TECHNICAL PAPER ON DYNAMIC PRICING MODEL FOR FREIGHT TRANSPORTATION SERVICES

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Abstract - The implementation of dynamic pricing in the freight industry has emerged as a highly effective strategy for optimizing revenue and improving operational efficiency. This abstract provides a succinct overview of the dynamic pricing of freight goods, focusing on its fundamental concepts and implications. It delves into the objectives underlying dynamic pricing, the multitude of factors that influence pricing decisions, and the pivotal role played by technology and data analytics in facilitating dynamic pricing strategies. Additionally, it highlights the advantages and benefits that dynamic pricing offers to both freight service providers and shippers. By comprehending the intricacies of pricing dynamics within the freight industry, stakeholders can make well-informed decisions, thereby unlocking new avenues for growth and profitability.

Index Terms - Dynamic Pricing, Freight Transportation Services, E-commerce

I. INTRODUCTION

Dynamic pricing models for freight and transportation goods consider various factors that influence the shipping price, such as demand, capacity, fuel prices, competition, and route complexity. The pricing model may use different algorithms and techniques such as machine learning, artificial intelligence, and predictive analytics to optimize the shipping price.

Dynamic pricing can be applied to various transportation modes such as trucking, rail, air cargo, and maritime shipping. For example, in the trucking industry, dynamic pricing can be used to adjust the shipping price based on factors such as the weight and volume of the cargo, the distance traveled, and the availability of trucks. In air cargo, dynamic pricing can be used to adjust the shipping price based on factors such as the time of day, the demand for cargo space, and the fuel price index.

The benefits of dynamic pricing for freight and transportation goods include increased revenue and profitability for the carrier or logistics provider, improved customer satisfaction through competitive pricing, and better utilization of transportation assets. However, the successful implementation of dynamic pricing requires careful consideration of the unique characteristics of the transportation industry and its market conditions. It also requires accurate and timely data, sophisticated algorithms, and effective communication with shippers and other stakeholders.

Dynamic pricing can be implemented in a variety of ways, including rule-based approaches, optimization-based approaches, and machine learning-based approaches. Rule-based approaches use pre-defined rules to set prices based on specific criteria, such as time of day or inventory levels. Optimization-based approaches use mathematical models to find the optimal pricing strategy based on factors such as demand, competition, and costs. Machine learning-based approaches use algorithms to learn from past data and make predictions about future demand, allowing for more accurate pricing decisions.

This approach to pricing can help engineering teams to better manage capacity utilisation and resource allocation, leading to more efficient and cost-effective freight transportation operations. For instance, if a transportation company has excess capacity in certain lanes or during certain periods, a dynamic pricing model can be used to incentivize customers to ship during those periods by offering them lower prices. Conversely, if a company is running at full capacity, the dynamic pricing model can help them adjust prices to reflect the increased demand and optimise revenue.

II. RELATIONSHIP BETWEEN FREIGHT PRICES AND DEMAND

The graph shows that freight prices are typically higher when demand is high and lower when demand is low. This is because there is less available capacity when demand is high, so carriers can charge more. When demand is low, carriers have more available capacity, so they have to lower their prices in order to attract customers.

The graph also shows that the relationship between freight prices and demand is not linear. This is because there are a number of factors that can affect the demand for freight transportation services, such as the time of year, the day of the week, the type of cargo, and the distance that the cargo needs to be transported.

Carriers can use this graph to help them set their freight prices. By understanding the relationship between freight prices and demand, carriers can ensure that they are charging a fair price for their services and that they are maximizing their profits.

2.1 PRICING STRATEGY

Adjusting the prices is called a pricing strategy. A pricing strategy has a goal to establish an optimum price with current profit maximization of the number of units sold, etc. [3]. It refers to the methodologies and processes businesses use to set prices for theirservices and products. Businesses can use a variety of pricing strategies to determine the best one equipped to produce profitable margins. Pricing strategies can take advantage of using previous data to quantify and control factors such as time, customer preferences, market competition, etc.

