Manchester School of Architecture

Manchester Metropolitan University

Research and Design:
Innovative Digital Tools to Enable Greener Travel

Final App Development

12.6.7 Report (revA)

January 2018

cityverve

Contents

January 2018
Revisions: February 2018 (revA)

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Executive Summary

Use of ICT in journey chocies can allow greener travel.
The understanding of multiple travel options including more environmentally sustainable options between specific locations enables us to make a more conscious choice in the way we travel for a particular journey. The use of ICT provides information of available options for possible journey between two locations at a specific date and time.

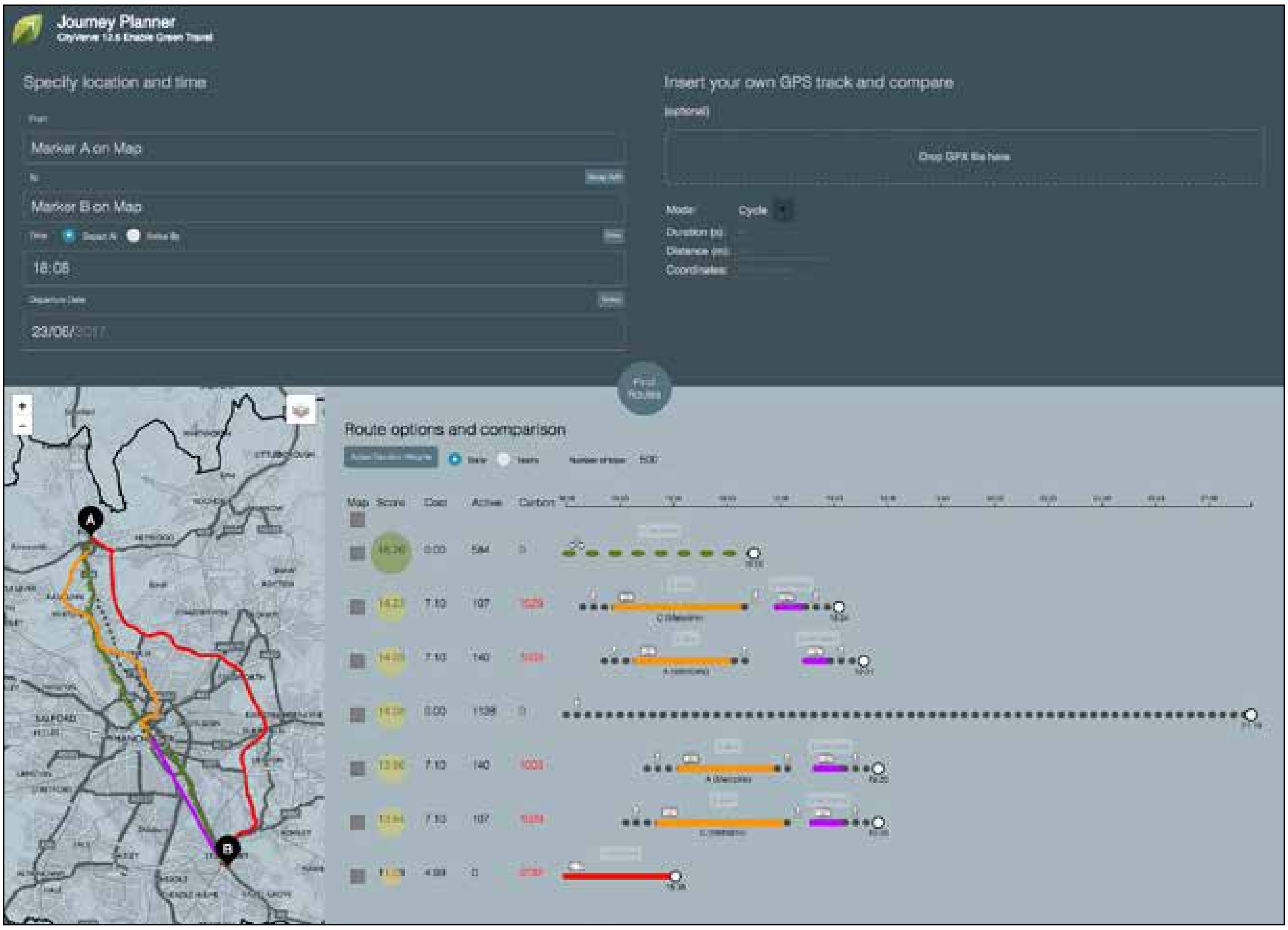
The final app development includes multi-modal journeys across Greater Manchester.
The journey route options are computed through a combination of spatial data and time schedule data for public transport. The data sets include specific data required for three types of routes calculation – private transport, public transport, bicycle and walk. The extent of the journey planner includes all of Greater Manchester. For public transport, bus and tram within Greater Manchester and UK national rail time schedules are included.

The final app development facilitates evaluation of carbon emissions and other factors.
A new tool was developed as part of the final app development to facilitate the evaluation of multiple travel options with multiple modes of transport using multiple factors including carbon emissions, time, cost, physical activity and number of transfers.

A new development area enables calculation of carbon emissions and other factors of GPS tracked journeys.
The tool enables the comparison of real travelled routes from recorded GPS data against the estimated routes as well as other alternative options.

Organisational travel plans can be informed by this tool.
A representation of carbon emissions in the context of commute to MMU has been developed. This is a projection for carbon emission values for each option comparing the projected emissions if all students travel in the same way (using the published figures for student travel commuting emissions).

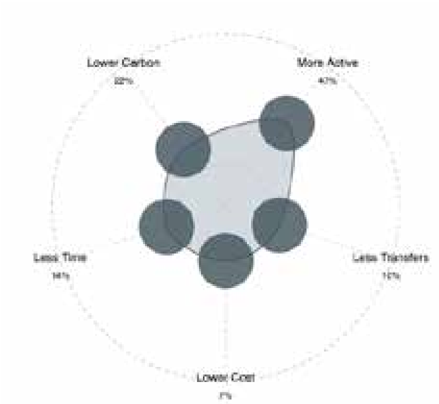
Personal journey choices enable sustainable mobility.
The tool facilitates the planning of journeys that can help to reduce personal travel carbon emissions. For example, a journey that can be taken in part by bicycle and the ability to adjust the number of passengers to estimate the carbon emissions per person in a car share.



Journey Planner

City Verve 12.6 Enable Green Travel

Journey Planner: City Verve 12.6 Enable Green Travel is an application to **search**, **compare** and **evaluate** multi-modal route options for journeys from A to B within Greater Manchester using private and public transport.



The **evaluation** of the alternatives, including **more environmentally sustainable** options, enables us to make a **more conscious choice** in the way we travel.

Aims and Objectives

The aim of this report for final app development is to describe the research and development of the application to enable greener travel. The aim of the development is to address key questions raised through the user feedback on the prototype application.

The prototype application (12.6.5 Prototype Journey Planner) was developed in order to gather user feedback. User feedback was gathered from user testing (12.6.6 End User Feedback Assessment) and meetings with TfGM.

