Institute of Transport Economics
Norwegian Centre for Transport Research

Summary

Value of travel time and related factors

Technical report, the Norwegian valuation study 2018-2020

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This report shows the results and documents the analysis that have been conducted to estimate values of travel time and related factors in the Norwegian valuation study. The results include values of in-vehicle travel time for a typical trip as well as values of headway, access time, reliability, travel time in congestion for car trips, travel time in public transport with in-vehicle crowding and travel time by infrastructure type for cycling and walking. The value of travel time for a typical trip seems to have increased over time in line with income growth, but the increase is lower for car trips than trips by public transport. We have also studied the impact of fully or partially autonomous vehicles on the value of travel time.

Background and objectives of study

This report is part of the new Norwegian valuation study on personal travel. The purpose of the study is to estimate new unit value for economic appraisal of transport projects in Norway. Many of the existing unit values are based on the previous valuation study, which was conducted in 2007-2009. This report contains values of travel time and time-related factors.

The benefits of shorter travel time typically constitutes the largest part of the benefit side in cost-benefit analyses of transport projects. It is therefore important that this value is estimated correctly. There is not just a single value of travel time, the value depends on multiple factors related to the travel context (trip purpose, time of day and year, travel mode etc.) and characteristics of the traveler. Futhermore, not only in-vehicle travel time is important, but also several other factors that are related to travel time. This report contains unit values representing the following factors:

- In-vehicle travel time
- Travel time of walking and cycling and on infrastructure type
- Public transport: Access time, headway, transfer time and transfer penalty
- Public transport: Waiting time quality and effect of mobile phone coverage
- Reliability (including cancellation risk)
- Travel time in different degrees of congestion
- Travel time in different degrees of in-vehicle crowding and when sitting or standing
- Air travel: Access time, transfer penalty and cancellation risk
- Car ferry: Headway and uncertainty
- Travel time and future car technology (autonomous cars)

A question that has received considerable attention in the scientific community lately is how the value of travel time will develop over time as new technologies enable travelers to utilize travel time in more ways than previously possible. The result of this could be that

values of travel time do not increase proportionally with income growth, or even decrease over time. It will also be more important to distinguish between different categories of travel time and take into account factors that affect travel comfort and which activities can be carried out while traveling.

Method and survey design

All results shown in this report are based on data from surveys in which respondents face hypothetical choice situations, so-called stated preferences (SP). Most of the data is based on stated choice, in which respondents make choices between travel alternatives that have several characteristics (attributes) that vary between the alternatives. The levels of these attributes are based on an actual trip that the respondent has recently made or is making while answering the questionnaire. The data are analyzed using different discrete choice models (logit models).

The reason for using SP data is that it is difficult to get good data on actual travel choices (revealed preferences, RP), particularly if the data is to be representative for the total traveling population and the various sub-segments used in applications. SP is therefore still the dominant method within this type of studies. At the same time, access to new sources of data has also opened new possibilities for RP studies, and we recommend carrying out more such studies in the future in order to validate our results

The value of in-vehicle travel time in motorized travel modes is estimated based on choice tasks involving only two attributes – travel time and cost – as shown in Figure E1. This makes it possible to include a large number of variables that explain the value of travel time while keeping a relatively simple model specification. Still, this very simplistic choice situation has been criticized for being too unrealistic. In Norway, where many car travelers are used to route choice than involve road tolls, such a choice situation might appear more meaningful and realistic. Our view is that the advantages of this experimental design outweigh the drawbacks. Using this design also implies that the results are comparable to previous results from Norway and other countries.

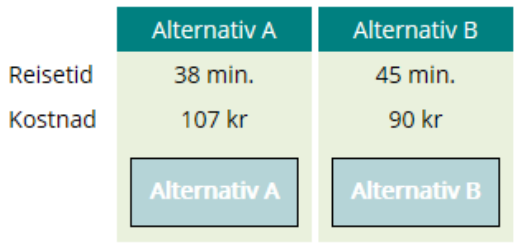

Figure E1. Example of choice task used to estimate values of in-vehicle travel time.

The values of other trip attributes are estimated based on a number of different choice experiments with multiple attributes. One example is choice tasks involving different degrees of in-vehicle crowding in public transport, as shown in Figure E2. Our study of crowding is the first of its kind in Norway.

