Sensitivity Analysis of Socioeconomic Values of Time for Public Transport Projects

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1. Abstract

The socioeconomic time benefits of two light rail projects in Copenhagen are investigated using three different sets of values of time. The first set is the one the Ministry of Transport recommends for use in socioeconomic analysis in Denmark. This set is used as a basis for comparison with the two other sets of values of time. The second set is the expected new recommended values of time with the same time values for non-business travelling. The third set is estimated from traffic modelling parameters and operates with different in-vehicle time values; the reason for this is thoroughly described and supported by examples. Traffic modelling of the two light rail projects has been performed and the results are used to generate the time benefits. The time benefits for the two light rail projects using the expected new values of time will increase by approx. 20%, compared to the result obtained by use of the values recommended by the Ministry of Transport. Differentiated in-vehicle values prove to generate an even larger increase in time benefits, but they vary depending on the projects.

Keywords: Public transport, light rail, value of time, time benefits, socioeconomic analysis.

2. Introduction

In the evaluation of public transport projects, socioeconomic analyses are often the most important factor. This is because they provide a good comparability between different projects. In the socioeconomic analyses the time savings to be made in the public transport system because of the infrastructural improvement are nearly always the greatest benefit for the project. Thus, the time benefits have to be of a quite reasonable size to neutralise and, at most, exceed the cost of construction and operation so that the project can be amortised over a certain period.

Different evaluations of public transport projects (e.g. Copenhagen County et al 2003, Andersen 2005 and Landex and Nielsen 2005) reveal that large public transport projects rarely show socioeconomic viability. This can be due to many factors (e.g. Landex and Nielsen 2005), but it might also indicate that the socioeconomic values of time used in the analyses are either to low or do not represent the utility concept of travelling well enough. It has for some time been well known that the existing values of time recommended for use in socioeconomic analysis of public transport projects are insufficient, when more complex (and realistic) traffic models are used to calculate time benefits in the public transport system.

2.1. Objective

The objective of this paper is to investigate how different socioeconomic values of time for public transport affect the time benefit of infrastructural public transport projects. The emphasis is placed on the values of time that are recommended for use in socioeconomic analyses of public transport projects by the Danish Ministry of Transport. The intention is to see which results can be obtained by the present recommended and the expected new recommended values of time[1]. Furthermore, the recommended socioeconomic values of time do not distinguish between the different means of transportation. Thus, it is not taken into consideration that some means of transportation are more attractive than others, especially in terms of comfort and constructive time use during the travelling, also known as the rail factor. Theoretically, this leads to reduced time benefits since more complex traffic models take this into consideration. Therefore, also a set of values differentiated over the different means of transportation is evaluated.

To investigate impacts in practice, two potential light rail projects in the Copenhagen region are examined. Each project is evaluated separately for its time benefit using the different set of socioeconomic values of time.

The study does not question the appearance of the different values of time, but uses them only to analyse and compare their socioeconomic results. Therefore, the values will not be questioned in terms of actual travelling behaviour as such questions should rather be based on observed data. The study questions the worth of the values when the traffic models are used to generate the input for the socioeconomic time calculation.

3. The Projects

The public transport projects chosen for this study are two light rail projects with alignments running across the radial urban structure of greater Copenhagen. These projects have been a part of the public debate on the future transport planning of greater Copenhagen and one of them (maybe both) is likely to be constructed within the near future. A new infrastructural improvement as a light rail should show more significant time benefits in the public transport system than an upgraded solution for the existing network. The two light rail projects selected for the examination are Ring 2½ and Ring 3.

[1] These are expected to be published in the autumn of 2007.

3.1. Ring 2½

The alignment and stop pattern of the Ring 2½ light rail follow the proposal made by (Andersen 2005), except for the extension to Nærum Station. This means a light rail running from Friheden Station in the south to Lyngby Station in the north with 20 stops. Along its route the light rail services areas such as Hvidovre, Rødovre, Husum, Gladsaxe, Buddinge and Lyngby.

Providing close connection to all the radial S-train lines at Friheden, Rødovre, Husum, Buddinge and Lyngby Stations. The construction of the earlier described extension to Nærum Station is considered to be more likely in a later phase. The alignment and stop pattern of the Ring 2½ light rail are seen in Figure 1.

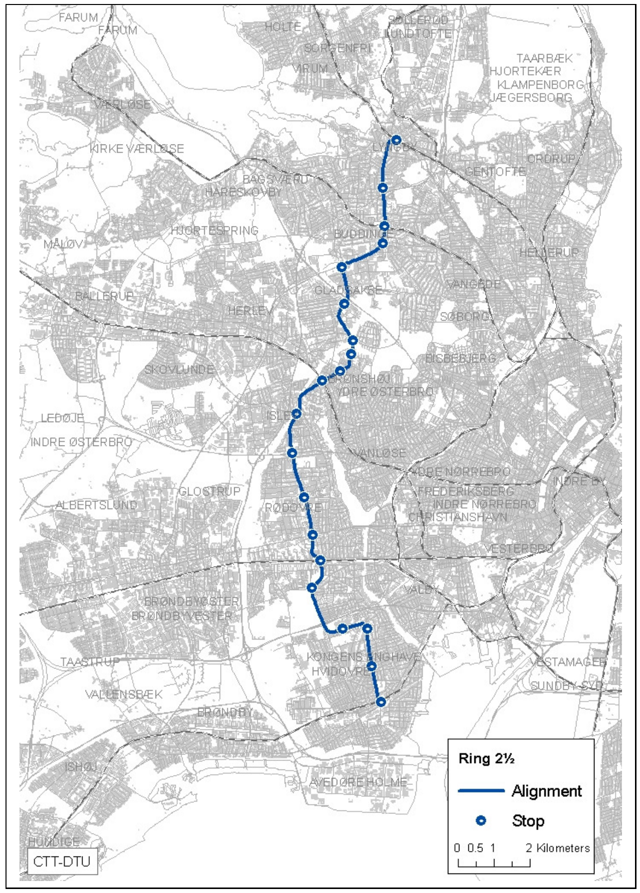

Figure 1 – Alignment and stop pattern of the Ring 2½ light rail.

