

SERVICE RELIABILITY AND TRANSFER CONVENIENCE ON THE BRUSSELS TRAMWAY NETWORK

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ABSTRACT

Do tram users prefer delayed services without transfers or reliable services with imposed transfers?

The study aimed to evaluate users preferences concerning the conditions of transfer as well as the unreliability of the tramlines on the North-South underground connection in Brussels town centre. This underground infrastructure of the town centre constitutes the trunk section of several tramlines, which take it and serve then the Brussels suburbs. The operator (the Brussels Public Transport Society) wanted to know if it is preferable to replace long current tramlines suffering from strong irregularities by modern reliable services obliging the passengers to transfer to another tram at the ends of the downtown area underground connection.

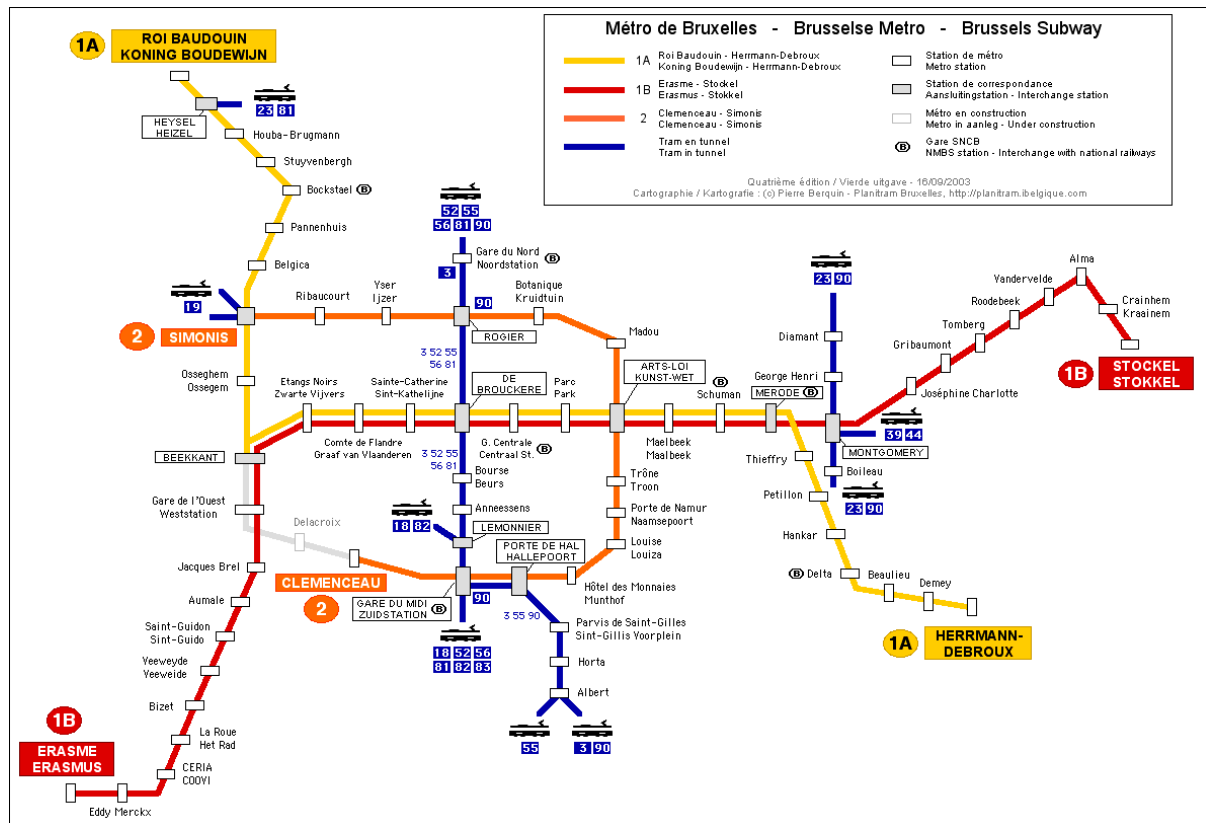
Analysis and modelling of users behaviours on this connection are based on a stated preferences survey. The survey was carried out on a working day between 6:30 and 22:00. Questionnaires were administrated face to face to alighting passengers. In all, 3500 questionnaires were collected, corresponding to a set of 8900 valid observations.

