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## The experience of travel time: worthwhile or wasted? Learnings from a large-scale smartphone-based data collection campaign and expected policy impacts (H2020 MoTiV project)

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### Abstract

In conventional transport appraisal methods, travel time is considered a disutility and therefore constitutes one of the largest costs associated with transport systems. However, this view of the Value of Travel Time (VTT) does not acknowledge the subjective dimension of the travel experience. To address this gap, the Horizon 2020 MoTiV project (2017-2020) developed an app that automatically detects trips and transport modes, and prompts the traveller to answer a short survey capturing their experience of travel time as worthwhile, neutral or wasted. Through the Woorti app, the MoTiV project offers insights into 1) how travellers value their travel time in terms of work-related or personal productivity, fitness, or enjoyment; 2) the causes for such experience in terms of comfort and other experience factors; and 3) the effects of a worthwhile experience in terms of the activities undertaken by travellers while on the move. In this conference paper and presentation, we highlight the design challenges related to the collection of data, we describe the underlying conceptual framework that was adopted, and we present initial results from the data collected across 8 European countries in the second half of 2019 and their potential policy impacts. One main take-away is that from travellers' perspective, the travel experience matters. The empirical evidence collected by the MoTiV project may help improve transport appraisal methods, particularly for comparing investment options between different transport modes. The project contributes to a shift in transport planning where travellers and their needs, preferences and expectations take centre stage.

**Keywords:** worthwhile travel time, value of travel time (VTT), travel experience, multimodal transport, door-to-door mobility, smartphone applications

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## **MoTiV Project Summary**

Mobility and travel time account for a significant portion of everyone's life. Despite this significance, we do not know much about what the Value of Travel Time (VTT) means for travellers. Depending on a large number of factors, travel time can be used more efficiently or just experienced differently by different people. The 30-month project "Mobility and Time Value" (MoTiV), running until April 2020, aims at reducing this knowledge gap by addressing emerging views and perspectives on VTT and adopting the travellers' viewpoint. In this respect, it does not only focus on the economic value of travel time savings, which is central to VTT studies carried out since the 1960s to support transport appraisals. Rather, it adopts a broader conceptual framework that attempts to quantify how endogenous and exogenous factors shape the individual travel experience for various trip purposes, thus contributing to the sense of "wasted" or "worthwhile" travel time.

Through a smartphone-based data collection, the project aims at collecting a sample from at least 5,000 participants from 8 European countries. The dataset is expected to cover a wide range of mobility behaviours, across all transport modes, and to be balanced in terms of gender representation, traveller profile and attitudes, as well as in geographical and generational coverage. Besides adding to the body of VTT research, the project results will provide visibility into the factors that contribute to a worthwhile experience in travel on different transport modes (public, active/semi-active or private motorised), therefore providing valuable data and evidence for investing in higher quality of transport as an alternative to investing in speedier transport.

The innovative approach proposed by the MoTiV project has attracted interest at international level. One of the major achievements of the first year of activities was the contribution to the high-level roundtable on value of travel time<sup>†</sup> organised by the International Transport Forum (ITF) at the OECD in September 2018. According to Dr Giuseppe Lugano, MoTiV Project Manager, "*the audience acknowledged the potential of the MoTiV project to support a better understanding of the factors that determine the experience of the journey and knowledge on the choices made by the traveller. Particularly appreciated is the MoTiV plan of releasing an Open Dataset based on its European-wide data collection. This data has the potential to allow identifying additional factors to those already used in conventional value of time studies that influence the quality of a journey*".