The plan of operation also follows a proposal by (Andersen 2005). The light rail will run at 10 minutes' frequency during daily operation and will stop at all stops. The driving time from end to end will be 34 minutes. This equals a 24% time reduction compared to the existing bus service of bus line 200S.

Bus adjustments for the Ring 2½ light rail scenario lead to closing of the parallel bus line 200S, which runs from Friheden Station to Lyngby Station. The bus and the light rail only have slight deviations in the alignment and have many common stops. However, the light rail has fewer stops than the bus line, but still they will be so competing that closing of the bus line seems to be the only correct option. No further bus adjustment has been made in this study.

3.2. Ring 3

The alignment and stop pattern of the Ring 3 light rail are one of the alternatives proposed in (Copenhagen County et al 2001 and 2003) running from Ishøj Station to Lyngby Station and with a total of 26 stops. It serves areas such as Ishøj, Vallensbæk, Glostrup, Herlev, Gladsaxe, Buddinge and Lyngby and also has close connections to all radial S-train lines at Ishøj, Vallensbæk (the same S-train line as Ishøj), Glostrup, Herlev, Buddinge and Lyngby. The alignment and stop pattern are seen in Figure 2.

The plan of operation is also proposed in (Copenhagen County et al 2003) with 12 departures per hour in each direction – meaning five minutes' frequency in daily operation. All departures of the light rail are planned to stop at all stops. The driving time from one end to the other will be 46 minutes. This equals a 16% time reduction compared to the existing bus service of line 300S.

Bus adjustments for the Ring 3 light rail scenario lead to closing of bus line 300S on their common alignment. This means that the service of bus line 300S in this study is closed between Ishøj/Hundige Station and Lyngby Station. The service that the bus line provides in areas north of Lyngby[2] is left unchanged.

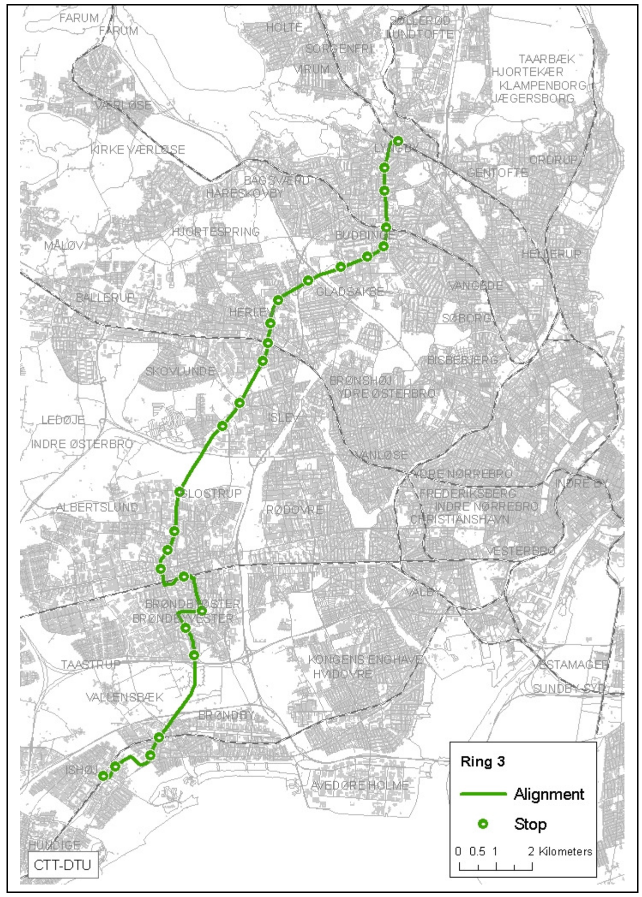

Figure 2 – Alignment and stop pattern of the Ring 3 light rail.

4. *Traffic Modelling*

Traffic modelling is used to evaluate the socioeconomic impacts of public transport projects. The most important results from the modelling are the time used in the system to determine time benefits, whereas the network impacts are not relevant to this study.

4.1. Route Choice Model

For the traffic modelling a time-table-based public route choice assignment model based on stochastic utility theory is used, as described in (IMV 2006). This model includes all departures in the public transport network of the greater Copenhagen area on an average working day in the year 2004. The data has been imported from the national Danish journey planner (www.rejseplanen.dk) and has been linked to a digital map (Kraks geodatabase, www.krak.dk) in ArcGIS. The route choice modelling (assignment) is carried out using the Traffic Analyst extension to ArcGIS (www.trafficanalyst.dk). For more information about the route choice model, see (Nielsen, Hansen and Daly 2001).

[2] In the 2004 situation where the traffic modelling has been performed, the bus line runs all the way to Kokkedal Station opposed to its current line end stop at Nærum. Hence it is even more important to keep the northern service.

