report for the Implementation part on these visualizations. Although the visualization for Question 1 was well-designed and effectively implemented, we were guided to describe only two visualizations in this report. Therefore, based on the project's requirements, we selected the visualizations for Questions 2 and 3 for detailed discussion. However the 3 visualizations, including visualization for answer Question 1, can be found in our GitHub repository.

Table 1 . Evaluation Scores for Final Visualizations

Final Visualizations per Question	New	Useful	Feasible	Total Score
FV1 Question 1	7	7	9	23
FV2 Question 1	4	8	9	21
FV1 Question 2	7	10	8	25
FV1 Question 3	8	9	9	26
FV2 Question 3	6	7	9	22

Visualization 1: Supply Chain Dynamics - Question 2



Intended Design:

- The intended design aimed to provide a view of the supply chain, from the supply of raw materials to sales, with a network that connects the three charts to visualize the flow within the supply chain.
- The intended design was planned to include interconnected visualizations that not only represent data but also illustrate the relationships among different stages of the supply chain, such as supplier performance, production efficiency, and sales distribution.

Actual Design:

Visual Encoding:

- *Supply of Raw Materials:* This section uses horizontal bars to indicate stages such as Goods Receipt, Inbound Transport, and Production. The length of each bar is the total time spent in each stage. Vendors are listed, linking them to specific supply stages. + *External Vendors List:* Displayed alongside the bars, linking specific vendors to stages in the supply of raw materials.
  by
- *Purchases Chart:* Combines bar and line charts to illustrate monthly deviations in receipt times and order quantities. Color coding differentiates internal vendors inside the plot, with bars representing total order quantities per month and lines showing Receipt Time Deviation per month. This dual representation helps in comparing vendor performance side by side in a year.
  - Receipt Time Deviation Calculation:
    $$Actual\ Goods\ Receipt\ Date\ -\ Planned\ Goods\ Receipt\ Date$$
    Where:
    Zero value: Goods received on schedule
    Positive value: Delay in receipt
    Negative value: Early receipt
    This calculation is important for monitoring vendor reliability and the consistency of supply chain operations.

- *Sales Chart:* Similar to the Purchases chart but focuses on delivery times and sales volumes.
  - Delivery Time Deviation Calculation:
    $$Actual\ Delivery\ Date\ -\ Requested\ Delivery\ Date$$
    Zero value: On-time delivery
    Positive value: Delivery delay
    Negative value: Delivery ahead of schedule
    This measure provides insights into the efficiency and reliability of the distribution centers, affecting overall customer satisfaction and supply chain fluidity.

Description

- The implementation focuses on three key areas: supply of raw materials, purchases, and sales, with metrics such as time deviations and order volumes clearly visualized.
- Bars in the supply chart quantify the duration of process steps for each vendor, offering insights into supply efficiency.
- The Purchases chart displays Receipt Time Deviation and monthly order quantities, highlighting vendor reliability and operational consistency.
- The Sales chart analyzes Delivery Time Deviation against planned schedules to assess efficiency.

Interactions:

- Hovering over elements in any chart displays detailed data, such as exact numbers for deviations or order quantities.
- Selecting a vendor from the list filters the data across all charts to show only relevant data for that vendor.
- Users can interact with the chart by selecting different months or vendors to see specific data points and trends.

Relation to Target Design:

The implementation shows major elements of the intended design, with a clear visual representation of the supply chain's key metrics. Due to complexity and space constraints, network connections between charts were not included, making the charts more readable and focused on displaying delay locations and performance metrics of vendors and distribution centers. Although the detailed network visualization was omitted, the existing design adequately addresses operational delays and performance efficiencies. This means that the visualization effectively addresses the research questions 2, offering insights into operational delays, vendor performance, and distribution center efficiency.

Missing Features:

- The planned network visualization of interconnected data points across different charts was not implemented.
- Some interactive features like dynamic filtering based on vendor selection across all charts were simplified.
- More complex interactions such as cross-chart data filtering and dynamic network visualization were not implemented.

