ENCHANCING MANUFACTURING EFFICIENCY WITH POWERBI INSIGHTS

OBJECTIVE

The objective of this case study is to leverage Power BI to conduct a comprehensive analysis of the 'Manufacturing Production Data' and 'Employee Performance Metrics' datasets. The goal is to uncover valuable insights and trends that can be utilized to enhance manufacturing efficiency, optimize resource allocation, and improve employee productivity and also to empower Pro Manu Analytics and its clients with actionable insights, fostering continuous improvement in manufacturing processes and workforce management.

Pre-processing Methodology:

- As a first step in this project, we established a connection with Excel, After that we have imported the two datasets and renamed them as "**product_data**" and "**employee_data.**" We moved to the model view , there we observed that Power BI automatically detected a relationship between the datasets based on the "**ProductID**" column.
- Now moving to the **Power Query Editor**, we identified missing values in "**ProductionCost**" and "**QuantityProduced**" in "**product_data**" and in "**Salary**" and "**PerformanceRating**" in "**employee_data.**" Additionally, we noted irrelevant data in the "**Warehouselocation"** and "**Department**" columns.
- Now to address missing "**Department**" values in "**employee_data**", we utilized "**Employee Training Records**" and replaced irrelevant data with the "**Logistics**" department.
- For missing "ProductionCost" and "QuantityProduced" values in "product_data," we employed a strategy of **mean** and **median**, respectively, based on "ProductType" and "CountryofOrigin." We created a **groupby** table and **merged** it with the original data after handling null values.
- Similarly, for "Salary" and "PerformanceRating" in "employee_data," we applied **mean** and **median** strategies based on "Department" and "CountryofOperations," creating a groupby table, handling null values, and merging it back with the original data.
- After filling missing values, we merged "product_data" and "employee_data" on the "ProductID" column, creating a final merged dataset named '**Final Data**.'
- At the end of preprocessing, we have dropped the rows which contains the irrelevant data in the "WarehouesLocation" column.
- We have imported the 'Final Data' into the Power BI from the Power query Editor.

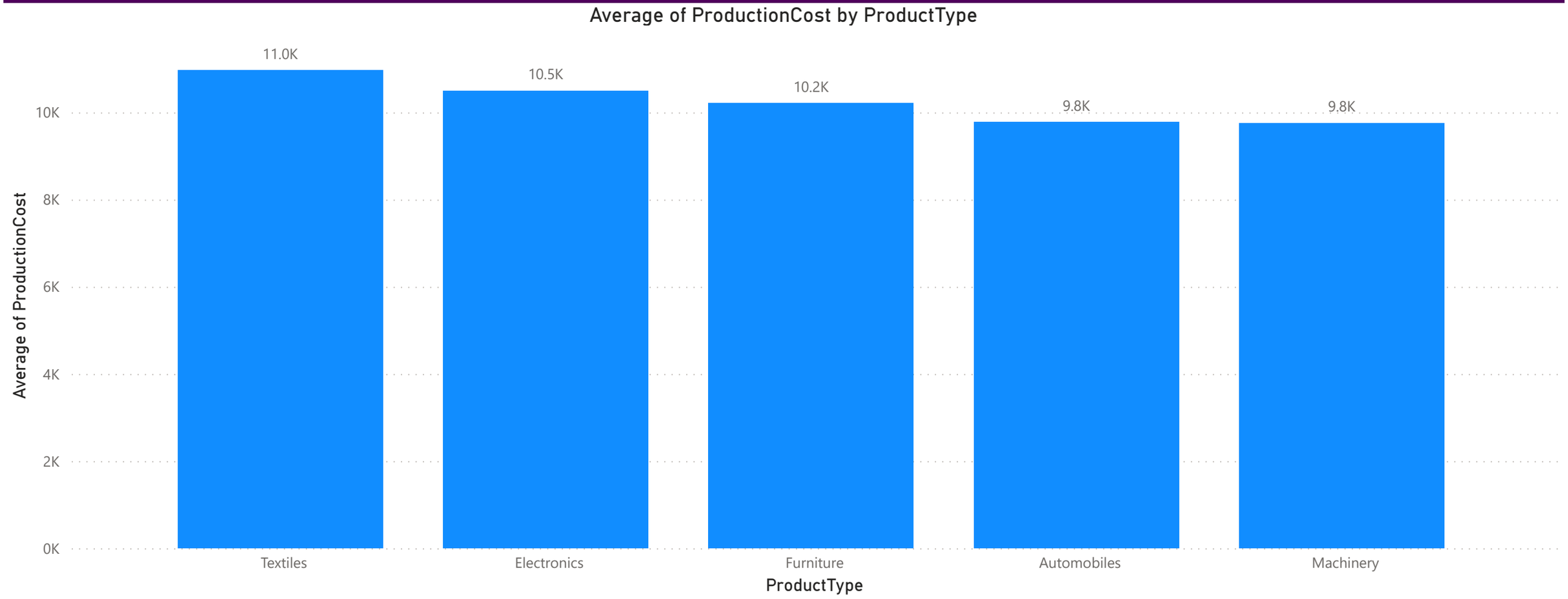
Categorizing Product Types

- Create a new column categorizing products into broader categories based on 'Product Type'. What categories did you create?

Ans. Since there is **no** broader categories based on 'Product type'. The data is already categorized well.
Product type: Textiles, Automobiles, Furniture, Automobiles, Electronics.

Analysis of Production Costs

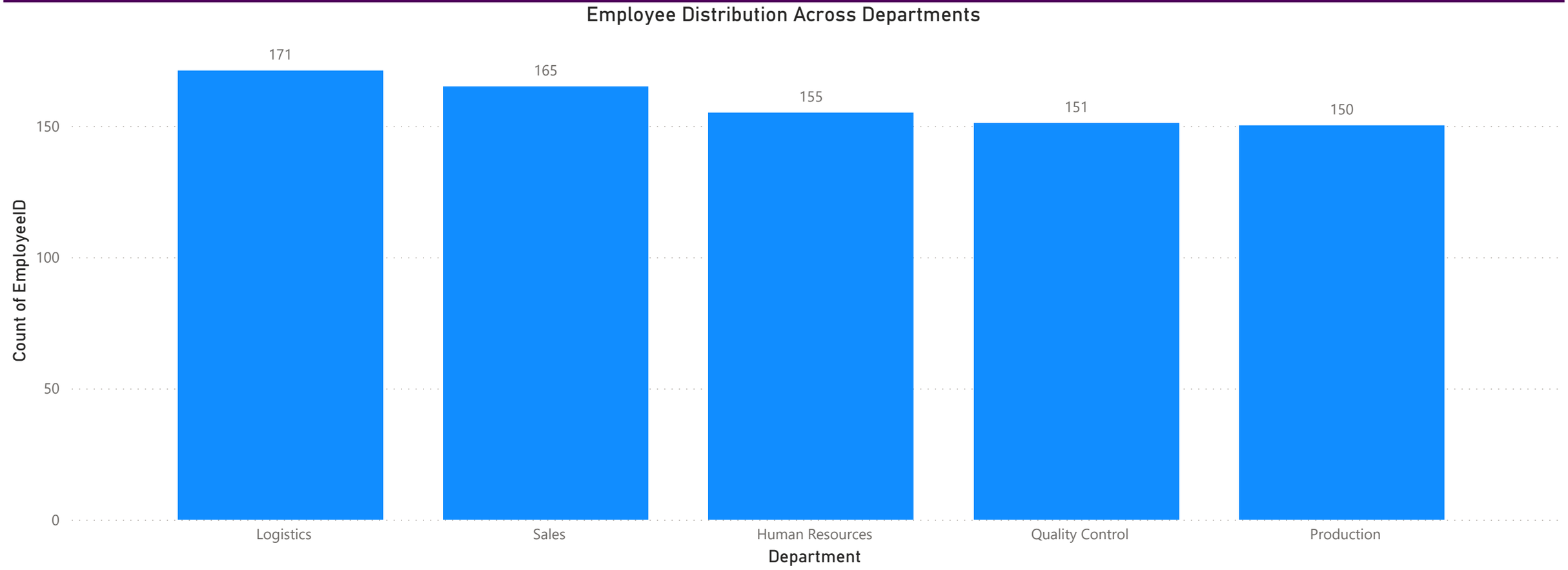
Calculate the average production cost for each product type. Which product type has the highest average cost?



From the graph, it is evident that Textile products have higher average production cost compared to all other product types.

Employee Distribution Across Departments

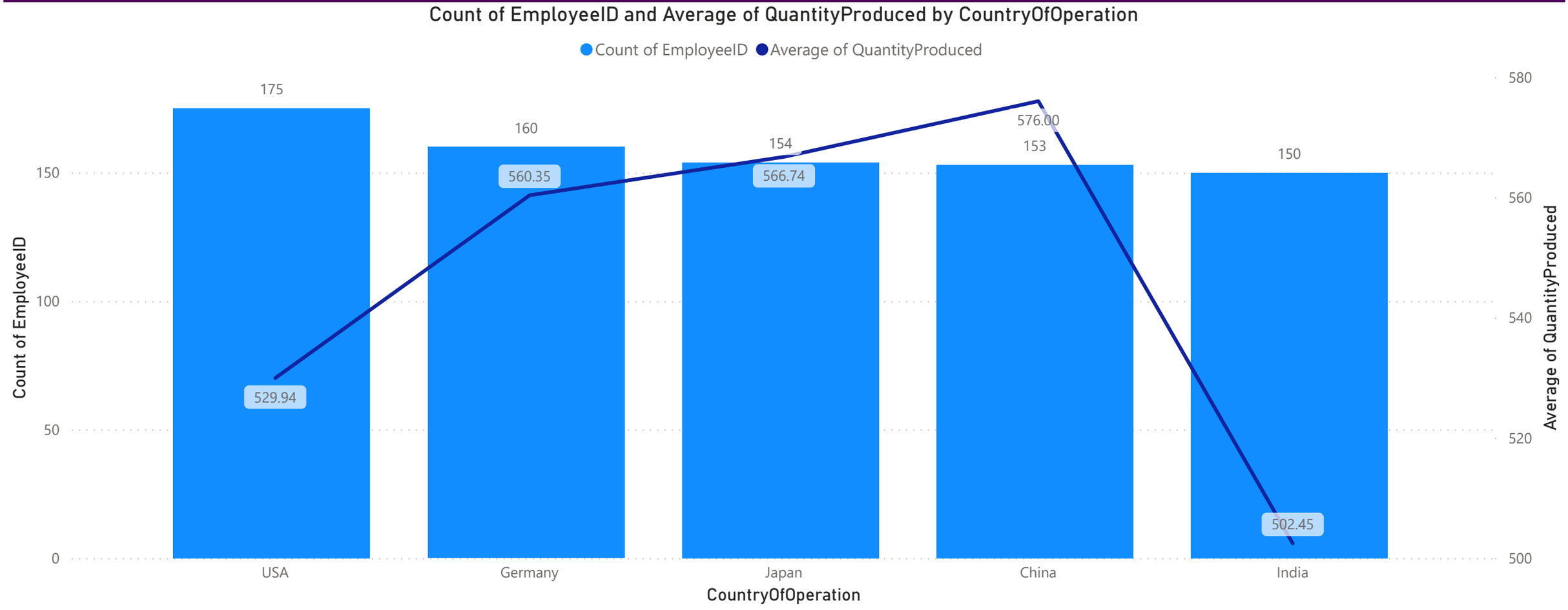
Analyze the distribution of employees across different departments. Which department has the most employees?



Logistics department has the most number of employees compared to other departments.