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As a basis for the route choice modelling, the zone structure and the corresponding trip matrixes from the Orestads Trafik Model (OTM) version 4.0. are used (Jovicic and Hansen 2003). This zone structure covers the greater Copenhagen area (a population of 1.8 million inhabitants) and it consists of a total of 618 zones. The trip matrixes contain travelling for three different trip purposes:

1. Home-work (commuter travelling)
2. Work-work (business travelling)
3. Other (leisure travelling)

Thus, the traffic modelling is performed separately for each of the trip purposes.

4.2. Route Choice Modelling Approach

The route choice modelling has been performed for a specific time interval (the calculation period), which is the morning rush hours (7.00-9.00) and the following socioeconomic calculation will be performed in this time interval.

The route choice modelling has been performed with six launches of traffic per hour, meaning a total of 12 launches during the calculation period. Furthermore, the number of iterations has been set to five, which means a displacement of the launch times that corresponds to launch of traffic every second minute during the entire calculation period.

The procedure is to start by modelling the present situation (the base scenario). Subsequently, the light rail project is encoded in the model and the situation with the light rail (the scenario) is then modelled. Induced traffic because of the improved public transport system is taken into account by updating the trip matrixes. This is done by using the considerations and percentages for new travelling suggested in (Nielsen, Israelsen and Nielsen 1998).

The assignment produces some level-of-service matrixes (cost matrixes). A cost matrix with the average time used for travelling between each zone relation and a cost matrix in-vehicle where the time is distributed into the means of transport. These cost matrixes are the basis of the time calculation to be presented later (cf. Section 6: Time Calculation).

The two light rail projects are investigated separately and therefore separate route choice assignments have been made for each project.

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5. *Values of Time*

To price the used time in the public transport system, values of time must be appointed to the different time components in a door-to-door public transport journey[3]. In this study the basic set of values is that recommended by the Ministry of Transport for use in socio-economic analysis of public transport projects (the Danish Ministry of Transport 2006). The results using these recommended values are compared to the results of two other sets of values. The first set is an estimation of what is expected to be presented very soon as the new recommended socioeconomic values of time. The third set is a formerly estimated set based on route choice assignment parameters handling an issue neglected by the values recommended by the Ministry of Transport.

To be able to compare the results, all values of time are here presented in 2004 prices. Hence, one set of values has been forecast to this yearly level, the others are already in 2004 prices. The procedure for forecasting values is as suggested in (Landex, Salling & Andersen 2006).

5.1. Values of Time Recommended by the Ministry of Transport

The Danish Ministry of Transport has guidelines and key figures for evaluation of the socioeconomics of public transport projects (the Danish Ministry of Transport 2003 and 2006). It is recommended to use these for evaluation of public transport projects in Denmark. Therefore, these values of time are used as the basis of comparison in this study. The set of values is seen in Table 1.

	Home-work	Work-work	Other
In-vehicle	60	266	35
Waiting/interchange	120	532	70
Hidden waiting	30	133	18

Table 1 – Socioeconomic values of time recommended by the Danish Ministry of Transport (Danish kroner per hour in 2004 prices).

Travelling time in public transport systems, as seen in Table 1, consists of the in-vehicle time which is the time used in a public transport vehicle ("driving time"). Waiting and interchange times are waiting and walking times in transfers, and hidden waiting time is the waiting time in the start zone. The set lacks a value for access/egress to/from the public transport system, which in the traffic model is represented by the connector time. Therefore, this value is appointed the same value as estimated in Section 5.3.2: The differentiated set of values.

[3] Impacts on car traffic are left out of this study for simplicity and to direct the focus on the main impacts of public transport.

5.2. Similar Time Values for Non-business Travelling – the Expected New Values

Another set of values is here presented using the same value of time for non-business travelling. The level of the travelling time value is higher than the level of the values recommended by the Ministry of Transport. The set of values is in Table 2.

	Home-work	Work-work	Other
In-vehicle	67	315	67
Waiting/interchange	134	631	134
Hidden waiting	34	158	34
Access/egress	101	473	101

Table 2 – The expected new socio-economic values of time with the same value of travelling time for non-business travelling (Danish kroner per hour in 2004 prices).

This set of values originates from studies conducted at the Danish Transport Research Institute (DTF). The study only provides values for in-vehicle time for non-business travelling. Thus, the remaining values to complete the set have been estimated as follows: The in-vehicle value for business travelling has been derived from the in-vehicle time for commuting and leisure, using factors estimated from the values recommended by the Ministry of Transport. Subsequently, the time value for hidden waiting and waiting and interchange values are estimated by use of the factors of the in-vehicle values recommended by the Ministry of Transport (0.5, 2 and 2 respectively) (the Danish Ministry of Transport 2006). The time value for access/egress is estimated from a factor of 1.5 of the in-vehicle time as DTF suggests in their study. It is expected that this set of values will be very close to the new values of time that the Ministry of Transport will recommend when they update the key figures. However, they have not yet been published (expected to be so in the autumn of 2007) and the set should, therefore, for now be regarded as a proposal.

5.3. Differentiated In-vehicle Values of Time

The values of time recommended by the Ministry of Transport and customarily used for socioeconomic evaluation of public transport projects have no separate values for in-vehicle travelling. This may be a problem when different values are used for different means of public transportation in the route choice assignment, since these results make up the basis of the socioeconomic evaluation.