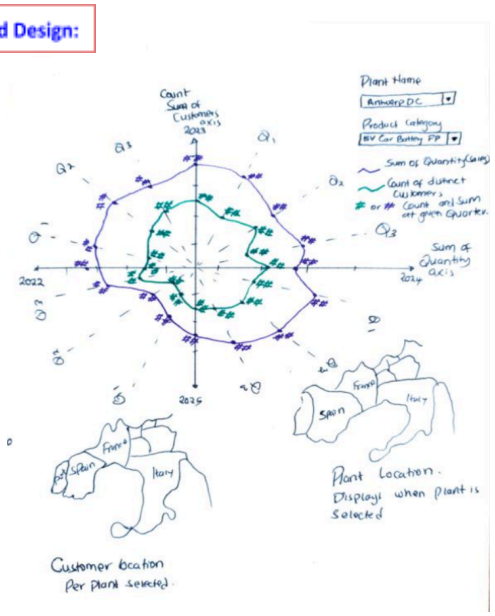
Enhanced Interactivity:

Added a filter in the Supply of Raw Materials section to check production, transportation, and goods receipt times by vendor, allowing for dynamic comparisons and deeper analysis.

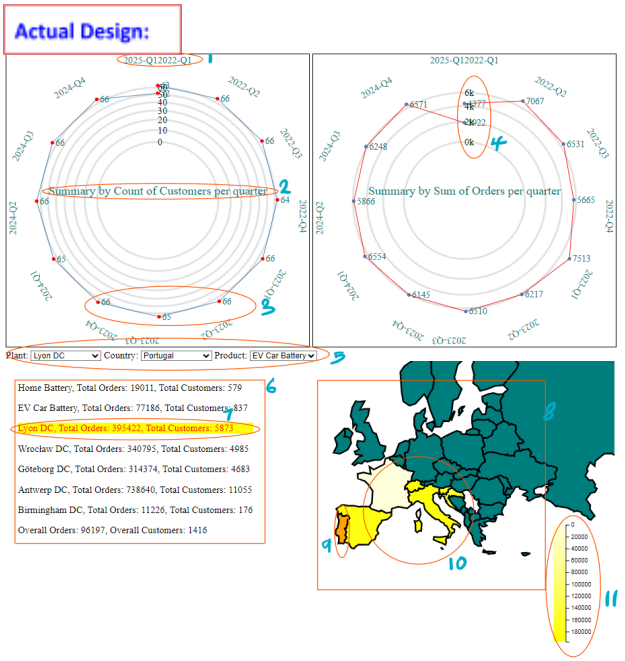
The Purchases and Sales charts include interactive elements that enable the selection of specific vendors, highlighting the receipt and delivery time deviations directly calculated in Svelte. This setup not only points out which vendors or distribution centers have timing inconsistencies but also relates these deviations to the volume of transactions, aiding in prioritizing improvements where they are most needed. These deviations were calculated directly in svelte.

Visualization 2: Plant Performance Insights - Question 3

Intended Design:



Actual Design:



Intended Design

- This design's intention was to visualize distribution plant performance based on number of customers as well as total sales per plant by utilizing a radial line chart and two maps with controls controlling their displays based on plant, country and product.
- This design was to represent the trend of count of unique customers as well as sum of all orders per each quarter of the report period using a dual axis single chart and also show the location of plant as well as the country they distribute to.

Actual Design:

Visual Encoding, Description and Interactions:

- Summary by Count of Customers and Sum of Orders per quarter[1, 2, 3,4): For this section, we see two radial line charts with each section broken down as follows
    - 1: Represents the year and quarter which serves as the cutoff period for which count of unique customers as well as sum of orders is based. In the chart it represents the x-axis for both charts.
    - 2: Represents what the radial chart is about, with the left chart being on count of customers while the right one being on the sum of Orders. Always on display.
    - 3: This section has both a circle point with connecting lines whose color is different based on the parameter being plotted. They are markers that enable plotting the trend over the period for both charts.
    - 4: The y-axis for the radial chart, with each circle displaying the radius which is the scale of the Charts. This scale is in thousands for radialChart2 but in hundreds for radialChart1. The original intention was to have both in one radial chart but there was an issue standardizing into a dual axis radialChart, hence the two different charts
- Controls with filters for Plant Name, Customer Country and Product[5]: This section features three dropdown selection controls.
    - The first controls for the Plant, which when selected updates sections in the visualization that point to the selected plant. The sections updated are highlighted below.
        - 8 and 10: The selected plant highlights Customer Countries it serves with a color whose intensity increases based on the total orders per the country.
        - 11: This also affects the color scale which serves as a legend for the color intensity of the highlighted country served by the plant.
        - 3 and 4: Dependent on selected country: where the selected plant serves the selected country the y-axis changes based on the sum of orders in each quarter while the points are updated along the axis where they fall into.
    - The second control is for the customer country which when selected updates the below sections in the visualization.
        - 6 and 7: the overall orders and overall customers entry at the bottom of the section updates with the respective totals for that country. Additionally the plant that serves the country is highlighted in yellow while the text is highlighted in red. This also serves as a guide as to which Plant to select in the plant dropdown inorder to update sections 3 and 4.
            - The two top rows of the static text[7] update the total orders and Total customers of the selected country for both products.
        - 9: The selected country is highlighted on the map with an orange color, just to visualize and emphasize the country in the current selection.
    - The third and final control filters based on which product we want to display the trend of. When selected, both radial charts change depending on figures for the selected product.
- Static figures display[7]: This section displays different total customers and total orders per selected country. It has three subdivisions:
    - Row 1 and 2: Display product summary for selected country
    - Row 3 to 7: Display plant summary with added advantage of highlighting the plant serving the selected country.
    - Row 8: Display total orders and total customers for the selected country.
- Map display[8, 9, 10, 11]: This section displays the location of all customers served by the Distribution plants in a map. All our customers are in Europe , hence a map of that region only.
    - The map has three different colors displayed at all times.
        - Teal: For countries not affected by selection of a country or plant.
        - Yellow-light yellow intensity: For countries served by the selected plant.
        - Orange: For the selected country.

- The map also features a legend to show the associated sum of orders with the light intensity of countries served by the selected plant.

Relation to Target Design:
This implementation also shows major elements of the intended design. The radial chart shows the pattern of both customers and orders over the years by quarter. The filters allow for interactivity enabling visualization of the metrics over different plant, customer country and Product. The initial design included a map for the location of the plant, which was to show the location of the plant city and even though this wasn't included, the visualization was sufficient to address research question 3.

Missing Features:

- The hover to display the count of customers and sum of orders per quarter was not implemented. The radial chart had enough room to accommodate the text without making it too crowded.
- Map displaying the location of each selected plant was not implemented. In the availability of a skilled programmer, we would have wanted to also include this so that we can also gauge the dynamics of serving customers who are too far away from the plant and also implications of serving distant customers if there are any.
- A tooltip on hover of any highlighted country(Yellow and orange) to display useful information as compared to the static one.

Link Video:
https://youtu.be/Ryg1v3uVeLE

Technical Implementation of Visualization Tools:
For the development of these visualizations, we employed Svelte, a framework that allowed us to build dynamic and responsive user interfaces efficiently. For the visualization "Supply Chain Dynamics"under Question 2, we utilized **Chart.js** to present complex data interactions through intuitive graphical representation.

For "Plant Performance Insights"under Question 3, we incorporated **D3.js** to leverage its powerful data-driven manipulation capabilities, allowing us to create complex and customizable graphics that could dynamically represent operational metrics at various plant locations (geo visualization).

Additionally, we used **Tableau** for initial data visualization to better understand the structure and quality of our data.

Code and Documentation:
Code Repository: https://github.com/Muirur1/GR37-Implementation

Part 5. Findings

In our exploration of SunCharge's data, we applied visual analytics to uncover how production and delivery times impact supply chain efficiency and how product sales vary across different plants. Guided by two research questions:

- **Q2: How does actual production and delivery times across suppliers affect supply chain efficiency in terms of time, and where can we identify potential areas for improving supply chain efficiency?** We began by examining the actual times taken by various suppliers to deliver raw materials and complete production. This examination helped us identify key bottlenecks affecting the overall supply chain and pinpoint specific areas where improvements could enhance efficiency.
- **Q3: How does the sale of finished products compare across our different plants, based on the number of customers served as well as orders across each quarter for the past few years?** We analyzed sales data to assess how different plants performed in terms of customer reach and order volumes. This analysis was crucial in understanding market dynamics and the effectiveness of each plant in serving its demographic, guiding us towards potential adjustments in our production and distribution strategies.