Country-Based Analysis of Operations

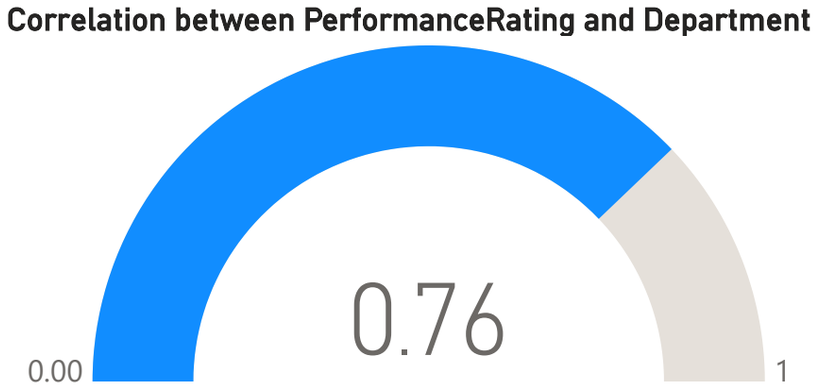
- Investigate which country has the highest number of employees and the highest average production.

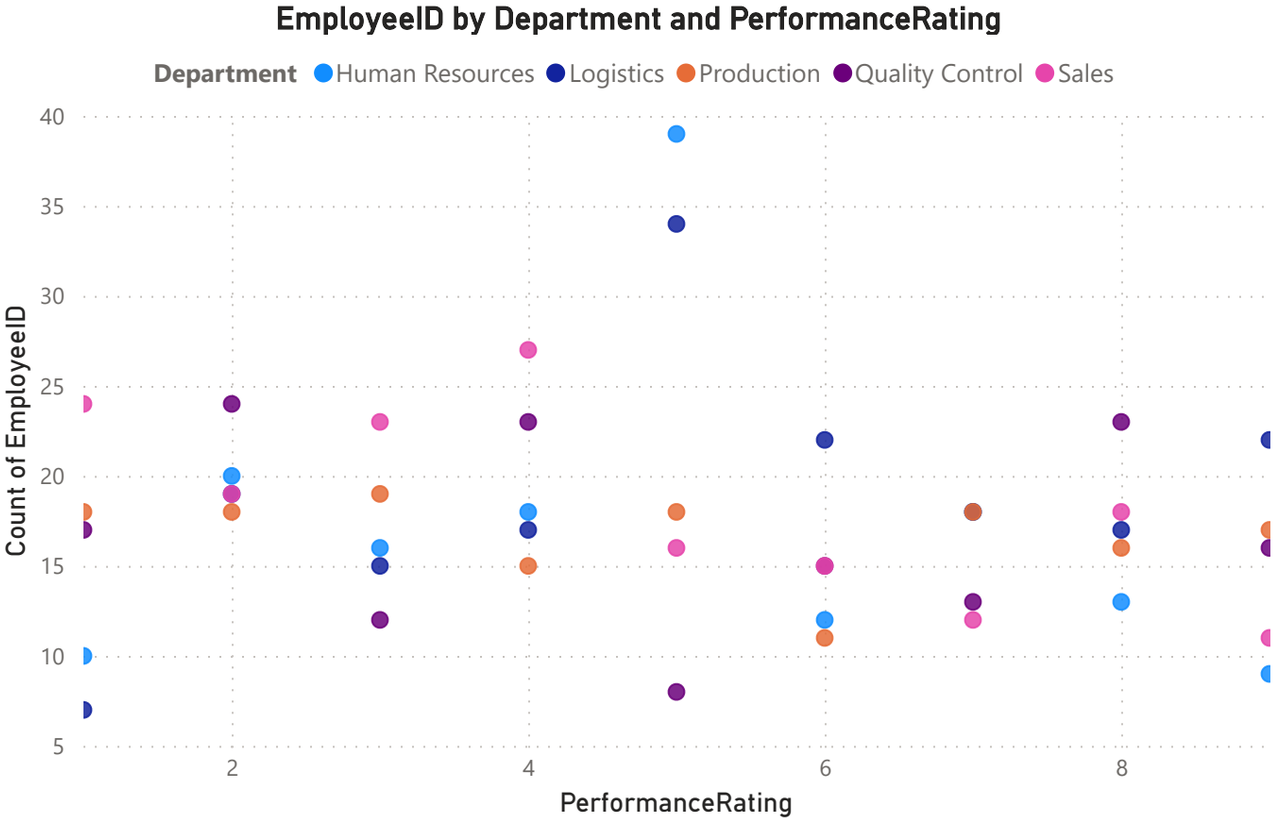


From the graph it is evident that USA has more number of employees compared to other countries whereas China has the highest average production.

Performance Rating Analysis

Using DAX, analyze the average performance rating by department. Is there a correlation between department and performance rating?





Observation:

Based on the gauge plot obtained , we can observe that the Department and performance rating is Positively correlated with a correlation coefficient of 0.76.

Warehouse Efficiency Analysis

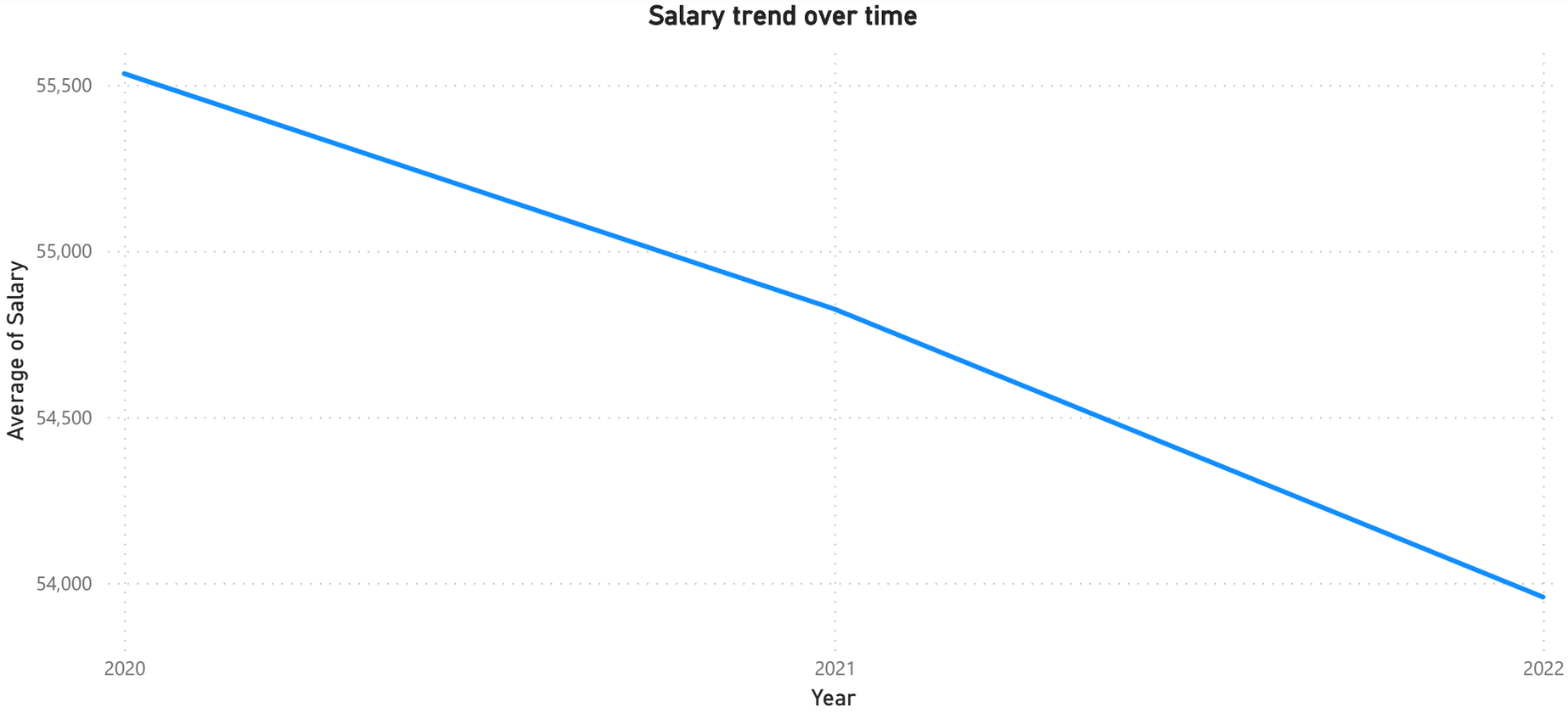
- Calculate the average quantity of products stored in each warehouse location. Which warehouse location is utilized the most?

Observations

- Ware house in the North location has produced more quantity compared to other warehouses.

Salary Trends Over Time

- Analyze the trends in salaries over time. Are there noticeable increases or disparities?



30,013.47

Min of Salary

79,990.83

Max of Salary

Observations:

- From the graph it is clear that there is decline in the average salary of the employees over the years.

Correlation Between Salary and Performance

- Explore if there's a correlation between employees' salaries and their performance ratings.