In the route choice assignment used in this study, different values for different means of transportation are used as parameters in the assignment to simulate that some means are more attractive than others, largely regarding comfort and constructive time consumption during the travelling. For instance, some travellers are willing to accept longer travelling time if the journey can be made by rail instead of by bus – the so-called rail effect (Truder 2005). When this issue is dealt with in the assignment, but not in the following socioeconomic analysis, the paradox may be that improvements will result in negative time benefits (disbenefits) and thus reduce total time benefits of the system. The following example is taken from (Landex, Salling and Andersen 2006) and illustrates the problem:

If a traveller is going from A to B, the traveller can go by bus from A to B with transfer at C. If a new metro, light railway or suburban railway is built between A and D (without changes in the existing bus connections), some travellers will choose to go by railway from A to D and then transfer to the bus going to B (cf. Figure 3).

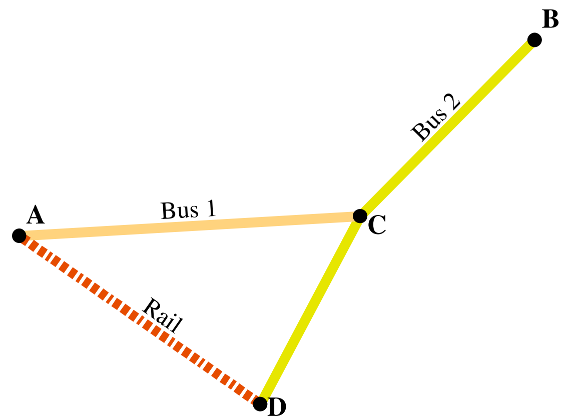


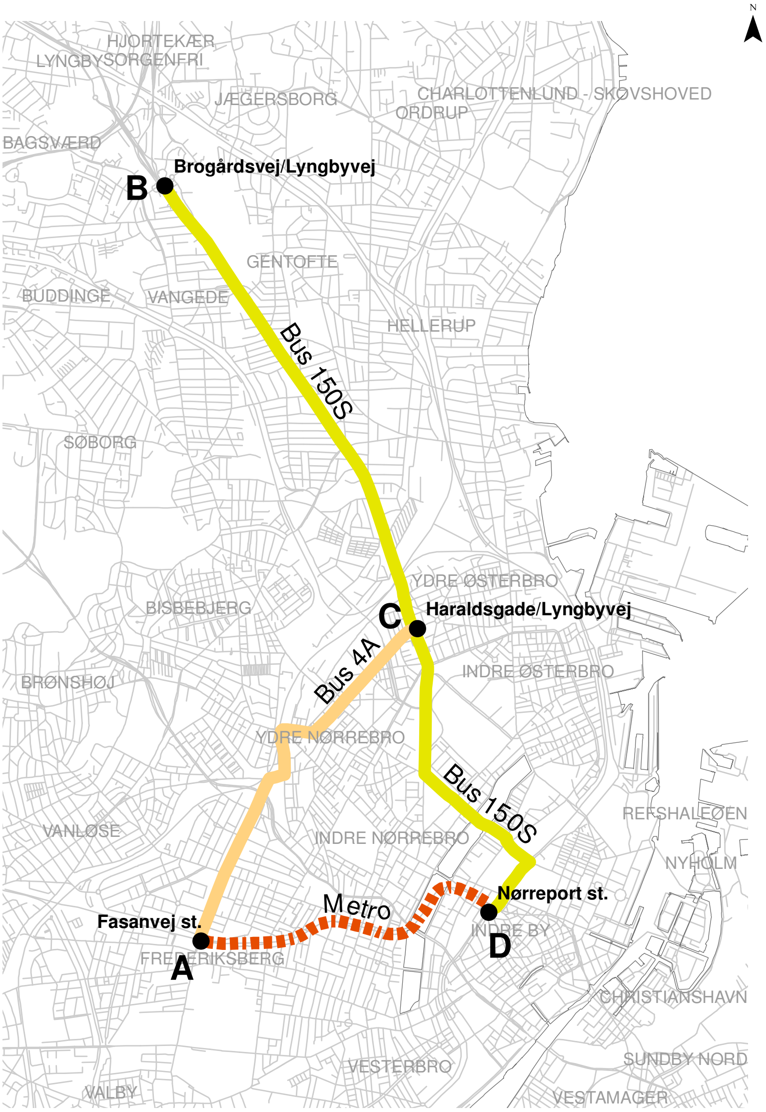
Figure 3 – Travelling opportunities between A and B (Andersen 2005).

The number of travellers from A to B via D depends on the time they save[4], but although it may take just as long or maybe even a little longer to travel via D, there are still people who will choose that as it is more comfortable to go by train than by bus. If the socioeconomic benefit of time saved on travelling is calculated based on a general value for in-vehicle time, the route via the new rail line (via D) is considered a disadvantage since it takes longer time than before. There are, however, passengers that choose to travel via D because they obtain higher utility with the new railway line, and therefore it should be considered as a benefit. However, this is only true if the actual values of inconvenience and time are taken into consideration for each means of transport.

[4] Using an All-Or-Nothing assignment model which prescribes that all passengers with a specific trip purpose would choose either the route A-C-B or A-D-B

5.3.1 Case Example from Copenhagen

A practical example of negative time benefits is illustrated in Figure 4 below:



A → D → B

First wait at Fasanvej st. (A):
1 min.

Fasanvej st. (A)
via Metro to Nørreport st. (D):
9 min. (including 4 min. transfer time at Nørreport st.)

Nørreport st. (D) via bus 150S to Brogårdsvej (B):
18 min.*

Total time: 28 min.