The variables included in the modelled utility functions concerned: the headway, the probability of delay, the size of delay, the fact of being informed of the exact arrival time by variable message signs, as well as the convenience of transfers (on the same platform, number of different levels to climb, outside waiting time...). Significant coefficients were estimated with a good precision for these different variables. The ticket price was also a variable included in the experimental design. So modelling enabled to consider the equivalent monetary value of these various parameters and, in particular the value of time when public transport services suffer from delay.

The application of this behavioural model to the case of the various studied lines highlighted the advantages and disadvantages of a service modification for the users. The results show that if certain users gain comfort when the irregularity is strongly reduced, others lose convenience because of additional transfers. They also show how to organize more convenient transfers. A first quantification of the advantages and disadvantages of the projected new services was carried out on the basis of quantified results coming from modelling. However the final assessment, based on the whole demand and balanced by the respective weight of the users subjected to new transfers, will be carried out in the study in progress of the new Brussels-Capital Region Transport Master Plan.

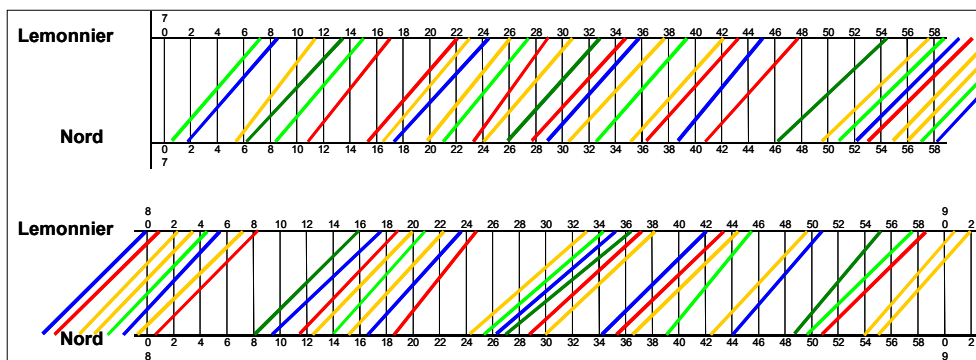
1. THE CONTEXT

The objective of this study was to evaluate user preferences concerning transfers and regularity on the Nord-Midi-Albert underground link of the Brussels tramway system. Located in the centre of the city, this infrastructure is the common trunk of several lines that crisscross the Brussels region in various directions and meet at this point. It is run by the Société des Transports Intercommunaux de Bruxelles (STIB).



source: Planitram

Given the length of these tram lines, which do not have dedicated track along their routes, inevitable delays due to irregular service regularly penalise passengers.



Source : STIB

The STIB would like to remedy this situation by dividing up the north and south branches of the tram lines, organising a regular new service called “Line 3” on a shorter route in the centre; the STIB therefore asked the following question: do users prefer a regular shuttle service circulating between the Albert and Nord stations but requiring transfers at the ends, or the current irregular services not requiring transfers?

In order to answer this question, a precise analysis of the behaviours of the users of the Nord-Midi-Albert infrastructure was conducted by STRATEC, according to the performances of the transportation offered there, especially in terms of regularity of services and transfer convenience.

2. THE SURVEY

The analysis and modelling of user behaviours are based on a *Stated Preferences* survey.

The objective of this survey method is to precisely estimate the weight of each attribute of the services studied in the behaviour of the users, and to measure the judgments they make among these various attributes. These weights can then be used to predict the choices that will be made in response to a given transportation policy.

