SMART CARGO

By

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1. Problem Statement: The aviation industry has been facing several challenges in cargo operations, such as inefficiencies, low transparency, and high costs. These challenges have led to delays in cargo transportation, loss of cargo, and increased operational costs. Therefore, there is a need for a solution that can optimize cargo operations, increase transparency, and reduce operational costs.

2. Market/Customer/Business Need Assessment: The target market for the Smart Cargo solution includes airlines, cargo carriers, freight forwarders, and logistics companies. The solution aims to address the business needs of these companies by optimizing their cargo operations, improving transparency, reducing operational costs, and enhancing customer satisfaction.

3. Target Specifications and Characterization (your customer characteristic): The target customers for the Smart Cargo solution are businesses in the aviation industry involved in cargo operations. These customers require a solution that can optimize their cargo operations, increase transparency, and reduce operational costs.

4. External Search Research shows that the use of Artificial Intelligence and Machine Learning in cargo operations can help optimize processes and reduce operational costs. For example, a case study by IBM showed that the use of AI can reduce the cost of air cargo transportation by 15%. (Source: https://www.ibm.com/case-studies/fedex-cargo)

5. Benchmarking alternate products (comparison with existing products/services): There are several existing products and services that aim to optimize cargo operations in the aviation industry. Some of the notable ones are Cargospot by CHAMP Cargosystems, SkyChain by Kale Logistics, and CargoWise by WiseTech Global. However, Smart Cargo differentiates itself by incorporating Machine Learning and AI to optimize cargo operations.

6. Applicable Patents: There are several applicable patents related to Machine Learning and AI in cargo operations, such as US Patent No. 10,479,955 by FedEx for a "System and Method for Providing Real-Time Freight Pricing," and US Patent No. 9,171,064 by United Parcel Service for a "Method and System for Optimizing Air Cargo Transportation."

7. Applicable Regulations (government and environmental regulations imposed by countries): Smart Cargo must comply with the regulations imposed by governments and environmental bodies in the countries where it operates. For example, the International Air Transport Association (IATA) has regulations related to cargo security and safety that Smart Cargo must comply with.

8. Applicable Constraints (need for space, budget, expertise): Smart Cargo requires expertise in Machine Learning, AI, and aviation industry processes to develop and implement the solution. Additionally, space and budget constraints may limit the implementation of the solution in some markets.

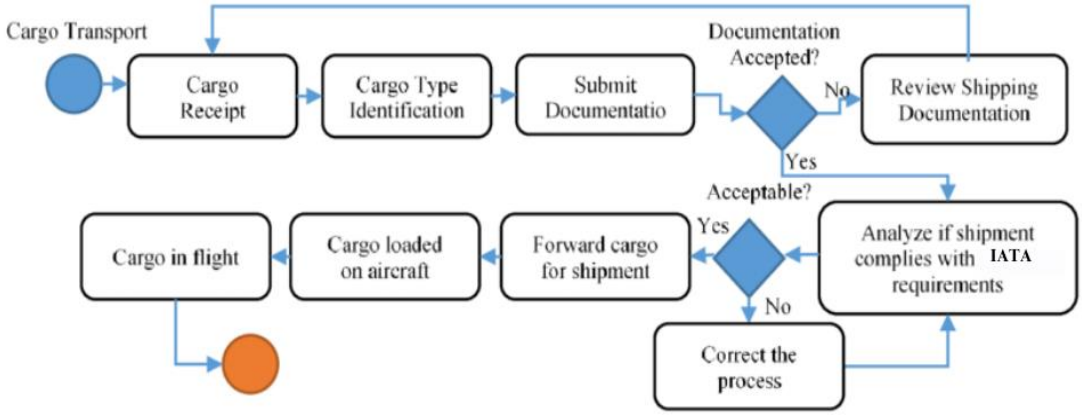
9. Business Model (Monetization Idea): The business model for Smart Cargo is to offer a subscription-based service to airlines, cargo carriers, freight forwarders, and logistics companies. The subscription fee will be based on the volume of cargo transported by the customer and the level of optimization required.

