SHIPMENT CHAIN FORECASTING

SRAJAN SETH

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Abstract

Supply chain always relies on the organization's ability to incorporate the end-end processes of getting materials or components, assembling them into products, and delivering them to the customers. As the demand is increasing for products, SCM sector is rapidly growing. Supply chain management (SCM) industry is expected to grow at a rate of 10-12 percent compound annual growth rate (CAGR) over next 5 years.

SCM mainly depends on logistics that is transportations and storage of goods. Logistics firms have been directly affected by the COVID-19 pandemic. Now the industry is in the recovery period. Considering these ground truths, Shipment forecasting could provide understanding of on-going demand and price variation according to the situations in supply chain. Predictive forecasting of this price is the use of statistical techniques and machine learning algorithms to identify the future trends and price of the shipment packages based on the historical data. It can map important and non-linear features and reduce them into variables that can help to understand the past, accurately predict future prices, help them to improve decision making process about cash flow, risk assessment, capacity planning and workflow planning and meet customer demands.

1. Problem statement

To provide a methodological approach to analyze the ongoing trends and predicting the future price of shipment packages based on various factors which affect the pricing. This prediction is to be done using the machine learning models.

2. Business Need Assessment

Forecasting provides a prediction of short term and long-term prices and the underlying reasons for those trends.

Customer satisfaction is key factor for growth. In order to keep the customer satisfied you need to provide the product they want when they want it. Usually, customer will not be satisfied to buy something that is costlier than its original price. This pricing increase is because of the demand and supply. By planning and executing these supply chains, we can have happy customers. The price forecasting will help to reduce the extra charging for shipment which directly reduces the price of the products. So that customers will be satisfied to buy commodities with lesser price.

This ability to forecast the price changes will have impact on both revenue and gross margin. So, it is will help the logistics firm and supply chain management businesses in an enormous way.

3. Target Specification and characterization

A. To change the traditional shipment pricing process to automated shipment pricing process.

B. Reducing the extra cost for the packages which directly decreases the retail price of the product.

C. Historical dataset of the shipment details is taken and based on that prediction is performed.

D. Getting the insights about prices of shipment packages can help predicting how far the price can fluctuate within certain budget.

E. Pricing forecasting will have a direct impact in the planning of inventory levels.

The proposed system will provide the firms with some pricing strategies so that their logistics business will boost up and they no longer have to go through an economic crisis.

4. External Search (information and characterization)

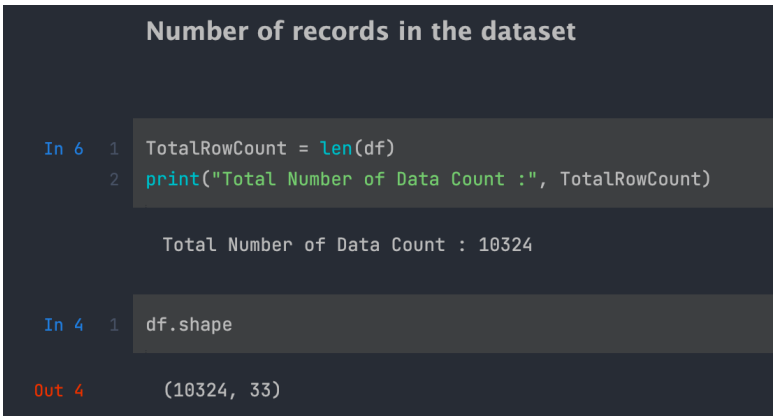
Machine learning is a branch of Artificial Intelligence that employs a variety of statistical, probabilistic and optimization techniques that allows computers to learn from past examples and to detect hard-to-discern patterns from large, noisy or complex data set. These datasets can be found in open-source platforms. We have taken this data from "U.S Agency for International Development". It is an organization that transforms families, communities and countries – so that they can thrive and prosper.

