





Worthwhile travel time: a conceptual framework of the perceived value of enjoyment, productivity and fitness while travelling

Yannick Cornet ^a, Giuseppe Lugano ^a, Christina Georgouli ^b and Dimitris Milakis ^c

^aDepartment of International Research Projects - ERAdate+, University of Žilina, Žilina, Slovakia; ^bUCL Energy Institute, University College London, London, UK; ^cInstitute of Transport Research, German Aerospace Center (DLR), Berlin, Germany

ABSTRACT

By tradition, transport appraisal relies primarily on travel time savings and monetary values. Assessment tools rarely factor in the perspective of travellers in terms of their subjective travel experience while on the move. Worthwhile travel time introduces the idea that travel can be pleasant, meaningful or worthwhile and not exclusively associated with the economic utility of the activity at the destination of the trip and the work-related productivity during the trip. This paper explores how the “worthwhile use of travel time” can be conceptualised and unpacked, so that it can be adequately captured and integrated into transport appraisal practice. We reviewed the literature on worthwhile travel time and perceived travel experience in psychology, economics, public health and travel behaviour research and we formulated the conceptual framework of worthwhile travel time that is grounded on the traveller’s perception of three forms of value emerging from existing literature: enjoyment, productivity, and health. Our conceptual framework of worthwhile travel time suggests that experience factors (i.e. travel conditions as experienced by the traveller) can enable travel activities (i.e. the trip itself or activities on-the-move), which in turn unlock the values of enjoyment, productivity and fitness that influence the perceived worthwhileness of a trip to a different degree each. Additional (explanatory) factors such as the door-to-door trip characteristics, the traveller’s personal characteristics and attitude, and the spatial and temporal conditions can also influence the perceived worthwhileness of a trip. On a policy level, the integration of the worthwhile travel time concept into transport appraisal practice could allow future transport investments to offer a better balance between reduced travel times and improved quality and experience of a trip for the traveller.

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CONTACT Yannick Cornet  yannick.cornet@uniza.sk  Department of International Research Projects - ERAdate+, University of Žilina, Univerzitná 82115/1, Žilina 010 26, Slovakia

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1. Introduction

Among human characteristics, this one is rather common: to love movement and change ... Travel seems to me a profitable exercise ... I undertake a journey neither to return from it nor to complete it; I undertake only to move about while I like moving. And I walk for the sake of walking. (Montaigne 1533–1592)

In transport economics, the Value of Travel Time (VTT) is considered primarily to be derived from the monetary value defined by the main trip purpose at destination, typically either work or leisure (Mackie, Worsley, & Eliasson, 2014; Wardman, Chintakayala, & de Jong, 2016). This view is based on the conceptual model of consumer welfare maximisation: because “time is money”, a person aims at maximising utility by spending her limited daily time budget on desired work or leisure activities, and therefore travel time to these activities is seen as a disutility to be minimised (Becker, 1965; Lugano & Cornet, 2018).

Hence, the Value of Travel Time Savings (VTTS) has represented a key metric for decisions of policymakers on transport infrastructure investment. Various methodologies to determine monetary VTTS were developed, notably, those based on average wage rates or willingness-to-pay (ITF, 2019; Wardman et al., 2016) using data from stated preference (SP) surveys on travel behaviour. To alleviate SP survey limitations such as potential biases in the questions or self-reporting errors (Lu, Fowkes, & Wardman, 2008), complementary approaches were developed such as revealed preference (RP) studies focused on observations of actual behaviour. It is worth noting that the unit of analysis of transport appraisal has been the overall travelling population, and how it could be affected, in an approximate way, by travel time savings at a systemic level.

Recent developments are shifting the attention from travel time savings to a traveller's perception, use and appreciation of travel time. For example, the advent of real-time collection of big data from a large amount of personal devices offers an innovative toolkit suitable to refine the existing VTTS methods of transport appraisal, by offering in-depth empirical insights into traveller's perception, use and appreciation of travel time. Such insights can enhance complementary approaches on VTT, challenging the derived demand paradigm and suggesting that personal travel can be valuable in its own sake (Jain & Lyons, 2008; Mokhtarian & Salomon, 2001; Shaw, Malokin, Mokhtarian, & Circella, 2019), as the opening quote by Montaigne foresaw. Based on these approaches both the utility of activities at destination and the intrinsic utility of travelling can play a role in shaping the overall value of a trip. In other words, travel time cannot be assumed to be always wasted: it may be perceived to be worthwhile to varying degrees. The idea that travel time is not always wasted was theorised in economics by DeSerpa (1971). Recent research in the social sciences highlights the central role of Information and Communication Technologies (ICT) in enabling new types of activities on-the-move which can make travel time more usable or just more enjoyable (Wardman & Lyons, 2016; Keseru & Macharis, 2018; Lyons, 2019).

The perceived experience of travellers has so far played a minor, indirect role in conventional transport assessments. However, determining a reasonable balance between speedier travel and the quality of travel calls for a better understanding of the forms of value that can be derived from travel time and how the travellers' perceived experiences compare between modes, also in multimodal trips (Banister, Cornet, Givoni, & Lyons,

2019). This paper contributes to the literature with a deeper exploration of the perceived experience of travel time and consequently the development of a conceptual framework on worthwhile travel time (WTT). We explore the worthwhileness of travel time from the traveller's perspective with respect to three forms of value emerging from existing literature: enjoyment, productivity (in terms of personal tasks or for work), and health (mostly in terms of fitness value).

The remainder of the paper is structured as follows. Section 2 presents the literature review on WTT and the traveller perspective. Section 3 introduces the conceptual framework of WTT, its components (i.e. experience factors, travel activities, perceived worthwhile travel time, explanatory variables) and a case study. Finally, section 4 presents the conclusions of the literature review and the suggested conceptual framework of WTT and discusses their policy implications.

2. Literature review

2.1. *Worthwhile travel time*

Established transport planning practice assumes that travel is a purely derived demand. "Travel time is zero productive in terms of work" hence the aim for any improvement in the transport system is for travel time to be minimised (ITF, 2019). Time-related benefits are expressed in VTTS (Mackie, Batley, & Worsley, 2018). However, several scholars from various scientific disciplines have challenged the assumption that travel has no intrinsic benefits and only derived benefits from moving to different places to perform other beneficial activities. They suggest instead that travel time can be worthwhile having an intrinsic, positive value that should be accounted for in the assessment of transport system improvements.

