

Transport Technology Research Innovation Grant (T-TRIG)

December 2016

**Grant Application Form**

# Project Title

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| Using Machine Learning and Big Data to Model Car Dependency: an Exploration Using Origin-Destination Data |

**Company/Organisation name**

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| University of Leeds |

**Competition applying for**

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| **Big data Targeted call** |

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| Application code | BD018 |

**Notes**

Please read the *T-TRIG Guidance* and the *T-TRIG Grant Specifications* documents before completing this form, they will provide valuable information. Requirements change between competitions, so please review this document even if you have entered previous T-TRIG competitions.

All information should be included in this application form. Only information included in this form will be assessed. No additional documentation should be submitted as part of your application.

All graphs, charts, diagrams and figures must be contained within the text box areas on this form.

The deadline for applications is **23:59 on 9th January 2017**. Your completed application form should be emailed to [T-TRIG@dft.gsi.gov.uk](mailto:T-TRIG@dft.gsi.gov.uk)

For further assistance, please also direct your query to the email address above.

The Department for Transport has actively considered the needs of blind and partially sighted people in accessing this document. The text will be made available in full on the Department’s website. The text may be freely downloaded and translated by individuals or organisations for conversion into other accessible formats. If you have other needs in this regard please contact the Department.

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| **A. AWARENESS OF T-TRIG COMPETITION** | | | |
| How did you learn about this T-TRIG competition? (Tick all that apply) | | |
| A.1 | Previous experience of applying for T-TRIG |  |
| DfT website |  |
| Twitter |  |
| LinkedIn |  |
| Informed by KTN (Knowledge Transfer Network) |  |
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| Media (i.e. online news, newspapers) |  |
| (please specify) Click here to enter text. |  |
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| Other social media channels |  |
| (please specify) Click here to enter text. |  |
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| Other |  |
| (please specify) Emails from colleagues encouraging me to apply |  |

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| **B. COMPANY/ORGANISATION INFORMATION** | | |
| B.1 | Full company/organisation name. *(If this application is successful, this is the name that will be used in publicity, unless an alternative name is clearly specified here)* | University of Leeds |
| B.2 | Registered office address | Leeds Institute for Transport Studies (ITS)  34 - 40, University Road, University of Leeds  Leeds, LS2 9JT |
| B.3 | Company/organisation or charity registration number | GB613451470 |
| B.4 | Is your company/organisation start-up, micro, SME, large, academia?  (Select from list) | academia |
| *Other (please specify)* | Click here to enter text. |
| B.5 | Is your company/organisation a voluntary, community or social enterprise organisation? | other |
| *Other (please specify)* | Educational |
| B.6 | Name of your immediate parent company (if applicable) | Click here to enter text. |
| B.7 | Details of other organisations (company name, contact person, address and their role in the project) that will help deliver the project | Click here to enter text. |
| B.8 | Details of authority involved (e.g. local authority, highways authority etc.), if applicable (authority name, contact person, address and their involvement in the project) | Click here to enter text. |

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| **C. COMPANY/ORGANISATION CONTACT** | | |
| C.1 | Name | Robin Lovelace |
| C.2 | Position | University Academic Fellow |
| C.3 | Address | Leeds Institute for Transport Studies (ITS)  34 - 40, University Road, University of Leeds  Leeds, LS2 9JT |
| C.4 | Telephone number | 01133430691 |
| C.5 | Mobile number | 07837788663 |
| C.6 | E-mail address | R.Lovelace@leeds.ac.uk |
| C.7 | Finance contact (for providing financial documents) | Denise Nicholas |
| C.8 | Finance contact’s Telephone and email address | D.Nicholas@leeds.ac.uk, 0113 343 3530 |