https://data.world/usaid/supply-chain-shipment-pricing

This data set provides supply chain of health commodity shipment and pricing data. In addition, this data set provides the commodity pricing and associated supply chain expenses necessary to move the commodity to countries for use.

```
df.head(10)
```

	ID	Project Code	PQ #	PO / SO #	ASN/DN #	Country	Managed By	Fulfill Via	Vendor INCO Term	Shipment Mode
0	1	100-CI-T01	Pre-PQ Process	SCMS-4	ASN-8	Côte d'Ivoire	PMO - US	Direct Drop	EXW	Air
1	3	108-VN-T01	Pre-PQ Process	SCMS-13	ASN-85	Vietnam	PMO - US	Direct Drop	EXW	Air
2	4	100-CI-T01	Pre-PQ Process	SCMS-20	ASN-14	Côte d'Ivoire	PMO - US	Direct Drop	FCA	Air
3	15	108-VN-T01	Pre-PQ Process	SCMS-78	ASN-50	Vietnam	PMO - US	Direct Drop	EXW	Air
4	16	108-VN-T01	Pre-PQ Process	SCMS-81	ASN-55	Vietnam	PMO - US	Direct Drop	EXW	Air
5	23	112-NG-T01	Pre-PQ Process	SCMS-87	ASN-57	Nigeria	PMO - US	Direct Drop	EXW	Air
6	44	110-ZM-T01	Pre-PQ Process	SCMS-139	ASN-130	Zambia	PMO - US	Direct Drop	DDU	Air
7	45	109-TZ-T01	Pre-PQ Process	SCMS-140	ASN-94	Tanzania	PMO - US	Direct Drop	EXW	Air
8	46	112-NG-T01	Pre-PQ Process	SCMS-156	ASN-93	Nigeria	PMO - US	Direct Drop	EXW	Air
9	47	110-ZM-T01	Pre-PQ Process	SCMS-165	ASN-199	Zambia	PMO - US	Direct Drop	CIP	Air



Journal about Forecasting in supply chain management

Predictive Forecasting

Supply chain challenges

IRAS

5. Bench marking alternate products

Large scale E-commerce giants like Amazon, Flipkart have been using affinity analysis to manage supply chain. Especially, Accenture Intelligent Revenue and supply chain (IRAS) Management is the service developed by Accenture in partnership with Amazon. This platform integrates insights generated by machine learning (ML) and artificial intelligence (AI) models into an enterprise's technical and business ecosystems.
It enables a business to proactively optimize and automate complex business operations. They can forecast the quantity of individual stock keeping units (SKUs) that need to be ordered on a rolling basis to stock key inventories.

Currently, supply chain activities are driven by the planning cycles of static sales and operations, and are executed manually. By deploying Intelligent Revenue and Supply Chain (IRAS), supply chain operators gain access to multi-dimensional sales and supply chain data points.

The forecasting models activated by those data points enable operators to reposition themselves and assume higher-value tasks that leverage their industry expertise. Those operators can share qualitative insights backed by quantified, real-time data from supply chain systems. They can offload, to AI models, vetted downstream business actions such as adjusting procurement orders or capping sales campaign initiatives. As they identify anomalies in attributes that impact the supply chain, AI models can recommend resolution options to the stakeholders to prevent logistical bottlenecks, and make a timely intervention. Using IRAS, sales and operational planning can evolve from linear execution to integrated dynamic execution.

The ML component of IRAS activates models that perform self-learning, prediction, and prescription of cross-functional “next steps.”

6. Applicable patents

- S. Tavassoli, M. Sardashti and N. K. N. Toussi, "Supply chain management and information technology support," 2009 2nd IEEE International Conference on Computer Science and Information Technology, 2009, pp. 289-293, doi: 10.1109/ICCSIT.2009.5234400.

- P. Giannakopoulou and P. Chountas, "Forecasting the Spot Price of P1A Shipping Route," 2019 Big Data, Knowledge and Control Systems Engineering (BdKCSE), 2019, pp. 1-8, doi: 10.1109/BdKCSE48644.2019.9010591.