First, from a microeconomic research perspective, several scholars have identified the positive, intrinsic or experienced *utility* of travel time (De Vos, Mokhtarian, Schwanen, Van Acker, & Witlox, 2015; Mokhtarian & Salomon, 2010). Mokhtarian and Salomon (2001) explicitly distinguished between the intrinsic utility of the trip itself, and the intrinsic utility arising from activities performed while travelling – although the two may be difficult to detangle in practice. Milakis, Cervero, van Wee, and Maat (2015) defined intrinsic utility as "any travel-related utility (or disutility) that is not based on the activity occurring at the trip destination". These researchers juxtaposed the two curves of derived and intrinsic utility for a hypothetical trip over time, introducing the concept of "Acceptable travel time" (the peak total value provided from the intrinsic and derived utility together). Singleton (2017) defined the Positive Utility of Travel (PUT) as "any benefit(s) accruing to a traveller through the act of traveling". These benefits are subjective and may be direct (such as increased health, enjoyment, productivity, monetary gain, or a feeling of purpose) or indirect (such as perceived external benefits to society in terms of reduced congestion or air pollution).

Second, from a psychology and travel behaviour research perspective, studies have shown that travel can be worthwhile for multiple reasons such as transitioning between locations, multitasking, killing time, experiencing flow states or gaining longer-term benefits such as personal growth and self-realisation. Lyons, Jain, and Holley (2007) were to our knowledge the first to introduce worthwhile use of travel

time in a large-scale national rail passenger survey in the UK, and in a follow-up mobile ethnographic study Watts and Urry (2008) described in which ways travel time was thought to be very valuable by business or commuter travellers. Jain and Lyons (2008) described two main types of the value of travel: (1) transition time, as a need for a physical experience in crossing space in time to mentally prepare or to unwind between two locations, and (2) time out, as a need for retreat, to do nothing, enjoy time to oneself, possibly engaging in various (not necessarily productive) activities. The value of switching from one place to another through travelling has been also identified as one of the possible factors explaining excess commuting (i.e. the additional commuting compared to the smallest possible within certain spatial distribution of jobs and housing locations) (Ma & Banister, 2006), while behavioural non-spatial factors have been acknowledged as potentially important determinants of commute lengths (Boussauw, Van Acker, & Witlox, 2012). Te Brömmelstroet et al. (2021) showed that most travel modes offer the potential for experiencing a flow state in different degrees by triggering mental states of awareness, increased creativity, concentration, disregard for the sense of self, and slowing down on time. Moreover, research on the positive journey experience of public transport users has shown a connection between activities performed while travelling and the perceived journey experience, but also highlighted that some activities might be performed just to kill time (Clayton, 2012; Ettema, Friman, Gärling, Olsson, & Fujii, 2012; Lyons & Urry, 2005; Mokhtarian, 2018). Singleton (2017) distinguished between direct benefits arising from “travel-based multitasking” (Kenyon & Lyons, 2007; Keseru & Macharis, 2018) and benefits from the travel experience itself, which is grounded in the literature on subjective well-being (Ben-Akiva & Abou-Zeid, 2014) and travel satisfaction (De Vos & Witlox, 2017). The literature on subjective well-being and travel satisfaction usually distinguishes between “hedonic value”, which refers to shorter-term benefits such as meeting needs and wants, feelings of pleasure, happiness and the enjoyment of the travelling experience, and “eudaimonic value”, which relates to longer-term, life-enhancing and more symbolic benefits such as feelings of purpose in life, personal growth, achievement of goals, and self-realisation (De Vos, Schwanen, Van Acker, & Witlox, 2013). Evidence suggests that active modes (cycling and walking) present the highest levels of travel satisfaction followed by car and public transport with bus being associated with the lowest travel satisfaction (De Vos, 2019; De Vos et al., 2015; Duarte et al., 2010; Handy & Thigpen, 2019; Mao, Ettema, & Dijst, 2016).

WTT can also be defined by its opposite: wasted travel time. Wasted travel time is considered without intrinsic value because it imposes unwanted physical, cognitive or emotional efforts on the traveller (Gatersleben & Uzzell, 2007; Stradling, 2006). In other words, wasted time includes all travel time spent that the traveller would prefer to re-allocate to other activities if it were possible, whether standing in a crowded bus (unwanted physical effort), being subject to noisy or attention-demanding environments (unwanted cognitive effort), or feeling stressed or unsafe (unwanted emotional effort) (Banister et al., 2019; Lugano & Cornet, 2018).

2.2. The traveller perspective

In this paper, the value of travel time is understood as the personal value derived from the perceived experience of travel (i.e. from the traveller’s perspective). Its underlying

assumption is that valuing travel time is a multifaceted, wicked problem (Givoni, Beyazit, & Shiftan, 2016; Lyons, 2019), and it is wicked because it is people travelling – as opposed to barcoded boxes.

Taking a broader traveller's perspective as a starting point is necessary to anchor WTT as a subjective, qualitative judgment. The same trip is not objectively and absolutely worthwhile: it is based on the individual traveller perception which depends on the interplay between attributes of the trip itself and socio-demographic characteristics, but also on the traveller preferences, personality, attitude, habits, life stage, and even cultural context (Kováčiková, Lugano, & Pourhashem, 2018; Ory & Mokhtarian, 2005). The traveller perspective is also necessary to avoid limiting upfront the analysis to the computational simplicity required by conventional transport models. The concept of Reasonable Travel Time (RTT) by Banister et al. (2019) is one of the expressions of perceived travel time which incorporates explicitly the traveller perspective: "RTT is the door-to-door journey time that is acceptable to the individual traveller for reaching a particular destination, and its associated activities, given the conditions provided to turn 'lost time' into 'useful time' while travelling".

This definition brings forth several considerations. First, a trip from a traveller perspective is inevitably door-to-door. It is therefore likely to be multimodal, and at minimum to require some walking to reach a motorised mode. The experience of a trip should therefore cover all movement (including all options of active or motorised modes) as well as connections between them (Hickman, Chen, Chow, & Saxena, 2015).