### **1. Introduction**

It is a common assumption in conventional transport planning and assessment that travel time is itself wasted. This assumption has led to travel time savings regularly being accounted as the most valuable benefit for justifying transport infrastructure developments, which in turn has led to a pursuit for more capacity and speed to address the apparently insatiable demands for more transport (Banister 2011). While this assumption of wasted travel time may hold true for single-driver commuters travelling by private car to their workplace, three major trends have been challenging this. First, the diversification of transport has increased the modal share of travellers who choose other modes. Quality public transport, active modes, new types of vehicles such as e-bikes or e-scooters, and new ways of sharing existing vehicles and capacities (car-sharing, bike-sharing, ride-hailing, app-based taxi services, etc.) offer an altogether different experience to the traveller compared to that of a car driver. Second, the wide adoption and use of mobile electronic devices has empowered travellers to put their travel time to use in a myriad of new ways, provided they are given the physical and mental 'space' to do so. Third, the continued growth of mobility based on single-occupancy vehicles is deemed unsustainable in terms of carbon emissions, but also and increasingly in terms of wider impacts on quality of life and the natural life.

Research on the value of travel time (VTT) in the last ten years has been exploring new paths that may allow overcoming the idea that travel time is wasted time – what early authors have called the "gift of travel time" (Jain and Lyons 2008) or, more recently "motility", when on-the-way benefits are seen as life-enhancing and directly contributing to personal well-being (Shliselberg and Givoni 2018). Holistic approaches to the study of VTT that incorporate the subjective value of the travel experience may therefore reveal what worthwhile use of travel time means from the traveller perspective.

This conference paper objective is threefold. First, we summarise the concept of travel time use in the literature and we propose a conceptual framework as well as a number of research hypothesis to be used as building blocks

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<sup>†</sup> <https://www.itf-oecd.org/zero-value-time-roundtable>

for designing an app-based data collection campaign. This work is based on the MoTiV public deliverable D2.2 “Mobility and Travel Time Report” (Lugano and Cornet 2018). Second, we share a summary of the learnings in addressing the design challenges for a survey based on a smartphone application (Cornet et al. 2019, this work was presented at the Smart Cities Symposium in Prague, May 2019). Third, we present preliminary results of the research project (European data collection campaigns have started on May 1<sup>st</sup> 2019 and results will be completed by the time of the conference).

## 2. Conceptualising worthwhile travel time

Banister et al. (2016, 2019) define “Reasonable Travel Time” as the “*door-to-door journey time that is acceptable to the passenger for reaching a particular destination and its associated activities, given the conditions provided to turn ‘forced time’ to ‘useful time’ while travelling*”. This definition implies three elements for further consideration when unpacking the understanding of time from the traveller perspective. First, the *full door-to-door trip* puts emphasis on the total journey time and, therefore, on the possibility of a journey being composed of a combination of transport modes as well as connections between them, all of which affect the traveller’s experience of time. Second, the *activities* available at locations along the way as well as at destination imply that a typical journey may serve more than one purpose relevant for the traveller. And thirdly, the traveller may experience *conditions under which time is lost* conducting the trip itself (driving, navigating the transport system etc.) may be repurposed to something more useful.

While RTT illustrates the importance of the experience of travel, it also raises further questions regarding the characteristics of a worthwhile use of time during travel as well as the environmental factors that may contribute to a positive – or negative - experience. The following subsections summarises the three key elements retained from the literature review to form the MoTiV conceptual framework: measuring worthwhileness as a whole, activities done while travelling as a proxy for assessing worthwhile time, and the environmental factors that contribute to a positive or negative experience (Fig. 1).