Correlation coef by Department

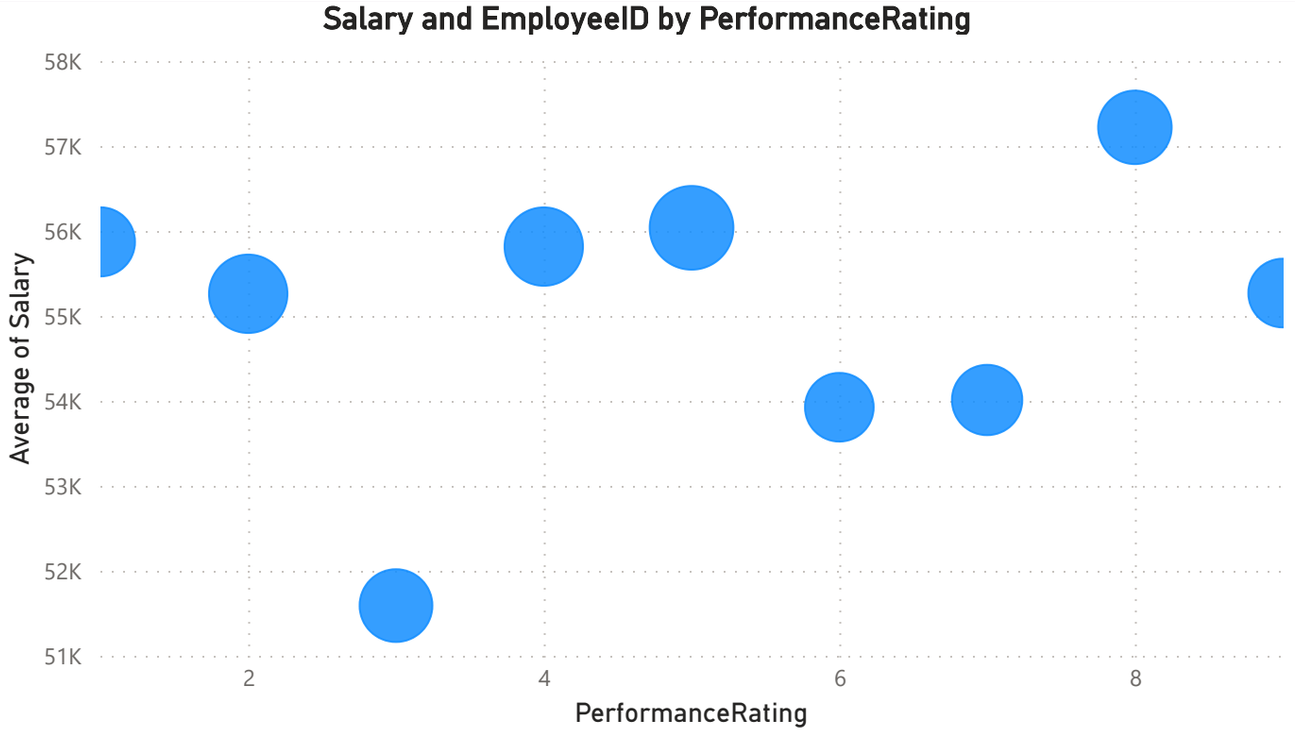
0.46

Correlation coef by countryOfOrigin

0.45

Correlation coef by countryOfOperation

-0.49

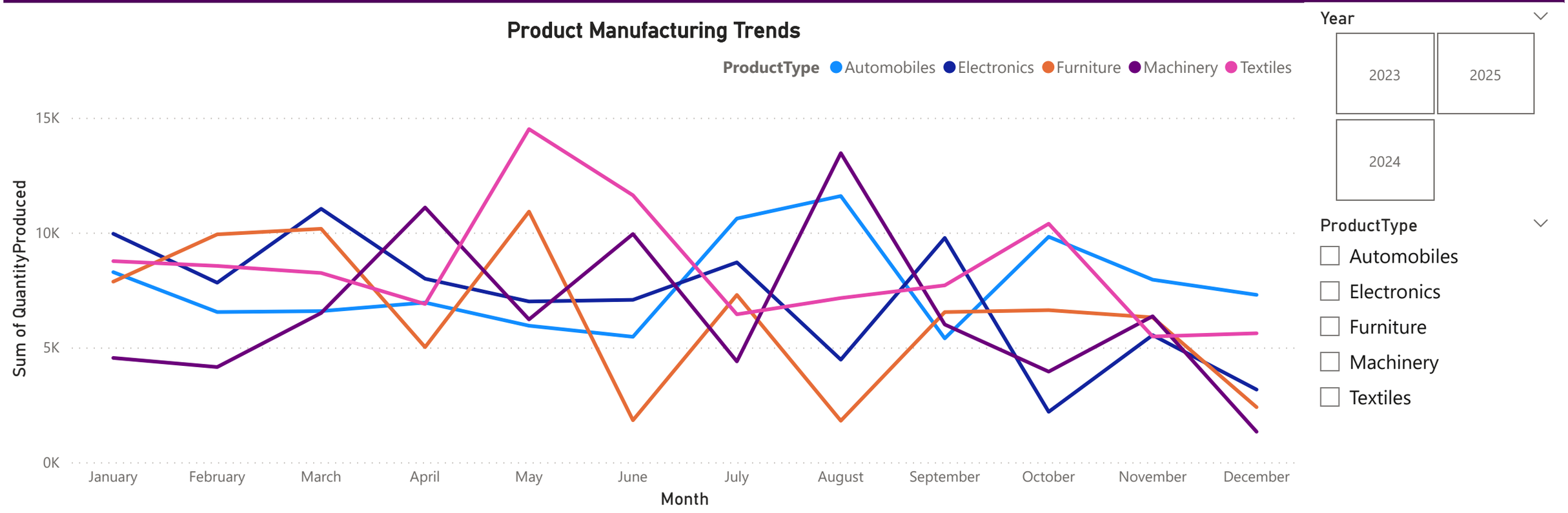


Observation:

- To explore the correlation between employee's salaries and their performance ratings it is recommended to use the quick measure ,an in-built function in Power BI. Based on the above methodology, it is observed that :
- Based on Department, the Average salary and Performance rating are **positively correlated** with a correlation factor of **0.46**.
- Based on Country of Origin, The Average salary and Performance rating are **positively correlated** with a correlation factor of **0.45**.
- Based on Country of Operation, The Average salary and Performance rating are **negatively correlated** with a correlation factor of **0.49**.

Product Manufacturing Trends

Analyze how the manufacturing of different product types has trended over time. Are there seasonal patterns?



Observations

- We have observed a increasing trend for the Machinery on April and November.
- We have observed a increasing trend for the Textiles on May and October .
- We have observed a decreasing trend for the Electronics on October.
- We have observed a increasing trend for Automobiles on July.
- There are no trends found for the Furniture product category.

Cost Analysis by Country of Origin

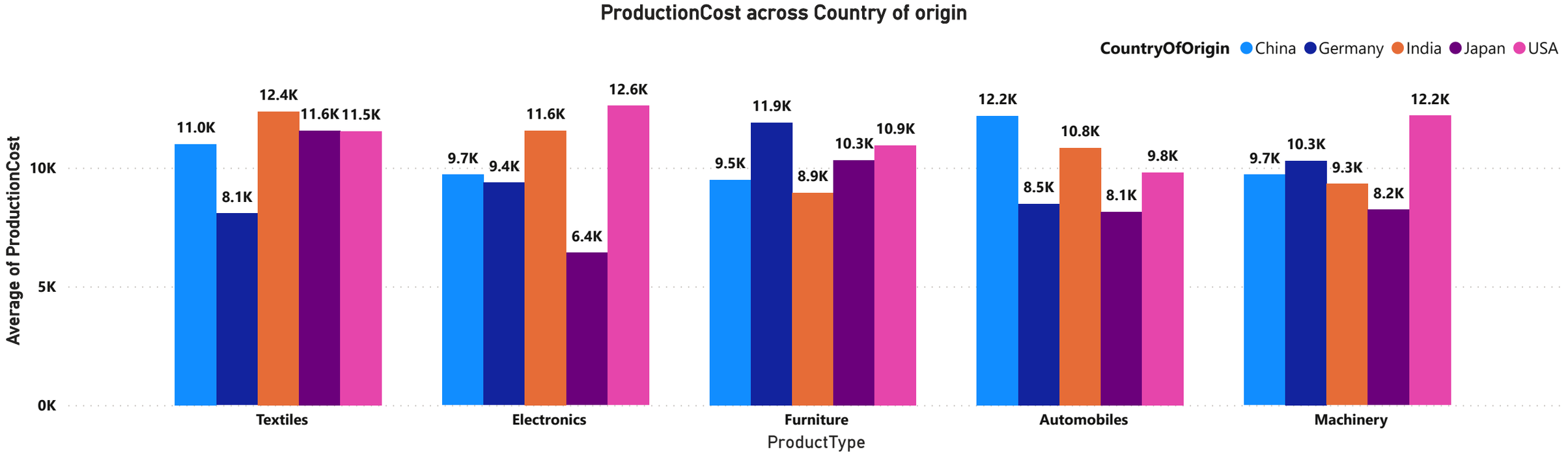
Investigate the average production cost per product in each country of origin. Which country has the highest and lowest costs?

ProductType	China	Germany	India	Japan	USA	**Total**
Machinery	9,706.83	10,294.58	9,325.41	8,234.71	12,200.47	**9,755.21**
Automobiles	12,191.38	8,480.09	10,829.88	8,141.09	9,800.20	**9,773.85**
Furniture	9,495.63	11,896.56	8,944.94	10,318.38	10,949.42	**10,205.17**
Electronics	9,710.41	9,377.58	11,566.27	6,420.49	12,612.91	**10,494.53**
Textiles	10,996.46	8,075.05	12,364.78	11,562.27	11,532.26	**10,966.43**
Total	**10,501.57**	**9,492.62**	**10,717.83**	**9,236.31**	**11,375.34**	**10,260.83**

Conclusion :

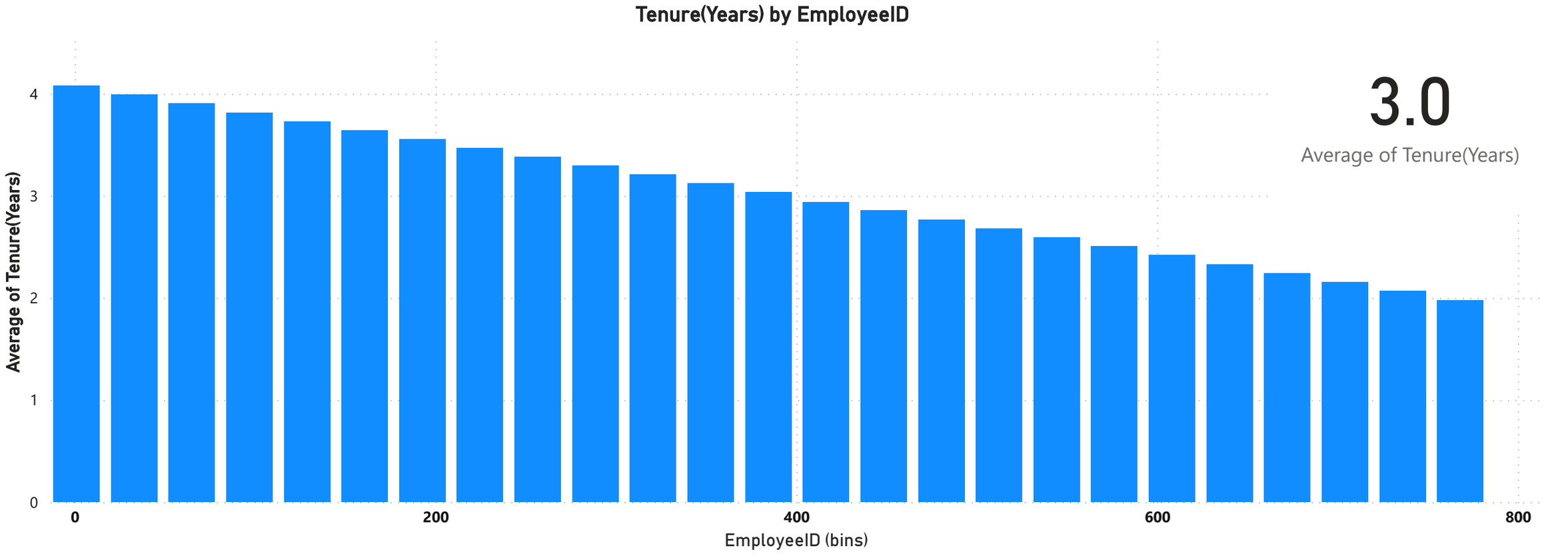
- To Investigate the average production cost per product in each country of origin, it is recommended to used stacked column graph for ease of visual inspection. Based on the stacked column graph obtained ,it can be concluded that:

Product type	Highest Average Cost	Lowest Average Cost
Textile	India	Germany
Electronics	USA	Japan
Furniture	Germany	India
Automobiles	China	Japan
Machinery	USA	Japan



Employee Tenure Analysis

- Calculate the tenure of employees in the company and analyze its distribution.