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| **D. CONFLICT OF INTEREST** | | |
| Question D.2 is a Pass/Fail question. If an applicant cannot or is unwilling to suitably demonstrate that they have suitable safeguards to mitigate any conflict of interest then their application will be deemed non-compliant and they will NOT be considered for this competition. | | |
| D.1 | Do you have any potential, actual or perceived conflicts of interest that may be relevant to this competition? | Yes  No |
| D.2 | If answered Yes in D.1, please provide details of any potential, actual or perceived conflicts of interest in respect of this project and outline what safeguards would be put in place to mitigate this risk arising during the project. | |
|  | Leeds Institute for Transport Studies (ITS)  34 - 40, University Road, University of Leeds  Leeds, LS2 9JT | |

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| **E. INNOVATIVE NATURE OF PROPOSAL** | |
| It is important that the project is novel or innovative. Has similar research been commissioned or carried out previously?  *If yes, please explain why your proposal is still a novel approach.* | Yes  No |
| This project will explore the potential for emerging methods in Big Data and Machine Learning to be applied to transport modelling, with a focus on mode choice, specifically car dependency. The work is novel in two ways: it uses new data sources and new methods to analyse and model the data.  The use of **Big Data** in transport is novel. New source of large datasets, commonly referred to under the umbrella term of Big Data (Lovelace et al. 2016) are increasingly available to transport researchers. Yet these datasets are rarely used. We will use the UK’s OpenStreetMap dataset to create variables at the origin-destination level on environmental conditions along the route. To the best of our knowledge this has never been done before.  Although frequently used in commercial data analytics and social media, **Machine Learning** has been slow to feed into the world transport research and practice. This is partly due to a ‘skills gap’ across many sectors that is particularly affecting public sector work. According to a 2016 report by the House of Commons Science and Technology Committee, these are reaching ‘crisis levels’ (STC, 2016). This skills gap is affecting the ability of UK-based organisations to innovate in the transport sector, according to research by the Transport Systems catapult (TSC 2016).  **References**  Lovelace, R., Birkin, M., Cross, P., Clarke, M., 2016. From Big Noise to Big Data: Toward the Verification of Large Data sets for Understanding Regional Retail Flows. Geogr Anal 48, 59–81. doi:10.1111/gean.12081  Transport Systems Catapult, 2016. UK must invest in skills for emerging transport technology [WWW Document]. Catapult. URL https://ts.catapult.org.uk/news-events-gallery/news/uk-must-invest-skills-emerging-transport-technology/ | |

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| **F. FUTURE OPPORTUNITIES** | |
| Can the DfT contact you about other innovation research competitions? | Yes  No |
| If your application is successful, the DfT would like to share your project details with partners who may be interested in working with you to progress the results of the project. Please tick if you are content for DfT to share your project details with others listed below.  **Note: Details will only be shared if you are successful and give permission by ticking the boxes below.**  Knowledge Transfer Network  Transport Systems Catapult  Other Government Departments  Other | |

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| **G. PREVIOUS APPLICATIONS** | |
| G.1. Have you previously applied to the T-TRIG scheme with this project? | Yes  No |
| If you answered yes to G1, please tell us which competition round(s) you applied to by ticking the relevant box(es) below.  December 2014  June 2015  October 2015  July 2016 | |
| G.2. Have you previously applied to the T-TRIG scheme with another project? | Yes  No |
| If you answered yes to G2, please tell us which competition round(s) you applied to by ticking the relevant box(es) below.  December 2014  June 2015  October 2015  July 2016 | |

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| **H. PROJECT PROPOSAL** |

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| **PROJECT TITLE** |
| Using Machine Learning and Big Data to Model Car Dependency: an Exploration Using Origin-Destination Data |

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| **PROJECT OUTLINE (one sentence max)** |
| This project will explore the potential for emerging methods in Big Data and Machine Learning to be applied to transport modelling, with a focus on car dependency at the origin-destination level. |