Supply Chain Dynamics - Insights and Optimizations

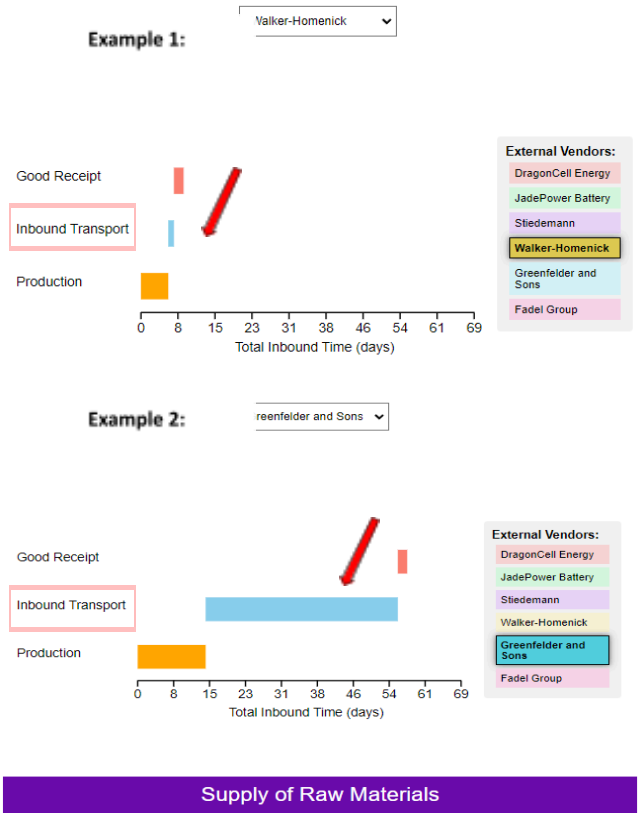
Our exploration through the SunCharge dataset began with enhancing supply chain efficiency. Our exploration was guided by Q2 about production and delivery efficiencies across SunCharge's supply chain:

<u>Supply of Raw Materials:</u>

Our visualizations highlight that external vendors like Walker-Homenick (Example 1) are good in their efficiency, often completing the supply process within 15 days. However, vendors such as Greenfelder and Sons (Example 2) and DragonCell Energy exhibit longer durations, exceeding two months due to prolonged inbound transportation times (see annotated image). The visualization made it evident that while production times were consistent across vendors, transportation was a critical delay point, especially for the latter two vendors.

Some of the optimization opportunities that we can see here; includes:

- Reducing Transportation Delays: Focusing on vendors with extended transportation times, such as Greenfelder and Sons and DragonCell Energy, could yield significant improvements. Initiatives might include optimizing transportation routes or renegotiating terms with freight carriers to ensure more timely deliveries.
- We can also focus on production efficiency, although less critical than transportation, streamlining production processes could further enhance the efficiency.



This part specifically helps us assess each vendor's performance individually by showing the exact time spent on each supply chain stage. It's particularly useful for identifying where each vendor may need improvements, as it doesn't show broad patterns but rather detailed, vendor-specific data. For example, while some vendors excel with fast supply times, others make delays that could be targeted for optimization. This approach allows us to tailor strategies for each vendor, improving efficiency where it's most needed without assuming one-size-fits-all solutions.

Purchases Analysis:

The Purchases chart indicated that all internal vendors consistently delivered earlier than the Planned Goods Receipt Date, with negative Receipt Time Deviations indicating efficiency. This trend is a clear indicator of operational efficiency within our internal supply processes. Notably, Lyon Production stands out, particularly in July, where they managed to deliver significantly ahead of schedule despite handling smaller quantities compared to other months.

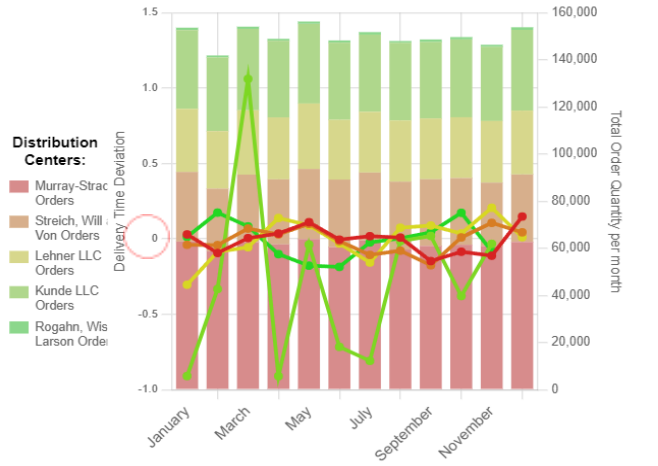
Purchases

Some of the optimization opportunities that we can see here; includes:

- Given Lyon Production's exceptional performance, conducting a detailed benchmarking exercise to identify and understand the best practices and operational strategies at Lyon could be beneficial. These practices can then be standardized and implemented across other production units to enhance overall efficiency.

