THE VALUE OF PUNCTUALITY ON SUBURBAN TRAINS TO AND FROM PARIS

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ABSTRACT

In this paper we describe the results of a research project that aimed to provide an operational methodology to assess the perceived benefits of investments to improve punctuality of suburban rail services to and from Paris. A literature review, train surveys and counts and a stated preference (trade-off) experiment have been conducted to obtain values of reliability. Also a simple tool was developed to quantify the benefits of specific projects. This was applied in a case study to the RER B Nord+ punctuality improvement project.

With regard to the value of reliability, the research indicated that an improvement in punctuality, expressed as a 5% reduction in the number of trains 5-15 min delayed, was worth about 4.6 minutes of travel time for commuters/education. Comfort appeared to be important, with particularly a clear dislike of the passengers of having to stand in very crowded trains. Information was also valued as worthwhile: explicit information about the duration of delays (in addition to information about the cause of delays) was valued similarly as a 10 minute reduction in travel time. The RER B Nord+ case study indicated that total annual benefits of about 10 million Euro were expected, over and above the 31 million Euro benefits due to travel time savings.

1. INTRODUCTION : WHAT DO WE KNOW ABOUT THE TRAVELLER'S PERCEPTION OF PUNCTUALITY?

In order to make public transport services more attractive to the traveler than private car, improving the quality of service is one of the priorities of transport policies in the Ile de France region (Paris and surrounding areas). However, the impact of quality enhancements on travelers' behavior is only partially known in France, qualitatively as well as quantitatively. As a consequence, it is not really possible to assess in advance, in cost-benefit evaluations, which measures will be most efficient to increase public transport modal share, or at least to avoid travelers' leaving public transport for their private car.

Due to the high density of population and employment in Paris, lots of persons commute each day in the suburban trains, and they frequently experience delays during their trips. Since 2000, poor punctuality of the suburban trains is certainly the major point of dissatisfaction of public transport travelers in the Ile de France region, but the investments required to reduce poor punctuality are almost as expensive as the creation of new infrastructure. To enable a rational allocation of public funding it is necessary to collect more knowledge about the impact of improving punctuality.

The Ile de France Transport Authority (STIF) therefore decided to conduct a study related to the qualitative and quantitative perception of punctuality by public transport travelers. This study was technically and financially supported by the public transport operators in Ile de France (RATP, SNCF and RFF). It was carried out by STRATEC (Belgium) and RAND Europe (Netherlands).

2. BACKGROUND: THE PARIS SUBURBAN RAIL NETWORK

The Ile de France region has approximately 11 millions inhabitants (20 % of France's population in a surface which represents only 2 % of the total country) and 5 millions jobs. Paris is located in the center of the region and counts an important part of the jobs (1,6 million). Therefore, each day 3,9 millions trips are made between the suburbs and Paris (for comparison, 23 million motorized trips are made each day in the whole region). Public transport modal share is high for all trips going to Paris: around 60%.

The railway network linking Paris to its suburbs (see Figure 1) comprises 1,400 kilometers (870 miles) of railway lines and serves 443 stations in total. Most of the lines are part of the express regional network (RER lines A, B, C, D and E) that offers different underground access points in Paris from the suburbs. Some other lines remain operated like classic trains stopping at only one terminal station inside Paris.