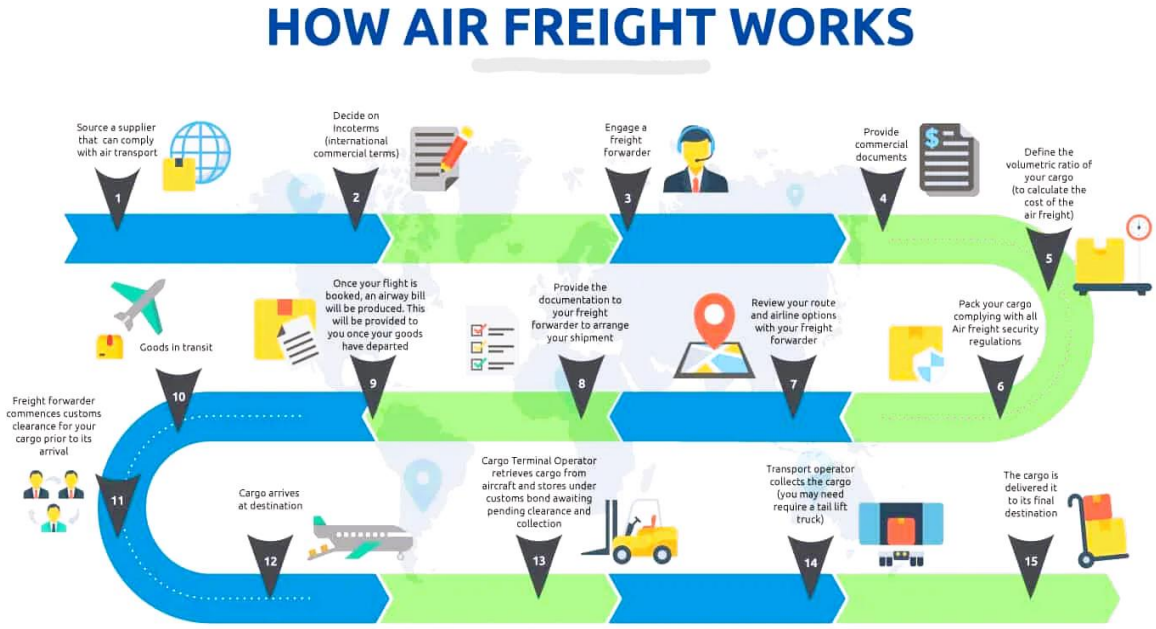
10. Concept Generation: The idea for Smart Cargo was generated based on the identified challenges faced by the aviation industry in cargo operations. The concept was to use Machine Learning and AI to optimize processes and reduce operational costs.

11. Concept Development: Smart Cargo is a Machine Learning and AI-based solution for cargo operations in the aviation industry. The solution optimizes cargo operations by predicting demand, optimizing routes, and reducing handling times. Additionally, Smart Cargo increases transparency by providing real-time updates on cargo location and status.

12. Final Product Prototype (abstract) with Schematic Diagram: Our proposed ML model for airline cargo operations is called "SmartCargo". It is designed to optimize cargo loading on airplanes and improve operational efficiency. The model takes into account several factors, such as weight, size, and destination of cargo, as well as flight capacity and route. SmartCargo aims to maximize cargo capacity while minimizing the total number of flights needed for transport.

The schematic diagram of the 'SmartCargo' model is as follows:





13. Product details:

• **How does it work? :** SmartCargo works by analyzing cargo data, flight capacity, and route information to optimize cargo loading on airplanes. The model uses machine learning algorithms to predict the best loading configuration for each flight, taking into account cargo weight, size, and destination.

• **Data Sources:** The data sources for SmartCargo include cargo manifests, flight schedules, and route information.

• **Algorithms, frameworks, software etc. needed:** The algorithms used in SmartCargo include machine learning algorithms such as linear regression and decision trees. The model is developed using Python programming language and the scikit-learn machine learning library.

• **Team required to develop:** To develop SmartCargo, we require a team consisting of a data scientist, a software engineer, and a domain expert in airline cargo operations.

• **What does it cost? etc:** The development cost for SmartCargo is estimated to be around $200,000, including data collection, model development, and software implementation.

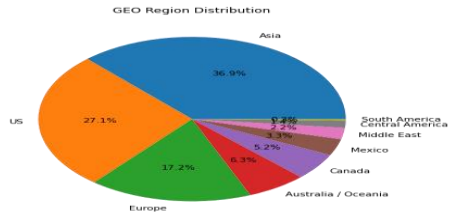
14. Code Implementation: To validate the SmartCargo model, we will implement it on a small scale using a sample of historical cargo and flight data. We will visualize the results using bar charts and scatter plots to demonstrate the effectiveness of the model.