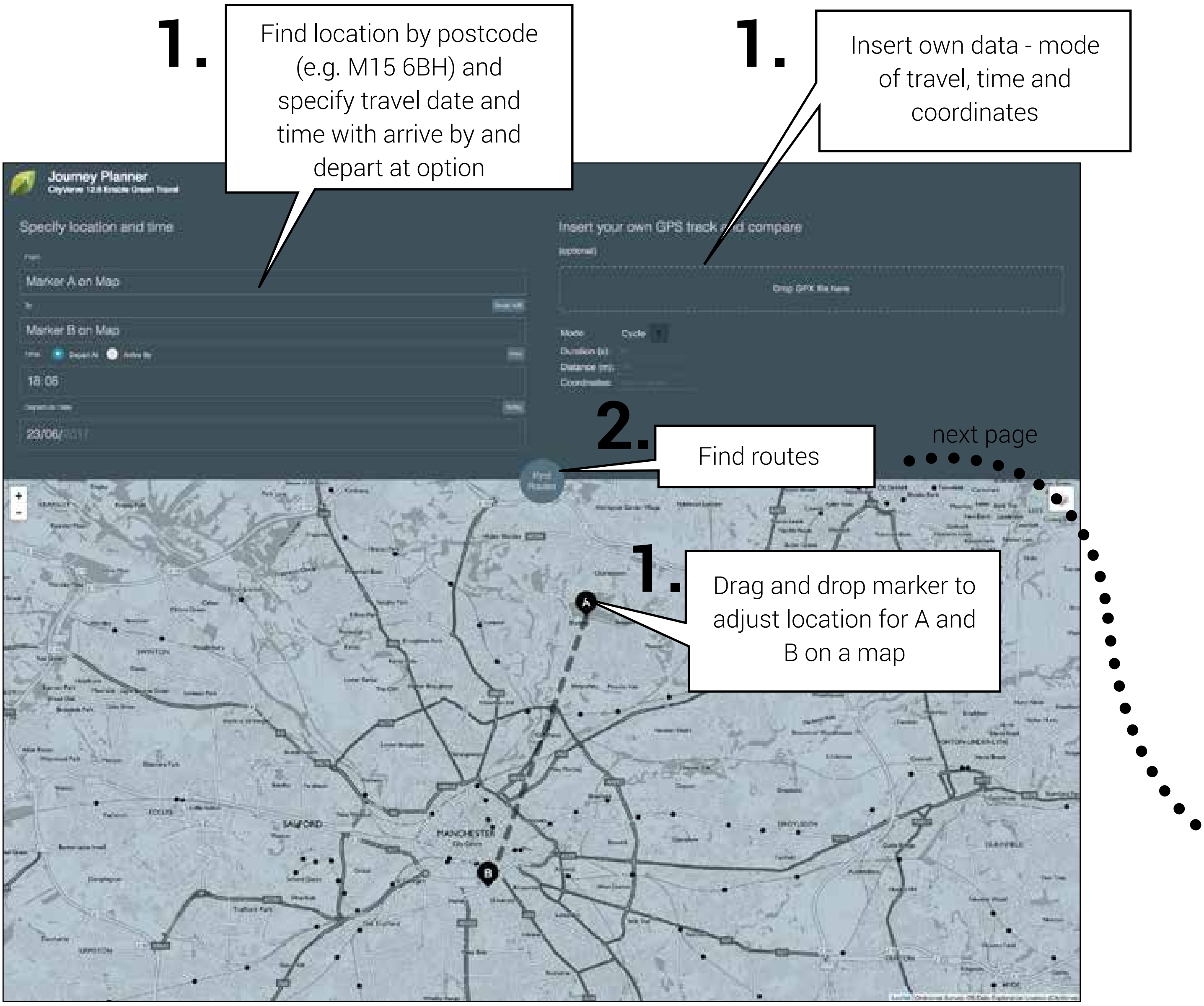
The key questions raised in the user feedback are as follows:
- Are the lowest carbon emissions route options realistic and what are the benefits to the individual?
- How do the computed journeys compare to real journeys? (Considering travel time due to traffic, parking and other conditions)
- What do the carbon emission values mean in context?

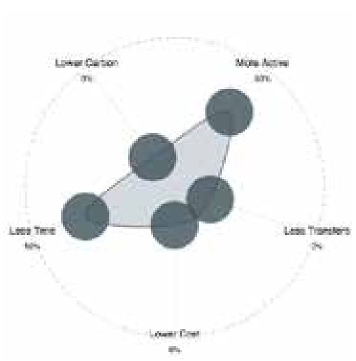
The final app development aims to address the three questions through:
- **A tool to evaluate options** - An integrated tool to evaluate travel options systematically considering carbon emissions, time, cost, physical activity and number of transfers.
- **Compare personal tracked routes** - Ability to use users' own GPS data in the evaluation.
- **Project and compare** - A representation of carbon emissions in the context of commute to MMU as an example case.

Abbreviations

app	Application
GHG	Greenhouse gas
CO2	Carbon Dioxide
CO2e	Carbon Dioxide equivalent
ICT	Information, Communication & Technology
GIS	Geographic Information System
BMR	Basal Metabolic Rate
MET	Metabolic Equivalent of Task
MMU	Manchester Metropolitan University
TfGM	Transport for Greater Manchester
GPS	Global Positioning System