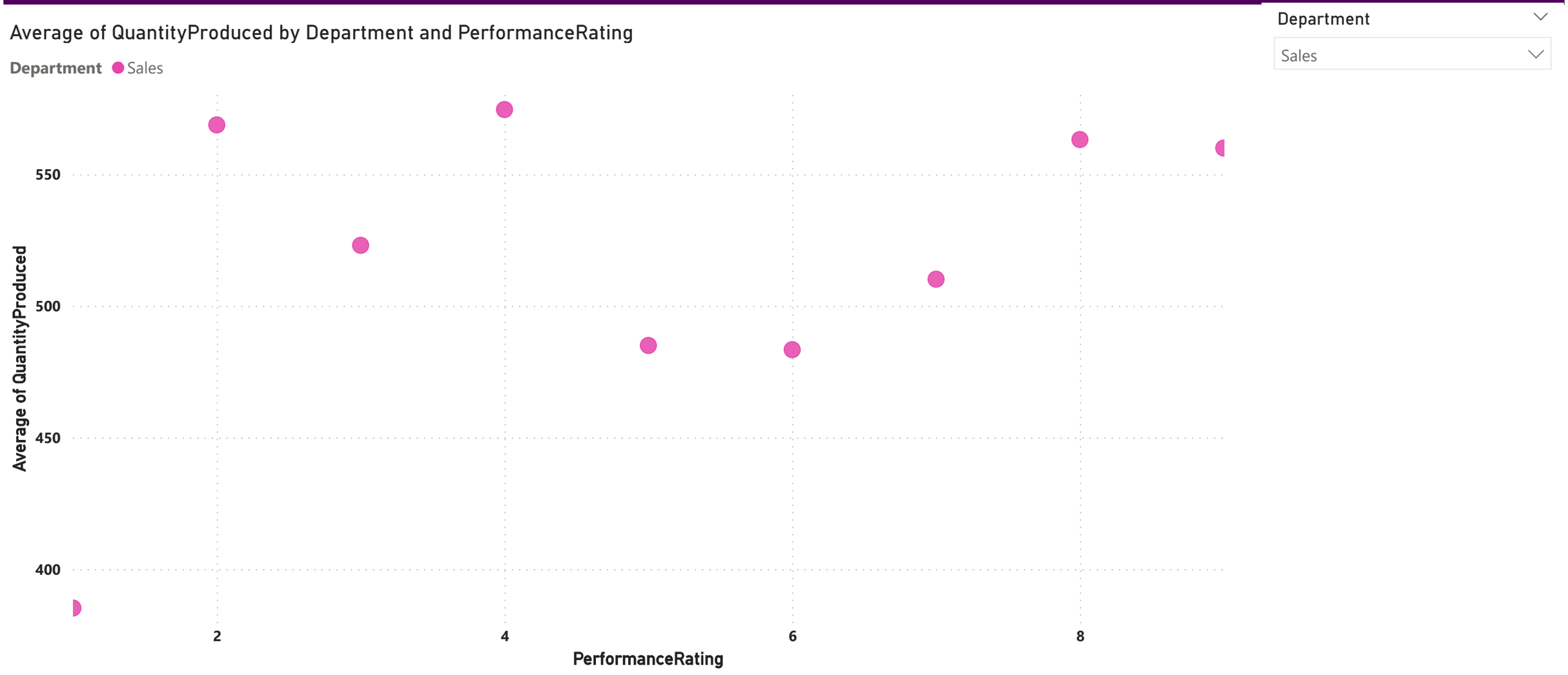


Conclusion:

- Based on the graph obtained , it can be concluded that the Employees in the company have varied range of experience with maximum being 4 years and minimum being 1.9 years. The average tenure(in years) of the employees is 2.9 years

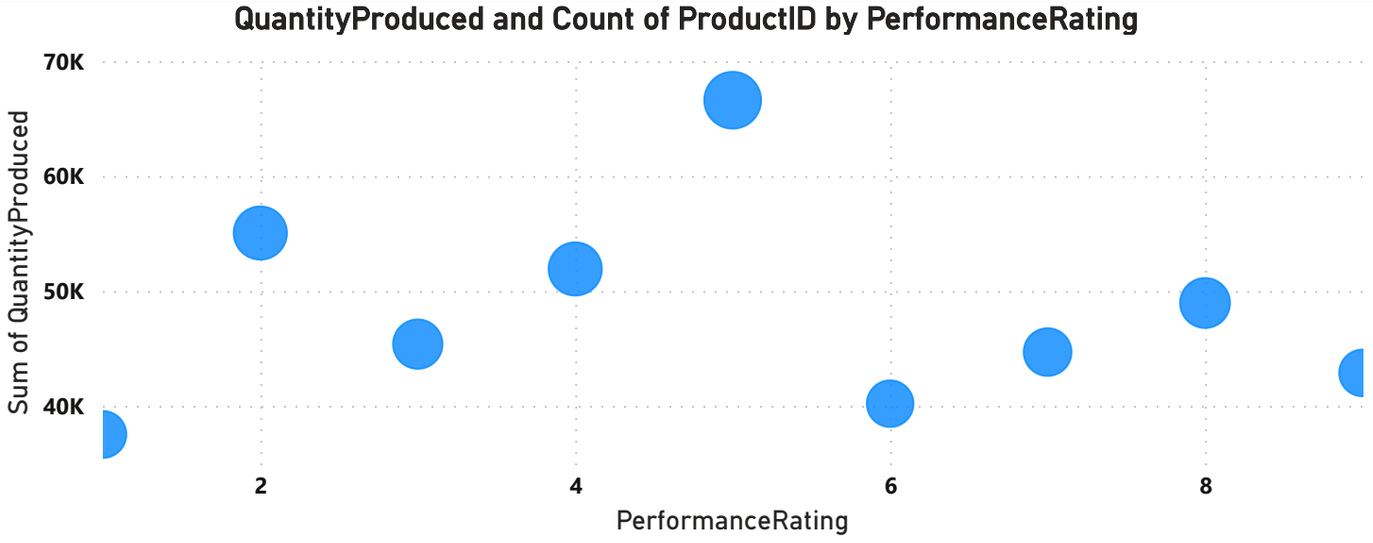
Production and Sales Correlation

- Create a measure to analyse the correlation between quantity produced and employee performance in sales.



Analyzing Product Lifecycle

Analyze the lifecycle of products based on their production date and quantities.



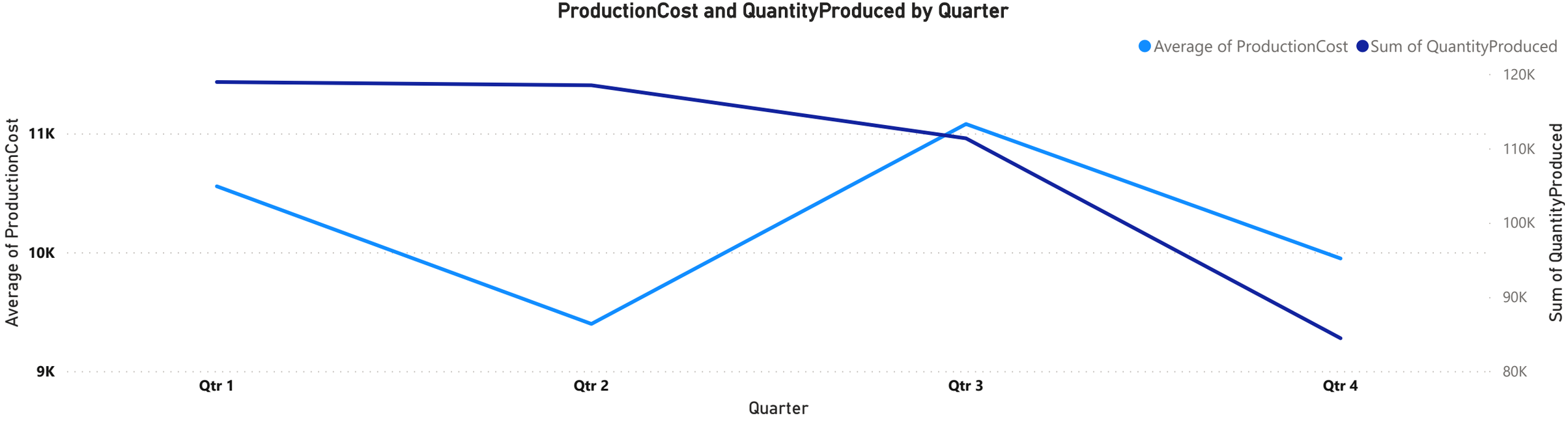
CountryOfOrigin

All

ProductType

All

ProductType	Count of ProductID	Sum of QuantityProduced	Average of ProductionCost
Automobiles	172	92439	9,773.85
Electronics	156	84727	10,494.53
Furniture	142	76693	10,205.17
Machinery	142	77946	9,755.21
Total	**792**	**433169**	**10,260.83**



Observations:

- As the Product Lifecycle will represent the introducing the products into the market, growth of the products in the market, reaching the Peak sales in the market and decline of the product sales. we have used the production quantity and Production time line to represent the Product Life cycle.
- The line plot reveals a correlation between production quantity and production cost, indicating a decrease in production quantity when production costs are high. Notably, manufacturing in bulk during the 1st and 2nd quarters results in higher production quantities and lower production costs. However, a declining trend in production quantity is evident from the 3rd quarter onward.
- Examining the scatter plot, it highlights the influence of employee performance on production quantity. Notably, employees with a performance rating of 5 positively impact production quantity.

Advanced DAX: Cost Efficiency Analysis

- Using DAX, explore the cost efficiency of production (production cost per unit of product).

Cost per unit Product

ProductID	Automobiles	Electronics	Furniture	Machinery	Textiles	Total
14			176.31			**176.31**
537			148.12			**148.12**
987			143.04			**143.04**
988					137.24	**137.24**
365			126.85			**126.85**
183			125.08			**125.08**
756		124.98				**124.98**
Total	**23.93**	**26.23**	**28.60**	**26.29**	**28.21**	**26.62**

Total Quantity Produced

ProductID	Automobiles	Electronics	Furniture	Machinery	Textiles	Total
599					998.00	**998.00**
46					996.00	**996.00**
542					995.00	**995.00**
327				992.00		**992.00**
954		991.00				**991.00**
705					989.00	**989.00**
931					987.00	**987.00**
87		986.00				**986.00**
64					984.00	**984.00**
Total	**537.44**	**543.12**	**540.09**	**548.92**	**563.13**	**546.93**

Total Production cost

ProductID	Automobiles	Electronics	Furniture	Machinery	Textiles	Total
90		19,969.78				**19,969.78**
205	19,865.08					**19,865.08**
707				19,773.90		**19,773.90**
80			19,750.99			**19,750.99**
14			19,746.34			**19,746.34**
811		19,742.03				**19,742.03**
599					19,729.01	**19,729.01**
579	19,716.37					**19,716.37**
312					19,704.24	**19,704.24**
Total	**9,773.85**	**10,494.53**	**10,205.17**	**9,755.21**	**10,966.43**	**10,260.83**

Conclusion:

DAX query : Production Cost/Quantity Produced is used to calculate the cost per unit.

Product ID: **14** in Furniture product type has highest cost per unit of 176.31.

Product ID: **599** in Textiles product type has highest production of 998.

Product ID: **90** in Electronics product type has highest production cost of 19,968.