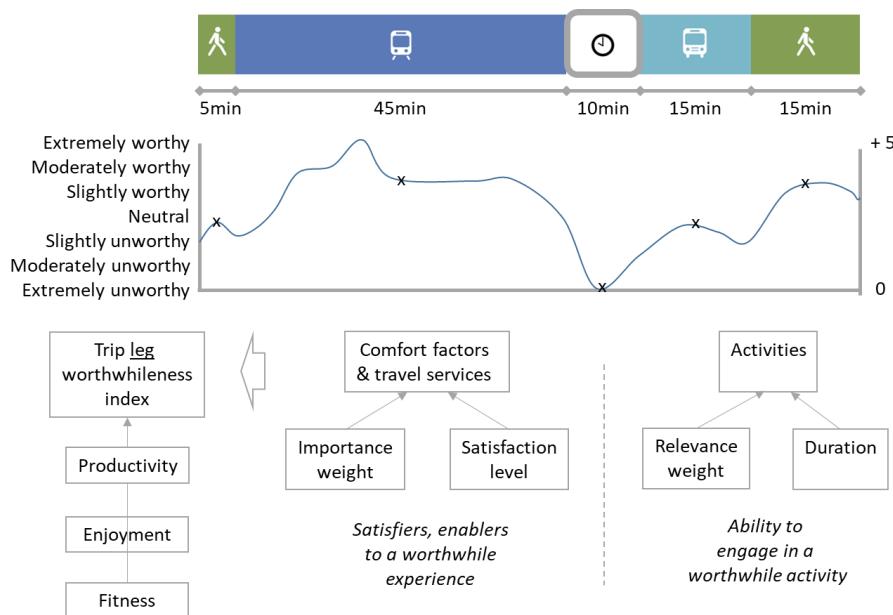


Fig. 1: MoTiV approach to assessing worthwhile travel time

### 2.1. Worthwhileness

In the late Seventies, David Hensher proposed an approach for determining the relative productivity of working time while travelling for business. Wardman and Lyons (2016) reviewed the studies that collected data using the Hensher formula’s two main factors,  $q$  and  $p$  (the  $q$  factor is the relative productivity of work done while travelling compared with the office environment,  $p$  is the average amount of time spent working while traveling, and  $p^*$  is the proportion of work done while travelling). Empirical data showed that train travel obtained the highest values

on the likelihood of productivity (with figures up to 57% in the latest studies conducted in the UK), followed by air travel, and last bus and car (Fig. 4).

However, from a traveller perspective, productivity is not the only dimension that can be associated to worthwhile travel time. Singleton (2017) provides a broader definition of VTT as “*any benefit(s) accruing to a traveller through the act of traveling*”. Each trip may be considered worthwhile in various ways and contribute with distinct types of value or benefits: for instance, the time devoted to bicycling to work can be regarded as worthwhile for its benefits to personal health, or simply for enjoyment. In this respect, a holistic analysis of what constitutes worthwhile travel time (and, similarly, time that is perceived as neutral or wasted) becomes linked to personal preferences and expectations on the quality of the experience and quality of life in general. In MoTiV, the worthwhile travel time is decomposed in three main dimensions: productivity, enjoyment and fitness (Fig. 2).