Walkthrough



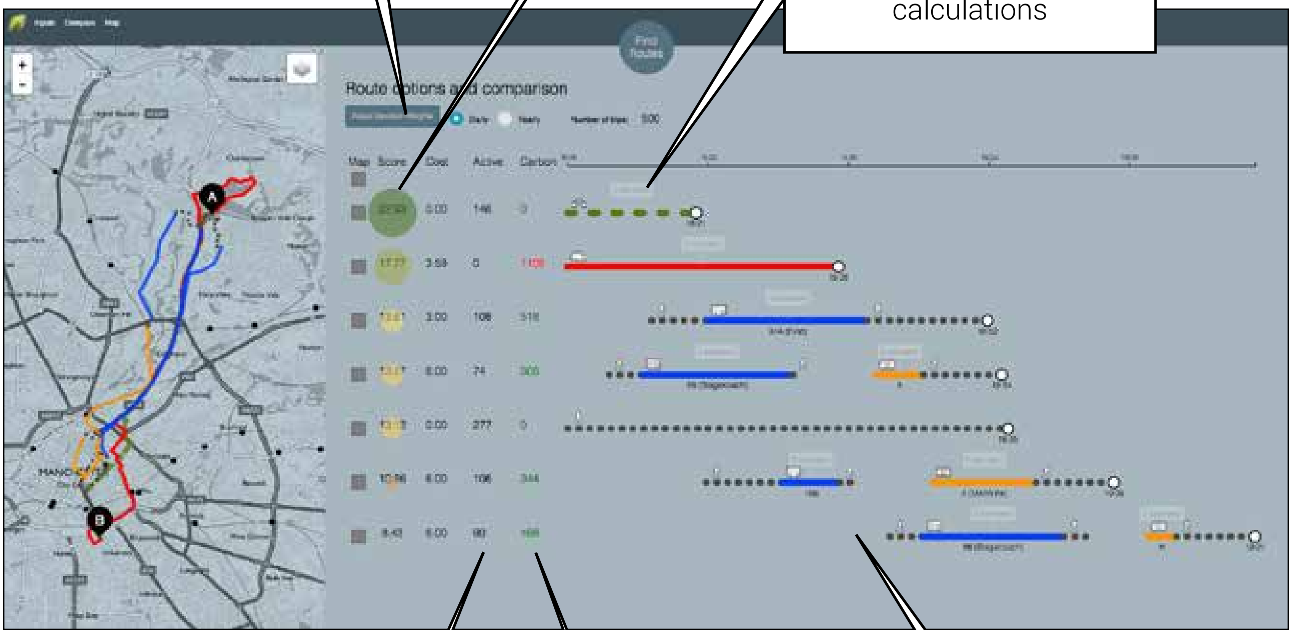


Click to adjust decision weighting on a UI widget

A score for each route is calculated based on the journey characteristics and the decision weighting. The list of options are ranked and ordered from top to bottom.

Hint for cost data or estimates, click to adjust calculations

3.

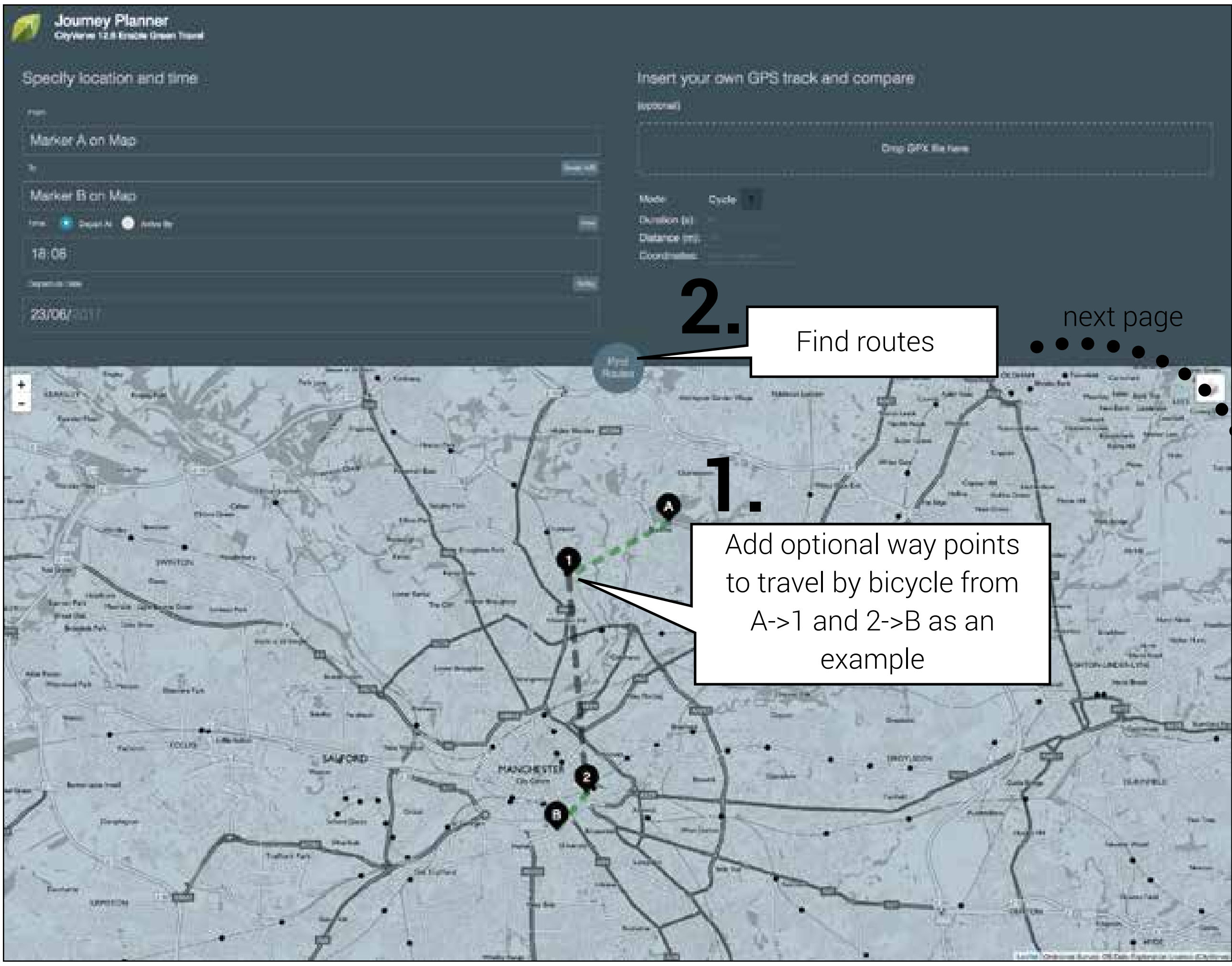


Physical activity in estimated Calories for walking and cycling in each option

Carbon emissions click to view more information and adjust parameters

Time line for each journey option

Walkthrough: with custom journey segments



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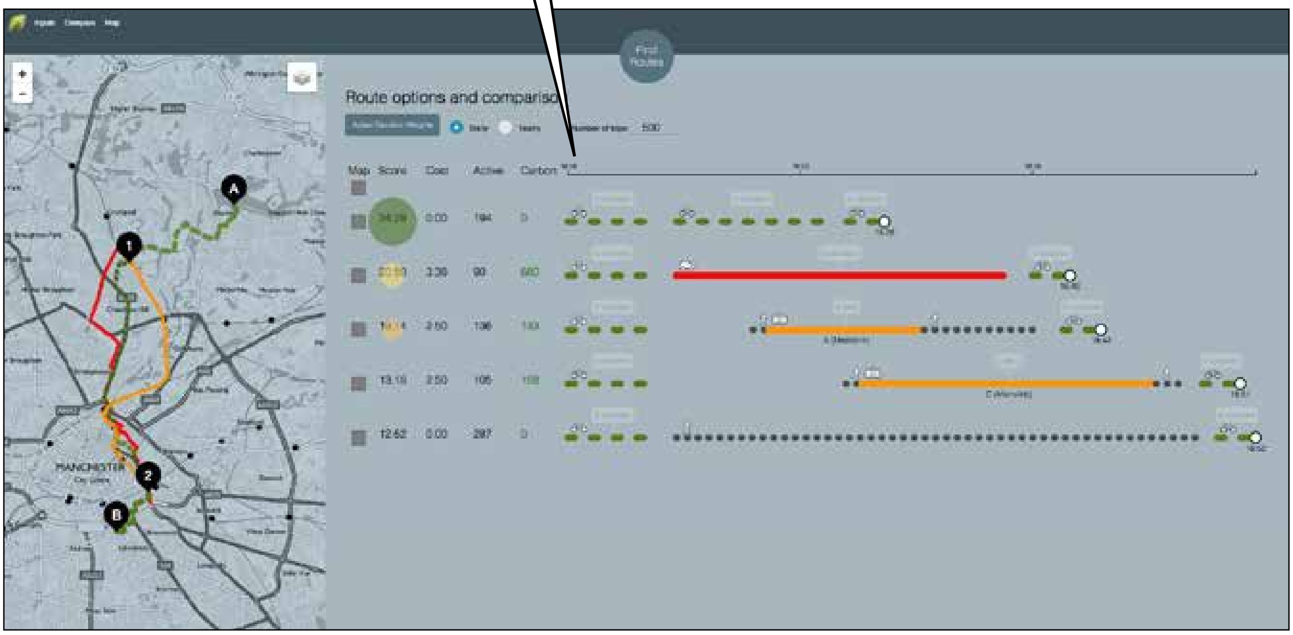
The route options and comparison has the same function as previously shown with the weighting factors. The time line includes the estimated time for cycle segments from A->1 and 2->B (in this example)

3.