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| **PUBLIC PROJECT SUMMARY** |
| Please expand on your single sentence outline. This description will only be published if your project is funded. This text will not be assessed. Please ensure it is suitable for public disclosure*.*  **Maximum words: 250** |
| The project will develop and demonstrate innovative methods to access, process and model large datasets, and apply new machine learning techniques to extract value from them. The primary aim of this project is to showcase how these new methods can be used by practitioners to solve real-world problems. For this reason it will use publicly available data and reproducible methods (primarily implemented in the open source statistical programming language R) to demonstrate the approach. The question we will seek to answer during the course of the analysis is: how can newly quantified environmental factors explain mode choice? Why is it that in some areas people tend to use the car for trips but in others public and active travel modes are more important? These environmental variables will include: speed limits along road sections; the presence/absence of cycle paths; the provision of green space; and proximity to major roads. The results will help feed-into the decision making process by enabling Local Authorities, consultancies and other stakeholders to identify the main barriers to sustainable travel in different areas and act accordingly. The datasets generated will be made publicly available and the code underlying the analysis will be published in well-documented and tested software (in an R package), greatly reducing the barriers to accessing Big Data and using Machine Learning for all actors in the transport sector. |

The following five sections form the main body of the proposal and the assessment criteria relate to these. When answering these sections you may find it useful to refer to the DfT’s [Priorities.](https://www.gov.uk/government/publications/dft-single-departmental-plan-2015-to-2020/single-departmental-plan-2015-to-2020) For the assessment criteria and details of how applications will be assessed please see *T-TRIG Guidance*.

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| **Questions** | **Weighting factor** | **Maximum score** |
| 1. **The Challenge**   What is the challenge being addressed by the proposed project? | 1 | 10 |
| 1. **Innovation**   How is your proposal innovative? | 4 | 40 |
| 1. **Project Management**   What is your project plan to deliver the project? What are the relevant skills and expertise of the team? | 1 | 10 |
| 1. **Impact and Exploitation**   How will the outcome from this research have a beneficial impact on UK transport? | 3 | 30 |
| 1. **Project Finances**   How much will the project cost to deliver and how will this be spent to ensure value for money? | 1 | 10 |
| **TOTAL** | **10** | **100** |

# Over and above this criteria, applicants must demonstrate an ability to communicate their ideas effectively by writing clearly and succinctly throughout. An inability to do so will reduce the score you achieve for each section affected. Likewise, final payment of the grant is dependent on receipt of a good quality final report that clearly sets out the objectives of the project, how the grant was spent and what was achieved with it.

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| **Question 1: The Challenge** |
| What is the challenge being addressed by the proposed project?  Please specify:-   * the transport challenge being addressed; * why you consider this to be a challenge; * the wider economic, social, environmental or cultural benefits (expected/potential) of this project.   You may wish to look at the [single departmental plan](file:///C:\Users\nebeneze\AppData\Local\Microsoft\Windows\Temporary%20Internet%20Files\Content.Outlook\TIM5AO5U\SDP).  Do NOT describe your proposed solution at this stage. You may wish to discuss how your solution will assist in meeting the challenge.  **Maximum score available: 10**  **Maximum words: 500** |
| The challenge addressed by this project is threefold, relating to the data generated, the methods used and made available, and knowledge produced during the project:   1. In terms of data, the transport sector has been slow in the up-take of new, large and unconventional datasets that are being made available through a range of sources. The challenge is to generate workflows that can harness such Big Data that is currently being under-utilised, and lacking verification, to generate value and assist the decision-making process (Lovelace et al. 2016). 2. An array of methods within the emerging field of Machine Learning (e.g. random forest, regularized regression) is now available thanks to rapid advancements in software, much of it open source. However, the skills needed to apply these new methods to the transport sector are lacking in industry and the public sector, posing a major challenge to practitioners and decision makers alike (TSC 2016). 3. There is urgent need to identify the main barriers to sustainable transport, especially in the context of the need to address air pollution, public health and active travel targets. Yet national datasets on the relative importance of different barriers across the country have yet to be produced, posing a major challenge to transport researchers. 4. The potential for combining diverse datasets to add value to existing sources has not been realized. Origin-destination data, whether it’s from commercial or public sector sources, is a staple of the transport community, yet is used in limited ways compared with what is possible when they are combined with newly-available environmental data on the nature of the transport network and the surrounding environment between OD pairs, using datasets from OpenStreetMap and the Ordnance Survey. 5. The ‘cloud’ is not utilized to the full extent in transport research. By generating data from online APIs, providing access to many new routing algorithms, cloud computing has the potential to enhance the option space available to transport researchers. However, this is a major challenge given the ‘skills gap’ in the transport sector.   **References**  Lovelace, R., Birkin, M., Cross, P., Clarke, M., 2016. From Big Noise to Big Data: Toward the Verification of Large Data sets for Understanding Regional Retail Flows. Geogr Anal 48, 59–81. doi:10.1111/gean.12081  Transport Systems Catapult, 2016. UK must invest in skills for emerging transport technology [WWW Document]. Catapult. URL https://ts.catapult.org.uk/news-events-gallery/news/uk-must-invest-skills-emerging-transport-technology/ |