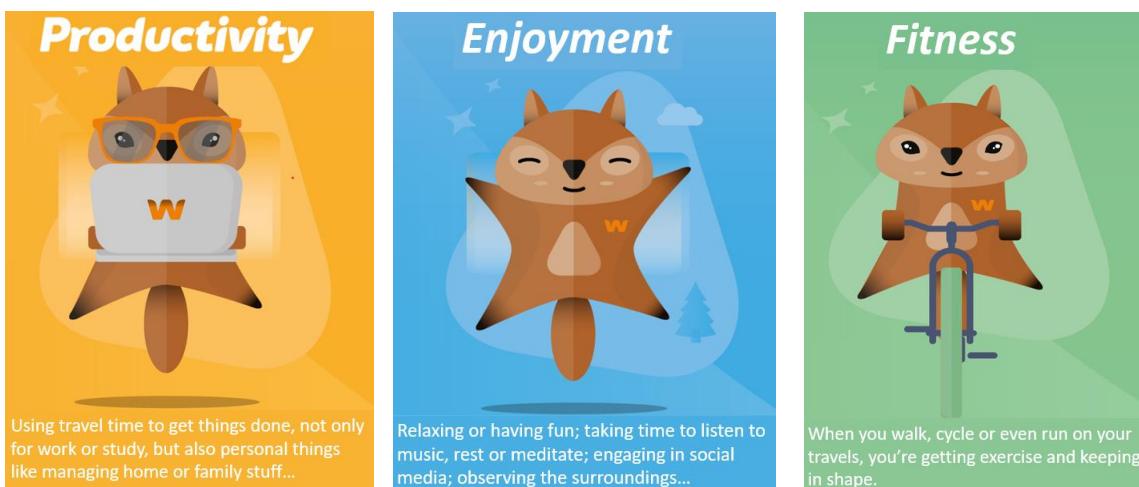


Fig. 2 Worthwhileness dimensions in the MoTiV app

## 2.2. Travel activities

Wardman & Lyons (2016) in their review concluded that “the value of time savings may be influenced by the scope for activities which can be undertaken during the journey”. Useful activities that can be performed during travel is particularly significant for business trips. In MoTiV we adopt Singleton’s approach and extend Wardman & Lyon’s conclusion to all types of activities, bearing in mind that not all activities are necessarily worthwhile and that some travellers may be more inclined to find ‘something to do’ to kill time. Assessing what type of activities travellers engage with during travel, the personal value attributed to each activity, the duration of activity relative to the travel time, and correlating those to an assessment of worthwhileness are therefore key aspects of the activity data collection. Table 1 lists the activities that are used in MoTiV.

Table 1: Travel activities defined in the Woorti app

Activities
The Driving / Cycling / Walking itself
Relaxing or sleeping
Browsing or social media
Reading / writing (paper)
Reading / writing (device)
Listening to audio
Watching video or gaming
Talking (including phone)
Accompanying someone

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- Eating / drinking
  - Personal care
  - Thinking
  - Other
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### 2.3. Experience factors

While the activities a user was able to conduct while traveling can be seen as actual evidence of worthwhile or wasted time, experience factors can be seen as the explanatory causes – or in other words, they are the enablers and barriers to worthwhile time use. Experience factors can be categorized in the following way: 1) “Getting there” factors, which relates to everything about cognitive efforts which takes away the ability to enjoy or be productive during travel, such as figuring out or worrying on how to get to destination, navigating the transport system, or driving or riding the actual vehicle; 2) “Comfort and pleasantness” factors which contribute to getting things done (like seating availability) or help the traveller enjoy the ride (like comfortable seats, nice view, or ambiance). Experience factors are mode-specific and often relate to transport infrastructure and the availability of services. Collecting this type of data requires a satisfaction level as well as an assessment of the importance each factor for the traveller (see for example Brons and Rietveld 2009, and see Cornet et al. 2019 for the full list of experience factors used in Woorti).

## 3. Research questions

In MoTiV, we aim at exploring factors shaping the value proposition of mobility which contribute (positively or negatively) to the experienced value of travel time. The holistic approach to travel presented by the concept of ‘reasonable travel time’ (RTT) and the literature review in Lugano and Cornet (2018) led to a number of research avenues for the MoTiV project to address. These are summarized in Table 2. As such, we do not expect to “test” hypotheses in a strict statistical sense, but rather to discover associations and interactions among factors through multiple methods including exploratory-descriptive analysis, correlations and multivariate regression analysis as well as content analysis in the case of open questions. The overarching research purpose is twofold. First, the project aims to show that from a traveller’s perspective, the travel experience matters, and the value taken from this experience goes beyond work-related productivity. Second, the project aims to validate the conceptual framework presented in the previous section and implemented into an app-based survey.

Table 2: Areas of inquiry (research hypothesis questions) for MoTiV per dimension of RTT (Lugano and Cornet 2018)

#	RTT	Area of inquiry	Purpose	Value dimension
1	Door-to-door trips	Door-to-door time	To explore how the choice of modes and route is influenced by the door-to-door travel time and experience.	Time
2		Reliable door-to-door time	To explore how VTT is influenced by the reliability of the planned travel choice.	Time
3		Trip planning time	To explore how time spent on travel planning and preparations impacts travel choices and VTT.	Time
4		Time constraints	To explore how VTT is influenced by perceived hard time constraints.	Time
5		Acceptable travel time	To explore how VTT is influenced by the acceptable travel time.	Time
6		Travel time budgets	To explore how closely the Travel Time Budget (TTB) matches with a constant 70+-10 minutes per day after factoring in time considered worthwhile.	Time