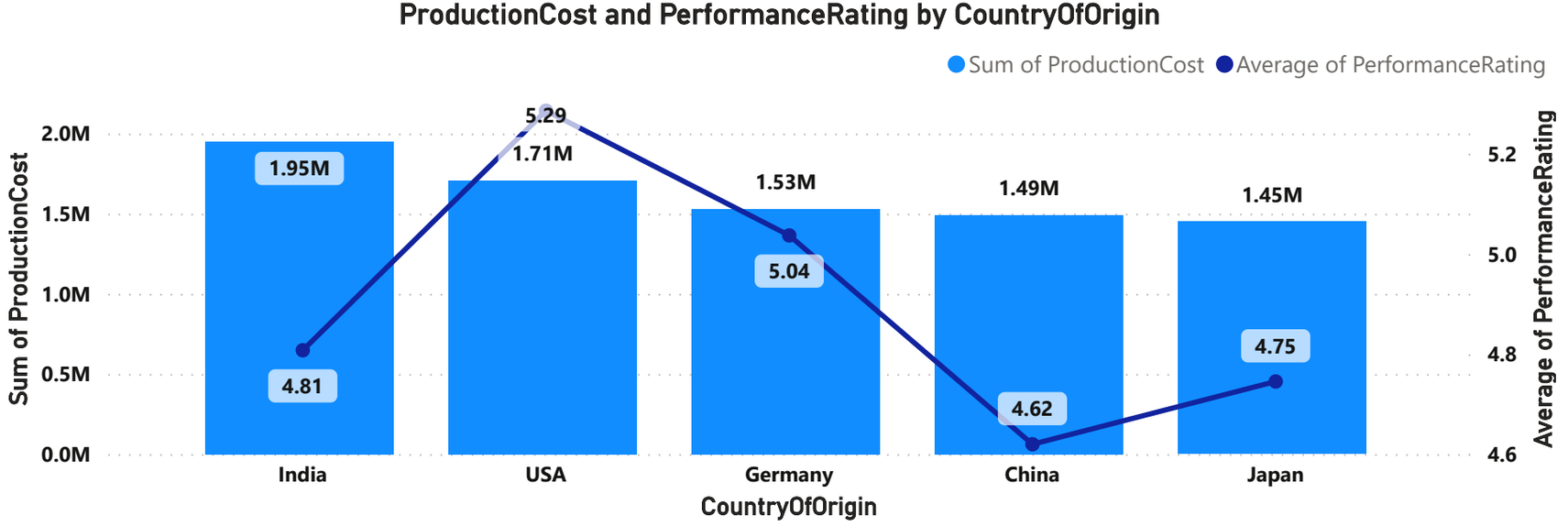
Extracting Key Information

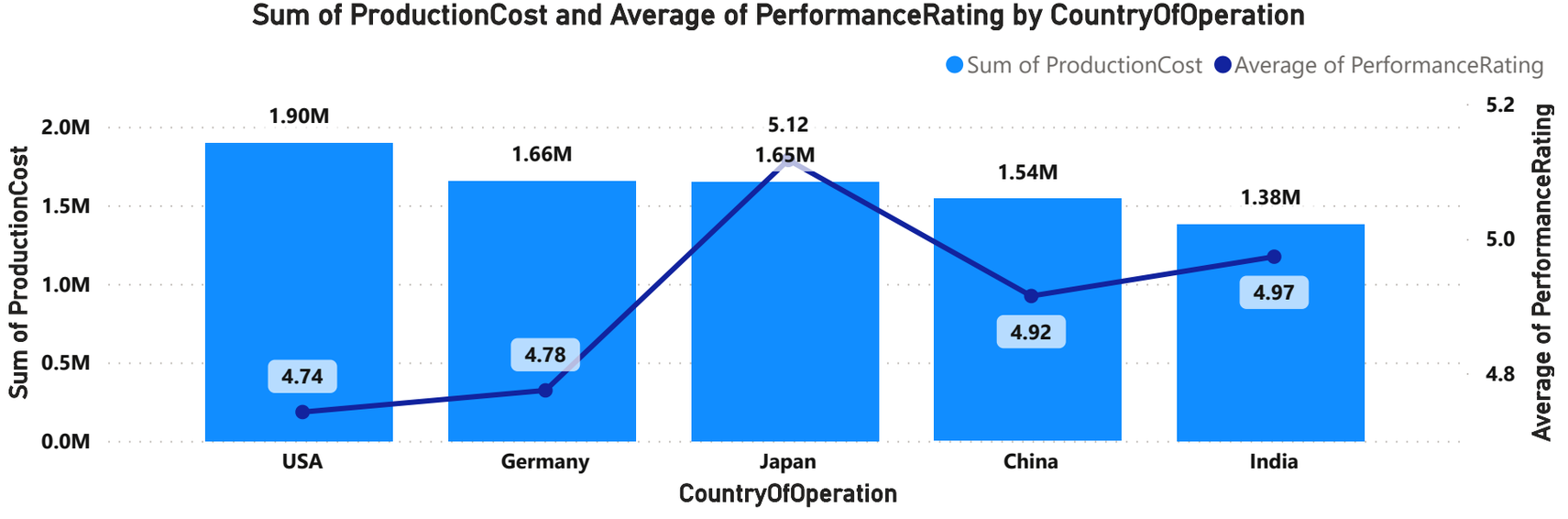
Using the 'Employee Training Record' column in the Manufacturing Dataset 2, create two new columns. One column should list the dates of all training sessions for each employee, and the other should list the types of training sessions (e.g., Sales Techniques Workshop, Leadership Skills Seminar).

- Firstly, split the column using split option using delimiters ':' ,';'. The column is split into 6 columns with 3 columns representing the training dates and remaining 3 columns for training the employee attended.
- Every employee did at least one training.
- Then merged all the date columns with separator as ',' and renamed.
- Also merged all the training name columns with ',' as separator and renamed.
- By following these steps key information is extracted like dates list, trainings list from the 'Employee Training Record'.

Country of Operation vs. Country of Origin

Compare the countries of operation and origin in terms of production and employee performance.



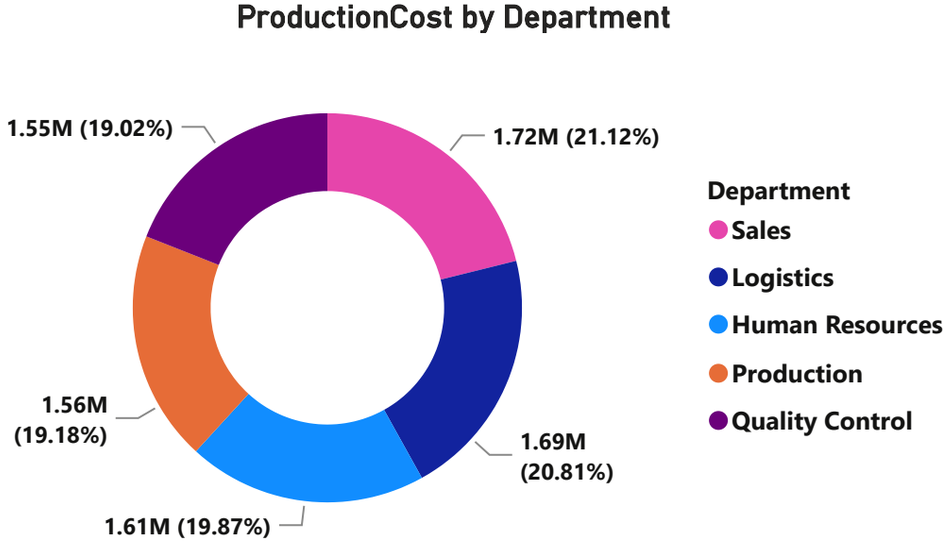


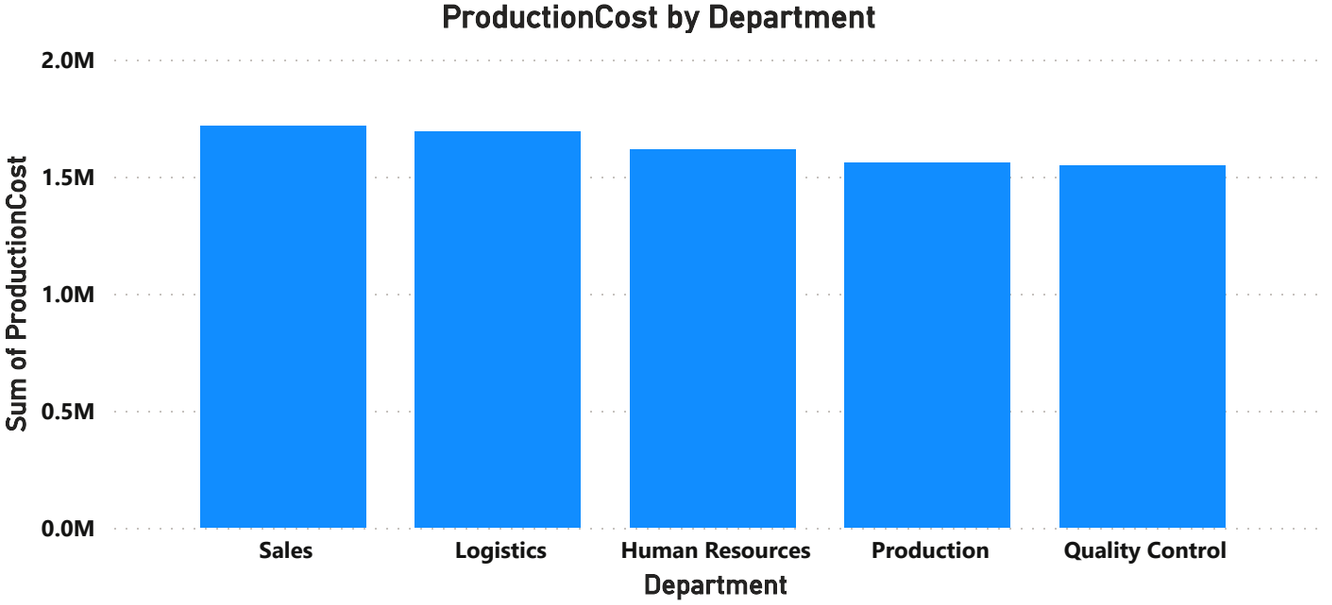
Observation:

1. Production cost for **INDIA** is greater with **1.95 million** and **Japan** having the lowest costs. On the other hand, the **USA** has the highest performance rating of 5.29 and China has the least.
2. The operational production cost from the **United States** is **1.90 million**. **Japan** has the highest performance rating.

Employee Role in Production Cost

Analyze if certain departments or employee roles have a significant impact on production costs.





Department	Sum of ProductionCost	Count of EmployeeID
Human Resources	16,14,790.09	155
Logistics	16,91,008.68	171
Production	15,59,069.08	150
Quality Control	15,45,440.37	151
Sales	17,16,272.75	165
Total	**81,26,580.97**	**792**

Observations:

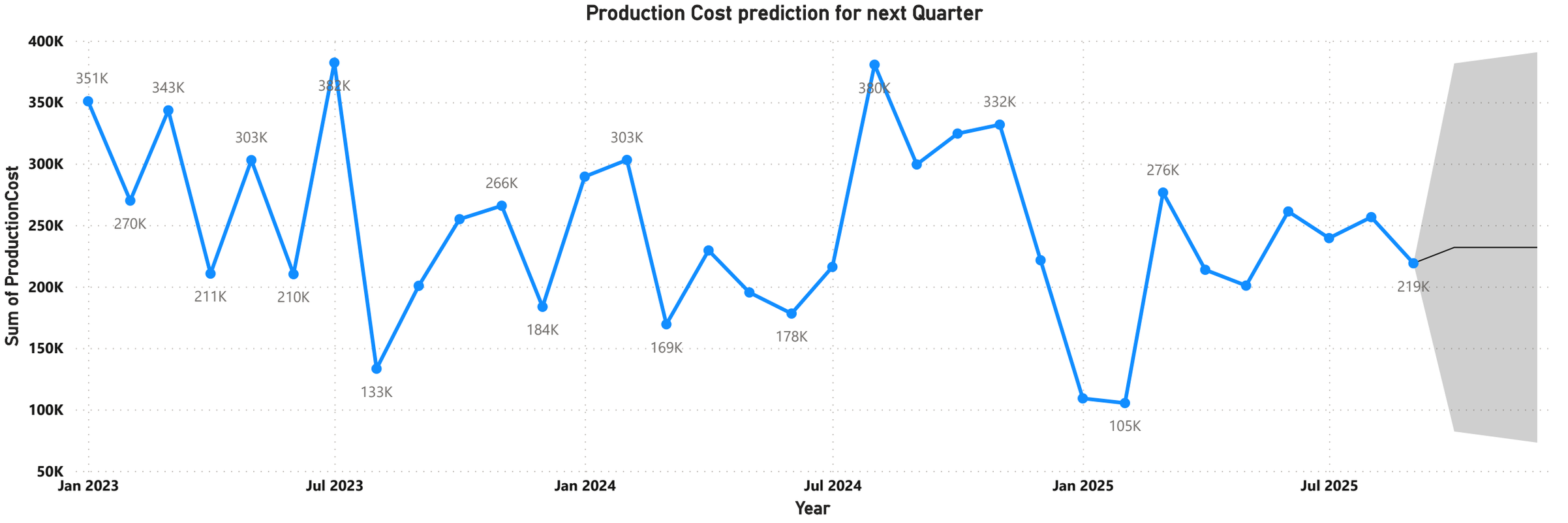
Employee Role in Production Cost:

The employee with the highest production cost is in the sales department, while the lowest is in the quality control department.