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| **Question 2: Innovation** |
| How is your proposal innovative?  Innovative proposals could include:-   * novel ideas, technology, processes, apps, devices, software; * ideas, concepts or solutions from other sectors that could be applied to transport.   Clearly describe the concept, technology or approach that you intend to use to meet the challenge described in question 1. Include relevant diagrams or figures. It would be helpful to demonstrate any evidence or previous work to support /validate your idea.  If applicable, describe what is currently considered state of the art and how your proposal differs.  **Maximum score available: 40**  **Maximum words: 1000 plus diagrams/figures. Maximum 3 sides of A4.** |
| This project will provide innovative new ideas, datasets, findings, methods and software to tackle challenges in transport decision making. By taking the case study of mode choice, and specifically car dependency, at the origin-destination level, across all of England, we will in the process generate policy-relevant findings and new datasets (that will be publicly available) that are in themselves innovative and valuable. However, the main innovation will be in the generation of new methods and software that will be documented, ensuring the impact of the project goes far beyond the confines of this funding bid.  **Conceptually**, the project will build on the finding that Big Data poses great potential benefits, and some risks, to the analysis of travel patterns. In a previous paper comparing Big Data (from mobile telephone providers, Twitter messages) with more conventional travel survey data, it was found that new datasets have great potential to augment existing datasets (Lovelace et al. 2016). However, it is important to separate the ‘signal’ from the ‘noise’ of large datasets and existing work (including the aforementioned paper) provides little in the way of reproducible methods for analyzing and modelling large datasets. Since then, software has moved quickly in the field of ‘data science’. The application of such methods to the transport sector at this critical time will be innovative in conceptual terms building on the concept of generating analyses with high ‘signal to noise’ ratios.  The **datasets** used in the project are not new but they have never been used together. Combining origin-destination (OD) data (which is a generic data form that can be produced from many sources) with geographical data is innovative and will greatly add value to existing OD datasets. Variables commonly associated with OD data currently include total number of trips (e.g. per day), mode of travel and, at times, breakdowns by time of day and trip purpose. However, researchers rarely have access to additional variables at the OD level which may be vital for designing transport interventions based on the best available evidence. The use of methods in Big Data will therefore be used to generate new datasets that will be useful in the real world, and these will be saved and made available to others. The provision of OD datasets with environmental variables, such as proximity to major roads, estimates of business and provision for walking and cycling, will be an innovation that has lasting value for transport researchers. Further, the processing of large OD datasets through new routing algorithms (e.g. as provided by the company TransportAPI) will showcase further innovation in how transport datasets can be used and supplemented by cloud computing. At a high level, an additional dataset-related innovation of the project will be to show how transport researchers can use the diversity of Big Data for robust analysis.  Although not the focus of this project, the **findings** generated are likely to be useful to transport practitioners in industry, the public sector and academia. We will use the data generated to explore the question why mode split for cars use by distance band (a good proxy for car dependency) is much higher in some areas than others. We will account, for the first time, for different trip-distant distributions in different areas, which can account for much of the variability in car dependency that has been found in previous studies. This will focus attention on variables over which planners have more control, such as local speed limits, the availability of bus and cycling routes, and car parking spaces in city centers.  The **methods** used to process and model the datasets will be highly innovative. OD data has been a staple for transport researchers for decades, but rarely are geographical methods used to add value to such datasets, e.g. via the analysis of the local environment between origin and destination. The project will explore innovative methods for generating OD level summary variables about the characteristics of desire lines connecting origins and destinations, such as:   * Summary statistics (maximum, minimum, standard deviation, average) of speed limits of roads intersecting the desire line between origin and destination. * Information about business and the provision of cycle paths, cycle parking and bus and train stations per OD pair, based on analysis of data provided by calls to web-based routing APIs and automated analysis of large geographical datasets.   Once the addition variable per OD pair have been generated, machine learning algorithms will be used to explore factors related to car dependency in each region of England. These methods, applied to the issue of car dependency for the first time, will include:   * Random forest, an iterative algorithm for discovering the most important explanatory variables affecting a dependent variable (percentage of trips made by car) and the functional form of models explaining variability, based on dozens of input variables. * Regularised logistic regression models will be trained to find out robust model parameters which will help generate new hypotheses about the applicability of the methods to new contexts, e.g. outside the UK.   