Table of Contents

Background

The transport system in Wales provides a wide range of means of transportation. The local authorities of Wales manage the local bus services, and they actively include communities in the development plans. Bus travel is provided free of charge for individuals who are disabled, injured, or aged 60 and above Cardiff Airport (CWL) is the only international airport providing air links to Cardiff. Despite the airport being situated in a village, there are both bus and rail services available,

connecting the airport to the city of Cardiff (Wikipedia Contributors, 2019). The Great Western Main Line operates trains from London Paddington to Cardiff (Wikipedia, 2024). The Wales Transport strategy has the primary theme being 'Connecting the nation", The Wales Freight Strategy, 2008), to provide an integrated transportation system.

The representation below encapsulates the different modes of transportation available in Wales.

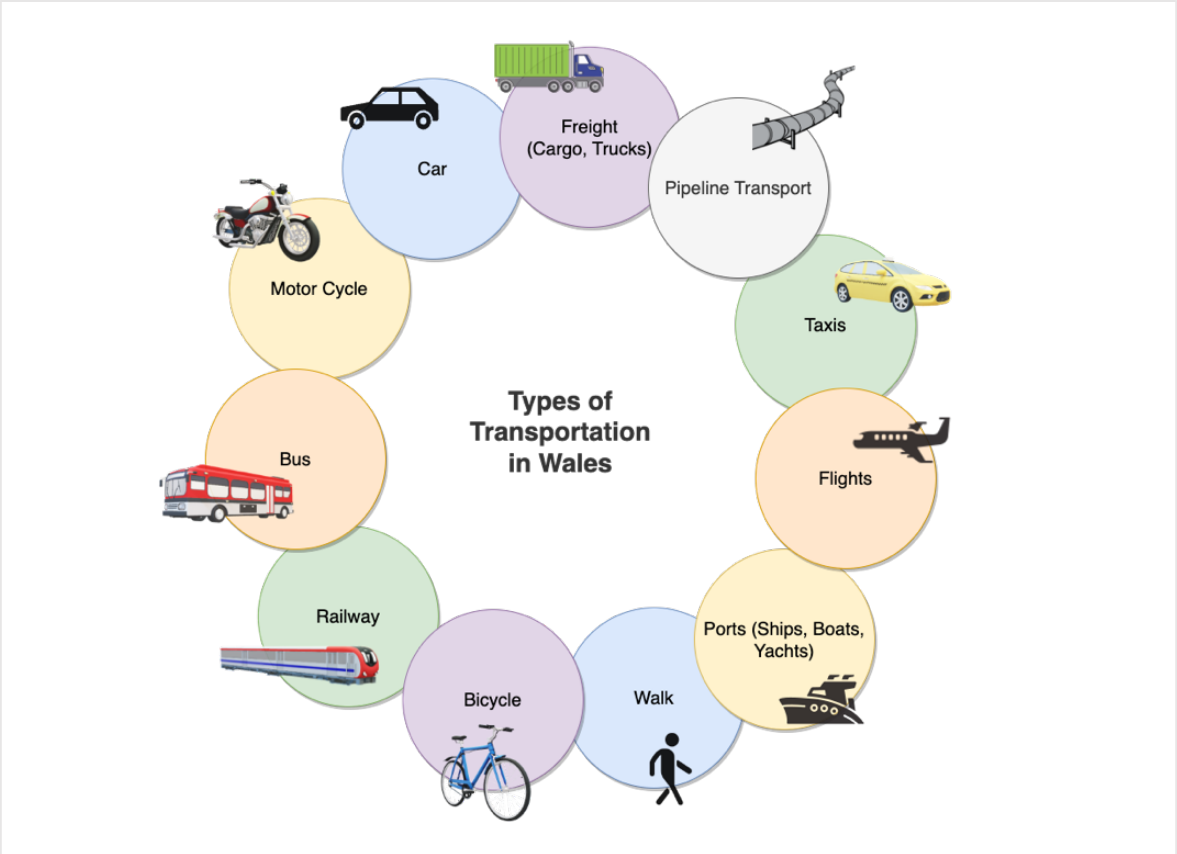

Figure 1: Wales Transportation (Gov.Wales, 2024)

Challenges

In a recently published report titled "Making the Connection," it was found that individuals across Wales are affected by issues of unaffordability and unreliability in transportation (Sustrans, 2022). More than 10% of income is being allocated towards the expenses associated with running a car. Daily life has been significantly affected by inadequate access to transportation in Wales.

Unreliable Services

- Buses have experienced a reduction of 17.8%, affecting approximately 12% of the population who now lack access to public transport (Sustrans, 2022).