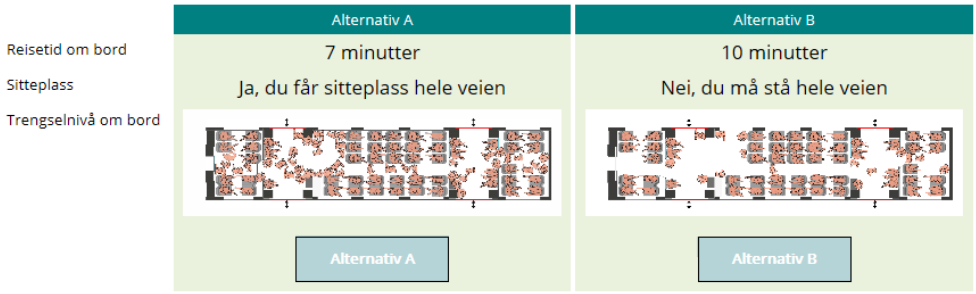

Figure E2. Example of choice task used to estimate values of in-vehicle crowding in public transport.

There are some important changes in the methods for valuing travel time compared to the previous Norwegian valuation study:

- The survey design makes it easier to estimate values of travel time based on the distance interval in standard transport models and appraisal tools: Trips shorter than 70 km, trips of 70-200 km and trips longer than 200 km.
- We distinguish between different modes of public transport also for short trips.
- We have estimated separate values for car passengers based on data on their choices.
- We distinguish between different trip purposes also for walking and cycling trips, and also between infrastructure types.
- The method for business travel takes into account both the value for the employer and the employee and the opportunities for working while traveling. This results in different values for different modes of travel.

All recommend unit values are based on current users of each mode of travel. We have also carried out sensitivity analyses that show values of time bases on a common user group for all modes of travel. This implies that only comfort and characteristics of the mode explain differences. We discuss advantages and drawbacks of this approach.

Data collection and representativity

The report combines results based on four data collections carried out in 2018 and 2019 as part of this project. Respondents were recruited partly from an internet panel (Norstat), partly from an alternative email register owned by the Postal service (Bring) and partly on-site (onboard public transport, at stops/stations or on the street). The largest survey in the fall 2018 covering the value of travel time and a number of other attributes involved all three recruitment methods. Those recruited on site (intercept) could choose between answering right away and answering later.

The results show that recruited method matters for the value of travel time and suggest that internet panel members are not representative for the traveling population in this dimension. We have therefore given a lower weight in the analysis to respondents recruited from the internet panel and also to respondents from the two other samples that report that they are members on an internet panel. This results in a higher value of travel time than if we had not weighted based on this. We have also weighted the sample based on the national travel survey (RVU) of 2018 to obtain more representative results.

Discussion

When comparing with the valuation study of 2009, our results suggest that the value of travel time has increased over time at approximately the same rate as income. Hence, there are no clear indications that increased travel comfort or opportunities to carry out more activities while traveling has resulted in a lower value of travel time. However, the chances over time differ somewhat between different segments, which can partly be explained by methodological changes. Overall, values have increased less for car trips than trips by public transport, particularly train trips. The values are on a reasonable level compared to other studies internationally, but the values for business travel are higher than in several other countries.

The results regarding the value of travel time are robust to various changes in methods and assumptions. One particular methodological issue that we have looked at is estimating values of travel time for different modes of travel based on a common user group. On average, this results in lower values for car trips and higher values for bus trips, which is in line with our expectations based on differences in income and other user group characteristics. We recommend doing more research on this method and its practical applications.

We have also investigated the effect on the value of travel time of increased vehicle automation, based on a choice experiment that includes scenarios with fully or partially autonomous cars. The effects go in the expected direction and show a 30 percent lower value of travel time in fully automated cars compared to the current value of travel time of car drivers. Since economic appraisal of transport project typically involves a long time horizon, more knowledge about this and other effects of new technology is important. It is also important to regularly carry out studies based on new data such that one can study the development in unit values over time.

The analysis of cycling and walking is improved compared to the previous valuation study, distinguishing between four types of infrastructure. The raking of values by infrastructure type is as expected: The value is lower for more comfortable/safe types (separate cycle lane or walking path) and higher for less facilitated infrastructure. The values of travel time for active travel seem somewhat high in general, but the level is comparable to the results from 2009 when taking into account growth in income.

For the first time in Norway, we have estimated the effect of in-vehicle crowding on the value of travel time ('crowding functions'). This effect has been taken into account in existing models, but based on empirical evidence from Great Britain. The effect of crowding in our results is lower than in the existing values, but higher than the results from a similar study in Paris.