Under either of these scenarios --or any other of the multitude of possible approaches and insights that could be generated depending on the available data—the possibilities for analyzing and using the data for beneficial purposes and in ways which may not have been foreseen are vast, and we are uniquely positioned to deliver them. To the best of our knowledge these methods have never before been applied to tackle the well-established problem of car dependency.  The project will be highly innovative in the sense that the methods outlined above will be made available to others via **open source software**. This is to allow others, in the public and private sector, to benefit from them with a minimum of effort. The work will build on the team’s publication of the **stplanr** R package, which is already being downloaded by more than 1000 times per month from the CRAN website (see <https://github.com/ropensci/stplanr> for more information). If a similar number of people use the software generated from this project, the impact will extend far beyond the scope of the project, yielding very high return on investment.  Each of the components mentioned above are innovative in their own right. Combined and represented in code as a unified workflow, the methods will have the potential to be part of a step-change in how transport researchers and practitioners use data to tackle pressing transport issues such as car over-dependency. |
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| **Question 3: Project Management** |
| What is your project plan to deliver the project? What are the relevant skills and expertise of the team?  Your answer should include:-   * aims and objectives; * skills and expertise of who will deliver the project; * clear deliverables; * timescales, with milestones; * an assessment and analysis of the risks to the project and risk mitigation measures; * Gantt Chart.   **Maximum score available: 10**  **Maximum words: 500 plus Gantt Chart** |
| Aim: Develop, demonstrate and disseminate methods for harnessing large datasets to better tackle transport problems using Machine Learning  Objectives and deliverables (deliverable in bold):   1. Add new variables to conventional OD datasets related to the environment surrounding the environment along the OD transect, representing the entire transport system of England and Wales. **The results will be delivered as an open dataset.** 2. Apply Machine Learning algorithms to explore the extent to which variables derived from the previous objective, and previously known variables, are associated with car dependency nationwide, and how this varies region-by-region to be **documented in a written report**. 3. Explore the policy implications of the findings in a **written report.** 4. Write-up, document and **publish code (in an R package) and data** allowing others to reproduce the results and use the methods to explore other transport problems using Big Data.   **Dr Robin Lovelace** is an Environmental Scientist and Computational Geographer by training and was recently recruited to commence a 5 year University Academic Fellowship in Transport and Big Data at the Leeds Institute for Transport Studies (ITS), whilst maintaining a role in the Leeds Institute for Data Analytics (LIDA). Robin’s expertise includes modelling modal shift, spatial data analysis and GIS. This experience has been demonstrated in the Propensity to Cycle Tool (PCT), the first nationally scalable interactive planning tool for planning cycling investment at the road network level that is available to the public, anywhere in the world. Robin’s skill-set combines computing (e.g. online interactive visualisation), data analysis and multi-disciplinary collaboration.  **Dr Ilan Fridman-Rojas**, Research Fellow in Data Science, Leeds Institute for Data Analytics (LIDA), University of Leeds. Ilan is a theoretical physicist by training with experience in Data Science both in academia and industry. In industry he both managed data-analytic reports on marketing performance for clients, as well as carrying out Research and Development projects building a classifier toolkit, creating proof-of-concept machine learning prototypes for new clients, as well as building the company’s first Deep Learning model. On the PCT project Ilan is currently involved in, he has been working on the analysis of the mode of transport and spatial distribution of primary and secondary pupils’ commute to school, modelling and predicting how the potential for increases in cycling uptake may vary across England’s route network.  Timescales and milestones:  The project will be divided into three Phases: Data Collection, Analysis and Ensuring Impact. The first face will take a month and a half, the most computationally intensive aspect of the project. The analysis will take a month, running from the third week in March until the second week of April. Dissemination will take place throughout via the **publication of code on GitHub**, social media a **report**, and **an academic paper** on new methods for processing transport data for policy-relevant findings (milestones in bold, to be released throughout the project, at the end of the project and within 2 months of the project’s completion, respectively).  Risks and mitigation measures:   * Data security: only open access data will be used in this project to ensure that data security is not compromised and that others can reproduce the results. * Processing times are longer than expected: our experience on the PCT project has led to agile workflows and a modular approach that ensure that a minimum viable product is delivered ahead of schedule. * Illness or absence: another staff at the University of Leeds (Dr Malcolm Campbell) will be recruited to fill any unexpected staff shortfall.   Gantt Chart: |
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| **Question 4: Impact and Exploitation** |