A → C → B

First wait at Fasanvej st. (A):
3 min.

Fasanvej st. (A) via bus 4A to Haraldsgade/Lyngbyvej (C):
16 min. (including 2 min. transfer time at Haraldsgade)*

Haraldsgade/Lyngbyvej (C) via bus 150S to Brogårdsvej (B):
8 min.*

Total time: 27 min.

* The travelling time for buses can vary during the day (depending on the level of road congestion and the amount of passengers)

Figure 4 – Travelling opportunities between A and B – Example from Copenhagen.

The example in figure 4 is an extract from the public transport network in Copenhagen, where the Metro stretch from Fasanvej Station[5] to Nørreport Station opened in 2003. Although it can be slightly faster to travel from Fasanvej Station to Brogårdsvej (and IKEA) using bus 4A with a transfer at Haraldsgade/Lyngbyvej to bus 150S, some people will choose the Metro instead and then transfer to bus 150S at Nørreport Station. This is because the Metro, due to the rail factor, is regarded as a more attractive means of transport. Travellers choosing the

[5] At the time of the opening of the Metro the station was called Solbjerg Station. However, this has been changed to Fasanvej Station in 2007.

Metro in the specific travelling relation in the example obtain a longer travelling time than before the metro line was in operation. However, they only choose this route because they in this way experience higher utility which should somehow be reflected in the socioeconomic time calculation.

Note that there are other travelling opportunities between Fasanvej Station and Brogårdsvej, but they are left out of the example for simplicity.

To illustrate how the above-mentioned example will behave in a route choice assignment, the following calculation is done. In the traffic modelling the route choices are determined by a utility function that roughly corresponds to the following expression[6]:

Formula 1

$$GC = P_{InVehicle} \bullet InVehicleTime + P_{Waiting} \bullet WaitingTime + P_{Transfer} \bullet TransferTime$$

where:

GC is the generalised cost

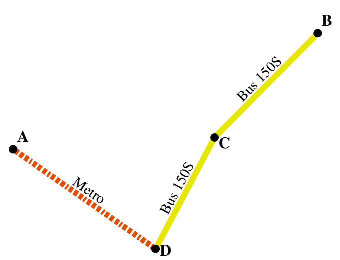
P is the parameter weight or value of time

Taking the P-values directly from the assignment parameters where

$P_{Metro} = 0.45$, $P_{Bus} = 0.583$, $P_{Waiting} = P_{Transfer} = 0.633$

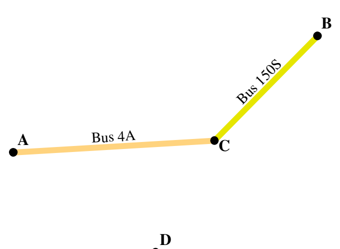
will produce the following results when used for the above-mentioned example from Copenhagen:

A→D→ B



$$GC = P_{Metro} \bullet 5\ min + P_{Bus} \bullet 18\ min + P_{Waiting} \bullet 1\ min + P_{Transfer} \bullet 4\ min = \mathbf{15.91}$$

A→C→ B



$$GC = P_{Bus} \bullet 22\ min + P_{Waiting} \bullet 3\ min + P_{Transfer} \bullet 2\ min = \mathbf{15.99}$$

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[6] The utility function is here a bit simplified. Factors such as transfer penalty and access/egress are normally implemented. However, for the illustration of the example they are not relevant; the transfer penalty is always the same and both sets of route choices have one transfer. Furthermore, the access is considered to be the same for the start stop whether Metro or bus. Also stochastic variables are not implemented and the expression represents an "All-Or-Nothing" situation.

Although the route A→D→B has a longer total travelling time it still has a lower generalised cost, meaning higher utility, and it is therefore the route that will be chosen in an All-or-Nothing assignment.

If the socioeconomic values of time recommended by the Ministry of Transport are used for the same example, a person taking the A→C→B route before the Metro line opened and then changing to the A→D→B route after the Metro opened, because of the higher utility, will get a time benefit at:

Socioeconomic cost for travelling before the Metro – Socioeconomic cost for travelling after the Metro:

(60 DKK/hour • (22 min./60) + 120 DKK/hour • (5 min./60))
– (60 DKK/hour • (23 min./60) + 120 DKK/hour • (5 min./60)) = **-1 DKK**

By using the socioeconomic values of time recommended by the Ministry of Transport, the person travelling from A to B will obtain a disbenefit of 1 DKK even if the route is chosen because of higher utility. This shows a mismatch between the results from the route choice assignment and the results from the socioeconomic analysis, leading to time disbenefits in spite of improvements. In fact, building the Metro can result in a socioeconomic loss of time benefits although the bus service is unchanged.

5.3.2 The Differentiated Set of Values

On the basis of the above-mentioned statement that improving the transport system can lead to a time disbenefit, a set of time values has been estimated with differentiated values for in-vehicle travelling time.

The set is a slightly modified version of the values of time used in (IMV 2006) and has its origin in (Andersen 2005). The in-vehicle values are based on the route choice parameters used for the traffic modelling. These parameters are taken from the KRM-research[7] (Nielsen 2000). The parameters have been scaled to the level of the socioeconomic values recommended by the Ministry of Transport by using scale factors derived from the share of the time used in each means of transport[8]. This ensures that the level of the differentiated in-vehicle values corresponds to the level of the in-vehicle values recommended by the Ministry of Transport. It is observed to fit quite satisfactorily in a comparison of the time cost of the basic scenario calculated with both the differentiated values of in-vehicle time and the values of time recommended by the Ministry of Transport (cf. 7.2: Differentiated In-vehicle Values of Time). The access/egress values are also scaled to that level using the same factors as for

[7] The Copenhagen-Ringsted Model.