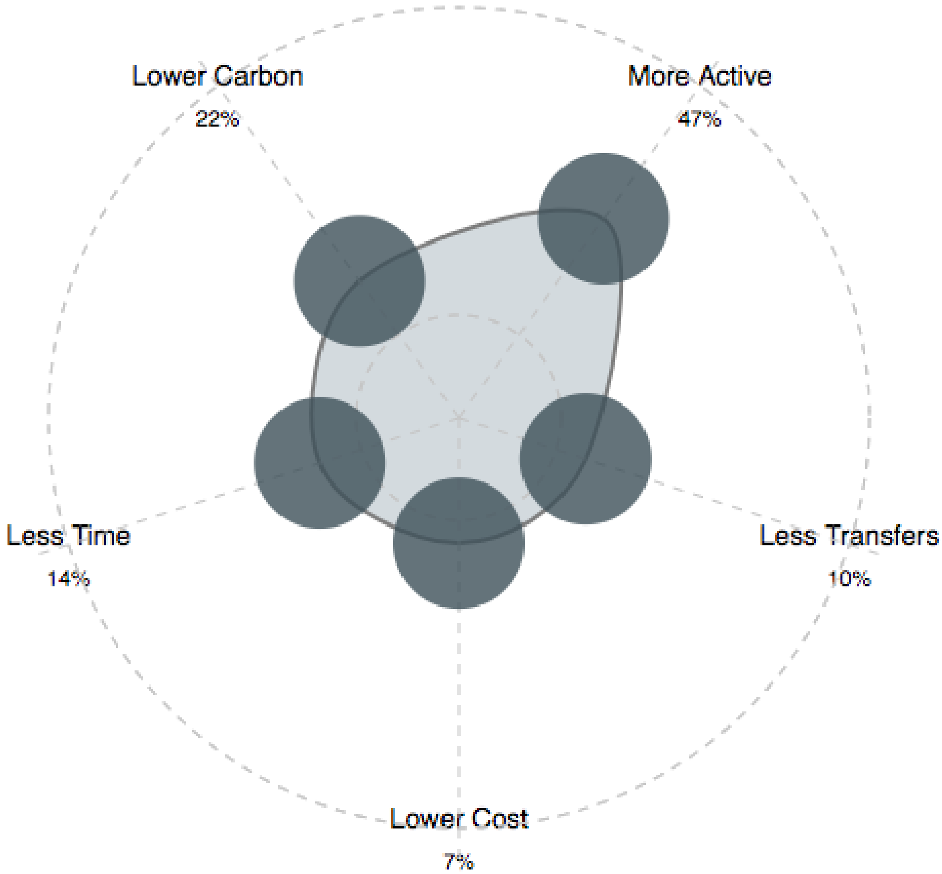
A tool to evaluate options

Are the lowest carbon emission route options realistic and what are the benefits to the individual? The tool evaluates travel options considering carbon emissions, time, cost, physical activity and number of transfers.

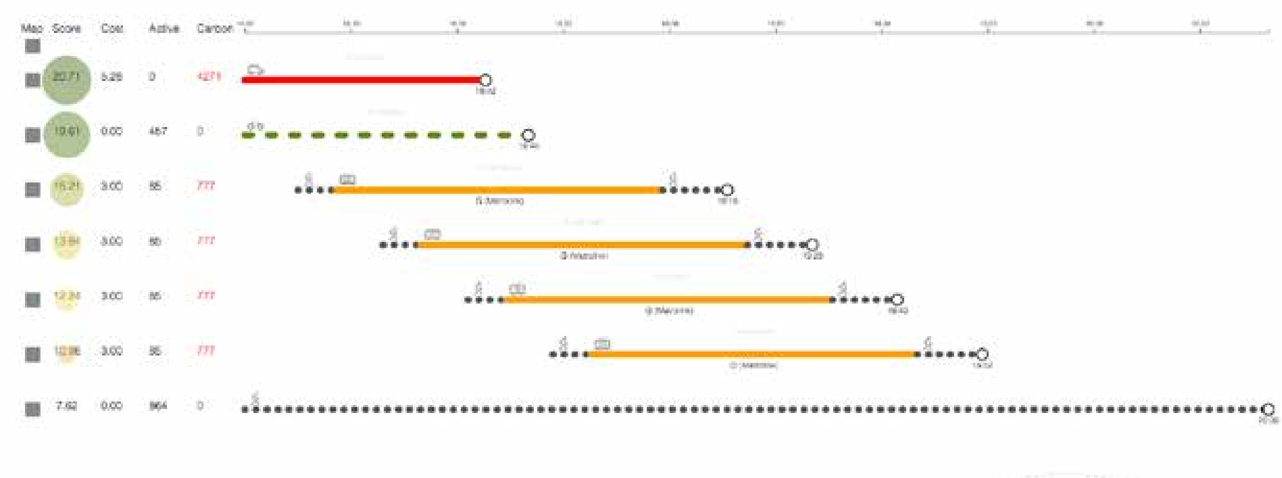
The choice set with multiple factors in combination is evaluated because it is possible to propose a route with the lowest carbon emissions that is not a reasonable option for individuals. For instance, a route that takes three hours to walk compared to a route by tram which takes twenty minutes including waiting time. It can be unreasonable for many reasons due to individual circumstances; the application seeks to provide information to facilitate a more informed decision.

Once the choice set is found between locations, the options can be systematically evaluated. Each option is evaluated by the combined effect of its journey characteristics and individuals' preferences. The journey characteristics include travel time, cost, physical activity, number of transfers and carbon emissions.

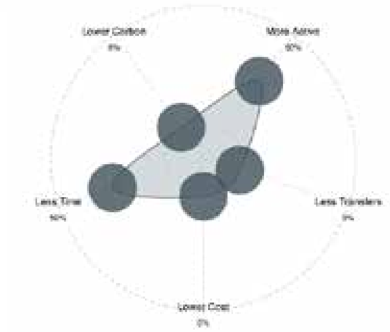
The tool allows users to set their own weighting for each factor. The overall weights add up to 100%, the percentage value is distributed to other factors when one slider is changed.

