OPTIMISING CAR SHARING PROFITABILITY WITH A REGIONAL PRICING STRATEGY

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MSc Data Science (with Specialisation in Artificial Intelligence) - Interim Report

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1 Introduction

In an era where environmental sustainability is paramount, sustainable transportation is crucial. Car sharing has a solid ability to reduce carbon emissions [1]. With a mission to transition society from car ownership to shared transport and a commitment to environmental sustainability, Co Wheels has established itself as a significant player in the UK's car-sharing market. Co Wheels was founded over 13 years ago, and since then it has grown to over 600 vehicles, serving more than 30,000 members across the UK. Unique in its approach, Co Wheels not only serves individual users but also manages closed fleets for organizations like councils, NHS trusts, universities, and housing providers. Notably, a third of its fleet consists of electric vehicles (EVs).

The introduction of shared-use vehicle systems has transformed urban mobility, providing an innovative alternative to traditional car ownership. These systems are particularly attractive in densely populated urban areas, where they can reduce the demand for parking, lower transportation costs, and promote the use of public transit and other sustainable transport modes [6]. Round-trip car-sharing systems, a subset of shared-use vehicle models, have gained significant traction due to their convenience, allowing users to pick up and return a vehicle to the same location.

Despite its success and growth, Co Wheels faces the challenge of optimizing profitability within the highly competitive and variable landscape of car sharing. Unlike its primary competitors, Zipcar, which focuses predominantly on London, and Enterprise Car Club, which leverages its extensive rental office network, Co Wheels operates a uniform pricing model across all locations. This model does not account for the considerable variations in demand and local economic conditions.

The necessity of this project arises from the inherent price sensitivity and seasonality of car-sharing services, particularly for B2C journeys, which are often discretionary, such as for shopping or leisure activities. By implementing a more flexible and data-driven pricing strategy, Co Wheels can better align its pricing with local demand, seasonal demand and cost structures, enhancing its competitive edge and financial sustainability.

Dynamic Pricing also known as surge pricing strategies have emerged as a promising solution to address this challenge. By dynamically adjusting prices based on demand, these strategies can incentivize users to make travel decisions that help balance vehicle distribution and improve system efficiency [8]. The effectiveness of such pricing mechanisms hinges on their ability to respond promptly to fluctuating demand while maintaining user satisfaction and system profitability. The price would increase, if demand for the product / service increases. The formula of Dynamic Price is as follows:

$$price = basePrice + (demandFactor * basePrice)$$

The revenue generation comparison between static pricing and dynamic pricing is as follows:

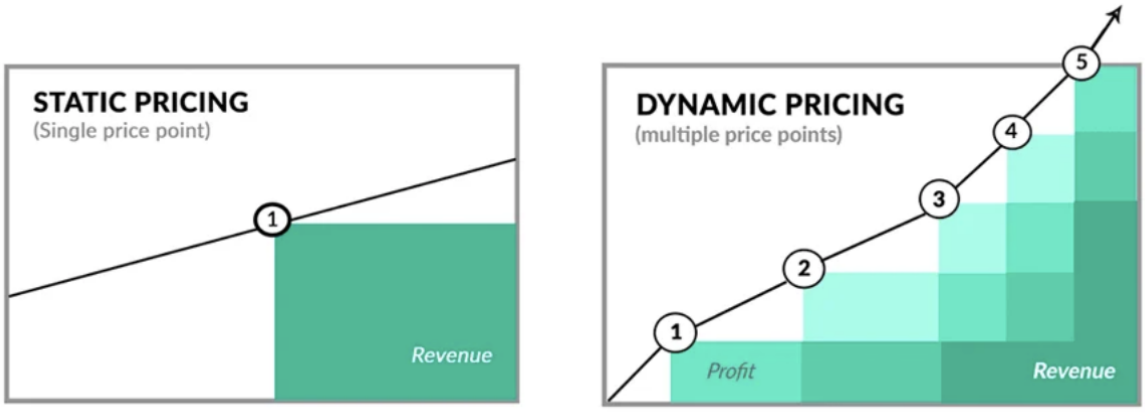

Figure 1: Static Pricing Vs Dynamic Pricing [4]

Recent studies have explored various aspects of pricing strategies in shared-use vehicle systems. For instance, differentiated pricing has been shown to influence vehicle distribution effectively [2], while other research discusses practical approaches for implementing these pricing models in real-world scenarios for customer retention [5]. Additionally, advanced technologies such as GPS and mobile applications facilitate real-time data collection and price adjustments,

enhancing the feasibility and effectiveness of these strategies, giving trip pricing with zone and time of the day price variation [3]. Furthermore, real-time pricing can contribute to broader societal goals by reducing traffic congestion and emissions, encouraging the use of shared vehicles over private cars, and promoting sustainable urban mobility [6].