2.2 COMMON PRICING STRATEGIES

Pricing strategies help any company navigate markets and understand whether their service is well, over or underpriced. Mispricingservices or products may result in forgoing much needed revenue and result in a downward curve in the company's growth. Commonpricing strategies may help in building a foundation for a company to put a well-suited price on the spectrum of available services.These strategies may then be inter-connected and established deeper to provide a well-rounded system.

Fig 2.2.1: Common Pricing Strategies

Cost-plus Pricing: Cost-plus pricing, also known as markup pricing, is where a fixed, pre-decided percentage is added on top of thecost price to produce the selling price of the product or service. The factors affecting the implementation of this strategy include competition intensity, company size and industry [4]. These external factors are secondary to the internal factors of the individual business focusing intensely on production costs or internal costs to provide the end service. However, cost-plus pricing does not seem to take into consideration every factor that affects the spectrum of pricing for the product or service. The primitive nature of the strategy does not take multiple factors into consideration [5]. But overall, this system is simple to use, can justify prices correctly, and provides a consistent rate of return.

Competitive Pricing: Competitive pricing is the setting of pricing relative to the competitors in the market [6-7]. The process of strategically setting price points for services or goods based on market competitor pricing, rather than basing them solely on business costs and profit margins. This pricing method is commonly used in businesses selling the same service or products while there maybe the presence of unique attributes. When services reach an equilibrium, excessive substitutes can be produced in the market, to which prices must respond to keep the market

fresh for consumers. Categorizing competitors and defining data parameters are heavily relied on while implementing such a strategy.

Price Skimming: Price Skimming strategy is one of the popular systems deployed for both services and products. It is known for charging a high price once the product or service hits the target market and then gradually lowering it down [8]. As a new product is introduced onto the market, it is sold at a very high price and then gradually reduced when competitors start introducing a similarproduct. Skim pricing is also the opposite of penetration pricing. The objective is to skim off consumers who are willing to pay more for the newly launched product or service [9]. When the demand from the consumers starts decreasing, the price is then lowered, which also wards off high prices from competitors.

Penetration Pricing: Penetration pricing is the opposite of price skimming. It is a pricing strategy which involves offering a new service or product at a low initial price to gain the consumers' attention and sway market decisions. The goal is to aggressively getcustomers in the door with low prices and gain market share. Moreover, the strategy includes choosing the price point to set the cost underneath the product, an incentive to the customers, guaranteeing bigger market coverage and a stronger base [10]. The goalof this strategy is to incentivize the audience to switch to the brand due to the lower costs of the product or service in the market.

Value-based Pricing: This type of strategy primarily relies on the consumer or market response to the value of a product or service.Businesses deploying such a system for pricing believe that the estimated value of price on the product is justified and one that theconsumers are willing to pay. The company then tries to earn the differentiated worth of its products when compared to other similarproducts in the market. Value to the customer is the overall satisfaction that the client gets from the acquisition of the product or service [11].

2.3 PRICING MODEL STRATEGY FOR FREIGHT TRANSPORTATION SERVICES

The unique nature of the goods industry makes it difficult to estimate an accurate demand curve that's required to apply conventionalrevenue maximization pricing strategies. Multiple parameters affect the pricing strategies for these services, and the comparison between those factors allows us to produce a clean analysis to operate on competitor pricing strategy. The goal is to determine the most optimal price for the company to stay ahead of competition, and to maximize the long-term profit.

Parameters influencing the pricing strategy can be but not limited to the following:

1. Weight of the package
2. Dimensions of the package
3. Distance to Delivery location
4. Fuel fluctuations
5. Delivery Speed
6. Type of Delivery Location
7. Weather conditions
8. Shipping Insurance
9. Customs and Duties
10. Multiple orders
11. Seasonality Changes and Public Holidays

III. FREIGHT TRANSPORTATION SERVICES

3.1 FREIGHT TRANSPORTATION

Freight transportation is a primary component of all supply-chain and logistic systems. The cost of moving commodities between cities and countries is borne directly by the stakeholders (shippers, carriers, and consignees) as well as other members of society who may not directly benefit from it [12]. Rail is a common and cost-effective method of freight transportation. Although this method is known to be less reliable than others, it costs much less which makes the price of the service go down [13]. This plays asanother parameter influencing the dynamic prices of these services and thus, mode of transport directly affects the price that the consumer pays.