The SP questions offered the user three options:

- an alternative without transfer with up to schedule services
- an alternative with transfer with up to schedule services
- an alternative without transfer but with delayed services

The surveys were done during the week (Tuesday or Thursday) continuously from 6:30 a.m. until 10:00 p.m., among users of the STIB’s public transportation who use in particular the lines in the Nord-Midi-Albert tunnel. They were administered face-to-face to people stopped as they got off their tram. In all, 3,500 valid surveys were collected, corresponding to a sample of 8,900 SP observations.

3. BEHAVIOUR MODELLING

The variables used during the modelling concerned:

- the frequency of vehicles,
- probability that the vehicle is late,
- the amount of delay,
- whether the vehicle’s arrival time is announced,
- the type of transfer,
- the fare.

3.1. Modelling results

An estimate of the coefficients of the utility functions is obtained by adjusting a Logit-type utility function to the declared choices. The results are shown in the following table.

1Mode	Attribute	Coefficient	Value	t-Student
DIRECT TRIP UP TO SCHEDULE	Cost difference in the trip in relation to a reference cost of 0.8 euros Vlue to be added if:	cost	-1.36	-25.3
	<ul style="list-style-type: none"> woman 	cFemme	0.236	5.3
	<ul style="list-style-type: none"> going to work 	cVersT	0.197	3.4
	<ul style="list-style-type: none"> recreational trip 	cVersL	-0.303	-3.5
	<ul style="list-style-type: none"> under age 18 	cJeune	0.337	4.0
	<ul style="list-style-type: none"> age 18 to 30 	c1830ans	-0.125	-2.7
DIRECT TRIP NOT UP TO SCHEDULE	1-in-2 delay likelihood	cProba1s2	-0.947	-15.6
	1-in-5 delay likelihood	cProba1s5	-0.551	-9.5
	Length of delay	cDureeRet	-0.133	-21.7
	Value to be added if variable message panels are present to inform users of delay	cInfo	0.231	4.6
TRIP WITH TRANSFER UP TO SCHEDULE	Frequency	cFreq	-0.0794	-9.2
	Value to be added if:			
	<ul style="list-style-type: none"> 1 level of escalators involved 	cTypo1n1	-0.136	-2.2
	<ul style="list-style-type: none"> 2 levels of escalators involved 	cTypo1n2	-0.290	-4.7
	<ul style="list-style-type: none"> waiting outdoors 	cAttExt	-0.218	-4.0
	<ul style="list-style-type: none"> waiting outdoors after crossing thoroughfare 	cAttExtAxe	-0.439	-6.0
	Specific constant to be added for those not currently making any transfers	csCRNoCor	-0.690	-7.3
	Specific constant to be added for those already making one (or more) transfers – base value	csCRCor	-0.301	-3.4
	To be added according to place of transfer:			
	<ul style="list-style-type: none"> Albert 	csCRCorL1	0.574	2.3
	<ul style="list-style-type: none"> De Brouckere 	csCRCorL2	0.418	3.6
	<ul style="list-style-type: none"> Midi 	csCRCorL3	0.131	1.5
<ul style="list-style-type: none"> Louise 	csCRCorL9	0.165	1.5	
<ul style="list-style-type: none"> Montgomery 	csCRCorL10	0.201	2.4	
<ul style="list-style-type: none"> Simonis 	csCRCorL12	0.261	3.1	
Number of observations				8889

3.2. Perception of service irregularity: duration and likelihood of delay

User perceptions are as follows:

- a 1-minute delay per trip is perceived as a loss of € 0.10.
- a one-in-two likelihood of delay is perceived as a loss of € 0.70.
- a one-in-five likelihood of delay is perceived as a loss of € 0.41.

A user who has to take transportation that is delayed once for two or three minutes thus perceives this irregularity as a loss of about € 1.00 (= € 0.70 + 3 * € 0.10).