The sales department accounts for 21.2% of the overall cost of production, followed by logistics (20.81%), human resources (19.87%), production (19.18%), and quality control (19.02%).

Data Modeling: Time Series Forecasting of Costs

- Perform time series forecasting of production costs using historical data. What are the predicted costs for the next quarter?

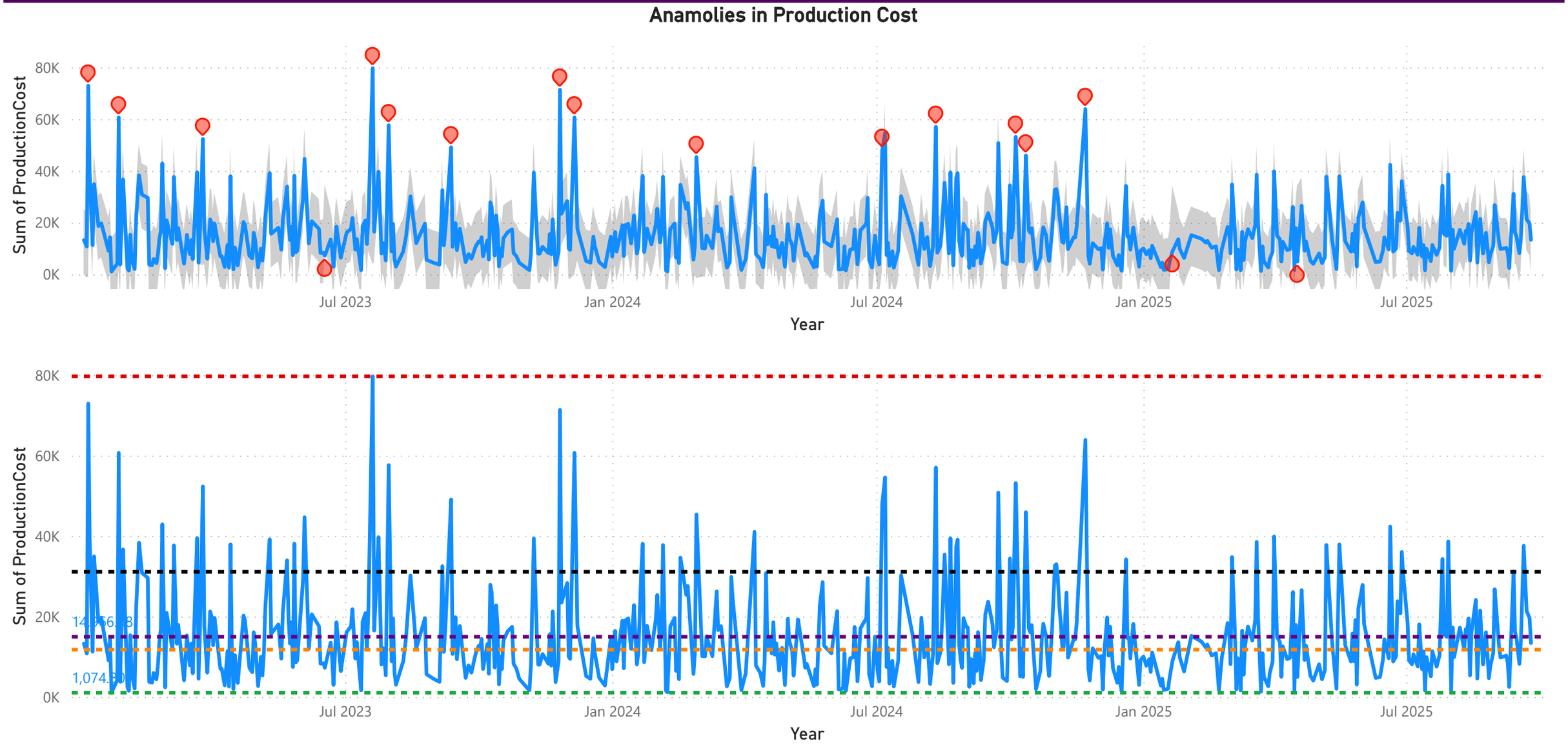


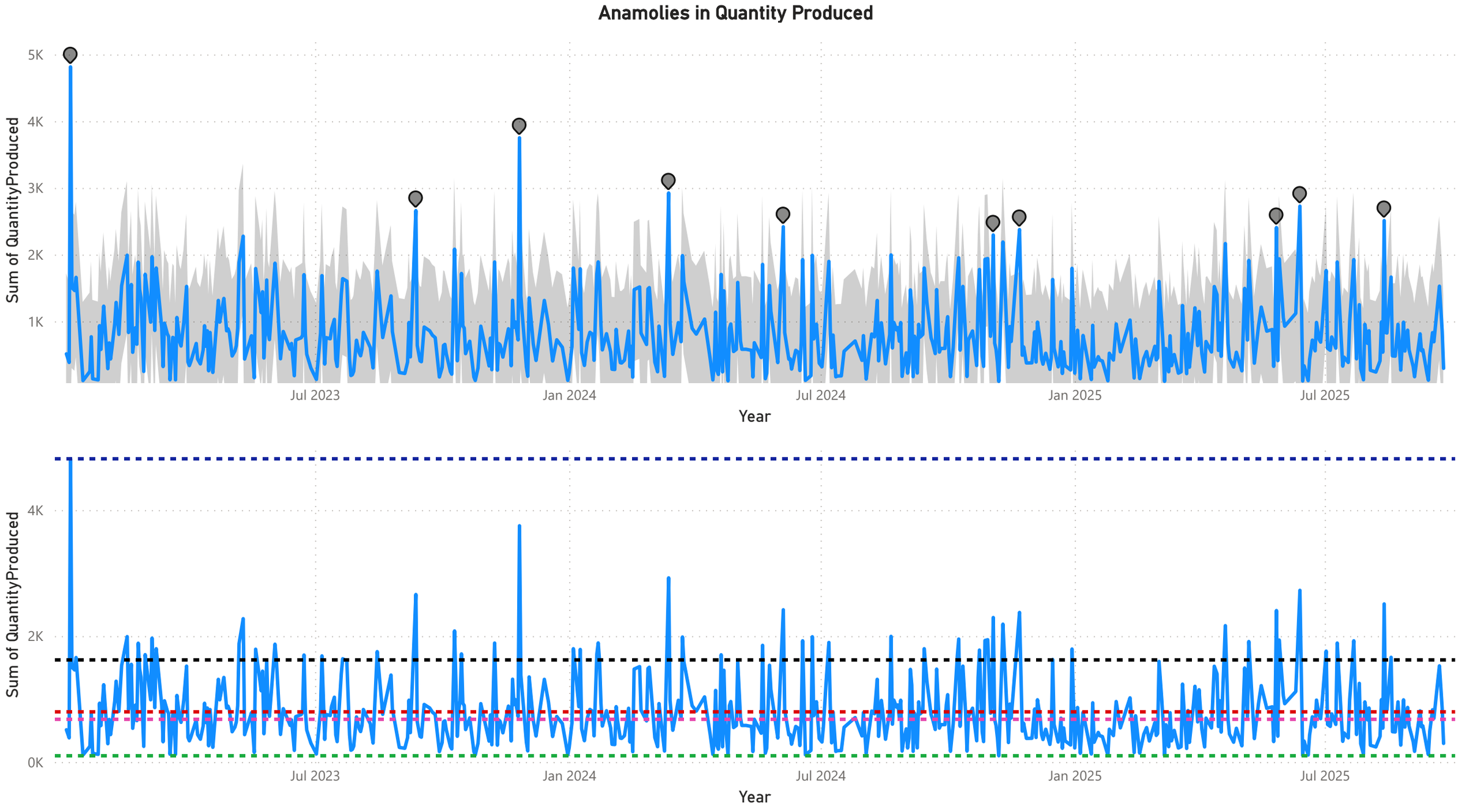
Conclusion:

- In Time Series Forecasting of Costs, We have predicted the manufacturing cost for the upcoming quarter using analytics, and that cost is expected to be 231842.30 with an upper bound of 390,638.78 and a lower bound of 73045.83.

Advanced Data Transformation: Identifying Production Anomalies

- Using Power BI's data transformation capabilities, identify any anomalies in production data (e.g., unusually high costs, sudden spikes in production quantity).




Anamolies in Quantity Produced
Sum of QuantityProduced
5K
4K
3K
2K
1K
Jul 2023
Jan 2024
Jul 2024
Jan 2025
Jul 2025
Year
Sum of QuantityProduced
4K
2K
0K
Jul 2023
Jan 2024
Jul 2024
Jan 2025
Jul 2025
Year

Conclusion:

We can infer from the graph that both the quantity produced and the production cost exhibit anomalies
10 anomalies in the quantity produced column and eighteen in the production cost column.

Manufacturing Report

warehouse Location: East | North | South

Production Year: 2023 | 2024 | 2025

Department: All

Product Type: All

Country: All

Production Cost across Product type and Country of Origin

ProductType	China	Germany	India	Japan	USA	Total
Machinery	9,706.83	10,294.58	9,325.41	8,234.71	12,200.47	9,755.21
Automobiles	12,191.38	8,480.09	10,829.88	8,141.09	9,800.20	9,773.85
Furniture	9,495.63	11,896.56	8,944.94	10,318.38	10,949.42	10,205.17
Electronics	9,710.41	9,377.58	11,566.27	6,420.49	12,612.91	10,494.53
Textiles	10,996.46	8,075.05	12,364.78	11,562.27	11,532.26	10,966.43
Total	10,501.57	9,492.62	10,717.83	9,236.31	11,375.34	10,260.83

Total Production Cost

8.13M

Average Salary

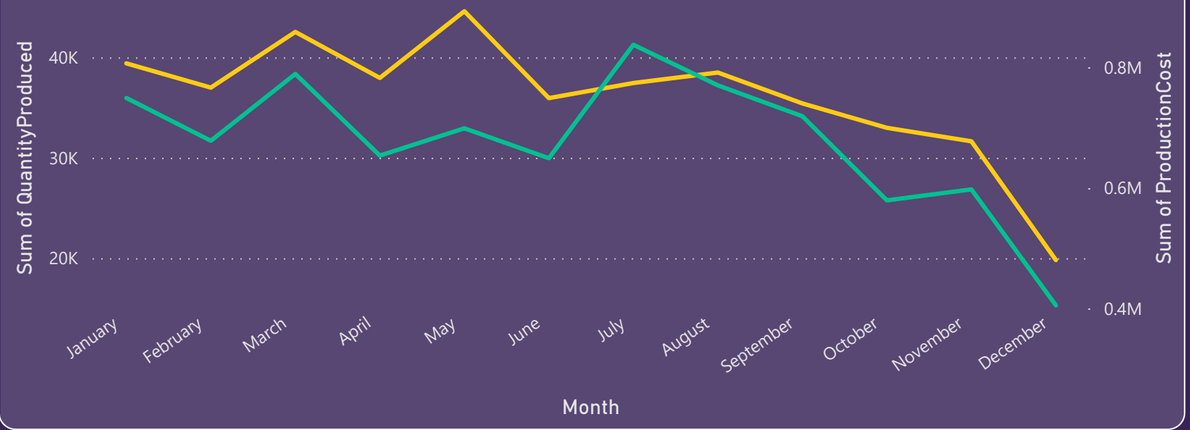
55.07K

Total Products

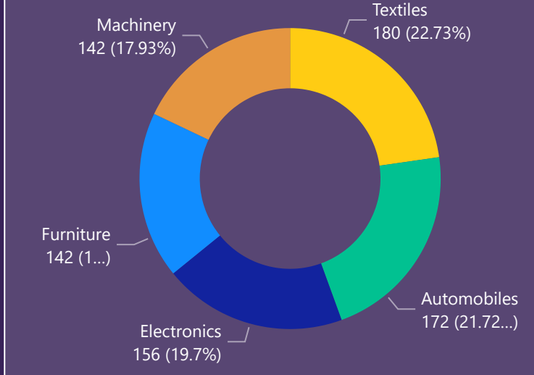
792

PerformanceRating and Salary Distribution across Department

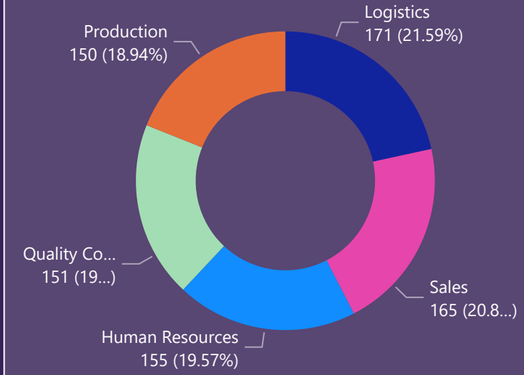
Production and Cost distribution across months