The importance and impact of freight transportation is amplified by the recent boom in E-commerce, the new online-to-offline (O2O) or omnichannel business retailing strategy [13]. The start of the services in the market were first primitive in nature which then slowly advanced to incorporate various options to boost competitiveness. Logistic service providers devote adequate resourcesto provide consumers with a wide variety of categories displaying options

on time, delivery type and speed. To optimize transport operations, the Freight Transportation Procurement Service mechanism is employed. It widely increases the efficiency and effectiveness of freight transportation operations.

3.2 FREIGHT SERVICE STRATEGIES

The freight transportation companies should ideally be able to increase their profit margins while remaining competitive in the market with well-adjusted prices for their services. The freight goods shipping service industry is very dynamic. The various consumers' needs explain the volatile nature of this industry. Global Corporations, small businesses, E- Commerce Companies, aswell as individual consumers all have a need to ship packages or documents to other businesses or individuals; however, the natureof these services will vary.

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It depends on:

- Extent of rivalry between established firms
- Bargaining power of buyers
- Bargaining power of suppliers
- Threat of substitute products

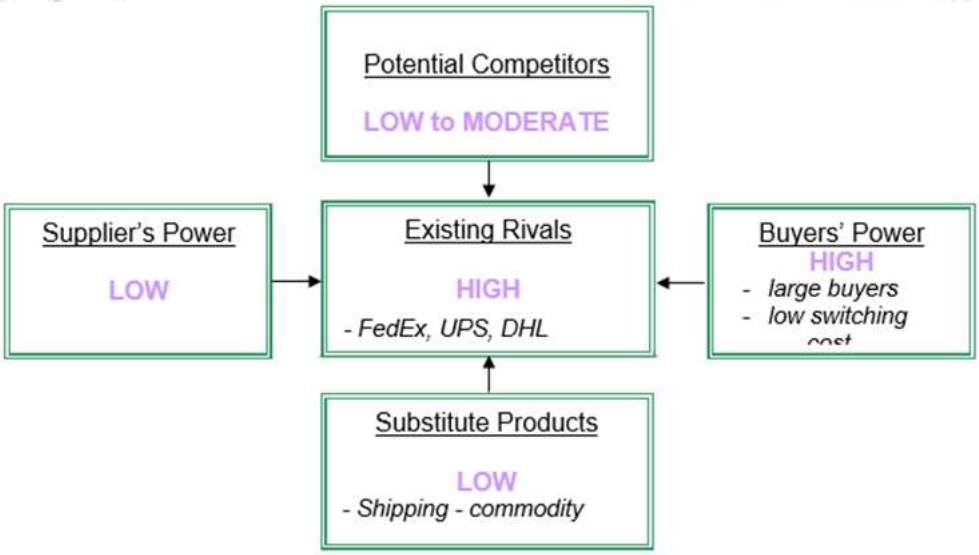


Fig 3.2.1: Porter's 5 Forces

3.3 STRATEGIES

The current strategies that are pursued by FedEx do build on the distinctive competencies that they have cut out in the past three decades. FedEx continues to offer faster delivery times and expand their global network. On September 2nd, 2003 FedEx announced that they would be offering next day delivery to and from Taiwan.[i] This further defines in the minds of its customers that FedEx as having faster delivery times, as this is the first firm in this industry to offer a direct flight from South China to the Continent of North America. Another industry first is the entrance that FedEx has made in Iraq, becoming the first shipping firm to offer door-to-door pick-up and delivery service in that country. This will continue to build their distinctive competence of offering services where no one else does. By opening up a hub in Iraq, FedEx has established themselves as an industry innovator of moving into new markets, putting them one step ahead of the competition. When the competitors of FedEx decide to finally move into that market it will be difficult to make up the step that FedEx has already established.

In **USA**, contender rates are competitive in overnight & saver.

In **Europe**, FedEx is competitive in Economy segment.

In **Asia**, contender pricing is competitive in most segments.

