Exploring Worthwhile Travel Time

Design Challenges of Capturing the User Experience by Smartphone

Yannick Cornet

H2020 MoTiV project, Woorti app
ERAdiate Team, University of Žilina (Slovakia)

yannick.cornet@uniza.sk
References


Smart Cities .. for people

- Gap: no attempt to collect data on travellers’ satisfaction while in transport

Measuring travel time “productivity”

Hensher formula

• $p = \text{average amount of time spent working while travelling}$
• $q = \text{relative productivity of work done while travelling compared with in the office}$

$p = 0.11 - 0.46$
(new: $0.30 - 0.57$)

$p = 0.07 - 0.36$

$p = 0.03 - 0.17$

$p = 0.02 - 0.22$

$q = 0.89 - 1.15$

$q = 0.99 - 1.02$

$q = 0.83 - 1.26$

$q = 0.90 - 1.20$

The bigger picture

- Why “worthwhile time” instead of “productive time”?  
  - Quality of living is not only about “effective” and “productive” use of time  
  - Need to extend “time and cost savings” objective with other relevant dimensions and indicators of value

- Liveable Smart City Transition: enhance perceived and experienced “quality of time” for higher quality of life (QoL)

<table>
<thead>
<tr>
<th>EUR per person-hour</th>
<th>Commuting/Leisure/Other</th>
<th>Work/Business trip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time</td>
<td>12.14 €</td>
<td>51.64 €</td>
</tr>
<tr>
<td>Delays (bicycle, car)</td>
<td>18.21 €</td>
<td>77.45 €</td>
</tr>
<tr>
<td>Delays (public transport)</td>
<td>36.42 €</td>
<td>154.91 €</td>
</tr>
<tr>
<td>Waiting Time</td>
<td>24.28 €</td>
<td>103.27 €</td>
</tr>
<tr>
<td>Transfer time</td>
<td>18.21 €</td>
<td>77.45 €</td>
</tr>
</tbody>
</table>

Example of monetary travel time values used by the Danish ministry of Transport (2018 values).
Travel “worthwhileness”

Trip leg worthwhileness index

- Productivity
- Enjoyment
- Fitness

Comfort factors & travel services

- Importance weight
- Satisfaction level

Activities

- Relevance weight
- Duration

Satisfiers, enablers to a worthwhile experience

Ability to engage in a worthwhile activity

Unwanted Efforts

- Physical
- Cognitive
- Emotional

Wasted time

Time ‘stolen’ by the act of travelling
General approach

- Smartphone-based data collection via the Woorti app
  - Focus on the individual travel experience
- Target
  - Minimum 5,000 valid samples in 10 EU countries
  - Active app use for minimum 14 days, 1 trip/day survey
  - Multimodal
- Release of Open Dataset at the end of the project
1. **User profile:** onboarding data, socio-geo-demographics
2. **Mobility layer:** automatic detection of start and end of trips and transport modes
3. **Experience layer:** trip purpose(s) and worthwhileness assessment
4. **Dashboard and mobility coach:** to feed data back to users
5. **Survey feature:** to collect additional information
Design challenges: Look and feel

• ‘Woorti’ = convey concept of worthwhile travel time
• Language and color
  • Orange intentionally fresh, youthful, creative and adventurous
  • Brown added to give a holistic, organic, simple and honest feel to the app
• Aim to appeal to a wide range of travelers across generations and socio-geodemographic profiles
Worthwhile Travel Time in MoTiV

Make your journey worthwhile:
Using travel time to get things done, not only for work or study, but also personal things like managing home or family stuff.
Worthwhile Travel Time in MoTiV

Making your journey worthwhile:

- Enjoyment
- Relaxing or having fun
- Listening to music, resting, or meditating
- Engaging in social media
- Observing the surroundings
Worthwhile Travel Time in MoTiV

Fitness

When you walk, cycle or even run on your travels, you’re getting exercise and keeping in shape.

Make your journey worthwhile:
Design challenges: Trip purposes

- Traditionally: purpose at destination determines leisure vs work trip which determines the value of (wasted) travel time
  - But latest research shows that most people would take travel time reductions as leisure time, not worktime!
- Also trip can consist of many purposes, with anchor and secondary purposes.
Design challenges: Trip purposes

- “Mark all that apply”
  - Not based on activity or location, but simplified
  - Yet keep compatibility with existing surveys

- Time constraint:
  - “Did you have to arrive at a specific time”? (yes/no)

- Newness:
  - “How often do you make this trip?” (Regularly, Occasionally, First time)
Design challenges: Trips and trip legs

• What a trip ‘is’ can be contentious....