Second, the traveller's perceived value of a trip can be seen on a continuum (Lumsdon & McGrath, 2011; Mokhtarian & Salomon, 2001). On one side, utilitarian or fast travel refers to circumstances where the perceived worth for travel derives completely from the intended activity(ies) at the destination. On the other side, undirected or slow travel refers to circumstances where the worth derived from a trip is entirely the trip itself. A recent study on the hypothetical case of teleportation instead of commuting found that people with longer commutes are more likely to prefer teleport, while walk and bicycle commuters would rather travel (Humagain & Singleton, 2020). The study also highlights that some people find commuting productive and enjoyable. These results hint that between these ends lies perhaps the bulk of what most travellers experience in reality: a fuzzy mix where personal value is derived from the planned activities at destination, the activities conducted while travelling (which includes "doing nothing", i.e. relaxation time), and enjoying the trip itself, either for its intrinsic pleasure or as a type of transition time between two locations (Jain & Lyons, 2008).

Third, this fuzziness challenges the assumption that trips have a single purpose, which is located at the destination, and that all time spent to reach this destination is therefore wasted. Although this might hold true for a significant portion of daily commuting trips done by car by the typical 9-to-5 wage earner, in practice even for these trips new destinations can be added in-route, such as dropping kids to school or picking up groceries on the way home (Susilo & Dijkstra, 2009). Valuable onboard activities can also be conducted while driving, such as making phone calls or simply taking some me-time (Kent, 2014).

Fourth, trip purposes do not necessarily dictate how savings in travel time would be used, nor does it dictate the type of activities (work-related or not) the traveller might perform while travelling (Wardman & Lyons, 2016). Someone commuting to work might not use travel time reclaimed from an improvement in their travel conditions for

doing more work, and any travel time savings reclaimed from a faster travel time might not be used for more work at destination either.

And fifth, the acceptability of travel time implies both that the experience of travel is subjective, that it is individual, and that it may vary with time itself – or with a combination of distance and speed (Banister, 2011). Several researchers have suggested a negative relationship between travel time, distance and travel satisfaction (see De Vos et al., 2013 for a review of the studies in the field) as well as life satisfaction (Ingenfeld, Wolbring, & Bless, 2018; Stutzer & Frey, 2008). Milakis et al. (2015) and Milakis and van Wee (2018) identified low levels of satisfaction of the subjects interviewed in Berkeley, California and Delft, The Netherlands with very short (<15 min.) and very long (>45 min.) commute times. Some respondents referred to the enjoyment of travel for their low levels of satisfaction with short commute times, while other respondents referred to tiredness and boredom among other factors for their low levels of satisfaction with long commute times. Humagain and Singleton (2021) identified eight different profiles of satisfaction with travel time among the respondents in their study in Portland, Oregon highlighting the large heterogeneity of travel time perceptions.

Although the issue of turning lost time into useful time does not specify the type of worth behind what may be considered useful, it does imply that (1) *travel conditions* can influence the ability to repurpose travel time for something worthwhile – or make travel time feel wasted, (2) worthwhile time will likely emerge to a large extent from *activities* conducted *while* travelling, and (3) *usefulness* to the traveller does not necessarily mean productivity. It is these three conceptual and analytical components that the next section explores in more detail.

3. Conceptual framework of worthwhile travel time

Our conceptual framework of worthwhile travel time is based on the understanding that *experience factors* (Component A) can enable *travel activities* (Component B), which in turn unlock *value* (Component C). This results in a perception of *worthwhile* or *wasted travel time* (Figure 1). This framework was derived analytically by reviewing the existing literature and through interdisciplinary collaboration within the consortium of the H2020 project “Mobility and Time Value” (MoTiV).

The *worthwhileness* level experienced by a traveller is reflected by three types of perceived value: *enjoyment*, *productivity* and *fitness* (Component C). These are not mutually exclusive: for example, a trip can be appreciated for both some level of enjoyment and some level of fitness. We chose the term *perceived value* to reinforce the traveller perspective: the value is both individual and subjective, and not to be understood as objective, collective to the whole travelling population, or monetary. Perceived travel value depends on *travel activities*, which can be the activity of conducting *the trip itself* or the ability to conduct *add-on activities* while on-the-move (Component B). The personal efforts necessary to conduct an activity can be *physical*, *cognitive* or *emotional*, and can be *wanted* or *unwanted*. For example, wanted physical efforts can lead to a fitness value, and a wanted cognitive effort can lead to productivity value. Inversely, the ability to gain value from the trip or from add-on activities is affected negatively by the level of *unwanted efforts* required to conduct the trip itself. *Experience factors* are travel

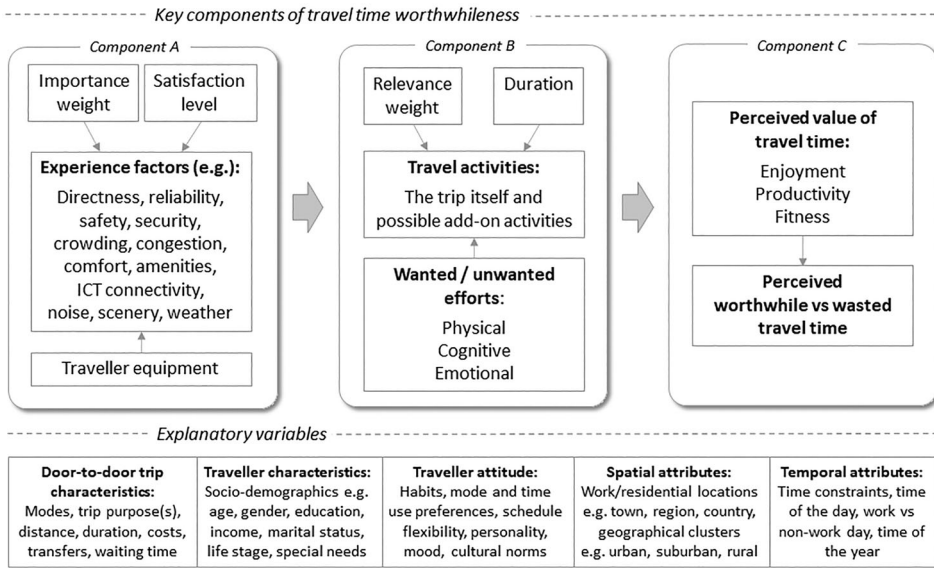


Figure 1. The conceptual framework of worthwhile travel time.

conditions as experienced by the traveller, which depends on the availability and quality of transport services, or on other external factors such as the weather (Component A). These factors can also depend on the *equipment* the traveller decides to bring along. Experience factors affect the amount of wanted or unwanted efforts required to conduct the trip and to engage with desirable add-on activities while on-the-move, ultimately affecting the perceived value of travel time. The conceptual model as a whole draws a causal chain, starting with experienced factors affecting travel activities and ending with perceived value and worthwhileness. In this model we consider the trip itself and potential add-on activities as an essential part in the sequence between experienced factors and perceived travel time: because value is traditionally measured by the activities at destination, it is the travel activities that take a central part i.e. without which there would be no need to assess the worthwhileness of travel time. Hence all three components provide different facets of the reality of travel time use and therefore measuring all three components will give a more complete understanding of the phenomenon. Additional contextual factors may also influence the perceived worthwhileness of a trip. These are listed as *explanatory variables*, which consist of the door-to-door trip characteristics, the traveller’s personal characteristics and attitude, as well as spatial and temporal circumstances. The following subsections unpack in more detail each of these components.