[8] The travelling time for each zone pair based on the output from a route choice assignment multiplied by the number of travellers for each zone pair from the OD trip matrix.

the in-vehicle time. The hidden waiting and waiting and interchange time are taken directly from the values recommended by the Ministry of Transport.

The procedure for estimating the set of values is described more thoroughly in (Andersen 2005). The set of time values is seen in table 3:

	Home-work	Work-work	Other
Bus	72	322	42
S-train/Metro	56	257	32
Train	56	219	32
Light rail	61	278	35
Waiting/interchange	120	532	70
Hidden waiting	30	133	18
Access/egress	93	305	70

Table 3 – The differentiated set of socioeconomic values of time with differentiated values for in-vehicle travelling (Danish kroner per hour in 2004 prices).

If the estimated set of values is used on the same example as in Section 5.3.1: Case Example from Copenhagen, a person taking the A→C→B route before the Metro line opened and then changing to the A→D→B route after the Metro opened will, because of the higher utility, get a time benefit at:

Socioeconomic cost for travelling before the Metro – Socioeconomic cost for travelling after the Metro:

(72 DKK/hour • (22 min./60) + 120 DKK/hour • (5 min./60))
– (56 DKK/hour • (5 min./60) + 72 DKK/hour • (18 min./60) + 120 DKK/hour • (5 min./60))
= **0.13 DKK**

The person travelling will (with this set of time values) obtain a time benefit as result of the improvement in the public transport system which is in accordance with the result of the route choice assignment.

5.3.3 General Rise in Time Benefits by Use of Differentiated In-vehicle Time Values

Because some means of transportation are more attractive than others, it is generally expected that the set of values with differentiated values for in-vehicle time will provide a better result (greater time benefit) for the light rail projects than the result provided by use of the values of time recommended by the Ministry of Transport. This is because it is more attractive to travel by light rail than by bus, which is also reflected in the differentiated in-vehicle values where light rail travelling has a lower value of time than bus travelling. Normally, light rail has a shorter travelling time than buses, so that time benefits will be obtained in the system when a new light rail is introduced instead of a bus. However, when the socioeconomic time benefits are calculated with the values of time recommended by the Ministry of Transport, the time benefit will be smaller than by use of the differentiated in-vehicle values of time as illustrated in the example below:

A journey from A to B is in the present scenario made by bus in 10 minutes. In the light rail scenario the same journey is now made by light rail in eight minutes (see Figure 5). Using the values recommended by the Ministry of Transport the time benefit will be:

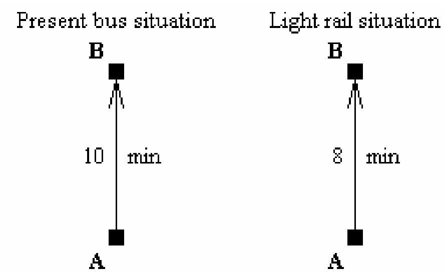

Figure 5 – Travel from A to B

Socioeconomic cost for travelling in the present bus scenario – Socioeconomic cost for travelling in the light rail scenario:

(60 DKK/hour • (10 min./60)) – (60 DKK/hour • (8 min./60)) = **2.0 DKK**

Using the differentiated in-vehicle values the time benefit will be:

(72 DKK/hour • (10 min./60)) – (61 DKK/hour • (8 min./60)) = **3.9 DKK**

In this case, using the differentiated in-vehicle time values will increase the time benefit by 1.9 DKK per passenger. The example shows that greater time benefits can generally be expected when the differentiated in-vehicle time values are used in the socioeconomic time calculation of new high quality public transport.

Note that all the above-mentioned cases of increased time benefits applied to the differentiated in-vehicle values of time are mainly relevant to upgrading the public transport system to a higher class than that of the existing system. This could for instance be a light rail line replacing a bus line, whereas for instance a bus optimisation will not display the same differences in time benefits.

6. Time Calculation

The time calculation is performed by use of the output from the assignments of the two light rail projects and the basic scenario. The procedure is carried out using the Rule-of-the-Half as seen in Figure 6 and thoroughly described in (Landex, Salling and Andersen 2006). The concept is that the Rule-of-the-Half also includes the effect from the new travellers (the induced traffic) by a fairly simple calculation approach where the demand curve is presumed to be linear.

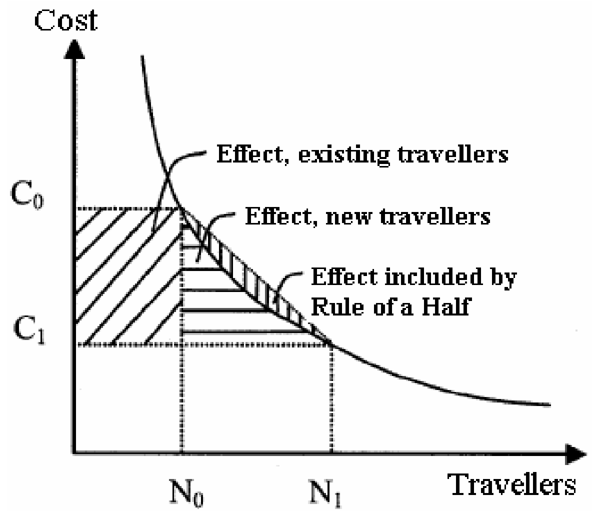

Figure 6 – Calculation of time benefit (Landex, Salling, and Andersen 2006).