7	Destination activities	Trips purposes	To investigate the urgency and importance of activities conducted at destination.	All dimensions
8		Diversity of location activities	To explore how the amount of worthwhile time is influenced by the range and diversity of activities at the destination or locations on the way.	Comfort
9		Modal distances	To explore how many urban trips are short distances.	Safety, Well-being
10	Travel experience	Proportion of worthwhile time	To explore how VTT is influenced by the share of worthwhile travel time out of total travel time.	Comfort
11		Unwanted efforts	To explore how VTT is influenced by physical, cognitive or emotional effort related to the travel.	Comfort
12		Travel activities	To explore how VTT is influenced by the range and diversity of activities while travelling.	Comfort, pro-social
13		Smartphone-based activities	To explore how VTT is influenced by smartphone apps and the time spent on them.	Comfort
14		Value of travel activities	To explore how VTT is influenced by the perceived worthwhileness of a trip leg.	Comfort
15		Travel comfort factors	To explore how VTT is influenced on the perceived comfort of the locations or while travelling.	Comfort
16		Jerkiness as a proxy for comfort	To explore how comfort while travelling is influenced by vibration, jerkiness and shocks.	Comfort
17		Transfer and waiting experience	To explore how comfortable transfer and waiting times are.	Comfort
18		Traveller needs and equity	To explore how the choice of travel speed is influenced by the user's demographic characteristics.	Cost, safety
19		Attitudes towards mobility and time	To explore how VTT is affected by the traveller's attitude about transport modes and time.	Well-being, curiosity, prestige, pro-social

#### 4. Data collection approach and app design challenges

The approach taken by MoTiV is to design and develop its own data collection app – the Woorti app – to collect mobility behaviour and travel experience data. The data collection campaigns is taking place between May 1<sup>st</sup> and November 30<sup>th</sup> 2019 in 8 participating European countries (Slovakia – leading the project, Norway, Spain, Belgium, Portugal, France, Finland and Italy; whereas Croatia and Switzerland were dropped during the summer of 2019 for lack of participation). One campaign manager in each country is responsible for engaging local NGOs, cities and transport operators and for organising events to attract a wide base of users to join each campaign. The project aims to enrol 5,000 active users validating and reporting a total of 70,000 trips across all transport modes (26 modes in total, see Cornet et al. 2019 for a full list).

The data collection app consists of two main modules: 1) using standard smartphone sensors (accelerometer, gyroscope, and GPS), the app automatically detects trip start and end as well as the transport mode associated to a specific trip leg, and 2) the app asks users questions on their trip purpose and their travel experience, including overall trip worthwhileness, travel activities and experience factors. This approach enables a ‘situational’ approach based on real life cases, as opposed to stated preference surveys which are based on hypothetical choices and have therefore been criticized for their lack of ‘realism’ (Cherchi and Hensher 2015).

Accurately identifying transport modes can be a challenge as some modes can expose very similar footprints in some context or for some travellers e.g. bus and trams can be difficult to distinguish, or fast cycling and driving can produce very similar sensor logs. In MoTiV, the Woorti app detection is based on a machine learning algorithm in which the traveller can manually correct the automatically detected mode and feedback that information to the MoTiV server. By processing this feedback, the detection algorithm is continuously improved and released into newer versions of the app. The detection algorithm is contained within the app itself and does not make use of external databases.

Capturing the travel experience using smartphone-based data collection needs to achieve an optimal balance among conflicting requirements, such as usability, implementability, clarity, precision, comprehensiveness, respondent psychology, data collection requirements, quantitative vs. qualitative variables, the assumed causal chain between activities and experience factors, and the risk of biases introduced by assumptions, preset lists of factors and the order of asking questions (see Cornet et al. (2019) for more details on the design process). The figures below shows the user interface implementation for the Woorti app version 1.0 used in the campaign started in May 2019 (Fig. 3).