Sales and Delivery Insights:

While the Delivery Time Deviations across most distribution centers hovered around zero, indicating on-time deliveries, notable inconsistencies were observed with Kunde LLC. This Distribution center showed significant variation, with considerable delays in March and advances in months like January, April, and July.



Sales

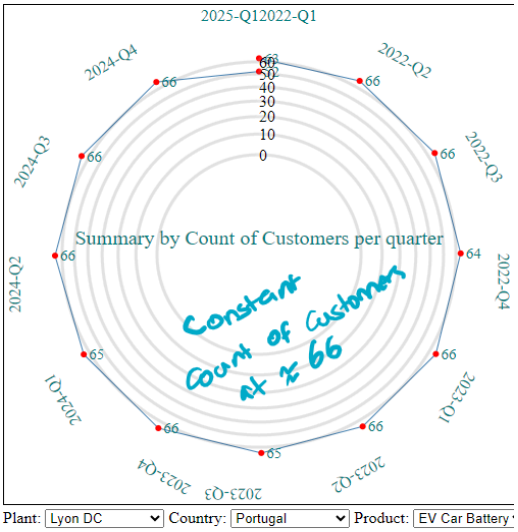
Some of the optimization opportunities that we can see here; includes:

- Areas for improvement could be streamlining distribution by addressing the inconsistencies in delivery times at Kunde LLC could improve reliability and customer satisfaction.
- Also, implementing stricter scheduling and forecasting measures could minimize these fluctuations.
- Finally, they can enhance monitoring by establishing more robust monitoring systems to track and respond to delivery time deviations in real-time could preempt potential delays.

Overall, for the supply Chain efficiency improvement, this detailed analysis facilitated by our custom visualizations can allow SunCharge to pinpoint specific areas within its supply chain that, if improved, could significantly enhance overall efficiency and reliability. These insights not only answer the research question but also provide actionable recommendations for supply chain optimization.

Plant Performance Insights - Insights and Optimizations

We also wanted to show the performance of our finished products based on sale Orders and number of customers served by each plant based on the Customer Country.



An observable huge difference between EV car Battery and Home Battery exists based on the number of unique customers served per quarter as well as overall. When order quantity per product is put into consideration, it supports the notion that we do well in the sale of EV car Batteries. From these initial observations, we also needed to confirm that this pattern exists for all our plants and if maybe for some countries served by the Plants, an alternative pattern would arise. This pattern was persistent regardless of the combination of plant and Customer Country It should also be noted that we are serving an almost similar number of unique customers per Quarter, and an almost similar amount of sales quantity per quarter. This might indicate that we need to do more advertisements in order to reach and attract new customers.

Lyon DC, Total Orders: 395422, Total Customers: 5873

Wrocław DC, Total Orders: 340795, Total Customers: 4985

Göteborg DC, Total Orders: 314374, Total Customers: 4683

Antwerp DC, Total Orders: 738640, Total Customers: 11055

Birmingham DC, Total Orders: 11226, Total Customers: 176

While carrying out the analysis, it was noted that in comparison to other plants, Birmingham DC came in too short on the number of units sold as well as customers served.

This could be either that this is a relatively new distribution plant and that we are yet to reach the ideal number of customers; that in the market it serves, there are other competitive similar products that might be more preferable to ours.