Recommended unit values

The tables below show recommended unit values for different attributes. For adjustment over time, we recommend adjusting the value of in-vehicle travel time based on growth in GDP/capita, using an elasticity of 1. For projects with a long time horizon, we also recommend sensitivity analyses based on a somewhat lower elasticity.

Table E1 shows recommended values of travel time in car travel for a trip in typical traffic conditions.

Table E1. Values of travel time on car trips, by trip purpose and distance (NOK 2018 per hour)

Mode	Trip purpose	Under 70 km	70-200 km	Over 200 km
Car driver	Business	512	524	631
	Commuting	93	232	316
	Leisure	77	130	187
	All purposes*	167	182	223
Car passenger	Business	395	470	470
	Commuting	55	83	83
	Leisure	71	134	134
	All purposes*	88	139	137

*Calculated based on vehicle occupancy and trip purpose shares in Handbook V712.

Table E2 shows recommended values of travel time for ferry trips with car. These are only to be applied to the ferry part of the car trip.

Table E2. Values of travel time on ferry trips, by trip purpose (NOK 2018 per hour). All distances

Mode	Trip purpose	Value
Ferry (car driver)	Business	452
	Commuting	133
	Leisure	133
	All purposes*	164
Ferry (car passenger)	Business	452
	Commuting	133
	Leisure	133
	All purposes*	164

*Calculated based on vehicle occupancy and trip purpose shares in Handbook V712.

Table E3 shows recommended values of travel time in scheduled modes for a trip in typical travel conditions (with respect to comfort level, crowding etc.).

Table E3. Values of travel time in scheduled modes, by trip purpose and distance (NOK 2018 per hour)

Mode	Trip purpose	Under 70 km	70-200 km	Over 200 km
Bus	Business	450	447	447
	Commuting	79	170	170
	Leisure	56	94	94
	All purposes*	75	118	132
Train	Business	451	391	419
	Commuting	108	183	233
	Leisure	94	120	150
	All purposes*	109	162	193
Metro/tram/light rail	Business	478	-	-
	Commuting	79	-	-
	Leisure	71	-	-
	All purposes*	86	-	-
Passenger boat	Business	438	357	357
	Commuting	105	169	169
	Leisure	83	108	108
	All purposes*	112	164	164
Air	Business	-	792	792
	Commuting	-	450	450
	Leisure	-	267	267
	All purposes*	-	495	495

*Calculated based on trip purpose shares in Handbook V712.

Table E4 and Table E5 show recommended values of travel time for cycling and walking, by infrastructure type. The values in the three upper rows are not to be used if accident costs are also included separately in the cost-benefit analysis. In that case, one may use the values in the three bottom rows.

Table E4. Recommended values of travel time for cycling as transport (NOK 2018 per hour)

Trip purpose	Not facilitated (road with cars or on the pavement)	Walk and cycle path	Cycle lane in the road	Separate cycle path	All
As estimated, not controlling for accident risk (deaths/severely injured)					
Commuting	164	122	134	101	126
Leisure	86	64	82	60	67
All observations	146	112	123	96	116
Controlling for accident risk (deaths/severely injured)					
Commuting	132	122	118	101	115
Leisure	73	64	71	60	64
All observations	121	112	109	96	113

Table E5. Recommended values of travel time for walking as transport (NOK 2018 per hour)

Trip purpose	Not facilitated (road with cars)	Separate walk path	Walk and cycle path	Pavement	All
As estimated, not controlling for accident risk (deaths/severely injured)					
Commuting	349	185	184	173	333
Leisure	290	93	101	103	218
All observations	292	95	104	105	228
Controlling for accident risk (deaths/severely injured)					
Commuting	267	185	184	173	258
Leisure	191	93	101	103	157
All observations	194	95	104	105	168

Table E6 shows recommended multipliers indicating the value of headway in public transport, relative to in-vehicle travel time. These multipliers are to be applied to the headway of the first public transport mode of the trip. The multipliers in the first column represent the benefit of a marginal change in headway within each interval. The multipliers in the second column indicate total (cumulative) negative benefit of headway up until and including the interval and may be used to calculate generalized travel costs given a certain level of service.

Table E6. Recommended multipliers for the value of headway, relative to in-vehicle time. All distances and public transport modes.