- A. Brieden and P. Gritzmann, "Predicting show rates in air cargo transport," 2020 International Conference on Artificial Intelligence and Data Analytics for Air Transportation (AIDA-AT), 2020, pp. 1-9, doi: 10.1109/AIDA-AT48540.2020.9049209.

“Predicting show rates in air cargo transport” paper’s baseline strategy is as follows. Overbooking is an important tool for revenue optimization in airline industry both, for passenger and cargo transportation. While the former is “binary and one-dimensional” as the passengers either show up or not, the latter is more difficult. In particular, a commodity might show up for transport but both, its actual weight and volume, might differ significantly from the values specified in the booking. A reliable prediction of the show rates is therefore instrumental for any reasonable revenue optimization in air cargo industry.

The paper presents a new mathematical optimization model for predictive analytics. The exposition focusses, on the one hand, on the theoretical background of our approach which combines statistics, diagrams, clustering and data-transformations. On the other hand, we report on the successful application on (near) real world data from air cargo industry.

Our prototype will overcome the shortcomings in these papers and will help us to forecast the pricing for any type of shipment. This also includes various modes of shipment like airways, waterways, land ways. This also covers various countries involved in this supply chain.

7. Applicable Regulations (Government and environment)

- Government Regulations for small scale businesses
- Laws related to privacy for collecting data from user
- Data protection and privacy regulations
- Open source, academic and research community License for educational purposes.

- Exports and Import Regulations of that countries.

8. Applicable Constraints

- Requires a whole lot of research to gather universal historical dataset of Shipment prices in order to provide more accurate and reliable results.
- In addition, it also requires current pricing strategies so that the model can be trained with current trends.
- Continuous data collection and maintenance.
- Implementing the project by replacing the traditional method
- Continuous integration and development of the application

9. Business opportunity

The above technique has only been used by large scale companies. This can be extended for small businesses and logistics. There is a huge chance for small scale logistics companies.

Increasing demand for the products and services will drive this field further for the development. This will lead to the overall growth of the country.

10. Concept Generation

Main concept is that the shipment pricing is automated and predicted based on various factors and situations. This will reduce the extra charging of amount while shipping commodities from one place to another. This will further increase the supply.

11. Concept Development

Initially we will analyze the past pricing strategies and perform Exploratory data analysis on the past data. Then we will analyze & explore the current trends in shipping. This will be added to the model and trained. When the new data comes into the model, then the model will be able to predict the price for the package based on weight, conditions, whether it is travelling in peak hours or not, etc.

This product needs the tool of machine learning models in order to suit our requirements. We can tweak these models for good accuracy.

This concept can be developed by using the appropriate API (flask in this case) as framework for the deployment. The cloud services have to be chosen accordingly to the need.

12. Final Product Prototype

The final product is a service that provides small businesses with detailed information on what pricing to be given for packages in the shipping. Other similar insights will also increase the growth of the business.

Back-end

Model Development: A lot of manual supervised machine learning models can be used to perform the prediction forecasting.

1. Data collection and data pre-processing must be done.
2. Feature selection and feature engineering techniques should be performed.
3. Perform Exploratory Data Analysis to realize the dependent and independent features.
4. Algorithm training and optimization must be done to minimize overfitting of the model and hyperparameter tuning.
5. Python language and ML models is used for the integration of this product.

Front-end

1. Different user interface: The user must be given many options to choose form in terms of parameters. This can only be optimized after a lot of testing and analysis all the edge cases.
2. Interactive visualization the data extracted from the trained models will return raw and inscrutable data. This must be present in an aesthetic and an “easy to read” style.
3. Feedback system: A valuable feedback system must be developed to understand the needs that have not been met. This will help us train the models constantly.
4. HTML/CSS/JS is used for the user’s front-end design.

13. Product details

- How does it work?