FedEx	UPS	FedEx vs UPS	Price Difference	Delivery Time
US				
FedEx First Overnight	UPS next day air early	🔴	+0.0% - 3.0%	Next day by 830am
FedEx standard overnight	UPS next day air saver	🟢	-1.0%	Next Day EOD
FedEx 2Day	UPS 2 Day Air	🟢	-1.0%	2 Business Days
FedEx Express Saver	UPS 3 Day Select	🔴	+5.0% - 45.0%	3 Business Days
Europe				
FedEx International Priority® Express	UPS Worldwide Express	🔴	+1.0 - +8.0%	2 or 3 Business Days Guaranteed
FedEx International Priority®	UPS Worldwide Saver	🔴	-1.0% - +8.0%	2 or 3 Business Days
FedEx International Economy®	UPS Worldwide Expedited	🟢	-8.0% - +4.0%	4 or 5 Business Days
Asia				
FedEx International Priority® Express	UPS Worldwide Express	🔴	-5.0% - +20.0%	2 or 3 Business Days Guaranteed
FedEx International Priority®	UPS Worldwide Saver	🔴	-5.0% - +28.0%	2 or 3 Business Days
FedEx International Economy®	UPS Worldwide Expedited	🔴	-6.0% - +44.0%	4 or 5 Business Days

Fig 3.3.1: Competitive Analysis

3.4 FLOW CHART

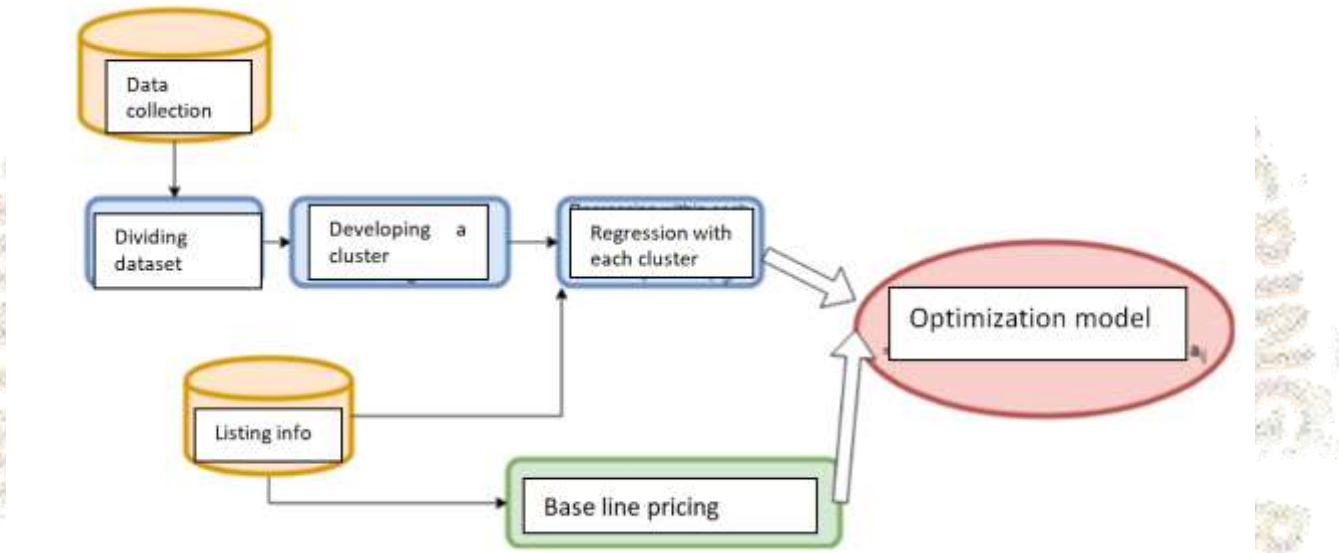


Fig 3.4.1: Flow Chart

The goal of our project is to determine the most optimal price in order for the company to stay ahead of competition, to maximize the long-term profit; we used time series regression and optimization modeling.