• Design decisions
  • A stop at a location for < 30 min = transfer
  • A stop > 30 min = destination = end of the trip
  • One trip leg = one single mode
  • Trip legs can be merged or split

• Trip leg modes are automatically detected but must be validated
  • In practice the self-learning algorithm can only distinguish between rail, bus, car, cycling or walking (max 60% accurate)
Design challenges: Transport modes

- Onboarding: preferred modes
- 3 categories of modes
- ... and yes, wheelchair matters

TABLE I
TRANSPORT MODE LIST

<table>
<thead>
<tr>
<th>Public Transport</th>
<th>Active/Semi-active</th>
<th>Private Motorized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro</td>
<td>Walking</td>
<td>Private Car (Driver)</td>
</tr>
<tr>
<td>Tram</td>
<td>Jogging/Running</td>
<td>Private Car (Passenger)</td>
</tr>
<tr>
<td>Bus/Trolley Bus</td>
<td>Wheelchair</td>
<td>Taxi/Ride Hailing</td>
</tr>
<tr>
<td>Coach/Long-distance Bus</td>
<td>Bicycle</td>
<td>Car Sharing/Rental (Driver)</td>
</tr>
<tr>
<td>Urban Train</td>
<td>Electric Bicycle</td>
<td>Car Sharing/Rental (Passenger)</td>
</tr>
<tr>
<td>Regional/Intercity Train</td>
<td>Cargo Bike</td>
<td>Moped</td>
</tr>
<tr>
<td>High-speed Train</td>
<td>Bike Sharing</td>
<td>Motorcycle</td>
</tr>
<tr>
<td>Ferry/Boat</td>
<td>Micro Scooter</td>
<td>Electric Wheelchair/Cart</td>
</tr>
<tr>
<td>Airplane</td>
<td>Skateboard</td>
<td>Other (please specify)</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>Other (please specify)</td>
<td>Other (please specify)</td>
</tr>
</tbody>
</table>
Design challenges: Worthwhileness

Trip leg worthwhileness index

- Extremely worthy
- Moderately worthy
- Slightly worthy
- Neutral
- Slightly unworthy
- Moderately unworthy
- Extremely unworthy

Comfort factors & travel services
- Importance weight
- Satisfaction level

Activities
- Relevance weight
- Duration

Satisfiers, enablers to a worthwhile experience

Activities
- Ability to engage in a worthwhile activity

Unwanted Efforts
- Physical
- Cognitive
- Emotional

Wasted time

Time ‘stolen’ by the act of travelling

Importance weight
Satisfaction level
Relevance weight
Duration

Productivity
Enjoyment
Fitness
Design challenges: Worthwhileness

1. Capture “feeling” of trip as a whole (must collect soon after trip is completed)
2. Capture Wasted vs Worthwhile assessment for a specific trip leg
Design challenges: Worthwhileness

- How to account for counter-productive or ‘ultra’-productive time?
  - Likert scale is limited...
## Design challenges: Travel activities

### Trip leg worthwhileness index
- **Productivity**
- **Enjoyment**
- **Fitness**

### Comfort factors & travel services
- **Importance weight**
- **Satisfaction level**

### Activities
- **Relevance weight**
- **Duration**
  - Ability to engage in a worthwhile activity

### Unwanted Efforts
- **Physical**
- **Cognitive**
- **Emotional**
  - Time ‘stolen’ by the act of travelling

### Wasted time

<table>
<thead>
<tr>
<th>Trip leg worthwhileness index</th>
<th>Comfort factors &amp; travel services</th>
<th>Activities</th>
<th>Unwanted Efforts</th>
</tr>
</thead>
<tbody>
<tr>
<td>5min</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45min</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10min</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>15min</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>15min</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extremely worthy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderately worthy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slightly worthy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slightly unworthy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderately unworthy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extremely unworthy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extremity</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely worthy</td>
<td>+5</td>
</tr>
<tr>
<td>Moderately worthy</td>
<td>0</td>
</tr>
<tr>
<td>Slightly worthy</td>
<td>-5</td>
</tr>
<tr>
<td>Slightly unworthy</td>
<td>-10</td>
</tr>
<tr>
<td>Neutral</td>
<td>-20</td>
</tr>
</tbody>
</table>

### Satisfiers, enablers to a worthwhile experience
- **Enjoyment**
- **Productivity**
- **Fitness**
Design challenges: Travel activities