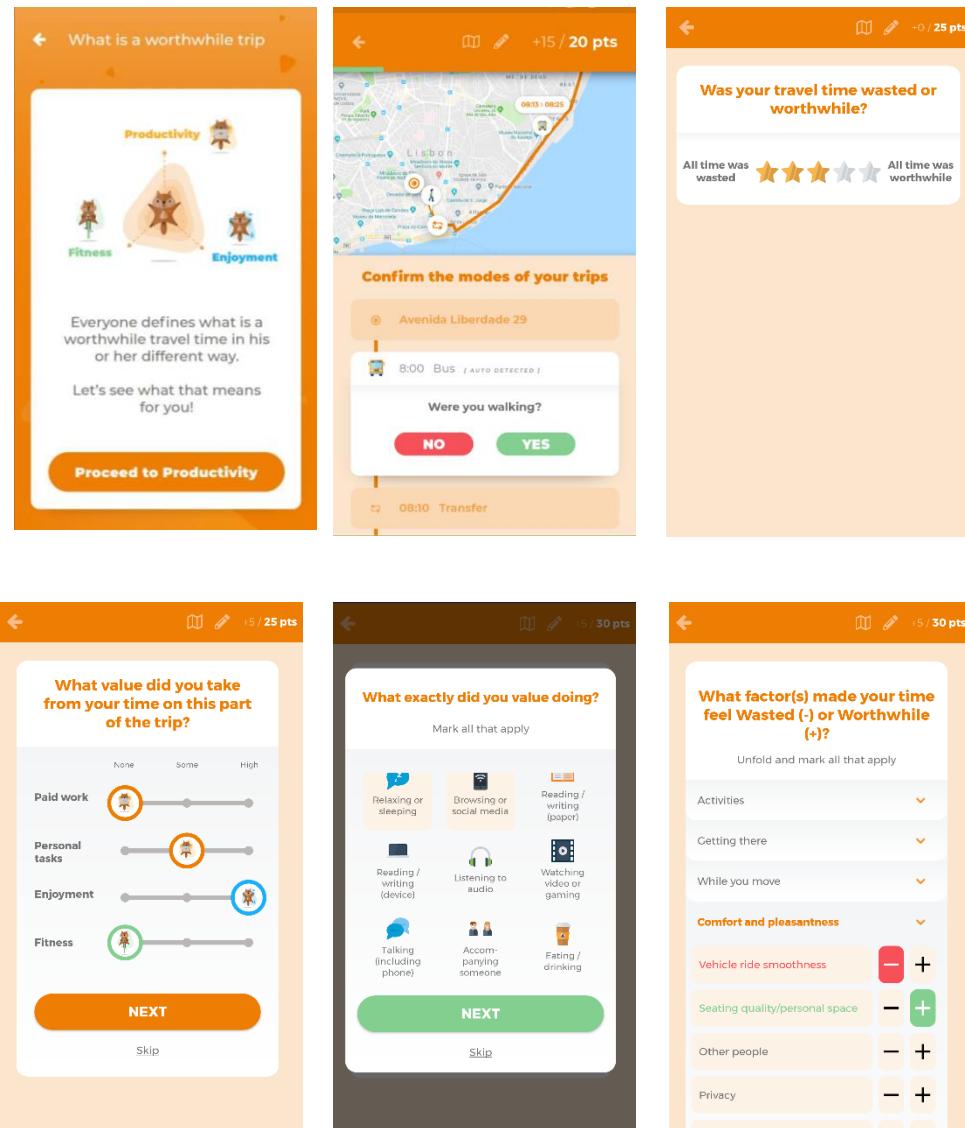


Fig. 3: User Interface Snapshots of the Woorti data collection app

In practice, retaining users to validate and provide feedback for the targeted 14 days with minimum one trip per day is difficult. On average only about 20% of the respondents commit to such duration. It is found that on average

users are willing to report about 2 trips per day for a period of one week. It is also found that female and older groups are proportionally less well represented in our sample, likely due to the design of the campaigns and app-based approach itself. In order to mitigate this, each country is given the option to provide their own incentives, varying from simple cash-outs to winning a sizeable prize (e.g. the Slovak campaign has two e-scooters to be given away in a final draw).