In Figure 6, C_0 is the existing travelling cost, C_1 is the new travelling cost, N_0 is the existing number of travellers and N_1 is the new number of travellers (induced traffic). The time benefit for existing travellers (without induced traffic) is found to be as follows

Formula 2 *The time benefit for existing travellers* $= (C_0 - C_1) \bullet N_0$

The time benefit for new travellers is found to be:

Formula 3 *The time benefit for new travellers* $= ½ \bullet (C_0 - C_1) \bullet (N_1 - N_0)$

The total time benefits of the public transport system can then be found as the sum of the time benefit for existing and new travellers.

The calculation of the time benefit is based on the OD trip matrixes (the original from OTM version 4.0 and the updated version) and the cost matrix from the basic scenario together with the cost matrixes from the scenarios with and without induced traffic. The calculation of time benefits is performed separately for each zone pair and for each trip purpose and then summarised in the end.

7. Results

The results are presented as the time benefits in the morning rush hours (7.00-9.00) for the scenario with both the Ring 2½ and the Ring 3 light rail projects. Calculations of the time benefits using the values recommended by the Ministry of Transport shows that the result for Ring 2½ is 21,900 DKK for all travelling purposes per morning rush hour, while Ring 3 has

19,400 DKK as time benefit for the public transport system. These results constitute the basis of comparison for the further study[9].

7.1. Similar Time Values for Non-business Travelling – the Expected New Values

Figure 7 below presents the time benefits with the socioeconomic values of time recommended by the Ministry of Transport and the expected new values with the same travelling time for non-business travelling.

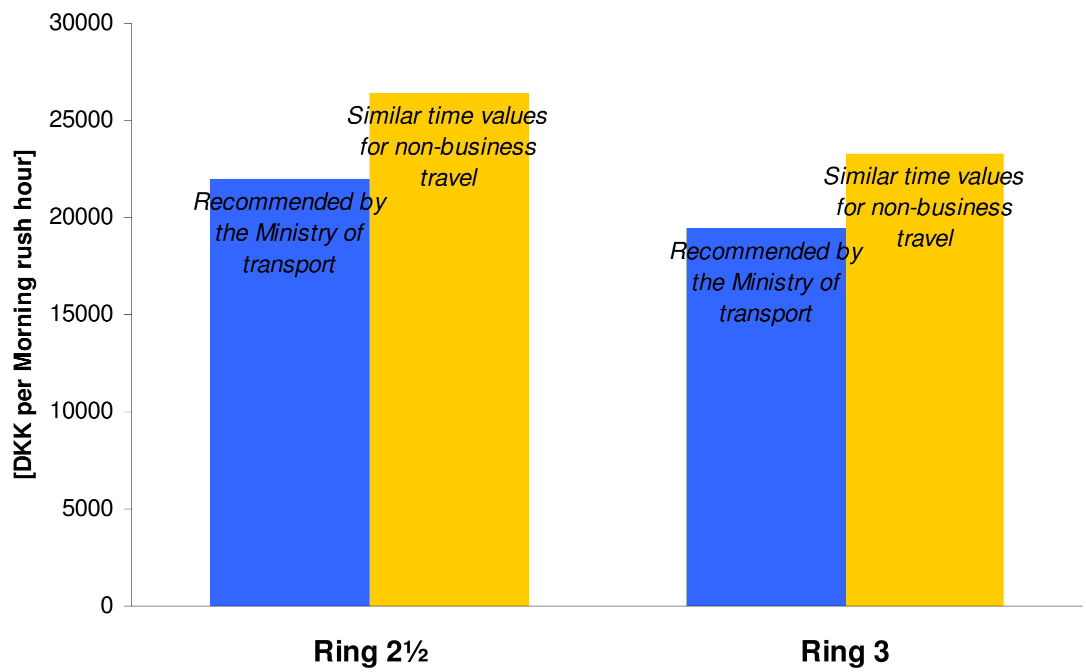

Figure 7 – Time benefits for Ring 2½ and Ring 3 calculated with the recommended values of time and the expected new values of time.

Figure 7 shows that the expected new values of time will result in greater time benefits than the present ones recommended by the Ministry of Transport. The increase in time benefits is seen in Table 4 below.

	Home-work	Work-work	Other	Total
Ring 2½	12%	19%	87%	20%
Ring 3	12%	18%	89%	20%

Table 4 – Increase in time benefits by use of the expected new values of time.

[9] Note: The time benefits are not comparable with those of previous studies as no major bus adjustment has been made.

Since the level of the values has generally been raised, the increase in time benefits is expected. The general increase in the level can be investigated by calculating the total time cost in the system in the basic scenario using both sets of time values. By application of the expected new values of time the increase in time cost in the basic scenario is 18%. Furthermore, it can be concluded that the increase of the values for the leisure travelling ("Other") to the level of the commuter travelling (similar time values for non-business travelling) results in a significant increase in the time benefits for leisure travelling. All in all, indications that the new socioeconomic values of time will result in greater time benefits for public transport projects and thus better socioeconomic viability of the projects.

7.2. Differentiated In-vehicle Values of Time

Figure 8 below presents the time benefits by use of the socioeconomic values of time recommended by the Ministry of Transport and the time benefits using the set with differentiated values for in-vehicle time.