- Highly unreliable service negatively impacts both employment and recreational opportunities
- A notable 34% of rail stations do not facilitate access for wheelchair users
- The data from the 2021 census indicates a decrease in car driving in Wales during the pandemic, and this trend has not rebounded (Coombes, 2023).
- During peak hours in main cities like Cardiff, there is notable congestion of cars
- The public transport network is not well-connected.

Unaffordable Services

The prices of bus, rail, and coach tickets have experienced an increase ranging from 33% to 55.7%. Lower-income individuals will be directly affected by the sudden price increase, impacting around 23% of people who rely on public transport and do not own a car (Sustrans, 2022).

Issues Affecting Rail-Network Services

Current challenges include (Gov.Wales, 2020) and (Gov.Wales, 2019).

- Less frequent express services
- Local commutation is very limited impacting the overall journey
- Unreliable rail journeys affecting overall efficiency
- Disruption in operations very frequently
- Safety Signal improvements and unsafe level crossings

Master Data Management

MDM solution provides a platform to standardize the data and improve data quality.

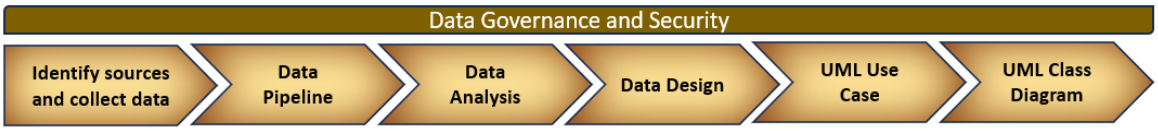

Figure 2: MDM Solution

The above are steps implemented as part of the MDM solution to analyze and design for Wales Transportation system (Raghavendra, 2022). Data collection is provided as part of the 42 tables mentioned in (Gov.Wales, 2024)

Data Pipeline

The below data pipeline is recommended for automating the data movement from different data sources. Using the data pipeline more complex tasks can be stored and transformed by filtering and joining data (Levy, 2022).

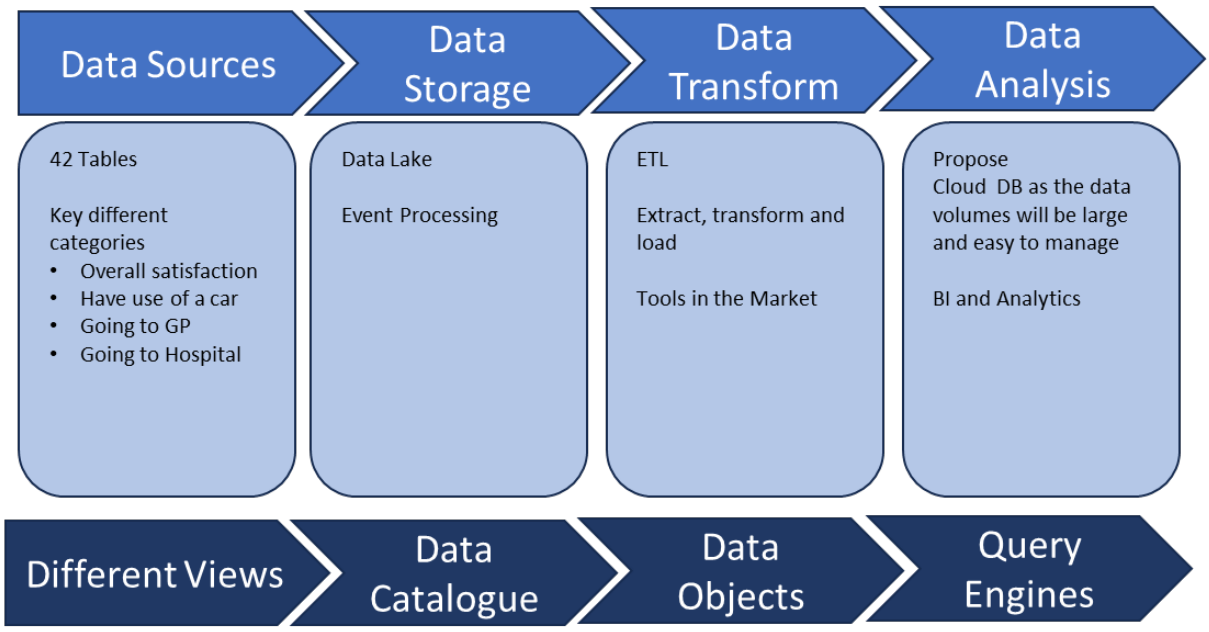

Figure 3: Data Pipeline Architecture

Implementation of data pipeline in the proposed model

- From 42 different tables, the data has been analysed
- The data catalog being setup and the data available for ETL
    - Proposed ETL Pipeline

Figure 4: ETL Pipeline

- As part of the transformation the data is transformed by joining and filtering (as used in Figure 4 and Figure 5
- Query on the data and conclude using business intelligence.