3.1. Component A: experience factors

These are the factors affecting the quality of travel experiences such as comfort, convenience, frequency, reliability and the potential of gaining utility from spending time on other activities. The experience factors, or journey conditions, can enable the participation in activities while travelling, therefore, contributing to different levels of travel

time utilisation. Given that a journey involves positive and negative experiences, travel time evaluations should account for both effects while making sure that the value of activities and travel conditions are not double-counted (ITF, 2019). The quality components of a trip may be satisfiers or dissatisfiers depending on the travellers' attitude and needs who then perceive travel time in a different way (Van Hagen, de Bruyn, & ten Elsen, 2017). In addition, being able to carry personal equipment can complement existing experience factors and allow the involvement in additional activities which can add value to the perceived travel time (Watts & Lyons, 2010). The importance weight that travellers assign to experience factors can change depending on the transport mode, stage of the journey (on-board time vs transfers) and individual preferences. Experience factors play a key role in enhancing travel experience also while walking or waiting in transfer points and interchanges (Hickman et al., 2015; Jiang, Christopher Zegras, & Mehndiratta, 2012).

3.2. Component B: travel activities

Activities are performed to provide a type of benefit to the participant (Lyons, 2019). Worthwhile activities contribute to utility levels during travelling while the trip itself constitutes an activity that people choose to undertake similar to other activities (Keseru & Macharis, 2018). Activities are typically distinguished between work and non-work related, or between productive and unproductive. The latter classification is associated with worthwhile versus wasted travel time. Another classification can be between useful (e.g. working or phoning) and pleasant (e.g. looking outside, making puzzles, talking) activities; the latter ones were found to have a stronger effect on trip valuation (Van Hagen et al., 2017). "Doing nothing" can also be a type of beneficial activity which may include relaxing, sleeping, snoozing, daydreaming, thinking, gazing out the window or people watching (Lyons et al., 2007).

The relevance weight and duration of each travel activity depend on various factors such as personal attitude, the activities expected to be performed at destination, travel companion(s) and the type of activity itself. The quality and total capacity for performing an activity can be undermined by unwanted efforts, external stressors that prevent engaging into worthwhile activities (Banister et al., 2019). Unwanted efforts can be (a) physical, when an effort is asked of or imposed on the body in undertaking travel e.g. having to stand in a crowded bus or climbing stairs with heavy luggage, (b) cognitive, when the effort is derived from the mental focus needed to execute the journey successfully e.g. difficulty in finding one's way, or attention-demanding environment, or (c) affective, which is the emotional influence of undertaking the journey e.g. in a stressful, unsafe or unreliable trip. For example, activities such as working or reading require more cognitive or physical resources compared to more passive ones like thinking or gazing out of the window.

Flexibility in how, where and when activities are undertaken is increasing with ICT enabling remote and mobile connections. The availability of wireless networks allows travellers to choose from a wider list of activities while on the move, enabling the actual use of travel time. The effect of multitasking in the valuation of travel time is found to be significant, while the traveller's attitude towards travel-based multitasking varies too (Ettema & Verschuren, 2008; Shaw et al., 2019).

3.3. Component C: perceived worthwhile travel time

While studies often focus on one of the perceived benefits of travel time (i.e. Enjoyment, Productivity and Fitness), these are likely to be interconnected. Identifying what makes a travel worthwhile also allows to characterise perceived wasted time from a traveller perspective i.e. travel time that is not productive, not enjoyable and not producing health benefits.

3.3.1. Enjoyment

This dimension of the travel experience contributes to the hedonic and eudaimonic aspects of subjective well-being (Roddis, Winter, Zhao, & Kutadinata, 2019; Shliselberg & Givoni, 2018). Empirical studies show that travel satisfaction influences emotional well-being and life satisfaction, with joy and pleasantness as potential experiences during travel (Friman, Gärling, Ettema, & Olsson, 2017). Enjoyment of a trip can therefore contribute to the realisation of the top aspect of the Maslow pyramid on self-actualisation representing the need for achieving one's full potential (Lugano & Cornet, 2018).

Enjoyment of a trip can be derived from various activities while travelling such as listening to music, reading, having a delicious meal, talking with friends or just enjoying the feeling of being able to do what you want (Páez & Whalen, 2010). It has also been found that there can be a measure of utility and enjoyment in the act of travelling itself, regardless of the trip purpose or any other activity in the origin or destination of the trip (Handy & Thigpen, 2019; Páez & Whalen, 2010). The travel itself can be enjoyable due to various feelings that may emerge such as autonomy, the thrill of speed, adventure, control, aesthetic enjoyment of scenery, satisfaction at a sense of mastery, novelty, escape, satisfaction of curiosity or freedom from the stresses of work and home (Morris & Guerra, 2014).

While enjoyment may be an effect of the trip itself, it can also result from any expected or predicted utility of activities planned at trip destination. Similarly, it can be associated with pleasant memories of previous travel experiences. These can play a role while planning for a trip to favour certain travel options rather than others. Even non-leisure travel such as commuting can be perceived as enjoyable (Ory et al., 2004). Furthermore, enjoyment in travel tends to "diminish one's awareness of travel amounts or reduce the cognitive weight that travel carries" (Ory et al., 2004). To the other end of this relation, empirical evidence suggests that enjoyment diminishes with longer travel time or distance in commute (Milakis & van Wee, 2018; Ory et al., 2004).

Finally, enjoyment levels and types of pleasantness can vary also across other explanatory variables of the conceptual framework, such as different modes of transport (Gatersleben & Uzzell, 2007; Mokhtarian & Salomon, 2001; Morris & Guerra, 2014) or socio-demographic attributes (Pronello & Camusso, 2011; Singleton, 2019).