An interactive user system will take inputs regarding shipping situations from the user and the user will get to know about the price for the shipping package that they wanted in real time considering the pricing factors in mind.

- Data sources:

https://data.world/usaid/supply-chain-shipment-pricing

- Algorithms, frameworks, software needed

This product uses machine learning algorithms. This requires python language for implementation. Visualizations can be done using some libraries like NumPy, pandas, matplotlib, seaborn, plotly, etc.

Flask framework is to be used for the integrating API.

DataSpell, Visual Studio Code and Google Colab is used as the editor.

14. Code Implementation on small scale

Link to code: https://github.com/srajanseth84/Supply-Chain-Analysis/blob/main/Supply-Chain-Analysis.ipynb

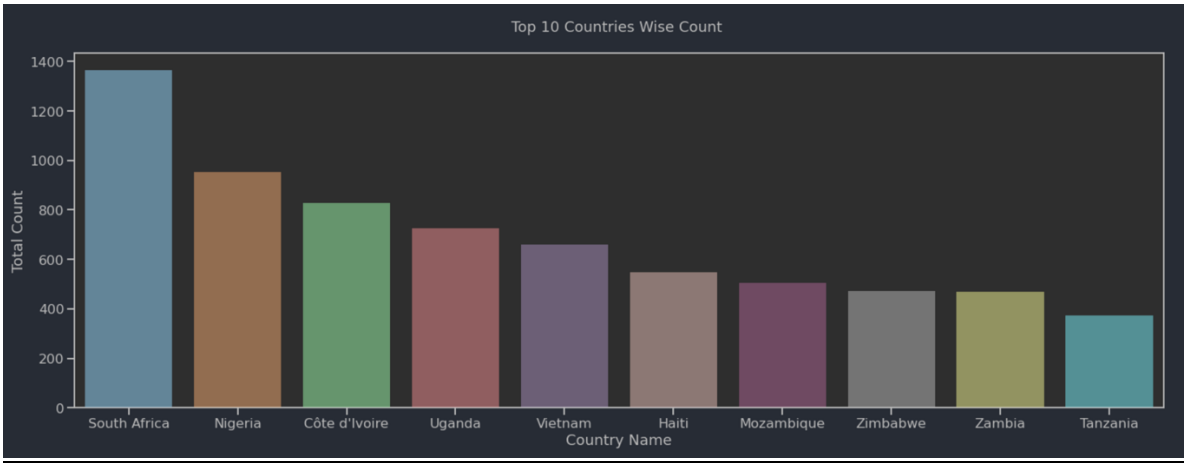
Visualizations:

Top 10 Countries Wise Count

Code-

```
DataSet = df.dropna()
ItemCount = DataSet["Country"].value_counts().nlargest(15)
plt.figure(figsize=(24,8))
sns.countplot(DataSet['Country'],order = DataSet['Country'].value_counts().nlargest(10).index)
plt.title('Top 10 Countries Wise Count \n')
plt.ylabel('Total Count')
plt.xlabel('Country Name')
```