## 5. Worthwhileness index and preliminary results

The full MoTiV dataset was not yet available at the time of writing. As a whole, MoTiV is expected to address and contribute to the research questions raised in section 3. More specifically, MoTiV will produce a ‘worthwhileness index’ similar to the p factor of the Hensher formula (Fig. 4), and therefore provide empirical data on the perceived value of travel time at aggregate levels, per transport mode (Fig. 5) and per geographical context, but beyond that of ‘productive’ time only and including modal assessments for personal productivity, fitness and enjoyment.

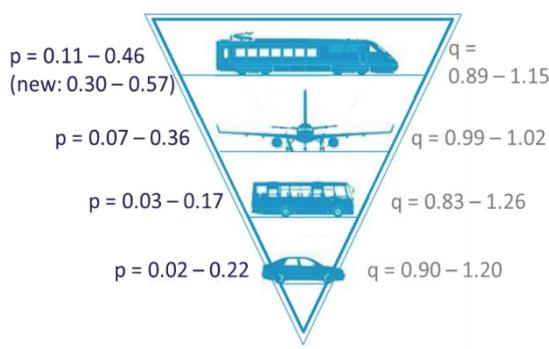


Fig. 4 Current values of productive travel time. p = proportion of work done while travelling. q = relative productivity of work done while travelling. 0 to 1 scale (Wardman and Lyons 2016)

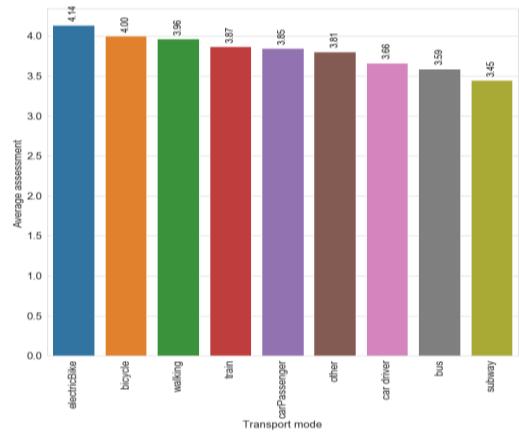


Fig. 5 MoTiV values of worthwhile travel time, aggregated assessments across modes and locations for 31571 trip legs collected between May 1<sup>st</sup> and July 30<sup>th</sup> with 5-star scale quantified as 1 to 5.

To complement this aggregate, top-down picture, it is also expected for the MoTiV data to contribute to the understanding of travel time in several ways, some of which may be particularly relevant for transport providers and operators. For example, it will be possible to extract the preferred activities people are engaging with in transport and where they gain the most value, as well as their enablers or impediments, and therefore inform specific policies to improve the experience of travel for various socio-geodemographic groups. Enablers of a worthwhile experience vary per transport mode, for example, cyclists reporting a positive experience most often state the weather and road path quality and safety as top factors, while those reporting a negative experience most often report cars and other vehicles, path quality and safety, noise and crossings as top dissatisfaction factors.

At the individual traveller level, the collected user preferences and attitudes towards different modes will provide a means to categorise types of travellers in clusters beyond simple socio-demographic characteristics and provide feedback to travellers about their personal Value Proposition of Mobility (VPM) (Kováčiková, Lugano, and Pourhashem 2018).

## 6. Conclusions and policy implications

Assuming the primary goal for investing in further development of the transport system is to save time, the concept of RTT suggests two complementary policy approaches: speeding up any segment of a trip (including transfers), and/or improving the quality of time spent on any of these segments. Quality of travel time includes conventional characteristics such as safety (particularly relevant for cyclists) or reliability (particularly relevant for scheduled public transport services), but also refers to a long list of other potential experience factors that can impose unwanted physical, cognitive or emotional efforts on travellers. The policy implication is that the same increased level of RTT can be reached by either approach, and that choosing to improve the experience of travel – e.g.

increasing the comfort or the seating availability in a busy train connection - may in some cases prove more cost-efficient than attempting to reduce headways (Fig. 6).