3.3.2. Productivity

Being able to spend travel time in a productive way can lead to increased levels of satisfaction or enjoyment, and opportunities for productive time when travelling can influence travel choices (Páez & Whalen, 2010). Exploring the perceived acceptable commute time, productivity was reported as one of the most important factors along with travel mode and travel experience (Milakis et al., 2015). The value of productivity has been widely explored and quantified with the "Hensher equation" prevailing in the literature which

introduced the concept of productive travel time for business travel (Batley, 2015; Fowkes, 2001; Wardman et al., 2013). Based on this approach, Wardman and Lyons (2016) found that productive time is highest for train, followed by air travel, bus and car. According to Batley et al. (2017) activities related to work are presented more frequently on trains compared to cars. If engaging in any type of productive activity is possible while travelling, productivity levels when travelling are similar compared to an office environment (Wardman & Lyons, 2016).

The experienced productivity can also extend beyond the trip itself with a chain effect of on-board productivity affecting the level of productivity of activities conducted before or after a trip. Lyons and Urry (2005) present productivity distribution ranging from counter-productive to ultra-productive depending on the travel experience of individuals on given modes. Similarly, Holley, Jain, and Lyons (2008) suggest that idleness during a trip can influence productivity levels outside a trip and assist creativity by providing incubation time pointing out that travel time may be vital for some travellers.

The scope of productive travel activities has broadened in two directions. First, to ensure consistency with conventional assessment methods that distinguish between leisure and work trips, productivity can refer both to work-related (paid) tasks and to personal tasks, a distinction which is not made in the original Hensher formula. Second, thanks to the digital revolution and services made available across transport modes, productivity is no longer only associated with the traditional work environment. Every location can potentially support productive tasks, depending on the availability of wireless networks (Wang & Loo, 2019), availability of a power socket or tables (Department for Transport, 2009), and crowding levels (Hickman et al., 2015; Wardman et al., 2013). Passengers tend to experience higher levels of productivity compared to drivers (Keseru & Macharis, 2018) underpinning one of the main benefits to be gained from connected automated vehicles, which may be designed to enable a productive travel environment (Wadud & Huda, 2019). However, productivity gains from autonomous vehicles may also be less than anticipated due to the expected engagement of passengers with operation activities or concerns about travel-sickness (Singleton, 2018). Furthermore, Singleton (2019) claims that excessive “productive use of travel time may decrease sensitivities to travel time and cost” and consequently increase travel demand and automobile dependency.

3.3.3. Fitness

Health benefits of travel, especially those related to active travel, have been widely explored. Walking and cycling, even within transit time, provide a wide range of benefits to physical and mental health (Gössling & Choi, 2015; Mulley, Tyson, McCue, Rissel, & Munro, 2013; Heinen, van Wee, & Maat, 2010; Litman, 2016). Research on health benefits of cycling and walking is so extensive that it reaches detailed impact analysis on human health metrics such as blood lipids, blood pressure or blood lactate (Oja, Vuori, & Paronen, 1998). Less known is how the health element, used as an influential factor of travel behaviour, affects the perceived travel experience and the value travellers assign to travel time (De Vos, 2018). In this respect, it has been found that stress can be present and negatively influence travel experience (Hansen & Nielsen, 2014). In this context, Vaitsis, Basbas, and Nikiforiadis (2019) found that cycling was rated high in physical and mental health compared to private car or public transport, and on par

with walking. As mental health is associated more to enjoyment and well-being presented above, this section focuses on the traveller's physical health, or fitness.

Popularity of health apps embedded in smart phones and smart watches (Shaheen, Cohen, Zohd, & Kock, 2013) indicates that people place a high value on their fitness levels, and walking or cycling as a means of achieving this. Health is perceived as an important factor for mode choice, which is reported among the most frequent reasons for cycling (Gatersleben & Appleton, 2007). Hopkinson and Wardman (1996) demonstrated that health is one of the two primary factors influencing the reason to cycle together with enjoyment. In an exploratory factor analysis on attitudinal characteristics on cycling, Heinen, Maat, and Van Wee (2011) placed health benefits high among the 13 different attributes examined.

Health benefits remain a strong motivation for cycling even in winter when cycling rates decrease, stated as the leading reason for commuters continuing to cycle in the winter season (Bergström & Magnusson, 2003). In a similar way, physical exercise is found to be the main motive when it comes to longer distances in commuting by bicycle (Hansen & Nielsen, 2014).

3.4. Explanatory variables

The three key components of WTT interrelate with several *explanatory variables* which can play a key role in determining its perceived value. The explanatory variables are categorised into five broad groups with a non-exhaustive list of different elements representing each one of them (Banister et al., 2019; De Vos et al., 2013; Geurs, Boon, & Van Wee, 2009):

- door-to-door trip characteristics such as various trip purposes along the way or at destination, actual travel modes for each leg, distance, duration and costs of travel, transfers and associated waiting time;
- traveller's socio-demographic and socio-economic characteristics;
- traveller's attitude, referring to the personal context of travel in terms of mood, habits, beliefs, preferences regarding mode choice, use of travel time and schedule flexibility, personality traits, wider social context and cultural norms;
- spatial attributes, i.e. the type of geographical area where the trip takes place;
- temporal attributes referring to time constraints (expected arrival time, opening times), time of the day (peak vs non-peak), time of the week (work vs non-work day), or time of the year (season, holiday).

Each one of the three components of WTT could be influenced by the explanatory variables in a different way, depending on the specific characteristics of a trip. For example, the mood of a traveller can have an impact on the perceived value of travel time (Gao, Rasouli, Timmermans, & Wang, 2017): depending on how happy or sad a traveller is when starting a trip, it may result in assigning different weights on the enjoyment value or the emotional effort required to perform the same trip over different days. Different traveller attitudes such as personality or cultural background, can affect the type of traveller equipment one chooses to carry while conducting a trip, differentiating the content and quality of time while travelling.

The complexity of the concept is apparent considering that in the examples mentioned above, almost no component or variable stays constant over time and space. In rural areas, the scenery might be more appealing and without noise pollution compared to urban areas in which case a train passenger might not find value in gazing out of the window while travelling. In this case, still, assuming the scenery is more appealing in a rural setting, the same traveller might not be interested in performing this activity on a busy working day with strict time constraints.

All these explanatory variables require a systematic effort to be collected and even more, a careful consideration as to which variables are relevant at the data analysis step. Not all explanatory variables are always relevant or necessary to be included in travel behaviour analysis, however *Components A, B* and *C* are present in every trip.