Viz-

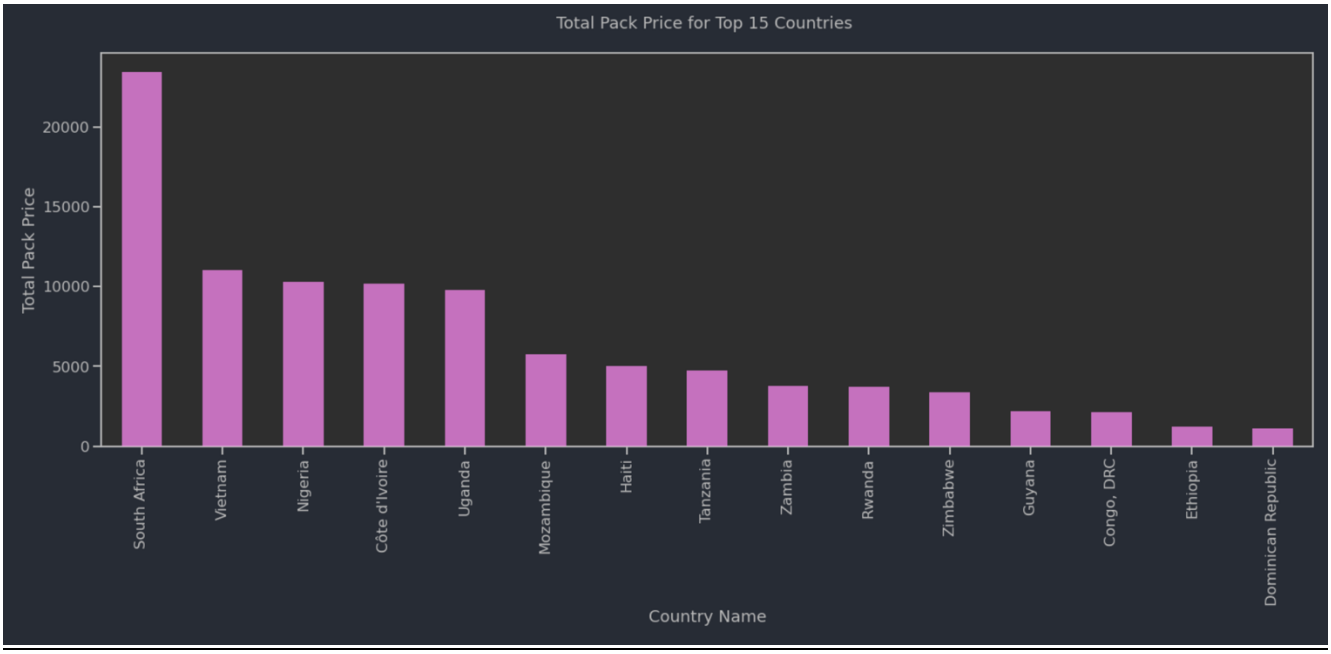


Total Pack Price for Top 15 Countries

Code-

```
TotalPrice = DataSet.groupby(['Country'])['Pack Price'].sum().nlargest(15)
plt.figure(figsize=(24,8))
GraphData=DataSet.groupby(['Country'])['Pack Price'].sum().nlargest(15)
GraphData.plot(kind='bar',color='purple')
plt.title("Total Pack Price for Top 15 Countries \n")
plt.ylabel('Total Pack Price')
plt.xlabel('Country Name')
```

Viz-



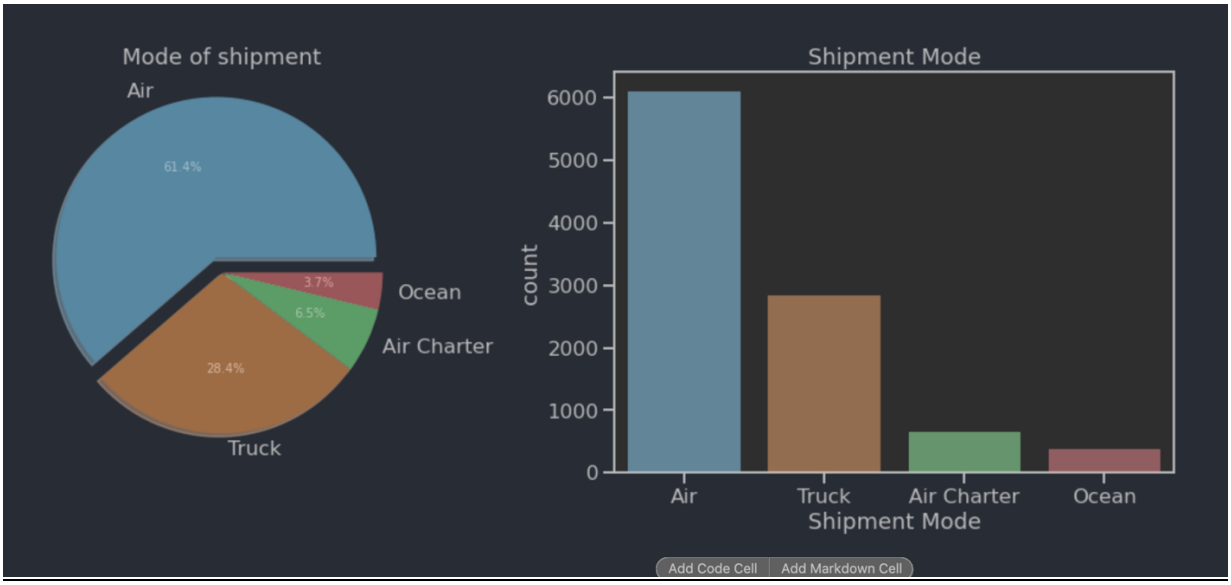
Mode of Shipment (Pie and Bar Chart)