The analysis has been conducted for 4 different scenarios based on the 42 tables data provided.

Data Analysis

Data analysis was conducted based on the 42 tables provided and identified the key tables which may require further analysis which can help identify the issue quickly to the local authorities to find a solution to the problems.

Overall Satisfaction with Access to Services by Groups

The overall satisfaction has about 14 tables, however, about 7 tables provide general information about the category of people living in Wales and their satisfaction level with the Welsh Transportation system.

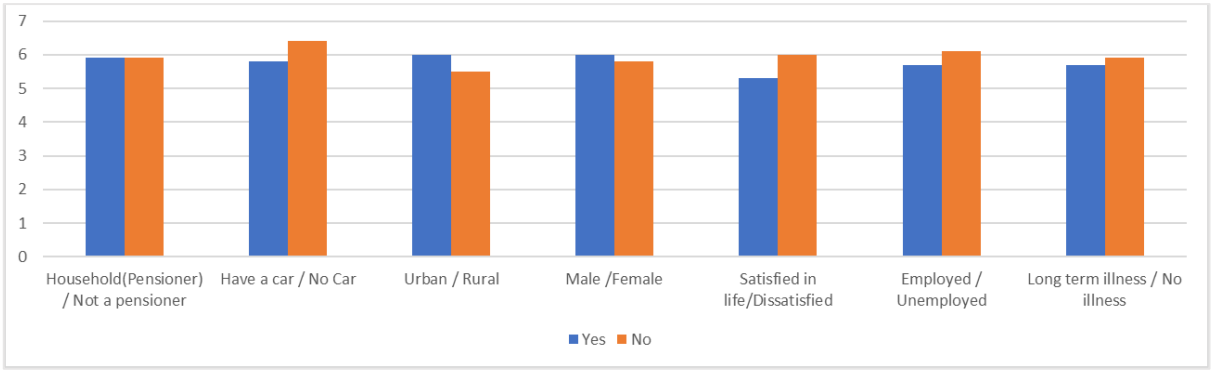

Figure 5: Tables 1-4, 9,11 and 12

Inference

The overall satisfaction is evenly distributed among both groups in each category, but those without a car express the highest dissatisfaction.

Deprived Score against Access to Services in the Area

The tables related to 7 and 8 are considered which provides data related to access to services in the deprived area. This information is chosen to identify the transportation services in different deprived areas.

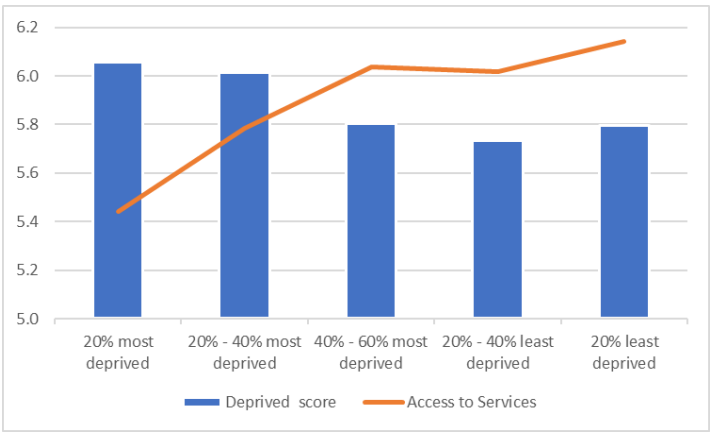

Figure 6: Tables 7 and 8

Inference

Overall satisfaction is low in the most deprived areas due to significantly limited service access.

Service Access with and without a car against Deprivation Score without a car

Tables 19 and 20 are chosen to identify the access to services when someone owns a car and does not own a car. The deprivation score across the people owning a car and not owning a car to understand the level of people suffering.