- ‘Built-in’ vs ‘add-on’ activities
- Separate value of activity vs actual activity
- Value may with journey purpose
- Nuance with paid vs unpaid work
- Relevance for operators
Design challenges: Experience factors

- Trip leg worthwhileness index:
  - Productivity
  - Enjoyment
  - Fitness

- Comfort factors & travel services:
  - Importance weight
  - Satisfaction level
  - Satisfiers, enablers to a worthwhile experience

- Activities:
  - Relevance weight
  - Duration
  - Ability to engage in a worthwhile activity

- Unwanted Efforts:
  - Physical
  - Cognitive
  - Emotional
  - Time ‘stolen’ by the act of travelling

- Wasted time

- Time: 5min, 45min, 10min, 15min, 15min

- Ratings:
  - Extremely worthy
  - Moderately worthy
  - Slightly worthy
  - Slightly unworthy
  - Moderately unworthy
  - Neutral
  - Extremely unworthy
### Design challenges: Experience factors

- Explanatory causes for worthwhile time
- When to ask? Onboarding, trip or trip leg?
- How to ask? Noisy vs quiet, or Noise level?

- Exhaustive list can be long, .. and hard to categorise
- Getting there
  - Everything about (cognitive, physical or emotional) efforts in figuring out how to get there
- Comfort and pleasantness
  - Factors helping to get things done or enjoy the ride

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<table>
<thead>
<tr>
<th>What factor(s) made your time feel Wasted (-) or Worthwhile (+)?</th>
<th>+5 / 30 pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities</td>
<td></td>
</tr>
<tr>
<td>Getting there</td>
<td></td>
</tr>
<tr>
<td>While you move</td>
<td></td>
</tr>
<tr>
<td>Comfort and pleasantness</td>
<td></td>
</tr>
<tr>
<td>Vehicle ride smoothness</td>
<td>- +</td>
</tr>
<tr>
<td>Seating quality/personal space</td>
<td>- +</td>
</tr>
<tr>
<td>Other people</td>
<td>- +</td>
</tr>
<tr>
<td>Privacy</td>
<td>- +</td>
</tr>
</tbody>
</table>
Design challenges: gaps (in grey)

- **Trip leg worthwhileness index**
  - Productivity
  - Enjoyment
  - Fitness

- **Comfort factors & travel services**
  - Importance weight
  - Satisfaction level

- **Activities**
  - Relevance weight
  - Duration

- **Satisfiers, enablers to a worthwhile experience**

- **Unwanted Efforts**
  - Physical
  - Cognitive
  - Emotional

- **Wasted time**

- **Ability to engage in a worthwhile activity**

- **Time 'stolen' by the act of travelling**
Other known research and UI gaps

- Trip satisfaction scale (lousy <-> great) may be too rudimentary
  - Literature recommends to cover affective (bored <-> enthusiastic, stressed <-> calm, .. ) and cognitive (travel did not work out well <-> worked out well) aspects (up to 9 dimensions!)
- Experience factors too complex, requiring redesign
- Attitudinal factors and profiles not yet fully developed
- Role of ICT in a worthwhile experience not explicitly captured
  - The rate of increase of Willing-to-pay to save time is growing slower than GDP
  - ICT increasingly used for complex trip-chaining across modes
  - Circular effect: users who expect to put their travel time to use bring ICT along
- Little explicit focus on the role of transfers
Key take-aways

• Assessing the perceived value of travel time is complex
  • No single perfect approach
  • Interdisciplinary challenge

• Need to achieve optimal balance among many conflicting requirements
  • Usability
  • Implementability
  • Clarity
  • Precision
  • Comprehensiveness
  • Respondent psychology
  • Data collection requirements
  • Qualitative vs quantitative
  • Assumed causal chains
  • Risk of biases...

• We welcome your ideas and best practices for Woorti v2.0!
Live survey: https://www.menti.com/nt7gnippf5

and you can see the results here

https://www.mentimeter.com/s/4592e2f89212c279ec6e557a079af422/5be52ad38014
Research Impact

Promoting valuable urban travel experiences: Policy implications and various reflections

Yannick Cornet

H2020 MoTiV project, Woorti app
ERAdiate Team, University of Žilina (Slovakia)

yannick.cornet@uniza.sk

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Valuable urban travel experiences?
Retrofitting road infrastructure
Politics of space

Here are 200 people in 177 cars

A.

How most traffic engineers see your city

B.