2 Aim and Objectives

2.1 Aim

The purpose of this dissertation is to create a dynamic pricing tool customised for Co Wheels. Utilising comprehensive trip data from the company's booking system (TripIQ), the research will develop a model that accurately represents the actual costs and demand patterns in various regions. This model will consider both fixed and variable expenses, including fuel and electricity, and will factor in seasonal changes and local economic conditions to recommend optimal pricing strategies.

2.2 Objectives

This work will focus on five primary objectives:

1. **Analyse Usage and Demand Patterns:**
   - Examine the extensive trip data available in Co Wheels' booking system (TripIQ) to identify patterns in vehicle usage and demand across different locations and times.
2. **Design and Develop a Pricing Model and Tool:**
   - Create a pricing model that incorporates fixed and variable costs, including fuel and electricity, to determine optimal hourly and daily rates for different locations and times.
   - Develop a straightforward tool that allows Co Wheels to input various cost factors and receive tailored pricing options based on location, demand, and seasonal variations.
3. **Evaluate Seasonal and Temporal Variations:**
   - Assess the impact of seasonal changes and time-of-day variations on car-sharing demand and integrate these factors into the pricing model.
4. **Assess Profitability and Utilisation Impact:**
   - Model potential outcomes of different pricing strategies to evaluate their impact on profitability and vehicle utilization rates in various locations.
5. **Validate the Pricing Tool:**
   - Test the pricing tool with real-world data to ensure its accuracy and effectiveness in optimising Co Wheels' pricing strategy.

3 Overview of Progress

Initially, a detailed competitor analysis was conducted to benchmark against major international players like Zipcar, providing insights into different pricing models and strategies [7]. Various pricing methods were researched, including static, tiered, and dynamic pricing, leading to the conclusion that dynamic pricing was the most suitable approach. This method allows for real-time price adjustments based on demand and other factors, crucial for optimising Co Wheels' profitability and utilisation. Key variables such as time of day, location, and vehicle availability were identified as essential inputs for the dynamic pricing algorithm.

The implementation of dynamic pricing was further informed by studies from various industries, illustrating its effectiveness in enhancing revenue and managing demand. To gain further insights, the project examined the airline industry's advanced dynamic pricing strategies, focusing on demand forecasting, pricing optimisation, and customer segmentation [9]. Furthermore, study of the impact of dynamic pricing on customers and business operations [5], balancing increased revenue with potential challenges like customer perception of fairness.

Co Wheels provided extensive trip data from their booking system, TripIQ, and SQL servers, which was securely stored in Google Drive. The data was explored, cleaned, and analysed using tools like Python's Pandas and NumPy libraries. Further, to get some technical understanding and implementation of dynamic pricing, some video tutorials are followed and learnt the implementation of Airline industry.

A thorough literature review has taken place. Research papers provided crucial insights, with studies on carbon emission reduction [1], shared-use vehicle systems, one-way car-sharing pricing, and practical solution approaches for differentiated pricing informing the project's development [2]. These milestones reflect a comprehensive approach to enhancing Co Wheels' pricing strategy through dynamic pricing.

Security and confidentiality are paramount considerations due to the sensitive nature of the data involved. The primary concern in this project revolves around data security, which is addressed by storing data on a password-protected local machine and labelling private data within Google Drive. The project utilises Google's Colab Pro web IDE along with Python, requiring a minimum of 8GB RAM and 15GB of cloud storage.

4 Project Plan

The project will run from 22nd April 2024 to 15th August 2024, with a detailed visual plan shown in Figure 2. Initial tasks included conducting a competitor analysis, exploring various problem-solving methods, and assessing the impact on customers and the business. A literature review has been prepared for the final report. The implementation phase will take place from 31st May to 2nd August. The pricing tool/software will be developed using an agile approach with regular testing and iterations. After comparing the model with the existing dataset, the results will be evaluated. Although this may slightly reduce the overall accuracy, it is expected to result in a more robust model. Project deliverables are defined, and progress is being monitored.