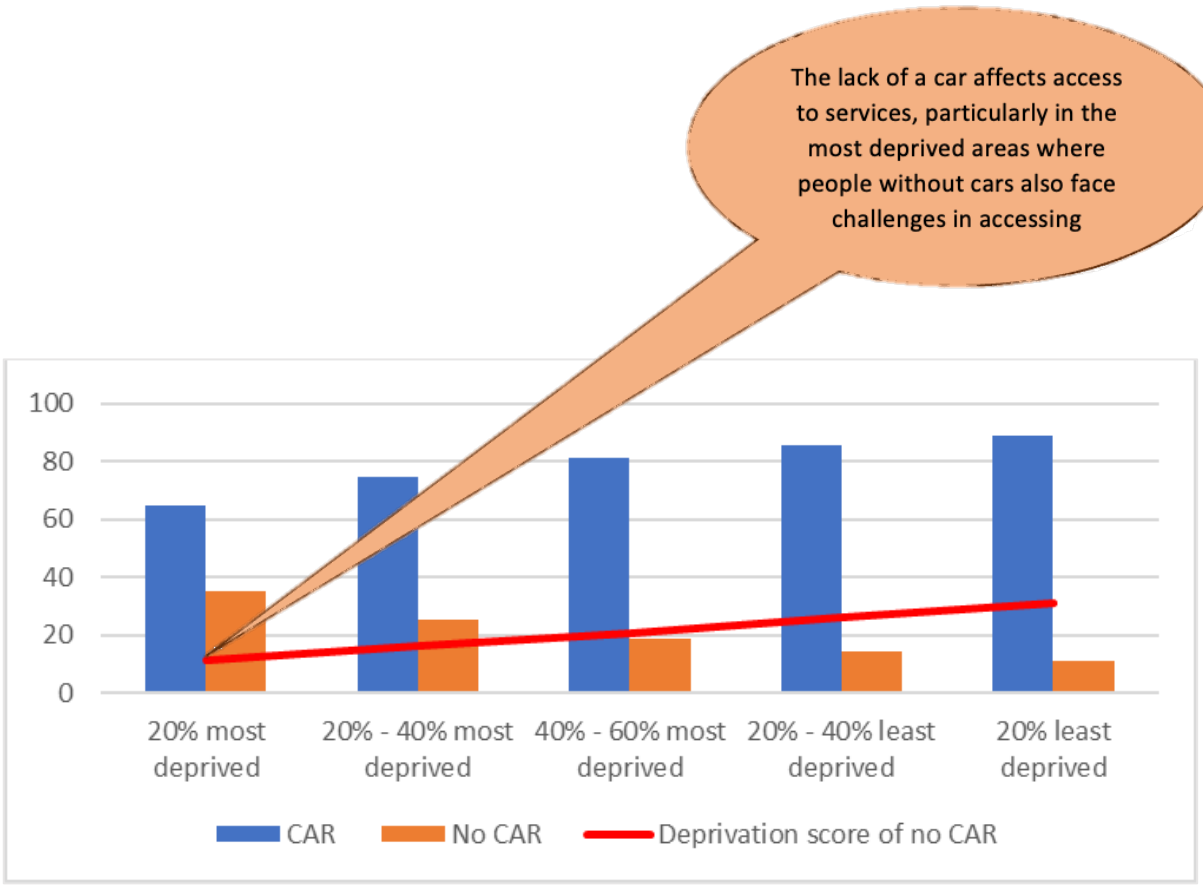

Figure 7: Tables 19 and 20

Inference

In the most deprived areas, a high number of residents lack cars, and service access is significantly lower compared to the least deprived areas.

Ease of Access to Hospital and GP

After analysis of having a car and not having a car, how people get to the hospital by access to services has been analyzed. Analysed how difficult it is in the deprived areas for people unable to reach to hospital.