How cities should be designed
Transition towards a new, sustainable urban and mobility systems

- More environmentally friendly
- Lower carbon footprint
- Lower space footprint

- Better travel experience for users?
- Better quality-of-life for citizens?
Impact on impact assessment

Reasonable travel time:
• Shift in transport planning
• Balancing quantify and quality
• Trade-offs between travel speed and travel experience

How to integrate into CBA?
• Challenge assumption of wasted time in transport?
  • VTTS includes two types of time savings: quantity and quality of travel time, OR
  • VTTS *not* a benefit

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Banister, David, Yannick Cornet, Moshe Givoni, and Glenn Lyons. “Reasonable Travel Time – The Traveller’s Perspective.” In Transport, Space and Equity. (Forthcoming).
.. is the transition fast enough?

Deep Adaptation:
A Map for Navigating ClimateTragedy

IFLAS Occasional Paper 2
www.iflas.info
July 27th 2018

Professor Jem Bendell BA (Hons) PhD

Occasional Papers

Occasional Papers are released by the Institute of Leadership and Sustainability (IFLAS) at the University of Cumbria in the UK to promote discussion amongst scholars and practitioners on themes that matter to our staff and students. Typically, an Occasional Paper is released prior to submission to an academic journal, as a method for receiving feedback. For instance, the first Occasional Paper, by Professor Jem Bendell and Professor Richard Little, was subsequently published in the Journal of Corporate Citizenship. However, this paper was rejected for publication by reviewers of Sustainability Accounting, Management and Policy Journal (SAMP), as reviewers made requests for major changes which were considered by the author as either impossible or inappropriate to undertake. Impossible, as the request to build off existing scholarship on this topic would require there to be publications on the implications of ecologically-induced social collapse, globally, upon which to build. A literature review indicated that there is not such scholarship in management studies. Inappropriate, as a reviewer’s request not to dishearten readers with the claim of “inevitable...

“Recent research suggests that human societies will experience disruptions to their basic functioning within less than ten years due to climate stress. Such disruptions include increased levels of malnutrition, starvation, disease, civil conflict and war – and will not avoid affluent nations.”
.. is the transition fast enough?

Trajectories of the Earth System in the Anthropocene

Will Steffen, Johan Rockström, Katherine Richardson, Timothy M. Lenton, Karl Folke, Diana Liverman, Colin P. Summerhayes, Anthony D. Barnosky, Sarah E. Cornell, Michel Crucifix, Jonathan F. Donges, Ingo Fetzner, Steven J. Lade, Marten Scheffer, Ricarda Winkelmann, and Hans Joachim Schellnhuber

Edited by William C. Clark, Harvard University, Cambridge, MA, and approved July 6, 2018 (received for review June 19

We explore the risk that self-reinforcing feedbacks could push the Earth System toward a threshold that, if crossed, could prevent stabilization of the climate at intermediate temperatures—a “Hothouse Earth” pathway even as human emissions are reduced. The threshold would lead to a much higher global average temperature than any interglacial in the last 12 million years and to sea levels significantly higher than at any time in the Holocene. We present evidence that such a threshold might exist and where it might be. If the threshold is crossed, the resulting trajectory would likely cause serious disruptions to ecosystems, society, and economic human action is required to steer the Earth System away from a potential threshold and stabilize toward a habitable interglacial-like state. Such action entails stewardship of the entire Earth System—climate, and societies—and could include decarbonization of the global economy, enhancement of carbon sinks, behavioral changes, technological innovations, new governance arrangements, and transformed social values.

Earth System trajectories | climate change | Anthropocene | biosphere feedbacks | tipping elements

The Anthropocene is a proposed new geological epoch (1) based on the observation that human impacts on essential planetary processes have become so profound (2) that they have driven the Earth out of the Holocene epoch in which agriculture, sedentary com-
Publication roadmap

• The experience of travel time, worthwhile or wasted? An interdisciplinary conceptual review and synthesis
• Productive, enjoyable or healthy use of travel time: using smart-phone based data to generate a modal worthwhileness index
• Integrating the experience of travel in cost-benefit analysis: application of the worthwhileness index to three European transport cases and implications for appraisal
• Technology papers: AI, travel and mode detection learning algorithms..
• Mode choice vs experience papers: focus on cycling, focus on gender equity, ..
Contact us:
Giuseppe Lugano
giuseppe.lugano@uniza.sk
www.motivproject.eu
Additional slides
# Unwanted efforts