However, being informed by variable message panels of the vehicle's precise arrival time is positively perceived by the user. This approval is worth a gain of € 0.17.

Looking again at the above example, the user who takes transportation that is delayed once for two or three minutes, but who is informed of it, perceives this irregularity no longer as a loss of about € 1.00 but as a loss of € 0.83.

3.3. Perception of transfers

Analysis of user behaviour reveals the following:

- the more levels involved in making the transfer, the more onerous it is. A loss of € 0.10 is perceived per level to pass through.
- the most onerous waiting conditions are those that require waiting outdoors after crossing a thoroughfare: loss of € 0.32.
- the longer the interval between vehicles, the more onerous the transfer. Users perceive a loss of € 0.06 per minute.
- the transfer is perceived far worse by passengers who currently do not transfer than by those who already transfer one or more times. Everything else being equal, they perceive a transfer as a loss equivalent to € 0.51 and € 0.22, respectively.
- transfers in certain stations are perceived more negatively than in others. That is, for these stations, there is an environmental factor that explains the difference, beyond the attributes already considered to define the transfer (levels to pass through, waiting area and frequency of vehicles).

The least onerous transfers are those done from platform to platform, and for which the waiting is done in the station, as is the case for example for transfers to Nord or to Lemonnier, which are worth € 0.22 for a user who currently makes no transfers,

whilst the most onerous transfers, as in the case at Arts-Loi to go from Metro 1 to the bus, are worth € 0.76.

The onerousness of a transfer expressed in monetary terms is around € 0.40 per transfer, according to the reasons, station types and way in which the transfers are organised.

3.4. Value of users' time

The value of the time of users' delay (VOT) produced by the model amounts to about € 6 per hour *of delay*.

This value is higher than the values for time obtained as part of the modelling of the choice of public-transportation itinerary in the study of the Brussels-Capital Region Master Plan, specifically:

- about € 1.50 per hour of time spent aboard vehicles
- about € 3 per hour of walking
- about € 4 per hour of waiting

This time value is consistent because it is indeed more onerous to endure the delay of a transport vehicle than to spend time aboard it or even to wait for it at the stop if there is no delay. Users seem to be willing to pay more in order to avoid irregular service.

4. APPLICATIONS

A detailed analysis has been done of the implementation of a fast and regular tramway Line 3 (one vehicle every three minutes at rush hour and every five minutes during non-rush hour) on the Nord-Midi-Albert axis.

This analysis led to the following conclusions:

- a user making a direct trip on Line 3 would perceive a gain equal to € 0.93 at rush hour (i.e., the user would be ready to pay € 0.93 per trip to get regular service at morning rush hour). This gain increases to a value of € 1.07 in the case of a man going to work, and to € 1.25 in the case of a woman going to work. Women therefore seem more sensitive to irregularity (lack of safety in the stations?) than do men. Logically, irregularity is perceived more unfavourably when it is a matter of getting to work: during non-rush hour, these values change to € 0.82, € 0.97 and € 1.14, respectively.
- a user forced to make a transfer on Line 3 when he had previously made a direct trip by tram would, depending on the regularity of the line, perceive either a gain or a loss:
 - for tram 52: a gain equivalent to € 0.07 at rush hour (and a gain of € 0.02 at non-rush hour);
 - for tram 55 N: a loss equivalent to € 0.38 at rush hour and € 0.58 at non-rush hour;
 - for tram 55 S: a gain equivalent to € 0.30 at rush hour, and a gain of € 0.22 at non-rush hour.

The results present above show that while certain users gain in convenience when irregularity is greatly reduced in the services circulating in the Nord-Midi-Albert infrastructure, others lose as a result of additional transfers.

In order to prepare a complete diagnosis relating to all users and weighted by the respective weight of users subjected to new transfers and users travelling without transfer, it will be necessary to apply the results obtained to the entire demand. This work will probably be done as part of the Brussels-Capital Region Master Plan.