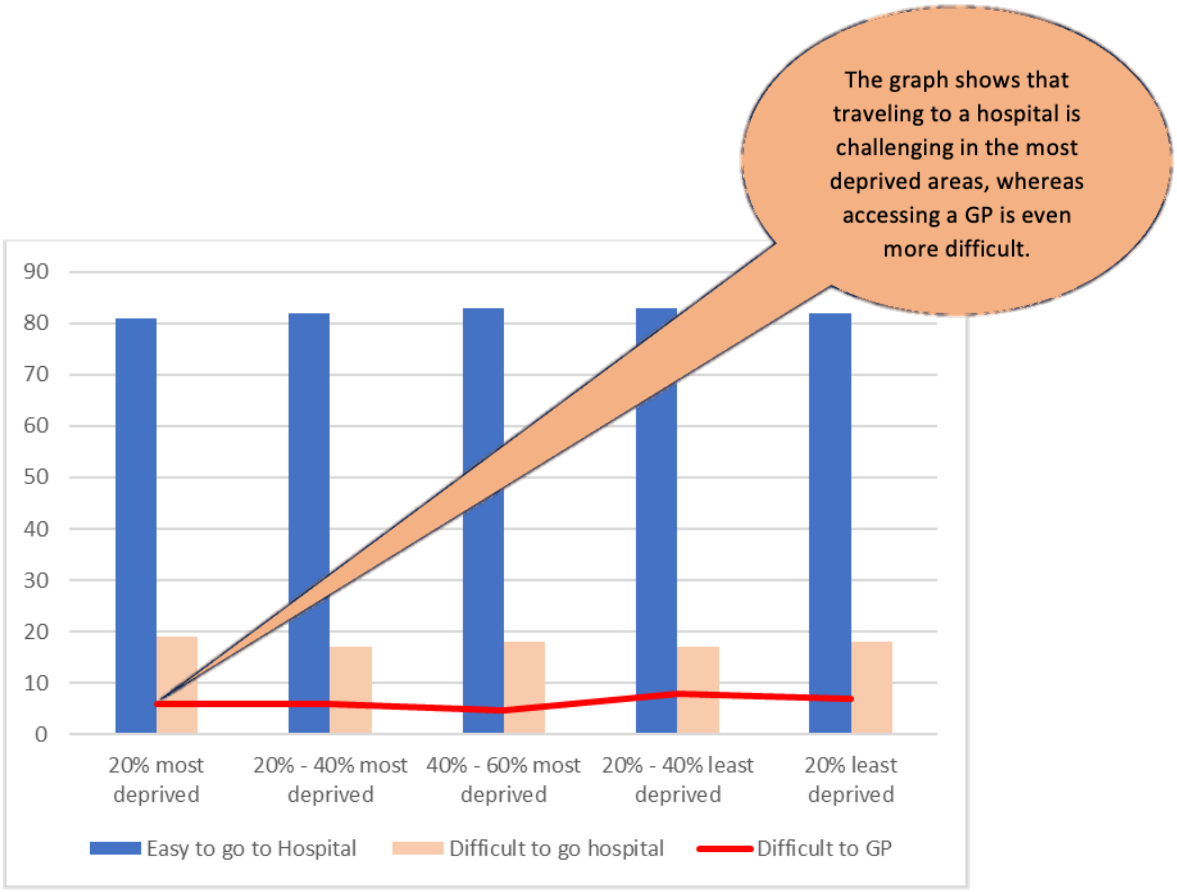

Figure 8: Tables 31 and 23

Inference

The ease of accessing hospitals seems easier than accessing GPs. Typically, individuals are advised to consult a GP first, and then, based on the GP's recommendation, proceed to a hospital.

Wales Transport Poverty

Wales tackles transport poverty with a strategic framework but faces implementation barriers as shown below (Cymru, 2022)