3.5. Case study

We designed a mobile app and conducted an app-based survey to provide first insights on capturing the various components of the proposed conceptual framework on WTT. The mobile app, called Woorti, was designed to automatically detect trip legs and transport modes based on measurements from mobile phone sensors. The app then prompts the traveller to validate the recorded trips, to confirm the trip purpose per trip, and to answer questions for each of the three components of the conceptual framework: experience factors, travel activities, and travel time worthwhileness assessment (see Cornet, Baradale, Bernardino, & Lugano, 2019).

The data consists of 120,713 trip legs (67,177 door-to-door trips) validated by 3,330 users between May and December 2019 in 8 European countries (Table 1). The data collection campaigns were designed to avoid a purely convenience sample by setting representativity targets for basic socio-demographic characteristics such as age and gender (Hudák & Cornet, 2019). Participants were asked to use the app for a period of 14 consecutive days. On average, each trip consisted of roughly 2.5 trip legs, including transfers. Walking represents a high share in the number of trip legs (45.4%), but a low share in distances travelled (4.3%). In comparison, car use (for both driver and passenger) represents a quarter of all trip legs (24.5%) and half of the distances travelled (51.7%). The “Train” category includes urban, intercity, and

Table 1. The number of trips and their distribution per mode (trips and travel distance) captured in the app-based case study.

Trips		Mode share		
Type	Number	Mode	Trip legs	Travel distance
Door-to-door	64,098	Walking	45.4%	4.3%
Legs	120,713	Car driver	20.0%	39.7%
Waiting events	38,184	Bicycle	13.6%	8.8%
		Bus	6.3%	5.9%
		Car Passenger	4.5%	12%
		Train (all types)	3.3%	14.6%
		Subway	2.0%	1.6%
		Electric bike	2.0%	2.1%
		Tram	0.9%	0.5%
		Plane	0.1%	6.6%
		Other modes	2.1%	3.9%
		Total	100%	100%

high-speed trains. “Other modes” include together the other 18 modes (out of 26) originally provided in the Woorti app, including, for example, motorcycle, taxi, ferries, long-distance bus, bike-sharing (Cornet et al., 2019). The project dataset is openly available (Consonni et al., 2021).¹

3.5.1. Experience factors

Based on a long list of mode-specific experience factors, the app survey asked respondents to mark those that contributed to a positive or a negative travel experience (Component A of the conceptual framework). This approach allows distinguishing expected travel conditions that are taken for granted as essential conditions (which travellers are likely to complain about if missing), from those that are not expected but appreciated for enhancing the travel experience (which travellers are likely to recognise if present but not to complain about if missing). This distinction may be relevant for transport operators in prioritising service improvements. Travel conditions that were most often reported either positively or negatively are identified as important overall. Table 2 provides an example of the data collected for public transport (PT).

For example, travellers often negatively rated the lack of internet connectivity, charging opportunity, high noise levels and crowdedness which may indicate these have high but unmet expectations when using public transport. On the other hand, they reported the “Ability to do what I want while I travel” as a positive factor, and much less often as a negative factor, which indicates that overall travellers may have low expectations but do value positively the freedom that public transport can provide in terms of using their travel time for something worthwhile. Finally, seating quality and availability, reliability, ride smoothness, and the weather were consistently rated as overall important influence factors of the travel experience, both positive or negative.

3.5.2. Travel activities

The app survey asked respondents to select travel activities they engaged with which they found to be valuable, including conducting the trip itself (Component B of the conceptual framework). It also asked to rate the type of value they gained from those activities on a simple 3-point Likert scale (0-None, 1-Some, 2-High): Enjoyment value, Productivity value (distinguished between Paid work and Personal tasks) and Fitness value. This emphasises the interdependency of travel activities and perceived worthwhileness of travel time. To achieve a high level of user engagement, relevance and duration for each activity and unwanted efforts were not collected in the Woorti app, as they would have been regarded as too demanding to specify in real-time for each trip leg.

Table 2. Expected, appreciated and important factors in public transport contributing to the travel experience.

Expected (most frequently rated negatively)	Appreciated (most frequently rated positively)	Important (most frequently rated positively or negatively)
Internet connectivity	Simplicity/difficulty of the route	Seating quality/personal space
Privacy	Ability to do what I want while I travel	Reliability of travel time
Noise level	Security and safety	Vehicle ride smoothness
Other people	Payment and tickets	Crowdedness/seat availability
Charging opportunity	Cleanliness	Today's weather

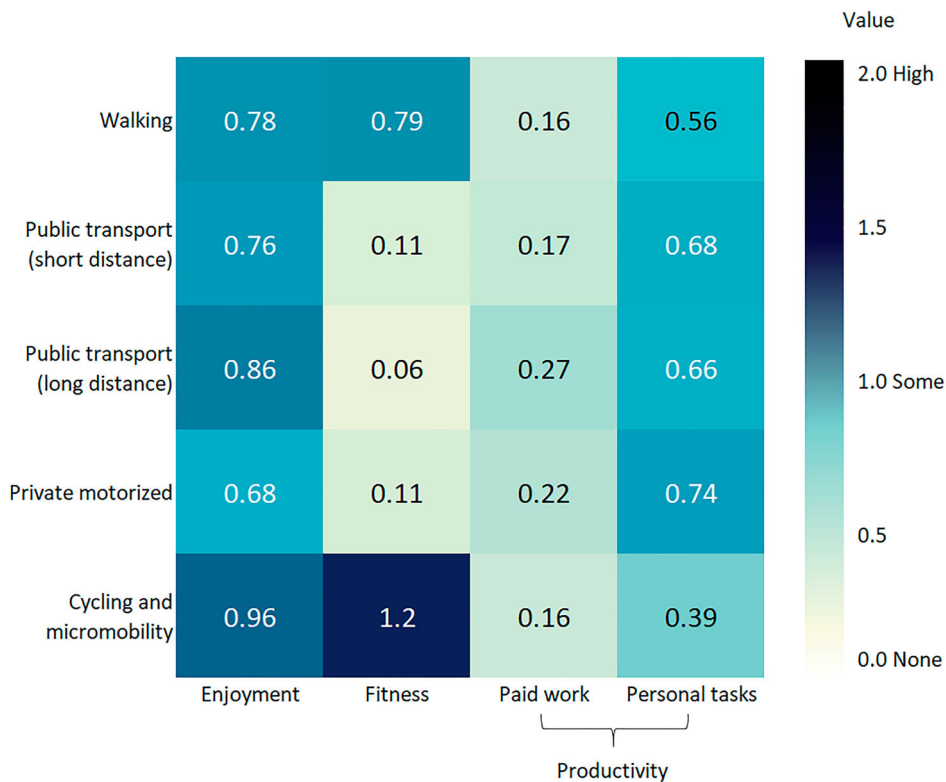


Figure 2. The average value (enjoyment, fitness, productivity) reported as gained from activities during travel per mode in our case study.