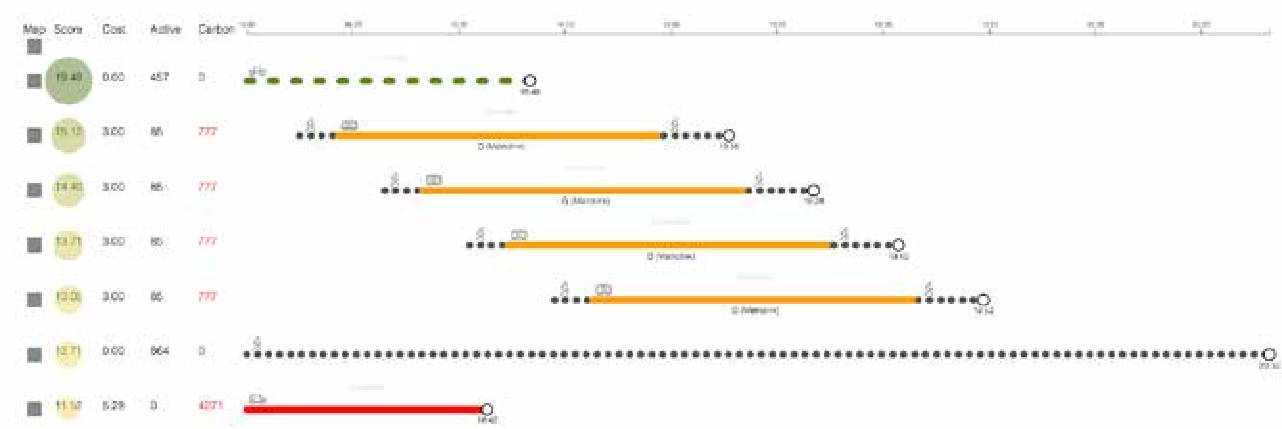


The route options are ranked according to the individuals' weighting for each of the five factors and the journey characteristics of each option. **The ranking of the journey options is not only one single factor such as travel time or carbon emissions as commonly explored in current journey planners but a mixture of five factors weighted by individuals' preferences.**

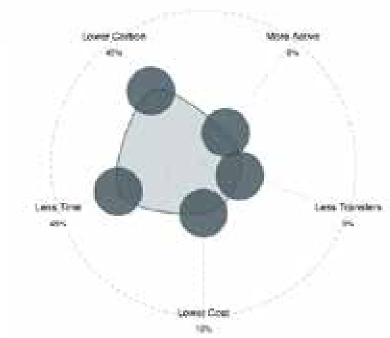


Example 1:
Route options ranked by 50% Less time 50% More active





Example 2:
Route options ranked by 45% Less time, 45% Lower carbon



The five factors are identified through feedback from user in The five factors include time, cost, physical activity, number of transfers and carbon emissions.

Time

The time factor depends on the user input option for a route to arrive by or depart at a specific time. If the “arrive by” time option is chosen, the time is taken as the estimated start time of the journey. If the “depart at” time option is chosen, the time is taken as the estimated arrival time.

The time element in the evaluation factor does not incorporate real-time data. A mechanism to collect and aggregate and resolve real-time data over time is required to make use of the data for long-term journey planning. For example, one where repeated journeys will be made frequently. The time reliability can be an additional factor to consider. However, there is no comprehensive dataset available.

Cost

The cost factor comprises of actual data and calculated estimations which varies for each mode of transport. For the car mode, an estimated cost is calculated by the average miles per gallon (mpg), the price of fuel per litre and the distance from the calculated trip distance. The miles per gallon and price of fuel varies by vehicle and by location and these are made as user inputs. For public transport, a rough estimated cost is provided where data is not available. Currently, the single fare for Metrolink is embedded in the system. The cost of cycling can be adjusted to match with the current price of a shared bike scheme. For example, £0.50 for 30 minutes.

An additional set of user inputs is included to calculate the overall cost for the same journey multiple times in a year. For a car, this additional cost includes car tax, MOT, services, insurance and also an approximate car cost per year. For a bicycle, an additional input is included to allow inclusion of cost associated with owning a bicycle and accessories.

There are current challenges in cost data available where there is no comprehensive dataset for bus prices within Greater Manchester. While some data is available for tram prices, it is useful to incorporate discount fares such as return, weekly and seasonal tickets for planning multiple trips. In addition, group travel discount can be used to better evaluate the cost to travel on public transport versus group travel in a car. It is known that train fare data is available through ATOC, this would require some conversion to work with the cost estimates.

Physical activity
The physical activity factor is an estimated energy in calories for walking and cycling over the estimated distance from the journey plan. It is known that the estimate is not precise as it varies for each individual. However, the relative energy required for walking and cycling can provide an understanding of the relative manual energy required for each journey. In addition, it is possible to differentiate multi-modal journeys which can consist of a combination of walking, cycling and motorised transport modes.

A common form of calories calculator based on physical activity uses the equation Calories (kilocalories) = BMR x METs / 24 x (hours of activity). The BMR is assumed as 1350, the METs for cycling as 6.8 at a speed of 11mph and the METs for walking as 3 at a speed of 2.5mph. The energy conversion factor kilocalories per kilometre is taken as 21.7 kcal/km for cycling and 42.2 kcal/km for walking. For future work, a better estimate of BMR can be found using additional information such as age, weight, height and gender per user. It can potentially be linked to the personalized tracker in association with other health-oriented devices.

Number of transfers
The number of transfers is the total number of transfers in a multi-modal public transport journey. This excludes the interchange between user-specified journey legs through user-defined waypoints.

Carbon emissions
The carbon emissions are calculated using the corresponding DEFRA emissions conversion factor for each of the transport modes. A value is provided for each corresponding modes of transport using the current published values. The conversion factor and the occupancy are adjustable through the user interface where an alternative or a more up to date conversion factor is known to the user. For example, a specific value can be used if a specific car carbon emission data is known. The emission conversion factor for CO2 equivalent is used.

Estimation in distance for public transport is calculated based on the route geometry for each service. The tram routes are built into the application. The fall-back option is used where data is not available. In the fall-back option, the distance is estimated using the straight-line distance between stops. This meant that the carbon emissions are underestimated in bus and train routes. However, the underlying system is capable of determining the distance if a corresponding spatial route data for each service is supplied as demonstrated by the tram routes incorporated in the journey planner. It is also known that the data source for public transport updates frequently – in the case of Manchester, the bus and tram data is updated weekly. When the data changes the underlying data model for the router has to be rebuilt and the route geometry data has to be re-associated as this is not part of the dataset available. For suggested further work, the estimation can be improved by incorporating the geometry data at the data provider level or as an additional automated step to associate geometry data to the data provided by TfGM (bus and tram) and ATOC (train).

