CO3016 Computing Project

Dissertation

GreenCar@UoL Carpooling Application

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Declaration

**DECLARATION**

All sentences or passages quoted in this report, or computer code of any form whatsoever used and/or submitted at any stages, which are taken from other people’s work have been specifically acknowledged by clear citation of the source, specifying author, work, date and page(s). Any part of my own written work, or software coding, which is substantially based upon other people’s work, is duly accompanied by clear citation of the source, specifying author, work, date and page(s). I understand that failure to do this amounts to plagiarism and will be considered grounds for failure in this module and the degree examination as a whole.

Name: Travis Kirton

Signed:

Date: 1/04/2018



# **Abstract**

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# **Introduction**

(500 words)

## Project Background

“All 13,000 taxis in New York City could be replaced by a fleet of 3,000 ride-sharing cars” [1]. A statement like this was proposed by MIT’s Computer Science & AI Laboratory. This would reduce emissions, passenger wait times & have a better impact on road congestion, all of which are constant issues today.

## Project Focus

For my project, I have researched and developed a carpool application directed at university students, but not limited to them. The projects core idea was giving more control to the user about who they want to ride with. Applications like Uber & Lyft only allow you to set destinations and then you’ll have to deal with whomever the algorithm seats you with, which could purely be based on the areas you’re coming from and going to. A more social and people centric approach would be to allocate riders with like-minded drivers as well as other suitable passengers. This could be completed by smart matching based on preferences, or by giving the user a choice of their own. The application I researched, designed and developed is all about creating a carpool application where the user is in control of the ride.

Current carpool applications simply exist to get riders from point A to B, but completely ignore the possibility of matching people based on personal preferences. Daily commuters who work 9 to 5 jobs using the same route each day would absolutely benefit from an application that could set reoccurring bookings with passengers of whom they actually get along with. (research has shown discomfort from riding with passengers).

## Objectives

The project included multiple core objectives that needed to be met throughout design, development & implementation. Firstly how the user would be interacting with the application and what would the best platform be? Asking this question led to the novel idea of using a Hybrid Web Application allowing access via a mobile deployed application, as well as a hosted web-application. A second core objective was to look at routing. As a carpool application is dependent on journeys, a way to view journeys & their route was required. Gathering map data, analysing it, performing algorithms on it and finally displaying results was a task that required the right tools and techniques to complete.

Design was a key component, as an interactive application requires clear usability and consideration into interaction. Using colour theory & sound Human Computer Interaction Principles, I could create an experience that the user would enjoy and gain satisfaction out of using it.

Evaluation of the applications was completed via usability testing by friends and family. This allowed a real response from individuals who weren’t involved in the design & development, users who might wish to use such an application in the future. This proved highly advantageous and results were positive with minimal complaints.

## Degree Relevance

I chose this project proposal as I found the idea of a carpool application interesting, especially as an avid user of current services such as Uber. As I put more & more time into the application, I realised that it wasn’t just an application to store and display data, but had core fundamentals that needed to be met. This includes algorithm development, database deployment, working with frameworks & libraries all while having to think critically about how to accomplish such a task. Throughout my degree I was taught all of these, and putting them to use with new technologies allowed me to understand quickly what was going on.

Throughout the project I have grown as a developer and gained more skills that I can now use in the workplace. The entire project is now one of the reasons I have secured a graduate position within the UKs leading car manufacturer, as it helped in my application and interview to explain routing, map data and the ideas behind it.

# **Literature Review**

(2500 words)

## Environmental

A significant impact of so many cars on the road is congestion can become a huge issue. Traffic congestion can cause a variety of negative effects, directly impacting the environment also drivers. Fuel Wastage from cars running but not moving increases air pollution and carbon dioxide emissions [2]. Recent studies by MITs Computer Science and Artificial Intelligence Laboratory has shown that using carpooling services could use around “3,000 four-passenger cars could serve almost 98 percent of taxi demand in New York City” [3]. This research could be applied to all major cities in the world, such as London or Manchester, allowing significantly less cars on the road to cause congestion and excessive pollution as well as having little impact on delays for riders of carpool services.

Instead of transporting people one at a time, a person could hop into a carpool service car and ride with two to four other people at once. This would reduce the amount of trips taken by cars, whilst costing the rider the same amount of money. MIT goes onto to mention how “A System like this could allow drivers to work shorter shifts while also creating less traffic, cleaner air, and shorter, less stressful commutes”[3], which encompasses some of the main benefits of creating carpool applications and each of which will be discussed in more detail.

There are some startling figures linked to the use of Single Occupancy Vehicles (SOVs), such as an increased in Metropolitan traffic within the US by 30% [4]. This increases causes traffic congestion, environmental degradation as well as mobility problems, with around 2 billion hours in traffic per year at a cost of $48 billion lost due to productivity in America. Traffic delays could reduce the average commuter anywhere from 5 minutes on a good day, up to perhaps 2 hours on a bad day in a highly congested metropolitan area.