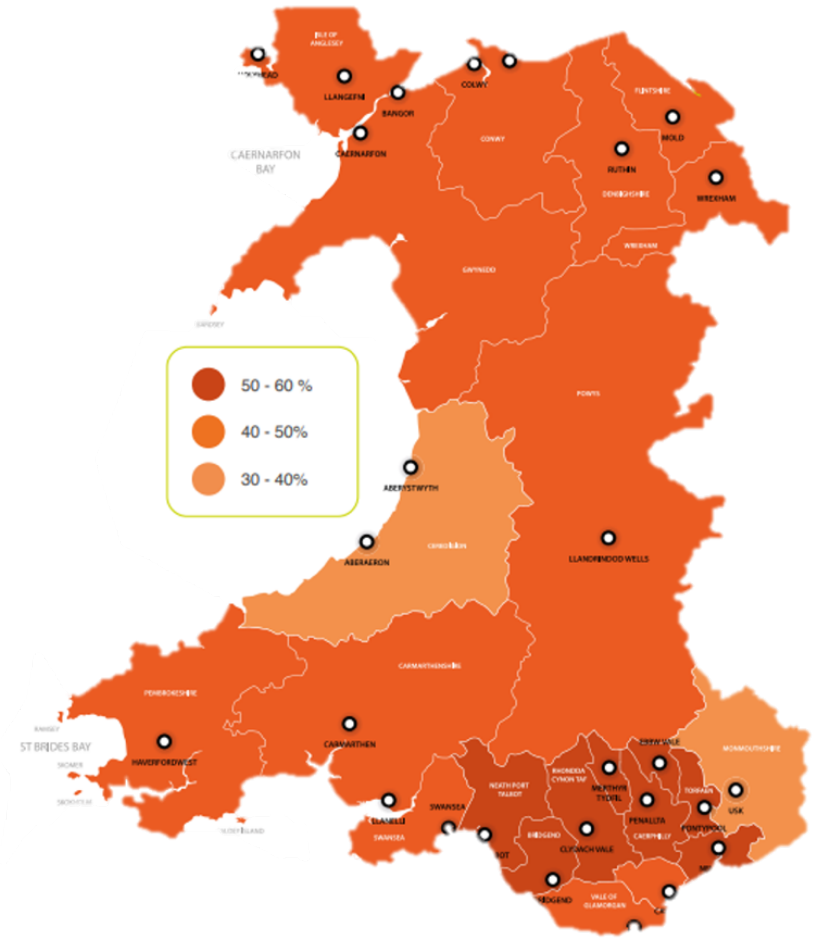

Figure 9: Percentage of Population Facing Transport Poverty

Data strategy

Figure-5 provides a generic overall satisfaction whereas Figure-6 is specific in providing access to service information. Figure-6 is considered as basis for the design.

Figure-7 provides the level of dissatisfaction with access to services when they have a car not having a car, whereas Figure-8 provides key information related to going to hospital and GP.

Limitation

The limitation across all of these strategies is there is no way to combine people going to the hospital and GP are safe to travel during night, as the information captured related to safety is collected in a different form to provide a broader view. The data relating to Gender, employment, and long-term sickness does not provide any combined view as the data is very discrete. The data does not provide how many of women employed are unable to travel and how many of the women having long term sickness is not satisfied with access to service. The amount of data collected for the overall satisfaction is low compared to other data collection. The important safety related data has been collected only with 3900, which is the lowest of all, however feeling of safety has a larger data collection. It requires more data to completely analyse and arrive at conclusions.

Design

Based on data analysis, the proposed Unified Network diagram illustrates the integrated public transportation system (Roberts and Jones, 2019).

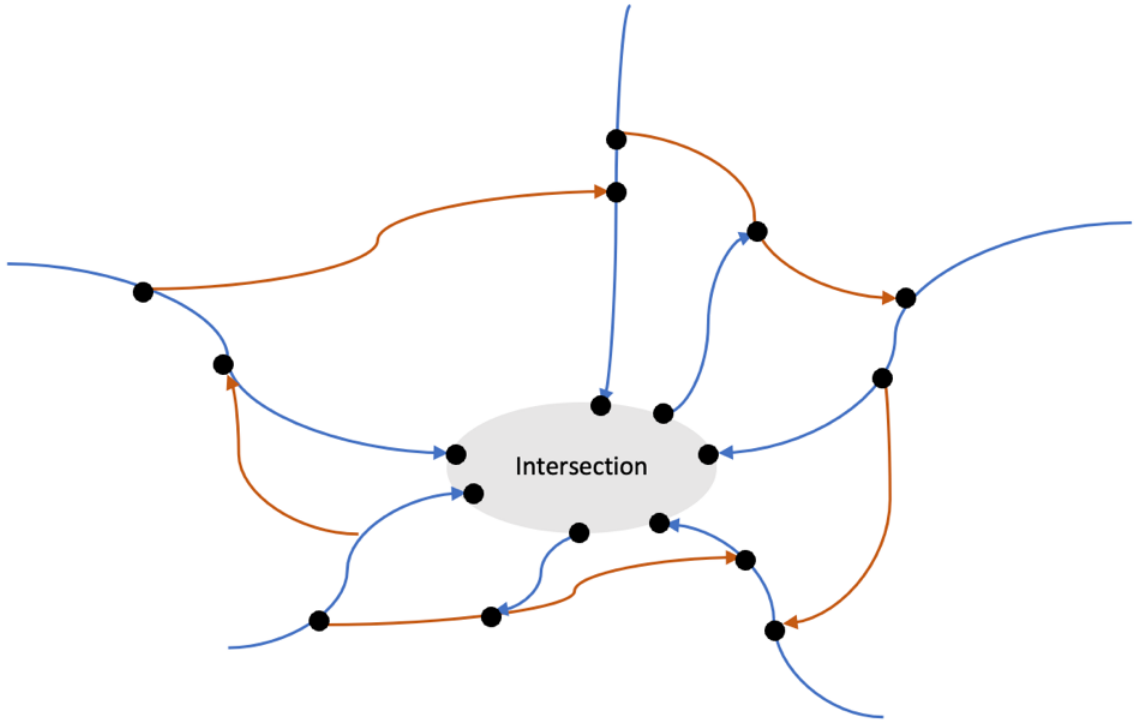

Figure 10: Unified Network for Transportation

This level of integrated system connects with rural and urban area and identifies an intersection point connecting all routes and similarly a similar concept for connecting multiple towns. This level of integrated model will address the issues like people from urban area traveling to Cardiff airport.