Code-

Shipment Mode percentage wise Pie Chart and Bar chart

```
f,ax=plt.subplots(1,2,figsize=(18,6))
df['Shipment Mode'].value_counts().plot.pie(explode=[0.1,0.005,0.005,0.005],autopct='%1.1f%%',ax=ax[0],shadow=True)
ax[0].set_title('Mode of shipment')
ax[0].set_ylabel('')
sns.countplot('Shipment Mode', data=df,ax=ax[1])
ax[1].set_title('Shipment Mode')
plt.show()
```

Viz-



More number of commodities are transported through the Air Ways. Less number of commodities are transported through Ocean.

Shipment Mode and its Unit price distribution.

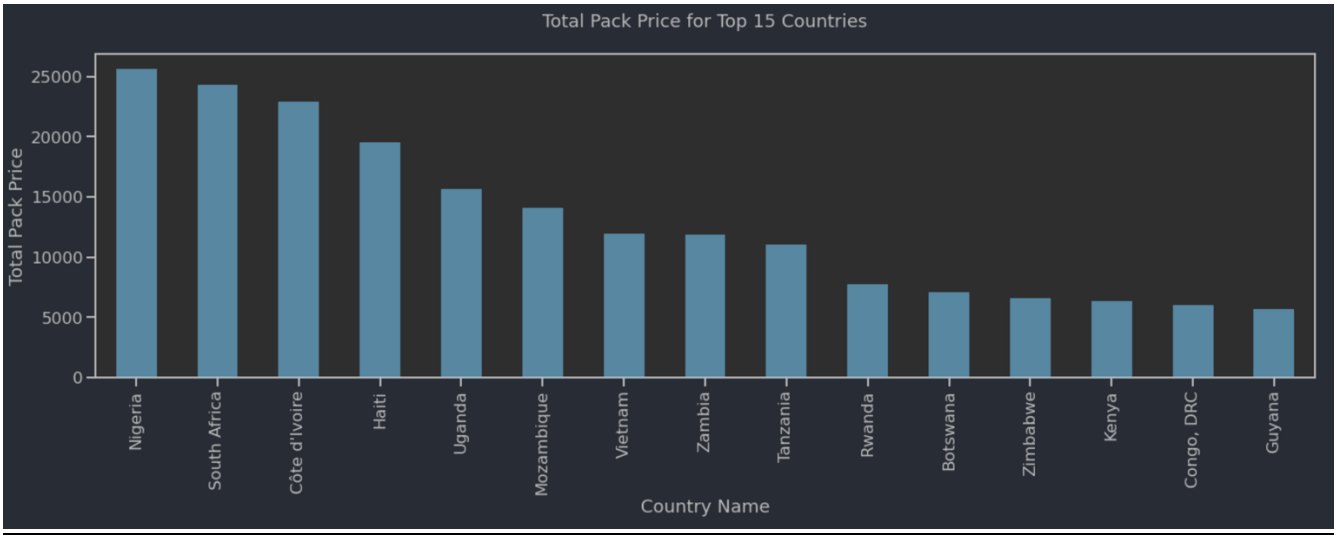
- Air ways mode have high price per unit
- Truck has lower price per unit comparing to Air ways
- Air charter have lower price per unit comparing to Truck
- Ocean ways have the lowest price compared to other ways of transportation.