Series regression is ideal for dealing with the daily fluctuation of price, and it can take into account the effect of other variables such as type of delivery, price of oil, distance, etc on the price of the shipment. However, time series regression doesn't guarantee that the "best fitted" price is the "optimal" price that will maximize our profit. On the other hand, optimization is ideal for finding the "optimal" prices, but if the optimization model will be very complex if we try to find optimal price for 365 days, as well as include the effect of characteristics on the daily prices. After a thorough consideration, we found a way to combine the regression model into the optimization by using it in our variable creation process; in addition we applied several assumptions to simplify the model while still taking the time series factors into consideration.

Factors like weight and zonal arrangement of multiple locations, and prices of shipping a package based on these two factors is available in these service guides. For phase 1 of the project, we've worked upon these two factors and developed a basic linear regression model. This model aims at predicting a pricing strategy for the company/user based on the weight and type of the shipment delivery service selected.

IV. TECHNICAL APPROACH

The technical approach consists of several steps, starting with data collection and analysis. Historical data on air freight transportation services, including pricing, demand, and capacity utilisation, is collected and analysed to identify patterns and trends. The data is then preprocessed to remove noise and ensure data quality.

Next, machine learning algorithms are trained to predict future demand based on historical data and other relevant factors. We utilised a range of machine learning algorithms, including regression models, decision trees, and neural networks, to develop a pricing model that can adapt prices in real-time based on demand and capacity.

Once the machine learning algorithms are trained and the pricing model is developed, it is integrated into the existing pricing system of air freight transportation services. The model continuously analyses market trends, demand, and capacity utilisation to adjust pricing decisions in real-time.

Furthermore, in the development of the dynamic pricing model for air freight transportation services, a range of variables have been identified and included in the machine learning model to improve accuracy and effectiveness. These variables include seasonality, weight, distance, country of origin, destination country, and crude oil price.

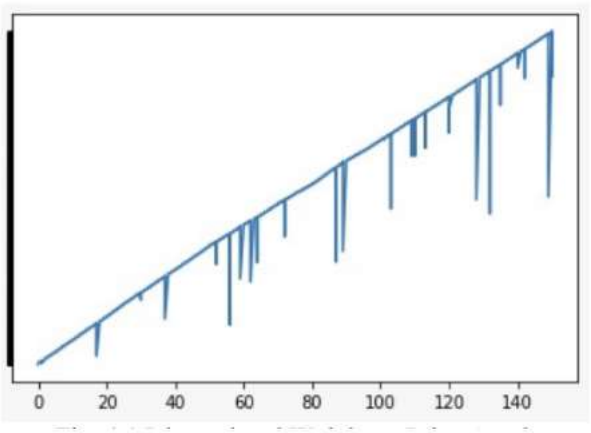
Seasonality is a crucial variable that influences demand for air freight transportation services. The pricing model takes into account seasonal trends and fluctuations in demand to adjust prices in real-time, optimising revenue and capacity utilisation.

The weight of the cargo is another variable that is considered in the pricing model. Heavier cargo typically requires more resources to transport, and as such, the pricing model is designed to adjust prices accordingly.

Distance is another critical variable that impacts pricing decisions. The cost of transporting goods over longer distances is generally higher, and the pricing model adjusts prices based on the distance travelled.

Country of origin and destination country are additional variables that are considered in the pricing model. The cost of air freight transportation services can vary significantly depending on the countries involved, and the pricing model adapts prices to reflect these differences.

Finally, crude oil prices are included in the pricing model as they impact fuel costs, which are a significant component of the cost of air freight transportation services. The pricing model adjusts prices based on changes in crude oil prices, ensuring that fuel costs are factored into pricing decisions.



Graph 1 › Dimensional Weight vs Price Graph

V. CONCLUSION

In this paper, we discussed the freight transportation system and the impact of dynamic pricing models on the systems deployed in the market. We saw the various characteristics of pricing strategies and their correlation to different parameters affecting the price of the service. We further discussed the advantages of using dynamic pricing models and strategies to increase business returns, boost revenue generation and operate efficiently. We then discussed sales, marketing and their integration model to increase customer lifetime value. These various aspects all contributed to fragments.

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