Use Case Diagram

The below use case diagram explains the use case that we would like to address to improve on the coordination between different parties, when the trip is based on requests.

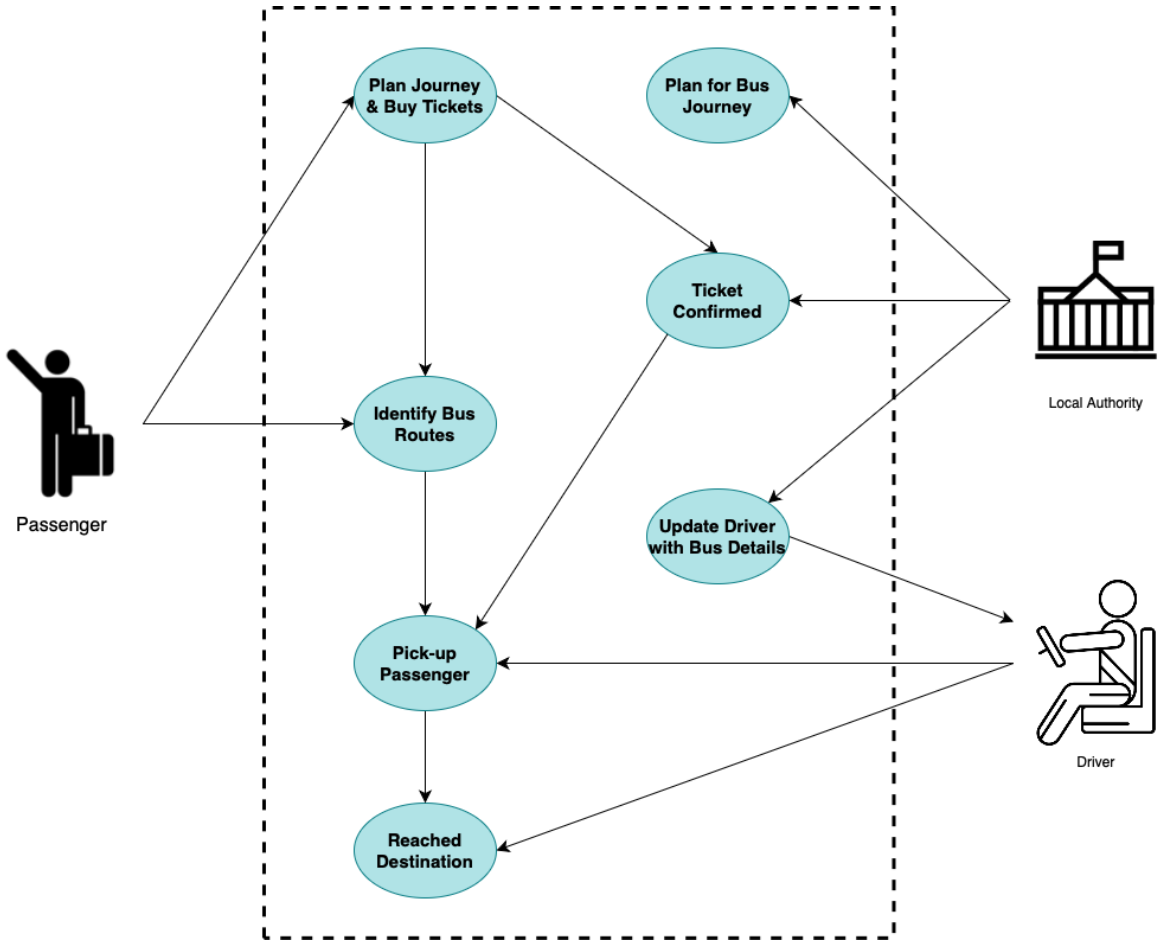

Figure 11: Use Case

UML Diagram

The UML design is to provide the working model wherein the Bus drivers collaborate with local authorities and franchises through the Welch Partnership scheme, introducing franchises to address rural travel issues.