Total Pack Price for Top 15 Countries

Code-

```
TotalPrice = df.groupby(['Country'])['Pack Price'].sum().nlargest(15)
plt.figure(figsize=(22,6))
GraphData=df.groupby(['Country'])['Pack Price'].sum().nlargest(15)
GraphData.plot(kind='bar')
plt.title("Total Pack Price for Top 15 Countries\n")
plt.ylabel('Total Pack Price')
plt.xlabel('Country Name')
```

Viz-

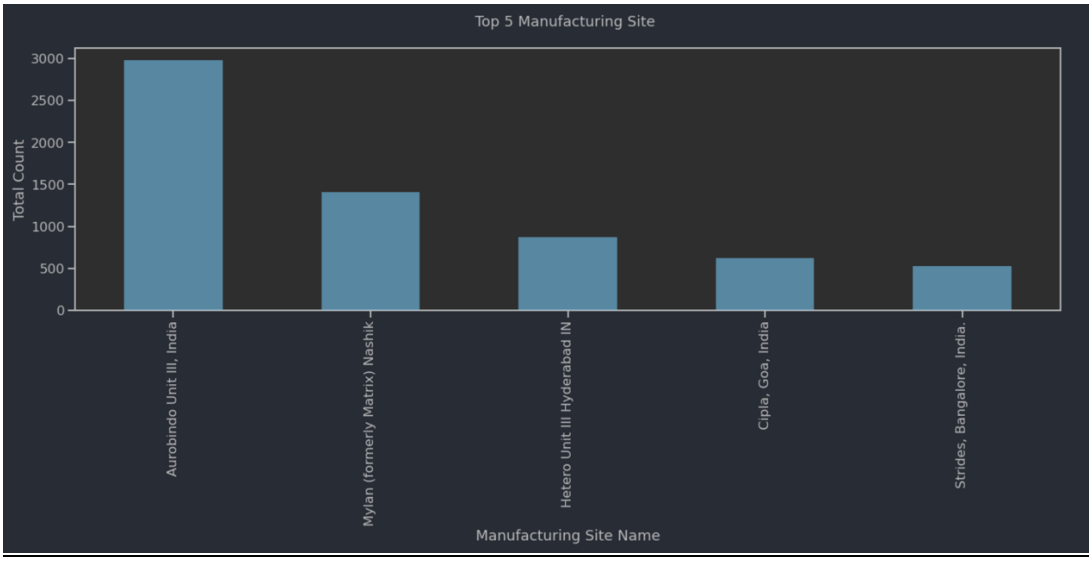


Top 5 Manufacturing Sites

Code-

```
plt.figure(figsize=(22,6))
TopFiveManufacturingSite=DataSet.groupby('Manufacturing Site').size().nlargest(5)
TopFiveManufacturingSite.plot(kind='bar')
plt.title('Top 5 Manufacturing Site \n')
plt.ylabel('Total Count')
plt.xlabel('Manufacturing Site Name')
```

Viz-



15. Full Code Implementation (with DataSet)

Github- **https://github.com/srajanseth84/Supply-Chain-Analysis**

16. Conclusion

AI is changing the way we are. So, we have to move forward to the advanced options to keep our pace in the world. Many organizations are switching to the AI module for their applications. With the right tools, software and programs, you can develop an automated process that improves the current pricing and forecast the future pricing.

Hence, I have explained the prototype and concept for the supply chain shipment price forecasting. It has a lot of scope for the current world. This will definitely create a great opportunity to improve the business in logistics, supply chain management and other related firms. The implementation in the real-world scenarios will bring a huge impact in SCM sector.