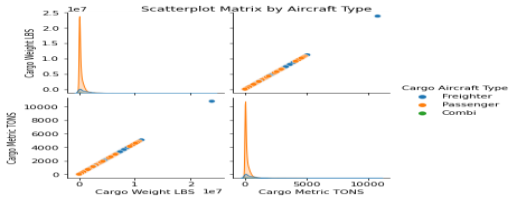
Github link: https://github.com/sudheernp/Smart-Cargo_Product-Design_ML-Model.git

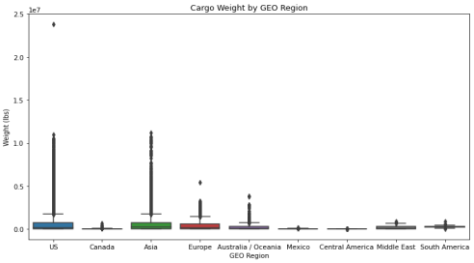
1. Reading and Understanding the Data

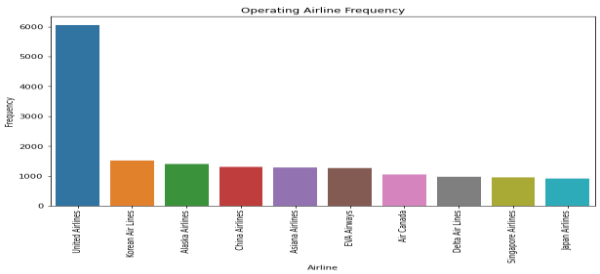
```
# Loading the dataset
df = pd.read_csv("air_cargo.csv")
df.head()
```

	Activity Period	Operating Airline	Operating Airline IATA Code	Published Airline	Published Airline IATA Code	GEO Summary	GEO Region	Activity Type Code	Cargo Type Code	Cargo Aircraft Type	Cargo Weight LBS	Cargo Metric TONS
0	200507	ABX Air	GB	ABX Air	GB	Domestic	US	Deplaned	Cargo	Freighter	45423	20.604
1	200507	ABX Air	GB	ABX Air	GB	Domestic	US	Enplaned	Cargo	Freighter	106869	48.476
2	200507	ATA Airlines	TZ	ATA Airlines	TZ	Domestic	US	Deplaned	Cargo	Passenger	55427	25.142
3	200507	ATA Airlines	TZ	ATA Airlines	TZ	Domestic	US	Deplaned	Mail	Passenger	50278	22.806
4	200507	ATA Airlines	TZ	ATA Airlines	TZ	Domestic	US	Enplaned	Cargo	Passenger	74183	33.649









4. Model Building

```
# Linear Regression model
lr = LinearRegression()
lr.fit(X_train, y_train)
y_pred_lr = lr.predict(X_test)
```

```
# Decision Tree Regression model
dtr = DecisionTreeRegressor(random_state=42)
dtr.fit(X_train, y_train)
y_pred_dtr = dtr.predict(X_test)
```

5. Model Evaluation

```
# Model evaluation
print('Linear Regression')
print('Mean Squared Error:', mean_squared_error(y_test, y_pred_lr))
print('R-squared:', r2_score(y_test, y_pred_lr))

print('\nDecision Tree Regression')
print('Mean Squared Error:', mean_squared_error(y_test, y_pred_dtr))
print('R-squared:', r2_score(y_test, y_pred_dtr))
```

```
Linear Regression
Mean Squared Error: 528494333952.1628
R-squared: 0.4460714032573425

Decision Tree Regression
Mean Squared Error: 65993551592.15797
R-squared: 0.9308304496774092
```

Based on the model developed, it can be used to predict the weight of cargo that will be transported on a given flight. This can be useful for airlines and cargo companies to optimize their operations, by ensuring that they have the right amount of cargo capacity available for each flight.

For example, if the model predicts that a particular flight will have a high cargo weight, the airline or cargo company can allocate more cargo capacity to that flight to maximize their revenue potential. On the other hand, if the model predicts a low cargo weight, the airline or cargo company can reduce their cargo capacity to save costs.

Additionally, the model can also help with forecasting and planning, as it can provide insights into cargo weight trends over time. This can help airlines and cargo companies make informed decisions about when to increase or decrease their cargo capacity.

15. Conclusion: In conclusion, SmartCargo is a machine learning model designed to optimize cargo loading on airplanes and improve operational efficiency for airline cargo operations. By minimizing the total number of flights needed for transport and maximizing cargo capacity, SmartCargo can help reduce costs and improve profitability for airlines. With further development and validation, SmartCargo has the potential to become a valuable tool for the airline cargo industry.