Lyon DC, Total Orders: 395422, Total Customers: 5873

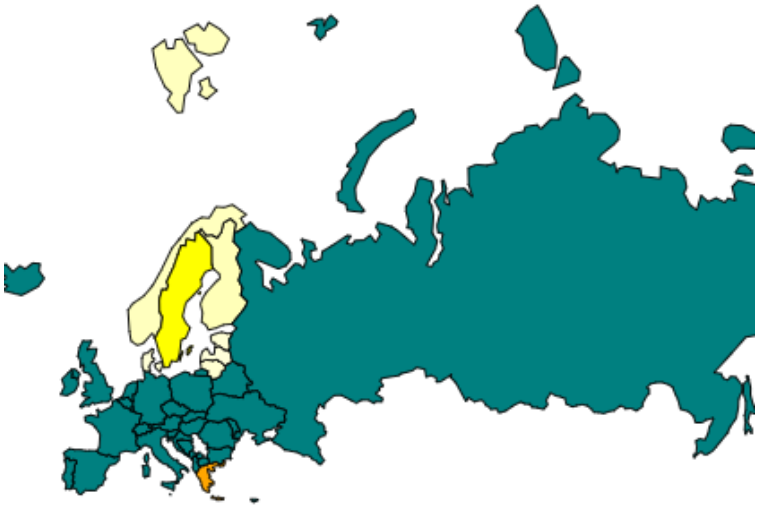
Wrocław DC, Total Orders: 340795, Total Customers: 4985

Göteborg DC, Total Orders: 314374, Total Customers: 4683

Antwerp DC, Total Orders: 738640, Total Customers: 11055

Birmingham DC, Total Orders: 11226, Total Customers: 176

Additionally, it was noted that Antwerp DC handles more than double in comparison to other plants. It might be a good idea to create another distribution center to offload the amount of traffic being observed through Antwerp DC. Germany is our best customer in terms of orders and number of customers and would be the best candidate for this new plant.



It was also noted that all our customer base is in Europe. We need to employ methods used to capture the European market for our product to sell in other regions.

Conclusions

- Analyzing supplier performance shows that improving transport logistics for slower vendors like **Greenfelder and Sons** can significantly enhance supply chain speed and efficiency.
- Early deliveries by internal vendors, particularly **Lyon** Production, highlight effective processes. Replicating Lyon's strategies across other units could streamline operations and reduce delivery times.
- Inconsistencies in delivery times, especially at **Kunde LLC**, highlight the need for stricter scheduling and real-time monitoring to ensure reliable and timely deliveries.
- Plant performance analysis proves that there is an overall good performance in the sale of **EV car Battery**. Using the same marketing strategies for **Home Battery** would improve their sale hence overall good performance for all the products.
- **Antwerp Distribution plant** has the best sales performance amongst our plants, with **Germany** having the highest purchases overall. To reach the vast majority of our customers, we should explore having a distribution plant in **Germany**.
- **Birmingham DC** which only serves one customer(**United Kingdom**) has the least sales. Having a distribution plant here might not fully meet our expectations and we would rather move this plant to **Germany** as in point above, then distribute Batteries to the **United Kingdom** from another nearby plant, such as **Lyon** Distribution Plant.

Part 6. Reflections

Reflecting on this project, there are several aspects that we are particularly proud of. The first is our ability to work effectively as a remote team, overcoming the challenges of distance and time differences. Another significant achievement is our rapid learning and application of Svelte from scratch in a very short time frame. This not only demonstrates our capacity for quick learning, but also our strong will to create non-trivial graphs. The balanced distribution of work, with each team member contributing a graph, showcases our collaborative spirit and commitment to equity. Lastly, our democratic and scientific approach to decision-making, particularly in selecting the two graphs for the report from the three initial graphs, underscores our dedication to fairness and methodical thinking. These accomplishments collectively contribute to a strong sense of pride in our work on this project.

Part 7. Individual contributions

The project was a team effort from beginning to end, with each member taking charge for implement visualizations focusing on each of our research questions:

- Ali: Question 1, He created visualizations that analyzed sales data across different countries. His charts helped determine potential markets for increased or decreased sales efforts. His visualizations, available in our GitHub repository, are not included in this report.
- Andrea: Question 2, She produced visualizations that mapped the efficiency of the supply chain concerning production and delivery times by suppliers. She also crafted our demo video using Microsoft Clipchamp.
- Charles: Question 3, He produced visualizations that compared the performance of various plants in terms of customer reach and quarterly sales figures. He also took care of consolidating all our code on GitHub.

Throughout the project, all team members regularly met to discuss the development and integration of their visualizations. In the meetings, we had various debates and suggestions, particularly in relation to the implementation part and the creation of interactive and engaging charts. Although Ali's visualizations are not shown in this report, he made significant contributions and put in the same level of effort as the rest of the team. His work is accessible for review in our GitHub repository.

Code and Documentation:
Code Repository: https://github.com/Muirur1/GR37-Implementation