| How will the outcome from this research have a beneficial impact on UK transport? Outline the future potential for further development.   * Demonstrate how the output of the project will be exploited to deliver impact against the DfT [priorities](https://www.gov.uk/government/organisations/department-for-transport/about); * Align the project to one or more of the DfT priorities: *Boosting economic growth and opportunity; Building a one nation Britain; improving journeys; Safe, secure and sustainable transport*; * If this project is part of wider programme, discuss both how the outputs from this project support the wider programme and how the wider programme will deliver impact; * If unsuccessful, please explain what impact not receiving this funding will have on the development of your innovation; * List the deliverables you expect to produce as part of this project to exploit the results. A final report is expected as a minimum.   **Maximum score available: 30**  **Maximum words: 700** |
| This project will have high impact through three main channels: the dissemination of a new, open dataset at the OD level, with new variables which can provide insight into factors associated with car dependency; the demonstration of new methods for handling Big Data for transport application and the publication of reproducible code (as an installable R package) for others to use; and the policy-relevant write-up and dissemination of results.  The work will help boost economic growth by finding ways to use new datasets to minimize travel times, potentially reducing the costs of excessive car dependency (preventing citizens from spending in other parts of the economy) and ensuring that investments aimed at reducing barriers to sustainable transport, primarily car dependency, are cost effective and based on a detailed analysis of the best available evidence. By showcasing the methods and providing the data to UK consultancies, the project could help give UK companies a competitive edge in the global transport consultancy marketplace.  In addition to the demonstration of methods for harnessing Big Data to tackle transport problems at high geographical resolution, it is likely that the results of the research will be valuable in their own right, for decision makers tasked with delivering safe and sustainable transport systems. It is likely that the Machine Learning methods will identify previously unknown variables associated with car dependency and un-sustainable practices, which can become the focus of policies for sustainable transport systems. Furthermore, it is likely that the dominant factors associated with car dependency will vary from place to place. This regional break-down will enable more targeted policies to ensure that investment is spent where it is most needed in different regions, and, via the route-level analysis down to the route network level.  This project is part of a wider push at the University of Leeds towards the development of world-leading expertise in the field of Transport and Big Data. This exploratory foray into machine learning on large geographical datasets will enable further work focusing on different pressing transport problems (e.g. air pollution, in collaboration with Dr James Tate or energy transition in collaboration with Professor Jilian Anable).  If unsuccessful, our team in Leeds will not have the opportunity to deploy recently developed Machine Learning algorithms on transport datasets and others (possibly not in the UK) will have the ‘early adopter’ advantage of implementing such methods on national datasets before we do.  The deliverables will include:   * The publication of **open source code** allowing others to reproduce the results or modify the methods to solve their own problems using large datasets (e.g. using newly available OD matrices derived from mobile telephone providers). * The publication of an OD **dataset** with additional variables that have never before been available to researchers that provides summary statistics about the characteristics of the desire line connecting the two places and route options between them. This will be valuable for UK companies, NGOs and public sector organisations looking to exploit new datasets for better decision making and investments. * A **report** outlining in detail the methods used and how they could be applicable to other transport problems including air pollution and modelling a low carbon transport system. * A high-level **academic paper**, to be submitted after the completion of the project, to showcase the potential of new methods for analyzing large datasets for policy-relevant results. This will help show UK innovation and leadership in the growing field of Big Data.   It is expected that the project will lead to much follow-up activity including collaboration between academics and an international transport consultancy, and international funding bids to deploy the methods in new countries. |
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| **Question 5: Project Finances**  How much will the project cost to deliver and how will this be spent to ensure value for money? | | | |
| **Costings**  Use this table to detail your costings for the project. List each person involved, along with their daily rate and number of days worked. Also include other costs, such as equipment, material and contracting. | | | |
| **Name of employee** | **\*Daily rate (£)** | **Number of days per employee** | **Total budget (£) (highlight field(s) and press F9 to calculate/update grey cells)** |
| Dr Robin Lovelace | 442.30 | 24 | 10615.2 |
| Dr Ilan Fridman-Rojas | 393.88 | 60 | 23632.8 |
|  |  |  | 0 |
|  |  |  | 0 |
| Consultancy/Sub-contracting charges (£) | | | 0 |
| Material costs (£) | | | 0 |
| Other expenses (£) (conference travel and accommodation 2 to travel to Modelling world, £250 each) | | | 500 |
| 1. **Total cost (£)**   **(highlight field and press F9 to calculate/update grey cells)** | | | 34748 |
| 1. **Total funding sought from T-TRIG (£)** | | | 34748 |
| If the total project cost **(A)** is greater that the funding being sought **(B)** please explain how you plan to fund the difference. | | | |