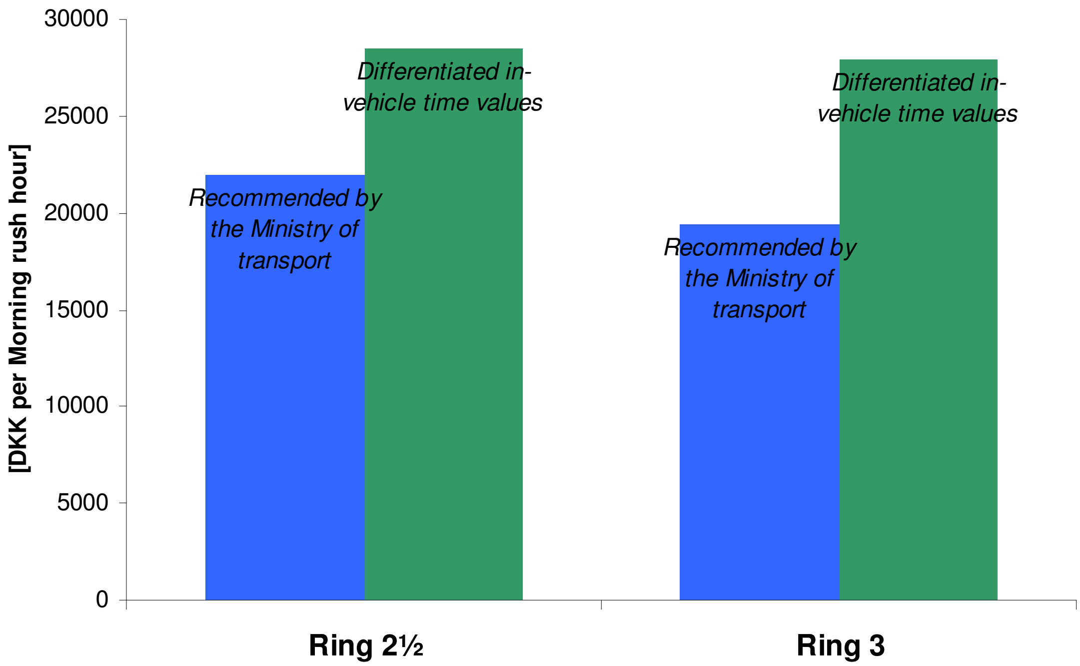

Figure 8 – Time benefits for Ring 2½ and Ring 3 calculated with the recommended values of time and the estimated values of time with differentiated in-vehicle values.

Figure 8 shows that the estimated values of time with differentiated values for in-vehicle time will result in significantly greater time benefits than the present ones recommended by the Ministry of Transport. The increase in time benefits is seen in Table 5.

	Home-work	Work-work	Other	Total
Ring 2½	31%	31%	17%	30%
Ring 3	46%	37%	34%	44%

Table 5 – Increase in time benefits when by use of differentiated in-vehicle values of time.

Unlike the scenario with the expected new values (cf. Section 7.1: Similar Time Values for Non-business Travelling – the Expected New Values), the increase in time benefits by use of differentiated in-vehicle time values cannot result from an increase in the general level of the values, since they are scaled to the level of the values recommended by the Ministry of Transport. This is supported by the total cost in the system in the basic scenario calculated with both set of time values. When the differentiated in-vehicle values of time are used the increase in time cost in the basic scenario is less than 1%. This means that the increase in time benefits is solely a result of the differentiation of the in-vehicle time values and supports the problem definition regarding use of differentiated or non-differentiated in-vehicle values (cf. Section 5.3: Differentiated In-vehicle Values of Time).

Moreover, it seems that the in-vehicle time fragmentation has a different impact on different projects depending on how travelling is changing in the system. This is illustrated by the fact that the relative increase in time benefit for Ring 3 is larger than for Ring 2½, as opposed to the expected new values where the relative increase is the same for both projects (cf. Section 7.1: Similar Time Values for Non-business Travelling – the Expected New Values).

8. *Conclusions*

This study has shown that changing the values of time used for calculation of socioeconomic time benefits for public transport projects also means significant changes in the results. The results can be evaluated directly since they are adjusted for inflation by calculating all values in the same year (2004).

The expected new set of values to be recommended has higher values and will therefore raise the level of the time benefits for public transport projects. Also the raised value of leisure travelling to the level of commuter travelling will lead to greater time benefits. When the expected new values of time are applied an increase in time benefit at around 20% for new infrastructural public transport projects can be expected, compared to using the present values of time recommended by the Ministry of Transport. In perspective, this conclusion will favour the chances of obtaining socioeconomic viability of public transport projects.

Differentiations of the values of in-vehicle time also shows significant results that prove the theoretical notion of improved time benefits. The differentiated in-vehicle time values correspond to route choices made in the traffic modelling and might therefore also be considered to reflect the preferences of actual travellers. That is when the differentiated in-vehicle values of time are used, the paradox of time disbenefits and entailed lower socioeconomic viability in spite of infrastructural improvements will be avoided. All in all, the differentiated in-vehicle time values ensure consistency between traffic model and subsequent socioeconomic analysis. Furthermore, the increase in time benefits by use of differentiated in-vehicle values of time is more significant than the increase when the expected new values of time are used. Moreover, the increase is very different for the two light rail projects, where Ring 3 obtains a larger relative increase than Ring 2½. By use of the differentiated in-vehicle values the increase in the time benefit can vary, but it still seems to be of a significant size. A characteristic that will assist the chances of socioeconomic viability for new infrastructural public transport projects.

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