<table>
<thead>
<tr>
<th>Effort type</th>
<th>Definition</th>
<th>Example</th>
<th>Intervention</th>
</tr>
</thead>
</table>
| Physical    | Effort asked of and imposed on the body in undertaking travel | Standing in a crowded bus | • Reducing transport connections and "smoothing them by integrating the transport networks  
  • Improving comfort, e.g. seating, personal space, or by alleviating crowding or travel-sickness  
  • Improving travel services, e.g. accessibility for the mobility-impaired, or younger/older people |
| Cognitive   | Mental focus that is needed to execute the journey successfully | Noisy or attention-demanding environment | • Improving the familiarity with the transport system  
  • Improving the ability to plan the journey effectively  
  • Reducing unwanted distractions |
| Affective   | Emotional influence of undertaking the journey | Stressful, unsafe or unreliable | • Improving the perceived security or pleasantness of travel  
  • Improving reliability |
Trip Detection

- Mobile sensor data are collected from device by app in background
- Combining GPS and accelerometer data to classify a user’s movement
- Many existing apps: MOVE, TravelVu, etc.
- Main challenge: battery consumption…
19 research hypothesis: design of KPIs to feedback to users is ongoing

<table>
<thead>
<tr>
<th>#</th>
<th>RTT</th>
<th>Name</th>
<th>Purpose</th>
<th>VPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Door-to-door time</td>
<td>To explore how the choice of modes and route is influenced by the door-to-door travel time and experience.</td>
<td>Time</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Reliable door-to-door time</td>
<td>To explore how VTT is influenced by the reliability of the planned travel choice.</td>
<td>Time</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Trip planning time</td>
<td>To explore how time spent on travel planning and preparations impacts travel choices and VTT.</td>
<td>Time</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Time constraints</td>
<td>To explore how VTT is influenced by perceived hard time constraints.</td>
<td>Time</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Acceptable travel time</td>
<td>To explore how VTT is influenced by the acceptable travel time.</td>
<td>Time</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Travel time budgets</td>
<td>To explore how closely the Travel Time Budget (TTB) matches with a constant 70+10 minutes per day after factoring in time considered worthwhile.</td>
<td>Time</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Trips purposes</td>
<td>To investigate the urgency and importance of activities conducted at destination.</td>
<td>All dimensions</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Diversity of location activities</td>
<td>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.</td>
<td>Comfort</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Modal distances</td>
<td>To explore how many urban trips are short distances.</td>
<td>Safety, Well-being</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Proportion of worthwhile time</td>
<td>To explore how VTT is influenced by the share of worthwhile travel time out of total travel time.</td>
<td>Comfort</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Unwanted efforts</td>
<td>To explore how VTT is influenced by physical, cognitive or emotional effort related to the travel.</td>
<td>Comfort</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Travel activities</td>
<td>To explore how VTT is influenced by the range and diversity of activities while travelling.</td>
<td>Comfort, pro-social</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>Smartphone-based activities</td>
<td>To explore how VTT is influenced by smartphone apps and the time spent on them.</td>
<td>Comfort</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Value of travel activities</td>
<td>To explore how VTT is influenced by the perceived worthwhileness of a trip leg.</td>
<td>Comfort</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Travel comfort factors</td>
<td>To explore how VTT is influenced on the perceived comfort of the locations or while travelling.</td>
<td>Comfort</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>Jerkiness as a proxy for comfort</td>
<td>To explore how comfort while travelling is influenced by vibration, jerkiness and shocks.</td>
<td>Comfort</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>Transfer and waiting experience</td>
<td>To explore how comfortable transfer and waiting times are.</td>
<td>Comfort</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>Traveller needs and equity</td>
<td>To explore how the choice of travel speed is influenced by the user's demographic characteristics.</td>
<td>Cost, Safety</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>Attitudes towards mobility and time</td>
<td>To explore how VTT is affected by the traveller’s attitude about transport modes and time.</td>
<td>Well-being, curiosity, prestige, pro-social</td>
</tr>
</tbody>
</table>
Shift of focus...
from quantity to quality

“We need to rethink most or all of our key travel demand models. The present models – understandably enough – focus on the objectively measurable constraints of travel time and monetary cost, to the virtual exclusion of other relevant variables such as the subjective constraints of stress, schedule inflexibility, motion sickness, physical and mental ability, and negative expectations of the travel experience; facilitating factors such as the expectation of a pleasant, entertaining, and/or productive travel experience; and motivations to travel in the first place”.

“Reasonable” Travel Time

Reasonable Travel Time 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 ‘worthwhile time’ while travelling.

*Banister, David, Yannick Cornet, Moshe Givoni, and Glenn Lyons. “Reasonable Travel Time – The Traveller’s Perspective.” In Transport, Space and Equity. (Forthcoming).*