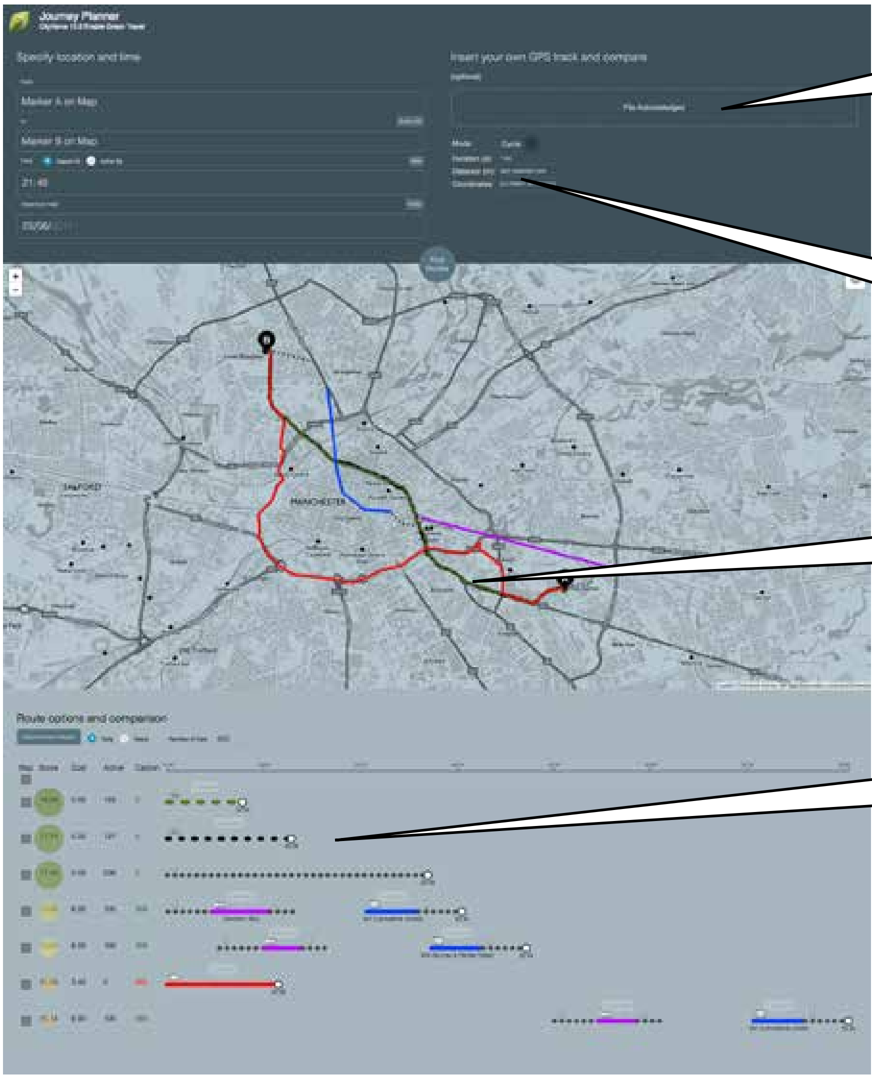
Compare personal tracked routes

How does the computed journeys compare to reality?
Ability to use users' GPS data in evaluation

We demonstrate the ability to insert users' GPS data and compare it against the estimated routes for multiple modes of transport. The minimum data requirement is defined as the mode of transport, a set of location coordinates in sequence and the overall travel time. The modes of transport covered are bicycle, walk and car each with their corresponding calculations affecting the factors as part of the evaluation in the comparison. For example, an actual car journey subject to traffic conditions at a specific time can be recorded and compare other alternative options.

It is possible to insert data from see-sense data through the BT transport data hub. In addition, a utility is provided to insert a GPX file (GPS eXchange Format), it is a common format to record GPS positions for routes and tracks.

The information with the comparison can help us answer the question: **If we were to make the same journey again, are there better options considering travel time, cost, number of transfers, effort and carbon emissions?**



Insert own data - drag and drop or select local GPX file

Insert own data - mode of travel, time and coordinates

Own data and routes from planner visualised on map

Own data in comparison with alternative estimated routes search using start time from GPS data

Project and compare

What does the carbon emissions value mean in context?
This example presents carbon emissions in the context of commuting as a student to MMU.

Is it environmentally better to travel on each route option on a regular basis compared to the commuting emissions in Manchester Metropolitan University?

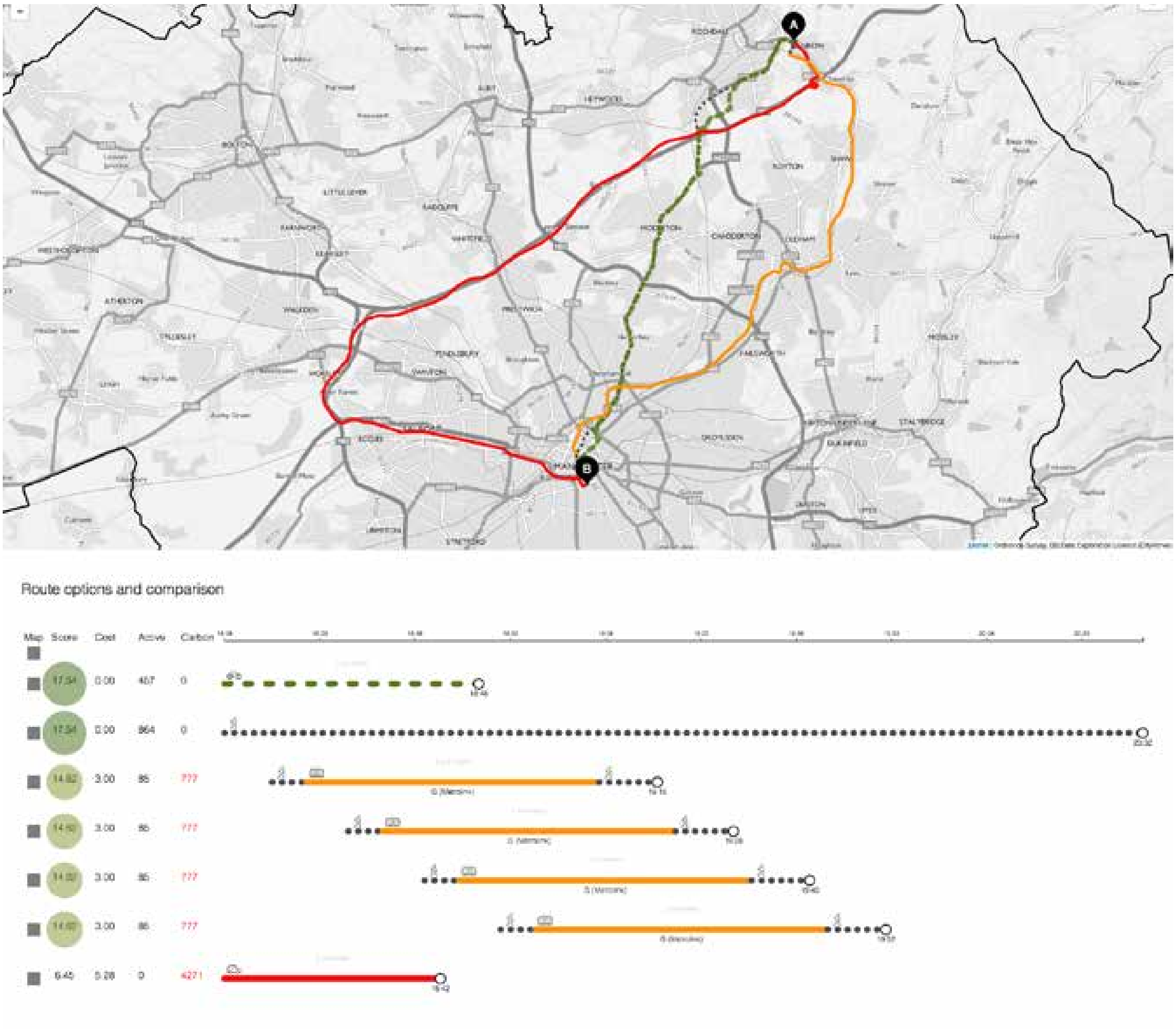
The total estimated carbon emissions are calculated per journey option over an assumed 500 trips per year. If all MMU students travel in the same way using each route option, the total projected CO2e is calculated and compared to the 2014-2015 value of 11168 tonne CO2e.