Project Repository

—- https://github.com/tejasnavalkhe/Optimising-Car-Sharing-Profitability-with-a-Regional-Pricing-Strategy

References

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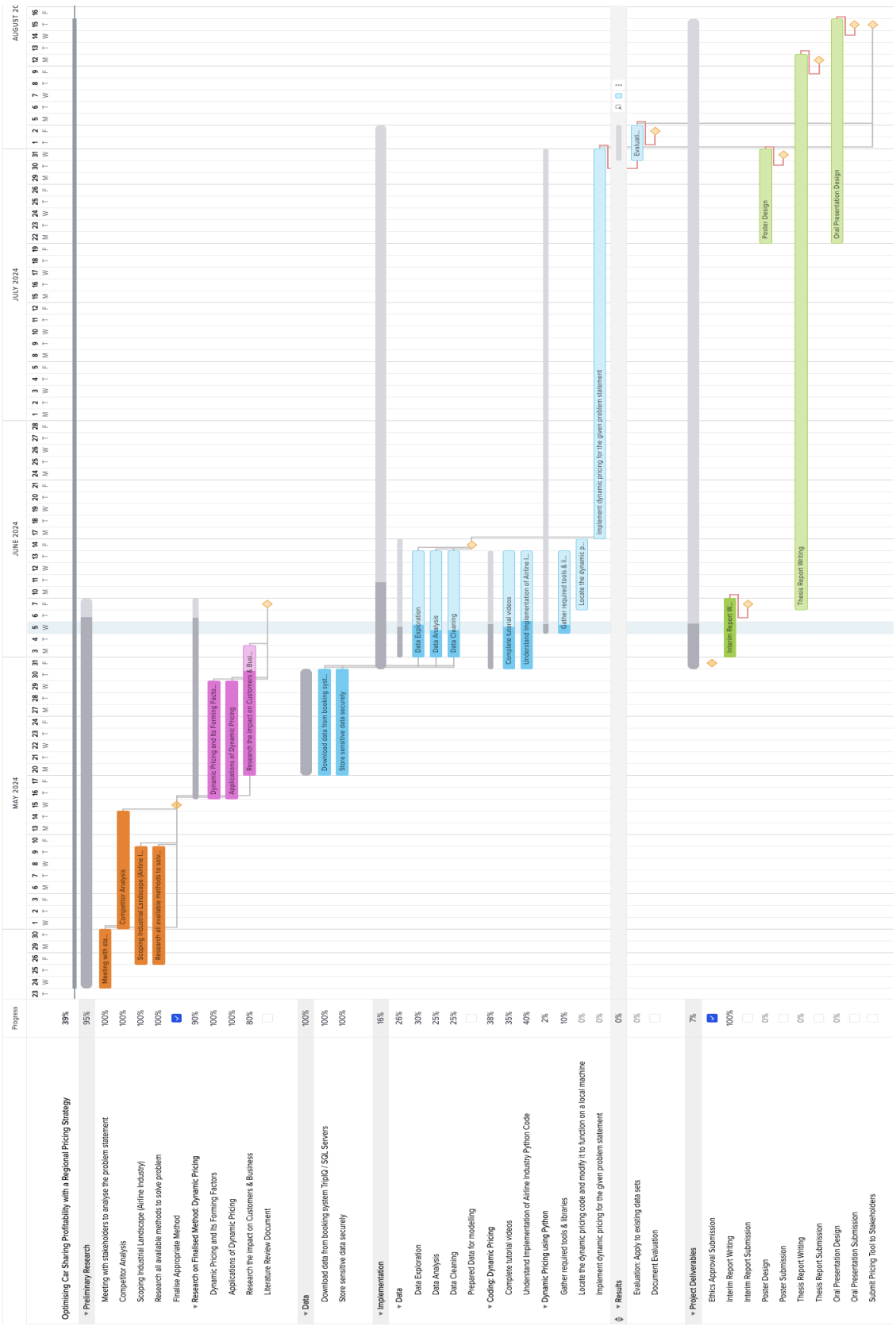

Figure 2: A Gantt Chart for the proposed project. Tasks are scaled as per date ranges, and dependencies indicated by connecting lines.