**\* To include Full Economic Cost (FEC)/overhead charges.**

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| Grants will be paid upon final report approval. Successful applicants will have the choice to claim 30% of the funding as an early payment to help with costs. Please indicate your preferred payment option. Tick one box only. | |
| I wish to receive an early payment of 30% of the funding sought, followed by 70% upon project completion and report approval. |  |
| I wish to receive 100% at the end of the project and upon report approval. |  |

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| Please explain the costs in the table above and describe how you plan to spend the grant funding. Your answer should:-   * Demonstrate value for money; * Justify the costs, showing how they relate to the project plan, and how they reflect fair market value; * Include sufficient relevant detail in the cost breakdown for the assessor to understand what the money will be spent on; * Clearly explain the staff costs, using reasonable, fair market value rates; * Explain any other costs, such as materials; * List and justify any sub-contracting costs (these must include VAT).   **Maximum score available: 10**  **Maximum words: 500** |

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| The funding will be spent on staff time.  We already have the capital assets at the University of Leeds (including High Performance Computing, secure data facilities and desk space) to deliver on the project. What is needed is the allocation of researcher resource on this project. Robin and Ilan will therefore be employed at 40% and 100% Full Time Equivalent (FTE) over the course of the project to ensure rapid development and impact.  Robin and Ilan already have a close working relationship on the PCT project and work in the same office, ensuring a highly productive working environment. Winning this funding bid will allow us to put into practice ideas we have already discussed and to some-extent prototyped in the **stplanr** R package.  For highly qualified data analysts and programmers, day rates of more than £1000 can be expected in industry, especially if the product involves national-level datasets and tested software, as in this case. For this reason the project represents very good value for money compared with industry rates. Furthermore, the impact value of many consultancy-led projects is hampered by their inability to publish code, data and methods underlying their work. The project will therefore likely have very high benefit-cost ratios. |