The total student travel commuting emissions of MMU in 2014-2015 is 11168 tonne CO2e (MMU Scope 3 carbon report). The total number of students in MMU in 2014-2015 is 31355 (HESA).

Each value in the column for carbon emissions is coloured in green if the projected emissions are lower, and coloured in red if the projected emissions are higher.

Example of projected emissions for a journey option

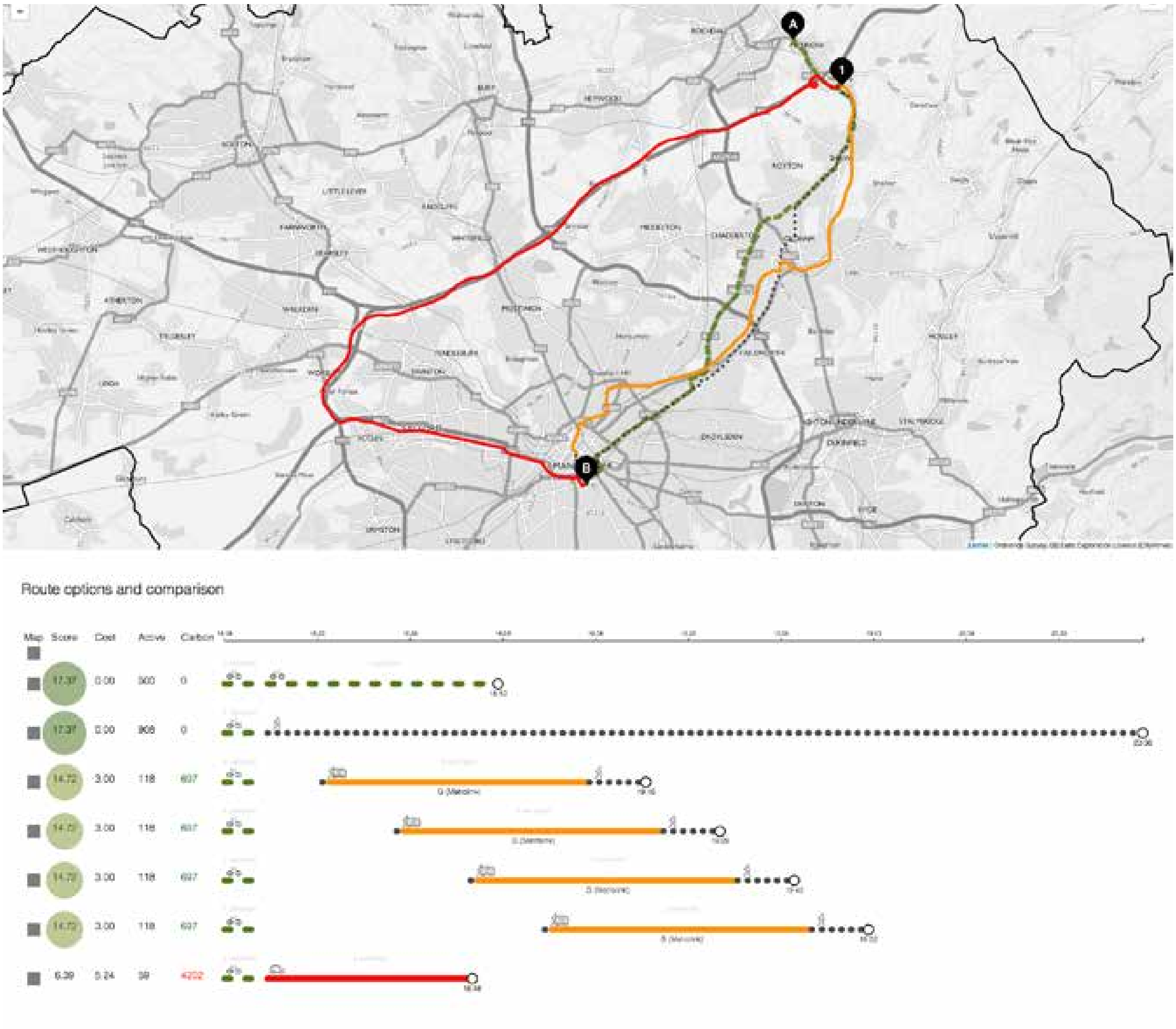
Custom journey segments



The tool developed includes the ability to add user-defined waypoints and specific mode of transport for a journey segment. The journey is computed based on the estimated time of arrival at each waypoint for each option. This is particularly relevant when there is a bicycle segment after a multi-modal segment as we have varied estimated start time for the bicycle segment for each option.

Given the representation of carbon emissions in context, it is possible to add a non-motorised journey segment to the planner to help reducing personal carbon emissions on a repeated journey. The following examples demonstrate the difference for a journey from Milnrow to MMU with and without a bicycle journey segment.