DATA
MANAGEMENT
PLAN
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0. Project title, author, version and date

Project: *Optimising Car Sharing Profitability with a Regional Pricing Strategy*

Author: *Tejas Satish Navalkhe*	***Version:*** *1*	***Date:*** *7th June 2024*

1. Description of the data

1.1 Type of study

The project involves studying the exploratory analysis of the Co Wheels UK LTD dataset to investigate various pricing methods and their applicability to the Co Wheels business model. This includes examining the factors that influence dynamic pricing and reviewing relevant literature to identify best practices. The study also encompasses practical implementation steps, such as developing a dynamic pricing tool.

1.2 Types of data

The research dataset, collected over several years by Co Wheels UK LTD, includes comprehensive booking details made by customers and all registered user information. This data was gathered through the company's app or website at the time of booking or registration.

1.3 Format and scale of the data

The dataset encompasses information from across the UK, including users who uses services of Co Wheels UK LTD and those who have simply registered. Stored in CSV (comma-separated values) files, the dataset includes booking data from 2019 to 2024 and information on all registered users, which requires secure storage. Each file contains over 150,000 records. This data, totaling approximately 5.5GB, is stored using SQL Servers and the TripIQ booking system and was securely shared by company via WeTransfer.

2. Data collection / generation

2.1 Methodologies for data collection / generation

The dataset is sensitive and therefore cannot be made available on the internet. Co Wheels UK LTD collected the data themselves through their car booking mobile app and website, storing it in the TripIQ booking system and SQL Servers. For this project, the data was securely shared via WeTransfer. No new data will be gathered or produced, as the existing data is sufficient for all analysis and the development of the pricing tool.

2.2 Data quality and standards

The quality of the data can be assessed through five dimensions: Accuracy, which ensures that the data is correct and free from errors; Completeness, which evaluates if all necessary data fields are filled and no information is missing; Consistency, which examines if the data is uniform and coherent across all records; Timeliness, which measures how up-to-date the data is and if it reflects the current state of affairs; Validity, which verifies if the data conforms to the rules and requirements of the dataset; and Uniqueness, which assesses whether each data entry is distinct and not duplicated.

3. Data management, documentation and curation

3.1 Managing, storing and curating data.

The dataset was first saved on a computer from WeTransfer, then put onto a Google Drive account to use with Google Colab Pro, which can do more complex calculations. Having the data in two places keeps it safe. Any models or tools created will also be saved on the computer, along with the project code on GitHub.

3.2 Metadata standards and data documentation

Details of the techniques and tools used to create the models and pricing tool will be kept and provided to only Co Wheels LTD UK, as this may contain sensitive information. Anything required for reproducibility will be clearly mentioned in a README file created for the project GitHub repository. Machine specifications and the environment will also be documented.

3.3 Data preservation strategy and standards

The dataset will only be kept for a short time, until the dissertation project is finished. Once the project is over, the dataset will be permanently removed from both the local machine and Google Drive, ensuring data security.

4. Data security and confidentiality of potentially disclosive information

4.1 Formal information/data security standards

The data contains sensitive information gathered by Co Wheels UK LTD. To ensure security, it has been stored in a password-protected local machine.

4.2 Main risks to data security

The dataset contains users' personal information, making data security a top priority. Data hacking is the main risks. The sensitive data is stored on a password-protected local machine ensuring changing password every fortnight, and the backup copy uploaded to Google Drive is labeled as private to maintain security.

5. Data sharing and access

5.1 Suitability for sharing

No: The data used in the project cannot be shared with the public due to its sensitive nature, which includes information of users of Co Wheels UK LTD. Therefore, access to the data has been restricted to ensure data security.

6. Responsibilities & Resources

Google Colab Pro *@ ≈ £9.72 / month*

7. Relevant institutional, departmental or study policies on data sharing and data security

Policy	URL or Reference
Data Management Policy & Procedures	https://www.ncl.ac.uk/media/wwwnclacuk/research/files/ResearchDataManagementPolicy.pdf
Institutional Information Policy	https://services.ncl.ac.uk/itservice/policies/Information%20Security%20Policy.pdf
Data Sharing Policy (Co Wheels)	https://www.co-wheels.org.uk/privacy2023