Products Distrubution across Product type



Employees Distribution across Departments



Time-Based Analysis of Salary and Production trends

warehouse Location: East | North

Production Year: 2023 | 2024 | 2025

Hiring Year: 2020 | 2021 | 2022

Department: All

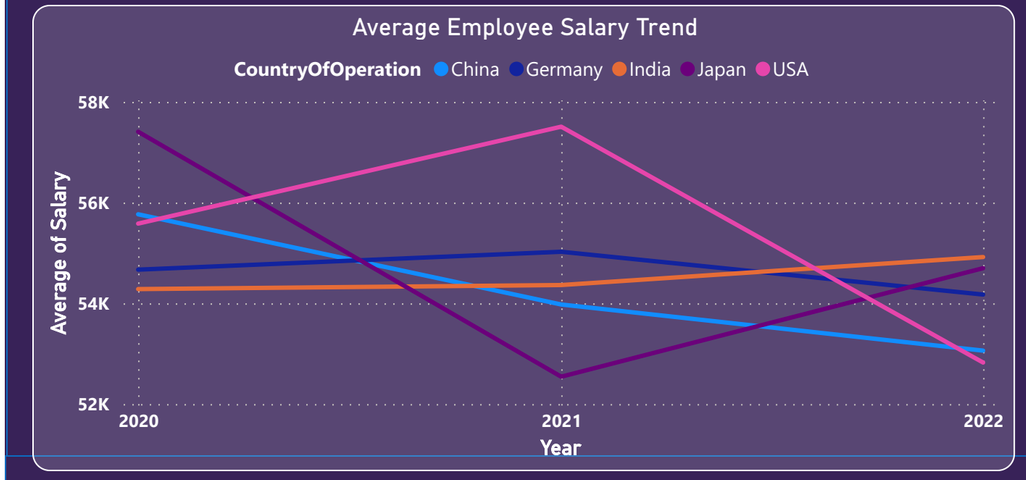
Product Type: All

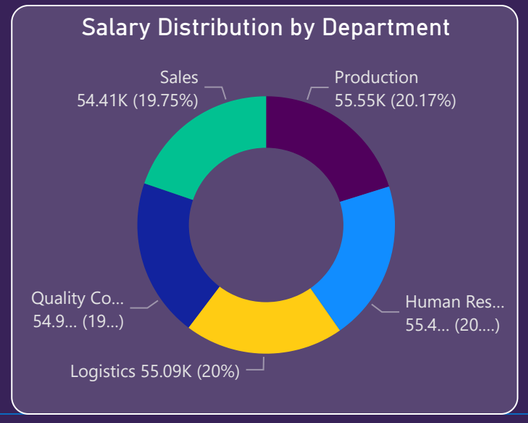
Country: All

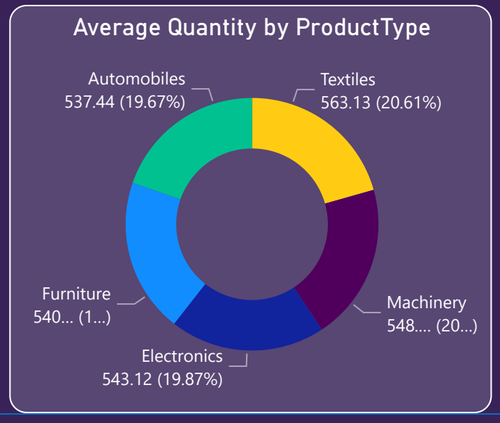
Average Salary
55.07K

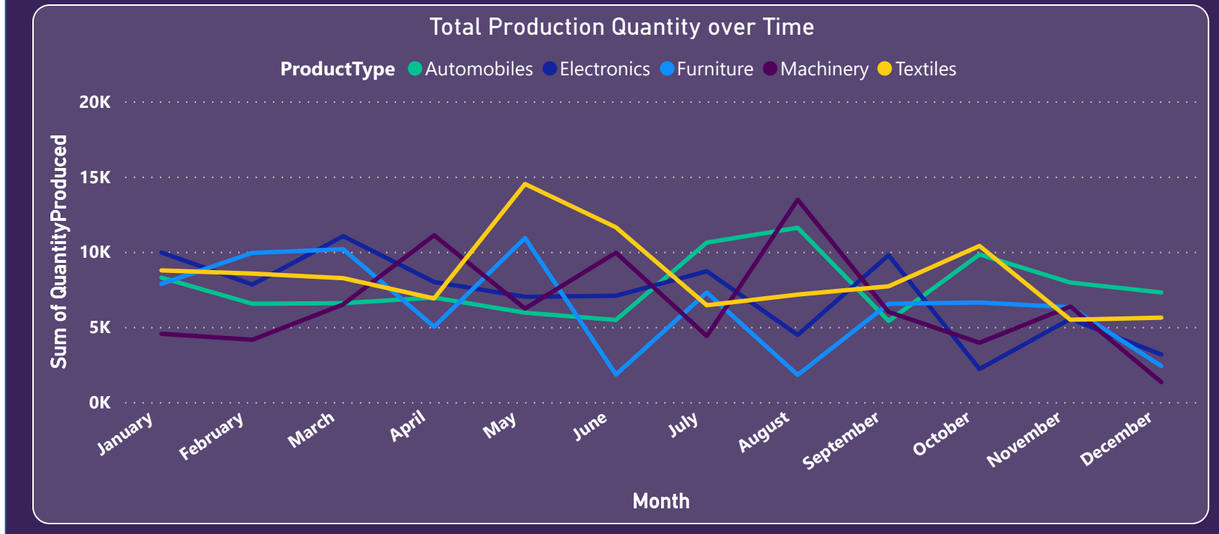
Average Production Cost
10.26K

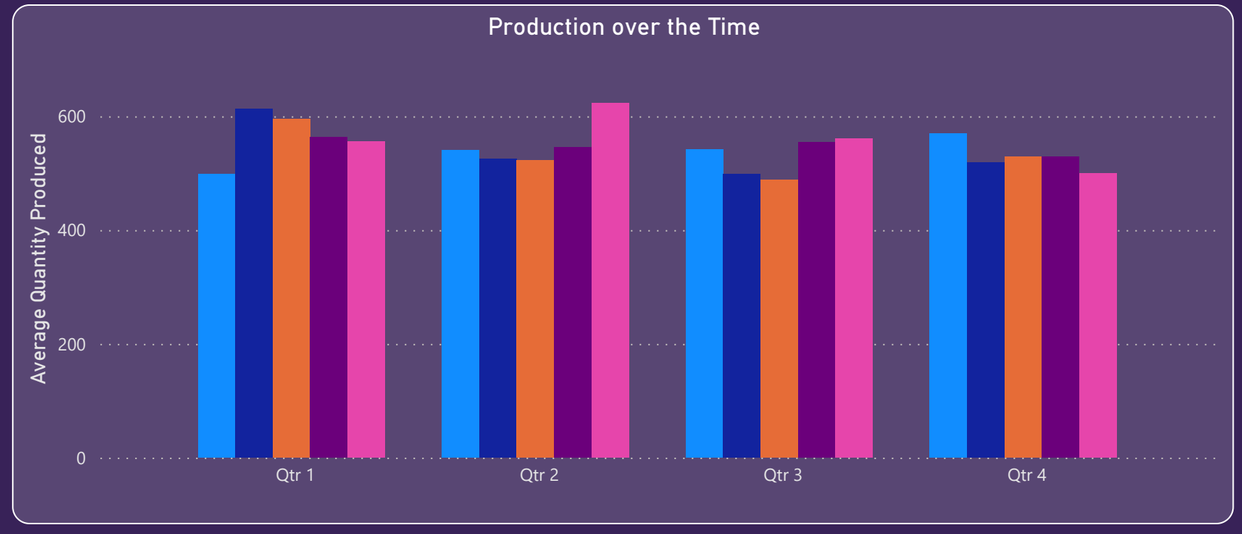
Average Production Quantity
546.93











Analysis Of Employee Data

Hiring Year

2020 | 2021 | 2022

Country of Operations

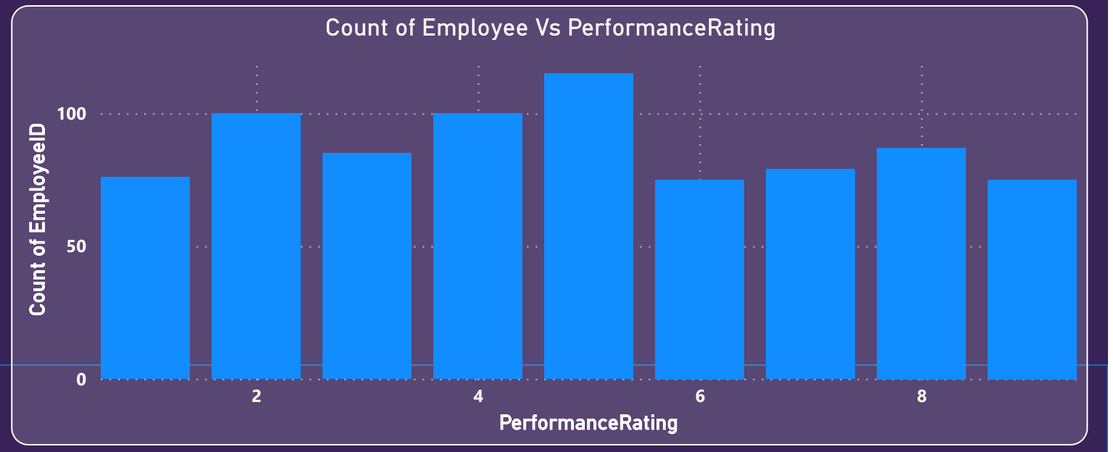
All

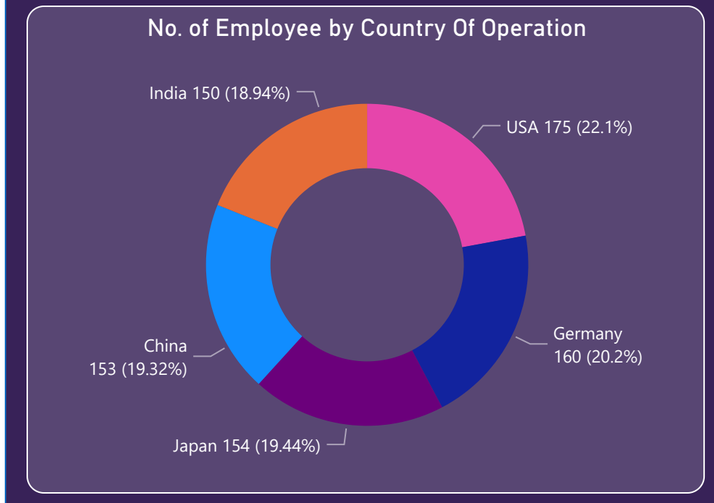
Total Salary

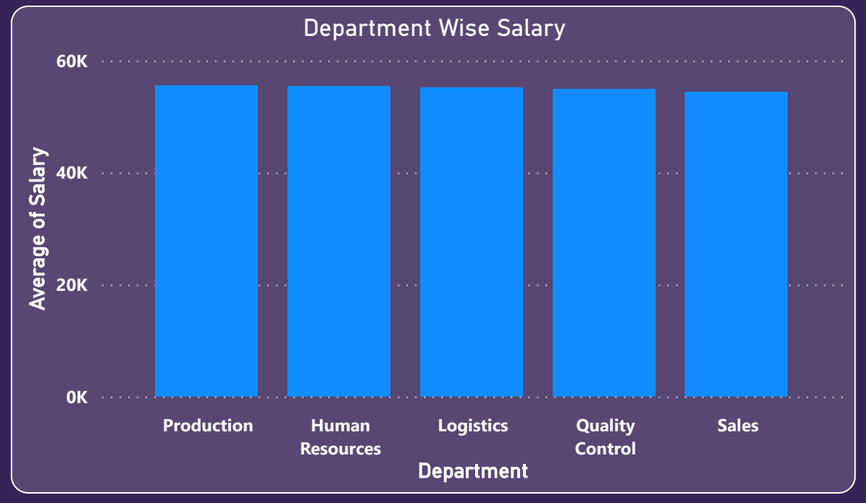
43.62M

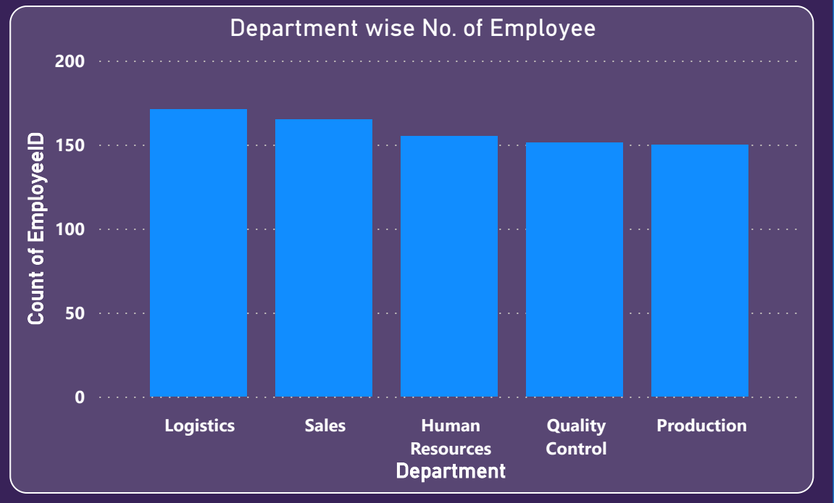
No. of Employees

792









Visualization of Production and Cost Data

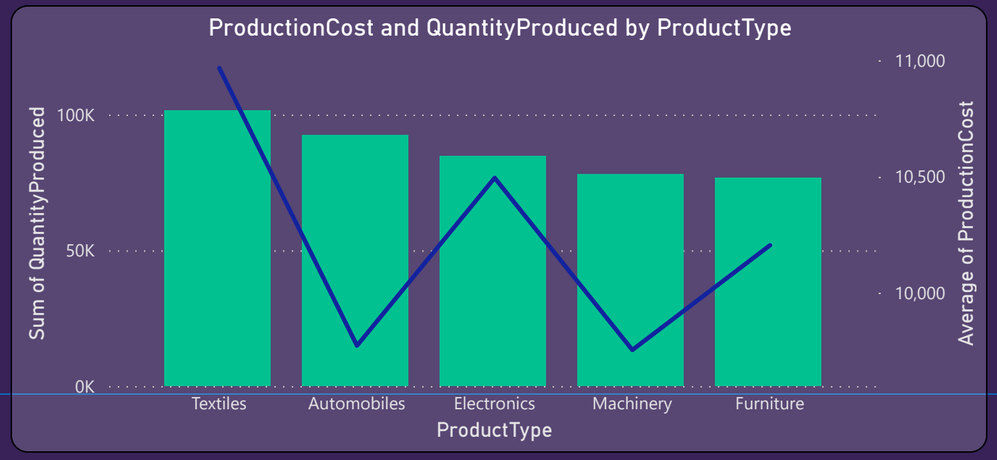
warehouse Location: East | North | South | West

Production Year: 2023 | 2024 | 2025

Department: All

Product Type: All

Country: All

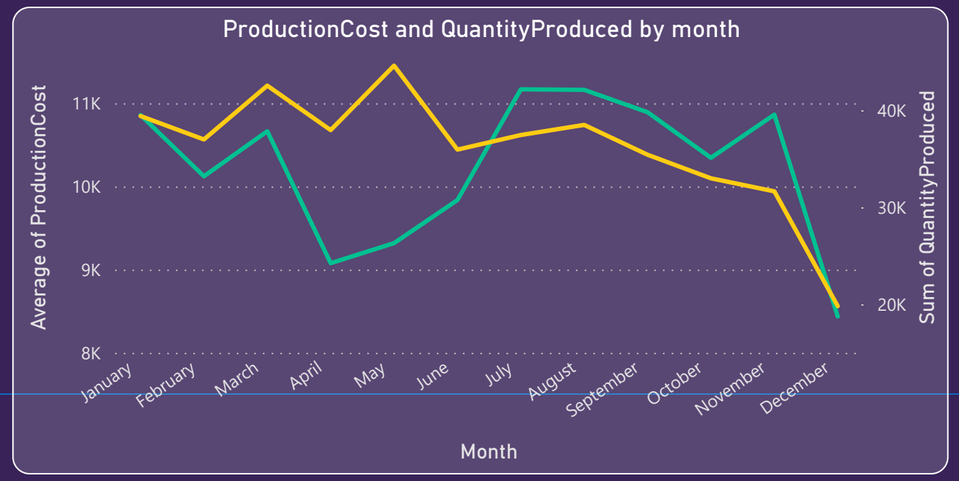


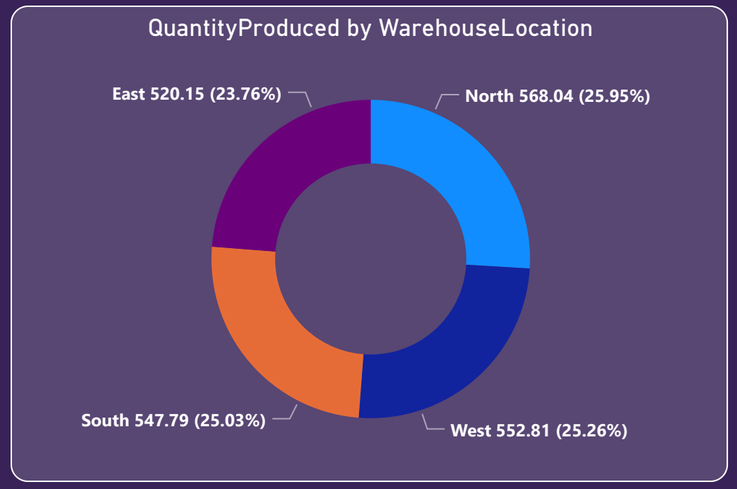
Average Quantity Produced

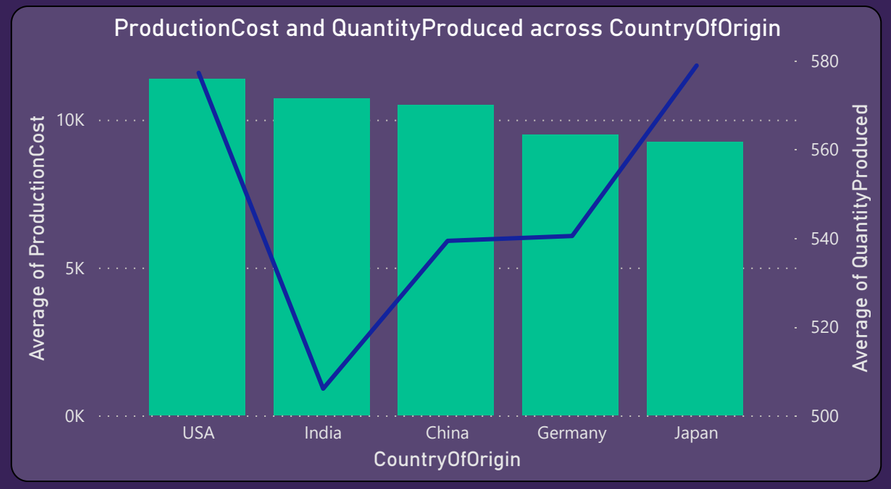
546.93

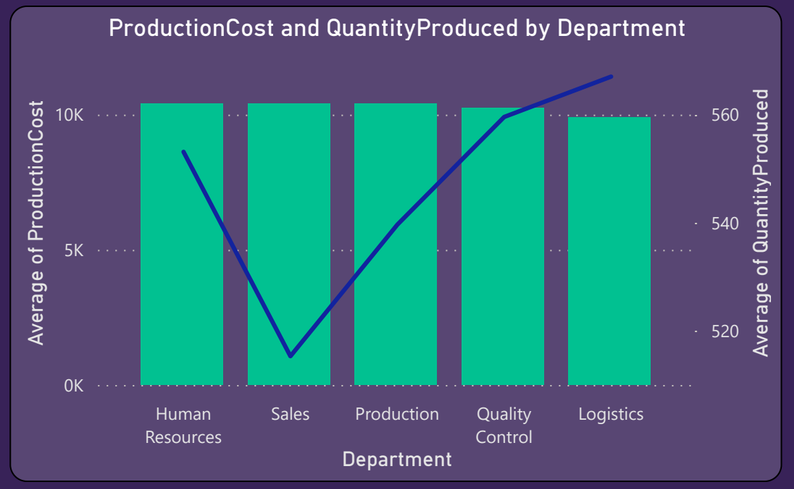
Avearge Production Cost

10.26K









Inferences from the Dashboard visuals:

- There are total 792 products of data in table.
- Identified Textile products as dominant in both quantity and cost, prompting a strategic focus on efficiency and cost reduction within this category.
- Uncovered an inverse relationship between production cost and quantity, signalling the need for cost-effective strategies while maintaining quality standards.
- The Human Resources department has the highest average salary and Logistics department has the highest production as well as more number of employees, indicating potential areas for optimizing workforce and resource allocation.
- Provided a comprehensive understanding of employee distribution, with India holding the majority, facilitating talent management and informed workforce planning.
- There is a decreasing trend in the employee salaries over the years.
- From the trends it is clear that over the years the production and cost both got reduced.
- It is observed that Japan has more average production whereas USA has highest average production cost.
- India is producing more textile products, Production cost for electronics and Machinery is higher in USA.
- Average salary of employee is 55.07K.
- We can see that the majority of employees have rating 5.
- The majority of employees are from India, while the least number are from China.
- It is clear that warehouse in North Location has more production.