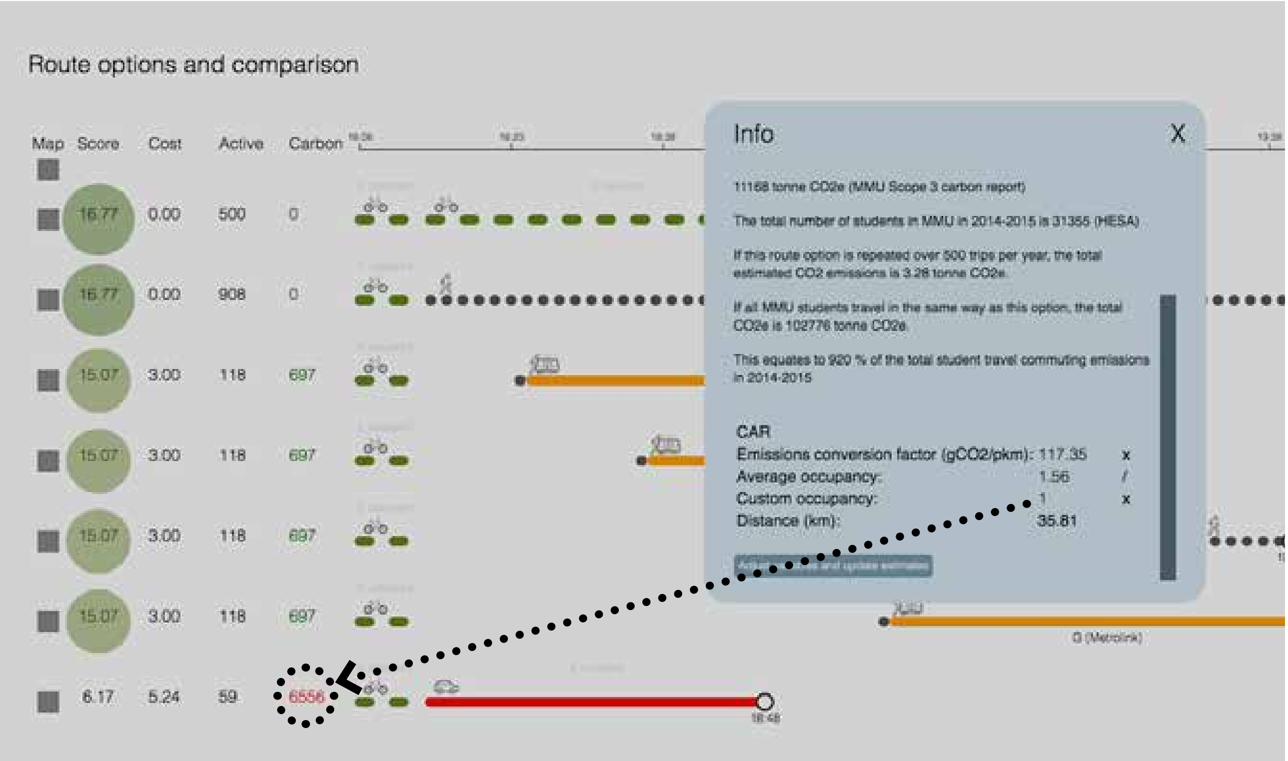
In the first example without a custom bicycle journey segment, all routes by tram have a +9% in carbon emissions projected against the MMU commuting emissions. (illustrated in the image above)



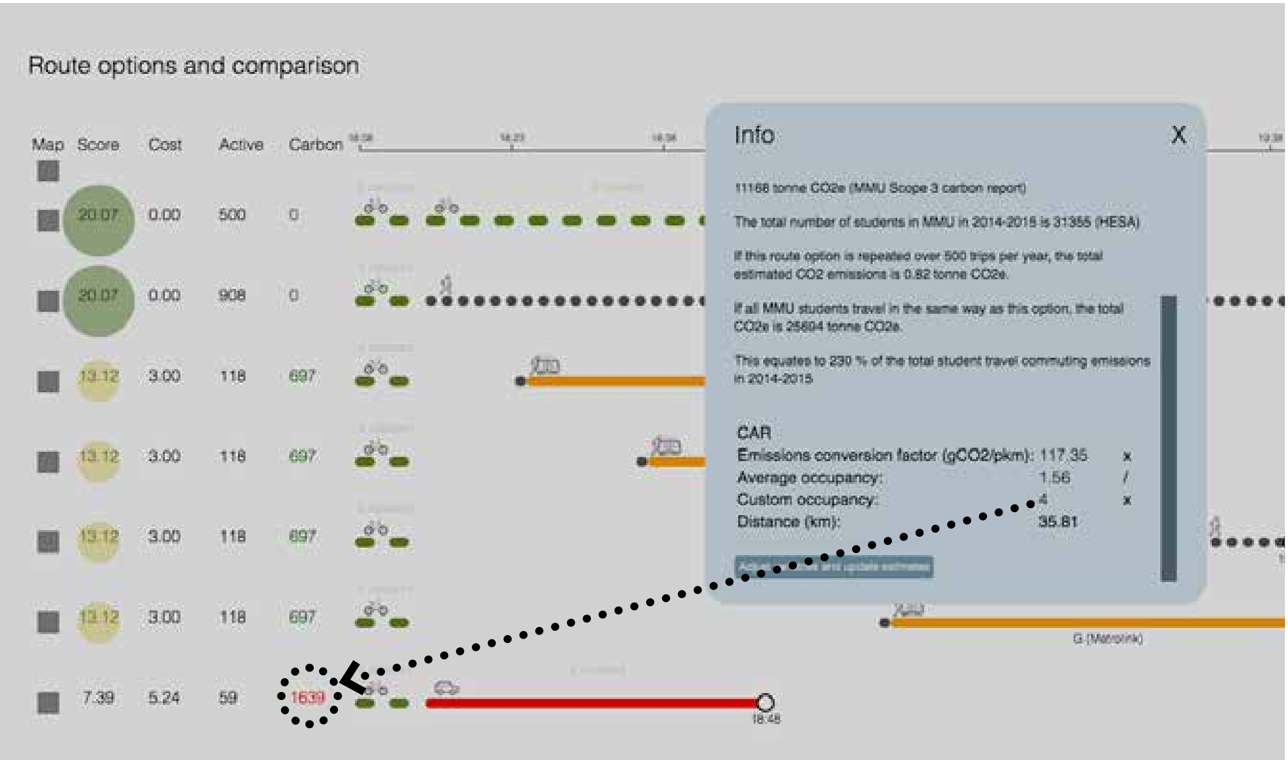
In the second example of a custom bicycle journey segment from Milnrow to Newhey, a -2% is projected against the MMU commuting emissions. (illustrated in the image above)

Number of car passengers

The number of passengers for car transport can be adjusted through the user interface. The value will influence the carbon emissions per person as the estimated carbon emission is shared amongst occupants.



Example: One person travelling in a car



Example: Four people travelling in a car

Conclusion

Passenger (land) transport contributes to 19% of the overall GHG emissions in the UK.

The green journey planner provides multiple travel options including more environmentally sustainable options between specific locations. This enables us to make a more conscious choices towards more sustainable journeys.

An integrated tool to evaluate travel options systematically considering carbon emissions, time, cost, physical activity and the number of transfers provides a way to understand route options with users' own preferences and perceived benefits in multiple dimensions. For example, a route with a lower cost and lower carbon emissions but also taking a reasonable length of time.

The ability to use users' GPS data for evaluation facilitates comparison of computed routes and real journeys travelled by users. This accounts for variations in travel speed under users' circumstances and external factors such as traffic and time to cross a road.

The method developed for a representation of carbon emissions in the context of the commute to MMU (as an example) helps us to understand and project whether or not a route option contributes to the reduction of travel carbon emission for an institution.

Features that help users to reduce personal travel carbon emissions are demonstrated such as custom cycle journey segments and the ability to adjust the number of car passengers as part of the carbon emissions calculation.

It is important to note that while there are methods to reduce the personal and institutional travel carbon emissions for a particular journey, the overall reduction of carbon emissions at a city scale needs to be through the reduction of private motorised vehicles. The journey planner enables comparison of car-based carbon emissions and other modes of transport on specific journeys.