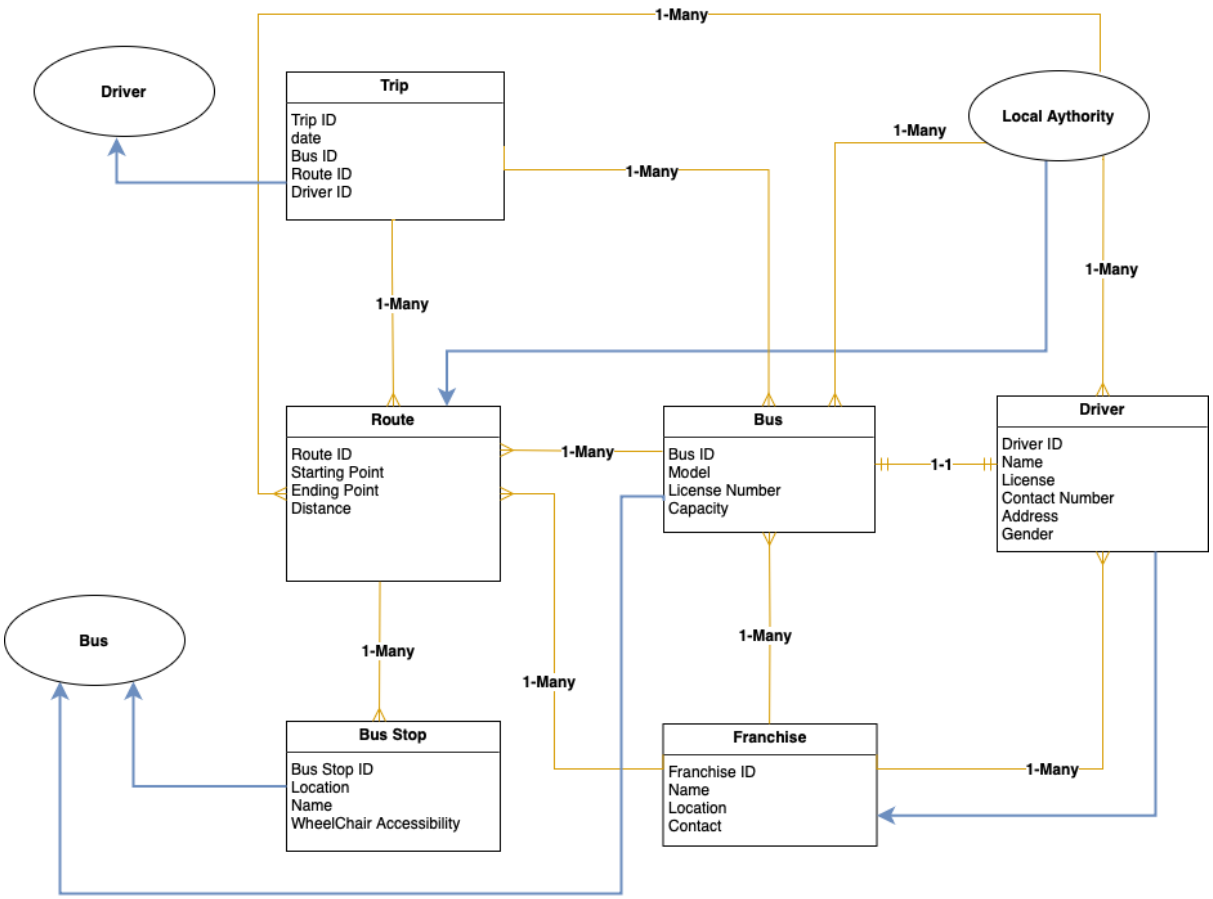

Figure 12: UML Class Diagram

This model requires a lot of coordination with local authorities and franchise to come up with a bus timetable. The local authority will get connected with the franchise based on the timetable and franchise will connect with the franchise bus drivers and agree on the route to serve the rural areas

Conclusion

The transportation plays a crucial role in the everyday lives of individuals by providing access to employment, education, health services, social interactions, cultural events, and sports activities. When travel is difficult and mobility is restricted, it can significantly impact daily activities. This dependence becomes a significant obstacle in lifting people out of poverty. It is crucial to provide affordable and reliable transportation options for the general public

Wales transportation system provides lot of options for public, however the results were not great as the system have a number of issues including safety of people presented in the Tables (Table 39 to Table 42). The information provided in different categories helps us understand the varied problems with respect to unreliable and unaffordable issues on the bus and rail services. To thoroughly understand the data, the data pipeline has been to come up the details of the analysis. The UML class model can be enhanced to address many different scenarios. Integrated the routes, stops, timetable, ticket and ticket fares in conjunction with integrated public transportation may resolve some of the issues faced in rural areas of Wales. The solution emphasizes integrating bus and rail services into an Integrated public transport, rather than solely relying on expanding local authorities or relocating them to rural areas.

In addition, the model will result in decrease in car usage as the integrated public transportation system will provide the need of the people. The data related to carbon emission and air quality can be collected and it can be validated for better results when using Integrated public transport.

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