Indicative results show that, at aggregate levels, value peaked when travellers felt empowered to conduct up to five different activities during the same trip leg, with the most popular activities being accompanying someone, thinking, talking (including on the phone), listening to audio, and browsing on the internet (including social media). [Figure 2](#) illustrates an example of the average value of Enjoyment, Fitness and Productivity gained by the activities during travel per mode. Paid work ranked comparatively low in value (0.16–0.27) in all modes, even when it is most expected to take place such as on long-distance public transport (0.27). Activities associated with the accomplishment of personal tasks were valued higher by private motorised and public transport mode users. The main value derived from travelling is Enjoyment (0.68–0.96), with Fitness taking a particularly high value for active modes (1.20) and low value (0.06–0.11) for private motorised modes and public transport. When averaging across modes, Enjoyment (0.808) stood higher than Personal tasks (0.606), Fitness (0.454), or Paid work (0.196).

3.5.3. Perceived worthwhile travel time

To complement the specific value obtained from conducting travel activities, travellers were also asked to assess their travel time worthwhileness on a scale of 1–5 stars, with 1-star representing that all travel time was wasted and 5-stars representing that all

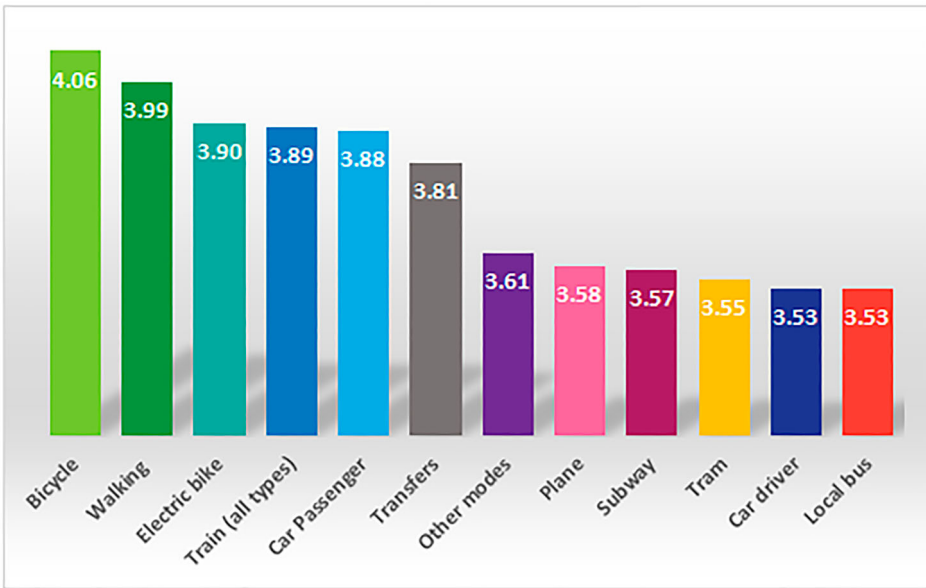


Figure 3. The average level of travel time worthwhileness per mode in our case study (1: wasted travel time, 5: worthwhile travel time).

time was considered worthwhile (Component C of the conceptual framework). Overall, 52% of trip legs were given a travel time worthwhileness assessment by respondents.

The results in our case study (Figure 3) show that bicycle (conventional: 4.06 and electric: 3.90), walking (3.99) and train travellers (3.89) along with car passengers (3.88) experience the highest levels of travel time worthwhileness. Car drivers (3.53), users of other forms of public transport (subway: 3.57, tram: 3.55, and local bus: 3.53) and plane passengers (3.58) experience the lowest travel time worthwhileness. Transfers seem to offer moderate levels of travel time worthwhileness (3.81).

4. Discussion and conclusions

This paper contributes to the literature with a deeper exploration of the perceived experience of travel time and consequently the development of a conceptual framework on WTT. We reviewed the topic of WTT and perceived travel experience in travel behaviour, psychology, economics, and public health research and we developed the conceptual framework of WTT based on the traveller's perception of three forms of value emerging from existing literature: enjoyment, productivity, and health. In the following sections, we first discuss the conclusions of our literature review on WTT and on the suggested conceptual framework of WTT, and then we discuss their policy implications.

4.1. Worthwhile travel time

Worthwhile travel time reflects the idea that travel can be pleasant, meaningful or worthwhile and not exclusively associated with the economic dimensions of utility and productivity. WTT does not exclude the idea that travel may be productive, but rather

introduces the notion that multiple types of “value” derived from the perceived experience of travel may be associated with each specific journey. Exploring the multiple types of value that worthwhile time encompass is challenging first to conceptualise, but also to measure and interpret. It might be this complexity and wickedness of WTT conceptualisation, measurement and interpretation that lay the ground to rather more simplified approaches, such as the wage rate, typically applied in traditional transport appraisal.

However, according to the outcomes of our review, there are several literature streams supporting that travel should not be considered as purely derived demand or wasted time. These literature streams support the core assumption of WTT that travel is associated with multiple types of positive and negative value. First, from a microeconomic research perspective, scholars have argued for a positive, intrinsic or experienced utility of travel time. Second, from a psychology and travel behaviour research perspective, studies have shown that travel can be worthwhile for multiple reasons such as transitioning between locations, multitasking, killing time, experiencing flow states or experiencing longer-term benefits such as personal growth and self-realisation.

Moreover, our literature review revealed that WTT refers to the personal value derived from the perceived experience of travel and thus is by definition a subjective, qualitative judgment influenced by a multitude of factors, including the attributes of the trip itself or travellers’ preferences and attitudes. Such an approach for WTT brings forth the following considerations about the value of a trip: (a) a trip from a traveller perspective is door-to-door and therefore the experience of a trip should cover all movements (most likely involving multiple modes, including walking) as well as connections between them, (b) the traveller’s perceived value of a trip can be seen on a continuum ranging from utilitarian or fast travel (with perceived worth deriving from the activity at the destination) to undirected or slow travel (perceived worth deriving from the trip itself), (c) a trip should not be considered as having one purpose only associated with the activity at the destination. Instead, the trip purposes should reflect the richness of values deriving from the activities at the destination, those conducted while travelling and the joy of travelling itself, (d) the trip purposes do not necessarily dictate how savings in travel time would be used, nor do they dictate the type of activities (work-related or not) the traveller might perform while travelling, and (e) the acceptability of travel time implies both that the experience of travel is subjective, that it is individual, and that it may vary with time, distance and speed of the trip.