## Traditional Vs Dynamic Ride Sharing

Traditional carpooling/ride-matching applications would match drivers who are travelling between the same places at the same time, and in 1991 a study by Washington DC: Transportation research [5] concluded that a successful system had the following five components:

1. A database that could store commuter journey information
2. A system that would link drivers and passengers
3. A method to deliver matched users
4. A validation system that deletes old data
5. An evaluation system

The study suggested that a fully automated system with mail-based contact (only mail was available in 1991) would influence match levels. These 5 system components are now more a lot more viable in 2018, with a plethora of options available for storage of journey and user information, as well as being able to match drivers and passengers based on journey, times and other additional preferences. Most of these components have been included within the system proposed, making sure to safely store data and match riders based on journey routes and departure times.

Dynamic ridesharing (also known as real-time-ridesharing) differs from traditional ridesharing in that it accommodates single, one way trips rather than trips scheduled on a regular basis. An example of dynamic ridesharing would be Uber Pool, which allows the user to book a single, one way trip to their destination, matching them with any available passengers who happen to be taking a similar journey. The study mentioned above was completed in 2001 and mentions how dynamic ridesharing would need to have “match information close to the time when users need to travel” [5], however for many years now we have had real-time data that can be pushed to a user’s device within seconds or even milliseconds. Real-time data allows dynamic ridesharing to flourish and has become a very acceptable way of carpooling.

Organised Dynamic Ridesharing [6] is what I would consider the proposed carpool application to be under category-wise. Organised dynamic ridesharing allows people to organise and request rides from a central database. Once a request is made, the database would look through a list of potential drivers and search for matches corresponding to the given request (e.g. journey, time of journey & optional preferences). This system requires no intervention from any agencies or actors on behalf of the application, yet allows ridesharing to take place when a match occurs organically through the system itself.

## Cost

There are many costs associated with single occupancy vehicles, such as the cost of fuel, repairs and maintenance of vehicles and insurance/MOT costs. In highly populated areas there are even congestion charges. Congestion charges exist in cities like London, which is a daily charge of around £11.50 [7] for driving within a “charging zone” (between certain times). These charges exist because of the high number of cars congesting roads, which causes delays for commuters via car and buses.

It isn’t hard to realise that given 100 SOVs in a stretch of road would cause congestion, but fit 4 people in each car and you now have only 25 cars each carrying 4 passengers. That’s a reduction in cars on this hypothetical stretch of road by 75%. Congestion on roads is also a leading factor in fuel consumption. According to a case study in Tehran, Approximately 40% of fuel consumption in large cities can be related to transportation, with a noticeable amount wasted during traffic in peak hours [8]. With high amounts of fuel being consumed idling in traffic, this would cause significant impact on the cost of running a SOV, spending extra on fuel each week just to witness it wasting away is surely an incentive for carpooling. Fuel isn’t the only cost factor associated with congestion and increased vehicles on the road. Vehicle maintenance per year can cost on average up to £621 (the average global spend on cars per year) [9]. Carpooling would allow a number of people running their own cars to save this amount per year by taking part in a carpooling service, be it paid or not. Fuel & maintenance can mount up quickly, increasing total costs to operate SOVs immensely.

However within the study of Tehran it showed a high percentage of respondents not knowing who to rideshare with or how to set-up their own ridesharing [8]. This leads to questions of whether carpooling applications in countries such as Tehran or even the UK are being marketed enough or perhaps that they should be incentivised more by companies & governments. A lack of awareness could be a huge factor in whether or not people join carpooling services. It’s been shown that companies who incentivise carpooling schemes internally do see higher number of participants, providing services such as discounted parking and flexible working hours can increase participation [10]. Given the above reasons, it stands that congestion, fuel cost and maintenance for SOVs can all be reduced by willing participants taking part in a carpool system either company promoted or an application such as GreenCar@UoL, which could be optimised for specific companies as a paid service hosted by GreenCar or as a standalone application free of charge for use by anybody.

## Health

Some of the great benefits of carpooling are actually health related, such as having a more relaxing commute in the morning in a less stressful environment. Having the option to commute or take journeys with people are friends or colleagues could reduce stress and increase productivity on arrival to work or wherever your destination might be.

A study in 2008 has shown surprising results when looking into the effects of carpooling to reduce stress during commuting journeys [11]. Results concluded that 78 respondents out of 212 responded “yes” to a question asking if they would consider carpooling to/from work knowing that research suggests it would save money, improve the environment and reduce stress. Other benefits could include having time during the morning to eat breakfast while carpooling/vanpooling, having a short nap on the way to work and feeling more refreshed for the daily tasks ahead or even just having a more peaceful commute without having to focus so much on the road for up to 60+ minutes each way.

* shorter, less stressful journeys (sleeping, resting)
* shorter shifts for drivers
* pollutants

## Social

* social interaction
* productivity
* Endorphins before work? (research)

# **Requirements**

(1500 words)

# **Design & Algorithms**

(1500 words)

# **Implementation & Testing**

(2000 words)

# **Results & Discussion**

(1500 words)

# **Conclusion**

(1500 words)

# **Bibliography**

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