Headway	Multiplier per interval	Cumulative multiplier (generalized cost)
0-15 min	1,07	1,07
16-30 min	0,98	1,03
31-60 min	0,63	0,83
61-120 min	0,47	0,65
over 120 min	0,18	0,41

Table E7 shows the recommended transfer penalty and transfer time multiplier, given that transfer time is known. The transfer penalty is expressed in equivalent minutes of in-vehicle travel time. The transfer time multiplier indicates the value of transfer time relative to the value of in-vehicle time for a typical trip

Table E7. Recommended unit values of transfer penalty and transfer time, relative to in-vehicle time. All public transport modes.

Trip purpose	Reiselengde	Omstigningsulempe (min.)	Omstigningstid (faktor)
Business trips	Under 70 km	3	1,2
	Over 70 km	5	1,2
Other trips	Under 70 km	12	1,2
	Over 70 km	23	1,2

Table E8 shows the recommended multiplier of access time to public transport. The multipliers is to be uses to value the travel time to the first and from the last public transport mode used on the trip. The multiplier gives the value of access time relatively to in-vehicle time for a typical trip.

Table E8. Recommended multiplier indicating the value of access time to public transport, relative to in-vehicle time. All distances and trip purposes.

Trip purpose	Tilbringertid
Alle	1,3

Table E9 shows the recommended multiplier ('reliability ratio') expressing the value of travel time variability relative to average in-vehicle travel time. The multiplier indicates the value of a one unit (e.g. one minute) change in the standard deviation of travel time relative to the value of a corresponding change in average travel time, for a typical trip.

Table E10 shows the recommended delay time multipliers for public transport. This may be used to value both arrival time delay and waiting time due to cancellations. The multiplier indicates the value of delay time relative to the value of in-vehicle time for a typical trip.

Table E9. Multipliers indicating the value of travel time variability relative to average in-vehicle travel time. All trip purposes and distances.

Mode	Variability (standard deviation)
Car driver	0,4
Car passenger	0,4
Bus	0,4
Train	0,4
Metro/tram/light rail	0,4
Passenger boat	0,4

Table E10. Multipliers indicating the value of delay time and waiting time due to cancellations in public transport, relative to in-vehicle time. All trip purposes and distances.

Mode	Delay time
Bus	2,5
Train	2,5
Metro/tram/light rail	2,5
Passenger boat	2,5

Table E11 shows recommended multipliers for valuing travel time in different traffic conditions, relative to the value of travel time for a typical trip. The multiplier is only to be applied to the part of the travel time that occurs under the relevant type of traffic conditions.

Table E11. Multipliers indicating the value of travel time in different traffic conditions, relative to travel time for a typical trip. All travel distances.

Mode	Trip purpose	Free flow	Moderate congestion	Severe congestion
Car driver	Business	0,9	1,1	1,4
	Commuting	0,8	1,2	2,3
	Leisure	0,9	1,3	2,4
	All purposes	0,9	1,2	2,3
Car passenger	Business	1,0	1,1	1,3
	Commuting	0,9	1,2	2,0
	Leisure	0,9	1,3	2,0
	All purposes	0,9	1,2	1,9

Table E12 shows multipliers for valuing travel time in public transport given different levels of in-vehicle crowding and depending on whether one is able to sit. The multipliers are expressed relative to the value of to travel time as a sitting passenger in an uncrowded vehicle.

Table E12. Parameters and multipliers for valuing travel time in different crowding levels, relative to in-vehicle travel time when sitting on a trip without crowding (for use in the Trenklin model)

Trikk, Train, t-bane og Bus	Fritid og arbeid	Tjeneste-reiser
Andel sitteplasser opptatt når trengsel inntrer	50 %	50 %
Faktor for sittende når 100 % av sitteplassene er opptatt	1,219	1,044
Marginal effekt av en person mer per kvadratmeter for sittende	0,0769	0,0154
Faktor for stående før det oppstår trengsel	1,646	1,646
Marginal effekt av en person mer per kvadratmeter for stående	0,0991	0,0198

The function based on these parameters is illustrated in Figure E3. The horizontal axis represents crowding and is divided into two parts. The first part measures the share of seats that are occupied, from 0 to 100 percent. After that, the axis indicates the number of standing passengers per square meter. If less than 100 percent of seats are occupied, it is assumed that all passengers are sitting. They will then have a value of travel time as sitting passengers which increases with the level of crowding. When 100 percent of seats are occupied, some travelers have to stand. Their value of travel time also increases with the level of crowding.