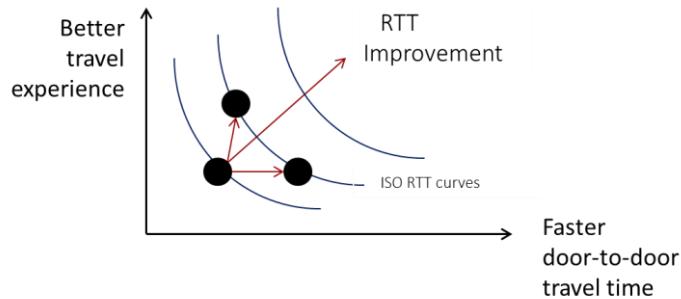
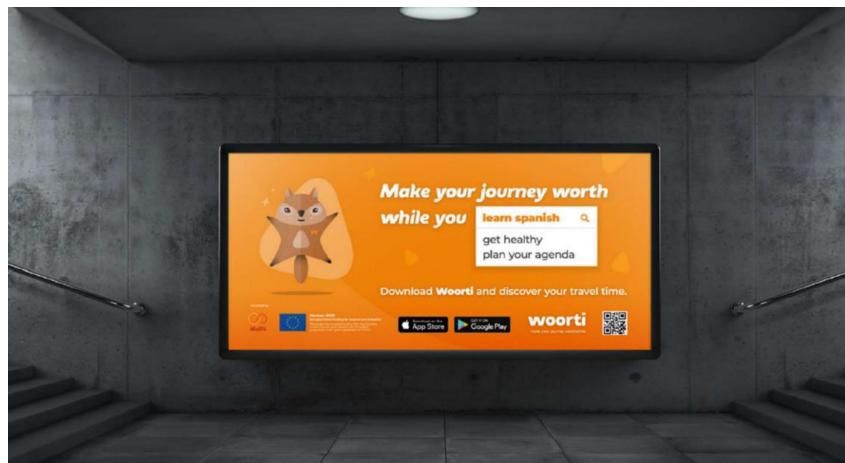


Fig. 6 Policy options for ‘saving’ travellers’ time. Banister et al. (2016, Forthcoming)

Producing a worthwhileness factor for different transport modes is also expected to have an impact on conventional approaches for assessing transport in a number of ways. First, such factor could be used as a weight to existing monetary values of travel time in conventional cost-benefit analysis (CBA). New research is already demonstrating that the higher the quality of the travel experience, the lower the value of time (VOT) (Bouscasse and de Lapparent 2019; Mokhtarian 2018). While this would seem logical, it raises an important question: if traditional value of travel time savings (VTTS) are reduced because less time is wasted during travel, wouldn’t that unfairly benefit improvements of transport modes where most time is wasted? This in turn risks exacerbating the bias towards improvements in car-based transport systems at the expense of more sustainable modes. We therefore foresee a need to revisit the assumptions behind the standard applications of CBA to transport assessments, and to build the case for evaluating transport projects from the starting point that time spent while in transport should not be wasted in the first place. In other words, questioning the basic assumption that travel time is wasted implies shifting from a CBA approach where VTTS is seen as the primary monetary benefit of transport investments to an approach where the amount and value of travel time wasted is accounted for as a cost.

Overall, MoTiV will provide empirical data in support for tangible improvement of the transport infrastructure, for example, an increase in seat capacity supply on public transport, better and more protected facilities for active and semi-active modes, as well as other soft measures that ensure that all travellers experience a high quality travel time instead of feeling “hostage” to their journey time. Particular attention is to be taken in gender analysis of the data in order to uncover potential embedded injustices in the transport system, particularly in the way it is experienced. Finally, in order to support a transition towards more environmentally sustainable and low-carbon transport, it would be interesting to explore whether there is a correlation between higher quality transport and lower environmental footprints per kilometre travelled.



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