Based on the outcomes of our literature review and the interdisciplinary collaboration within the MoTiV consortium, we analytically introduced a conceptual framework on WTT suggesting that the travel time from the perspective of the traveller can be decomposed into three types of value – Enjoyment, Fitness and Productivity. Our conceptual framework of worthwhile time is based on the understanding that experience factors (Component A) can enable travel activities (Component B), which in turn unlock the values of enjoyment, productivity and fitness (Component C). This finally results in a perception of WTT. Experience factors involve travel conditions as experienced by the traveller depending on the availability and quality of transport services or on external factors such as the weather. Travel activities can involve the activity of conducting the trip itself or the ability to conduct add-on activities while on-the-move. The worthwhileness level experienced by a traveller is defined by three types of perceived value (enjoyment,

productivity and fitness). Additional (explanatory) variables such as the door-to-door trip characteristics, the traveller's personal characteristics and attitude, and the spatial and temporal circumstances may also influence the perceived worthwhileness of a trip.

According to the outcomes of our app-based case study in eight European countries, out of the three types of value in our conceptual framework of worthwhile time, enjoyment in relation to travel activities (including the trip itself) was generally found to be the most important aspect in turning wasted travel time into WTT at aggregate level (across all travellers and transport mode categories). Productivity played an important role in shaping travel time savings and improvements in the perceived travel experience. Fitness value was found to play an important role in walking, cycling and emerging micro-mobility modes, which account for a high share of trip legs when considered from a door-to-door perspective and total travel time. In this case, and contrary to other modes like public transport, the value came directly from conducting the trip itself and not from conducting additional activities when travelling.

Overall, the suggested conceptual framework of WTT addresses the need for a multi-disciplinary approach in tackling the wicked issue of travel time experience. Our conceptual framework also contributes to the ongoing debate on whether and how to account for travellers' experiences in transport appraisal (ITF, 2019): the traveller perspective extends the conventional view on value of travel time emphasising cost and time savings by demonstrating that travellers create value by making meaningful uses of travel time, both in transport and in transfers. This approach is also an effort to integrate the existing knowledge from different transport disciplines into a framework that is actionable for policy and business applications.

Future research could focus on the validation of the suggested conceptual framework of worthwhile time. Mixed-method approaches that would involve qualitative methods (e.g. semi-structured interviews, ethnographic methods) in combination with quantitative methods (e.g. structural equation modelling based on questionnaire surveys and big data analytics) would allow a deep exploration of the causal relationships among the individual factors and the three components of our conceptual framework. Such an approach would also shed light on the strength and direction of the influence of the explanatory variables on the factors and components of the conceptual framework. Further work on the traveller's attitude dimension, as an explanatory variable of the conceptual framework, is also suggested to better account for the wider experience of time in different contexts (e.g. at home, at work), for example by intersecting attitudes towards transport modes and time use.

4.2. Policy implications

Understanding the perceived value of travel time may be particularly relevant for the sustainable mobility field, which makes a compelling case for a rapid transition away from high-carbon internal-combustion engine and single-occupancy personal vehicles to more environmentally neutral and socially inclusive modes of transport (Gärling, Ettema, & Friman, 2014; Geerlings, Shiftan, & Stead, 2012). Moreover, to make an accurate assessment of the societal effects of emerging mobility solutions such as automated vehicles requires a way to assess a wider range of impacts beyond conventional economic or time measures.

In the same way that air pollution levels and their impacts on human health determine improvements in environmental efficiency of transport services, the fact that enjoyment in the perception of the travel experience may be more important in some cases than traditional factors such as total travel time or costs indicates that new investments in transport systems should also be guided by qualitative and user-centric measures.

Our conceptual framework could contribute to improving current appraisal methods, particularly cost–benefit approaches (CBA). The low perceived value of productivity, and particularly paid work, challenges the foundations in economic appraisals of transport that travel time savings on work trips are to be reallocated to more work. Our study questions the assumption of CBA methods that travel time is wasted, and therefore that travel time savings are to be accounted as a benefit. This invites further reflection on ways to go beyond adopting different monetary values of reductions in travel time for different modes or journey characteristics, particularly for work-related trips. Perhaps it is the wasted time in transport that should be considered as a cost.

The main policy consequence from considering travel time as potentially worthwhile is to unlock the possibility for future transport investment to more adequately balance between reducing journey times and improving the quality of a journey (Banister et al., 2019). This is particularly true when taking a multimodal perspective, where transforming environmentally friendlier modes into more attractive travel experiences could support a transition towards low-carbon mobility (Páez & Whalen, 2010). For example, it is apparent that health benefits embedded in cycling and walking drive travel behaviour and affect choices of travellers. Systematic attention to this dimension of perceived travel experience followed by policies and regulations could unlock the potential for combining exercise and travel time (Hansen & Nielsen, 2014). This study also raises the question of what could happen if all travel time was 100% worthwhile: higher quality or value of travel time may mean that people would be willing to travel longer time and therefore longer distances (Ettema & Verschuren, 2008; Metz, 2008; Mokhtarian, 2018).

In this vein, to enable decisions that account for the traveller's perspective, future research could investigate how the worthwhile time concept can be integrated in transport appraisal practice such as CBA, for example through a numerical index similar to the Hensher equation (Wardman et al., 2013) or a complementary qualitative assessment.

Note

1. The dataset has been collected within the Horizon 2020 (H2020) project MoTiV and it complies with the H2020 regulation, MoTiV, Grant Agreement, EU/General Data Protection Regulation (GDPR), data protection legislation of the countries involved, and the European Research Code of Conduct for Research Integrity. Participants explicitly provided consent for the data collection through the app. Internal deliverables related to Ethics and Data Protection were approved by an independent Ethics Committee established for the project.

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ORCID

Yannick Cornet  <http://orcid.org/0000-0003-2590-9678>

Giuseppe Lugano  <http://orcid.org/0000-0001-5598-8579>

Christina Georgouli  <http://orcid.org/0000-0002-5324-4936>

Dimitris Milakis  <http://orcid.org/0000-0001-5220-4206>

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