The crowding functions are less steep for business travel than for leisure and commuting trips, based on the assumptions that the part of the value of business travel time that represents the value to the employers does not depend on the level of crowding. We assume, however, that also this part depends on whether one is able to sit, given that sitting is important for being able to work productively while traveling.

We emphasize that one cannot compare the slope of the functions below and above the 100 percent threshold, since the scale of the horizontal axis changes at this threshold.

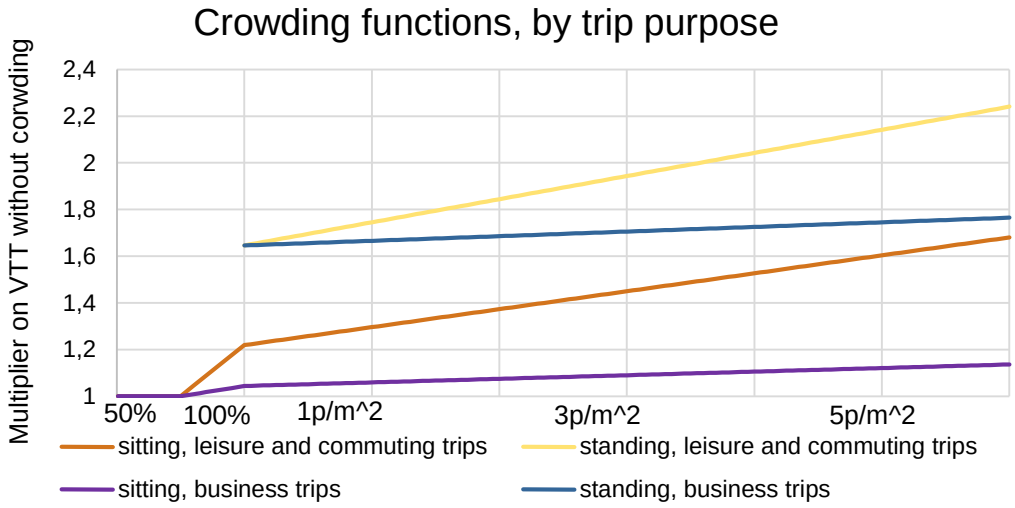

Figure E3. Recommended crowding fucntions.

Table E13 shows the recommended transfer penalty for air travel. The penalty is expressed in minutes travel time onboard.

Table E13. Recommended transfer penalty for air travel, expressed in minutes onboard travel time. By trip purpose. All distances.

Trip purpose	Transfer penalty (min.)
Business trips	13
Other trips	53

Table E14 shows the recommended cancellation penalty for air travel. The penalty is expressed in hours travel time onboard.

Table E14. Recommended cancellation penalty for air travel, expressed in hours travel time onboard. All trip purposes and distances.

Mode	Cancellation penalty (hours)
Air	11,8

Table E15 shows recommended multipliers for valuing access time to and from the aiport in air travel, relative to the value of air travel time onboard for a typical trip.

Table E15. Recommended multipliers of access time to the aiprort, relative to air travel time. All trip purposes and distances.

Mode to/from airport	Access time
Bil	0,8
Airtog	1,0
Train	0,8
Airbuss	1,0
Rutebuss	0,9
Taxi	0,9

Table E16 shows recommended multipliers for valuing headway on ferry trips, relative to the value of travel time onboard the ferry. The multipliers in the first column represent the benefit of a marginal change in headway within each interval. The multipliers in the second column indicate total (cumulative) negative benefit of headway up until and including the interval and may be used to calculate generalized travel costs given a certain level of service.

Table E16. Multipliers indicating the value of headway for ferry trips, relative to travel time onboard. All distances and trip purposes.

Headway	Multiplier per interval	Cumulative multiplier (generalized cost)
0 – 30 min.	0,8	0,8
31– 60 min.	0,8	0,8
61 – 120 min.	0,6	0,7
over 120 min.	0,3	0,5

Table E17 shows recommended multipliers for valuing waiting time as a result of cancellations and capacity limitations on ferry trips, relative to the value of travel time onboard the ferry.

Table E17. Multipliers of waiting time (delay time) due to cancellations and capacity limitations on ferry trips, relative to travel time onboard. All distances and trip purposes.

Mode	Cancellations	Capacity
Ferry	2,2	1,7