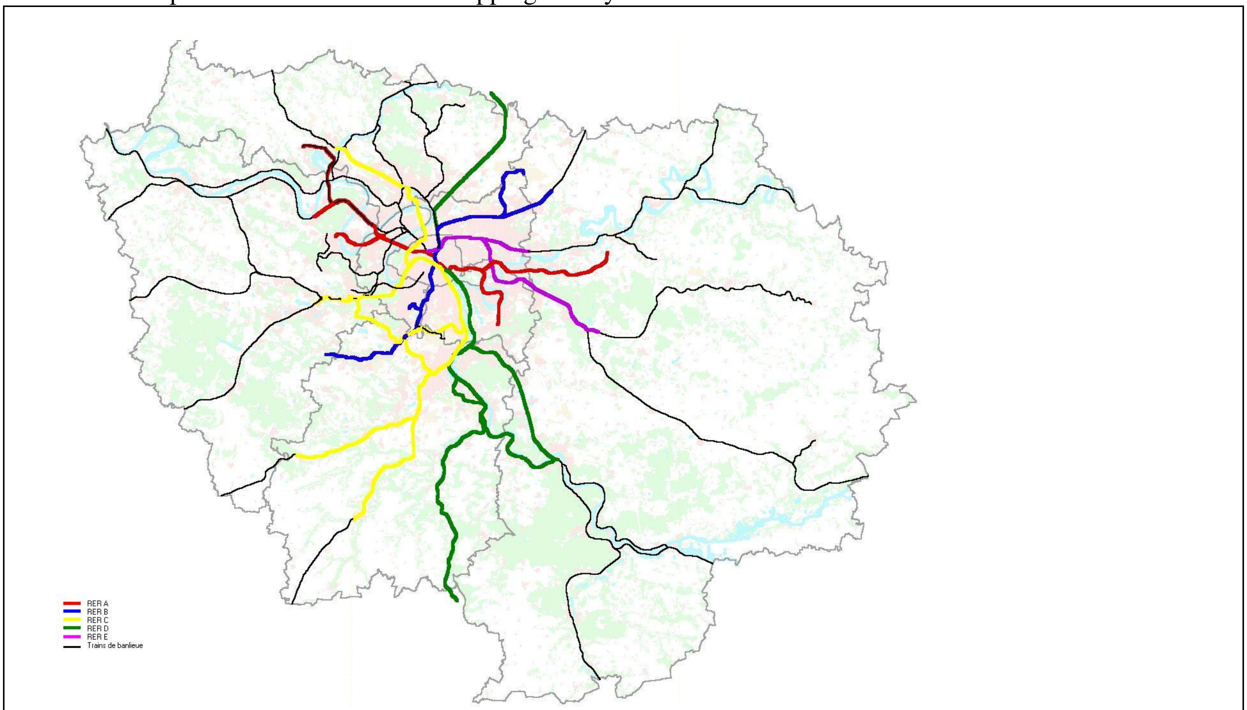

FIGURE 1 The Ile de France region and its suburban train network. In colour, the five RER lines, in black the classic trains

The railway network is operated by two state-owned companies: SNCF (French national railway company) and RATP (which operates also the metro network). SNCF operates services on the French national railway network (owned by Réseau Ferré de France, RFF). In 2004, traffic on RATP RER lines was equal to 434 million trips and 4,800 million passenger-kilometers (2981 miles). The same year, traffic on SNCF RER and railway lines was equal to 614 million trips and 10,000 million passenger kilometers (6211 miles).

SNCF and RATP operation is ruled by specific contracts concluded between these operators and STIF (the transport authority). These contracts address the provision of transport services, the fares that can be charged, the quality of service standards to be supplied, the operators' remuneration and a financial incentive system based on actual performance. These contracts include also a bonus/malus system based on the quality of service actually achieved.

Punctuality is at the moment the main problem of quality of service in Ile de France, as punctuality has been decreasing continually since the year 2000. In 2004, during peak hours, between 5 % and 16 % (depending on the line considered) of the trains on the SNCF network did not arrive on time. The best values are observed on lines where only suburban services are run, and on the RATP part of the network.

3. RESEARCH APPROACH

Given that there was insufficient information available about many elements associated with punctuality of trains and the value that passengers attach to improving the punctuality of suburban rail services, a comprehensive research program was carried out. This was structured in three main phases.

Phase one aimed at improving the knowledge of punctuality. The main objective was to learn about the key operational elements of punctuality associated with suburban rail. In order to achieve this, the international literature was reviewed, the available statistical data concerning Paris-oriented suburban rail were analyzed, and a passenger survey was set up to learn about passenger waiting times at rail stations and platforms.

Phase two consisted of qualitative research on the impact of unpunctuality on passengers. The main objective of this phase was to find out how delayed trains affect rail passengers, and what the consequences are. In order to achieve this, three group discussions were organized. The groups consisted of a carefully selected mix of suburban rail passengers of different ages, professional activities and household responsibilities, with different journey purposes, and using rail lines with different punctuality levels.

Phase three was the most important part and consisted of a quantitative analysis of the impacts of unpunctuality. Its main objective was to quantify the disutility associated with unpunctuality as perceived by the passengers. In order to do this, a stated preference (or trade-off) survey was carried out among a large number of rail passengers. In the survey different frequencies of delays were traded off against mean travel time, in-train comfort and the provision of information about delays. The results were analyzed to obtain utility estimates, which were expressed in equivalent minutes of mean travel time (e.g. reducing the frequency of delays from 10% to 5% of all trains is worth the same as a 5-minute reduction of travel time).

All three phases of the research were focused on punctuality. Punctuality is defined here as the provision of rail services with actual train departure times from, and arrival times at stations as published in the time table.

4. LITERATURE REVIEW

The literature search identified over 100 articles and reports dealing with punctuality, which were reviewed for potential relevance. Out of these, 21 articles were selected as relevant and were summarised. The main findings are summarised below.

- The key consequence of unpunctuality for passengers is that they (can) arrive late at their destination. Key elements are the frequency and length of the delay.
- The predominant passenger responses to unpunctuality are: (a) to accept the late arrival; (b) to build in a "safety margin" of time to minimize the risk of late arrival. There are few indications that passengers change their mode of transport or even their route to avoid irregularity.
- The distribution of train arrival times at their destination is non-symmetrical, skewed to the right, and with on average a small expected delay.
- Suitable statistical distributions to describe the train arrival pattern are the lognormal distribution, the gamma distribution and the Weibull distribution.
- The mean–variance method has been used most often to derive utility functions for public transport, with separate coefficients for the mean journey time and the spread (variance) in journey time.
- Passengers seem to understand the logic of an "unpunctuality" or "irregularity" variable when this is presented to them in the form of a "sample" of travel times of journeys on different days (e.g. the travel times on 5, 10 or 20 days).
- In the literature, stated-preference experiments involving punctuality typically include two, three or four variables, with (apart from the delay) variables including travel time, ticket price and/or comfort.
- In several stated-preference experiments, punctuality was described by means of percentage of trains delayed more than 5 minutes.

5. STATISTICAL ANALYSIS OF UNPUNCTUALITY

The statistical analysis of punctuality was based on the available detailed data concerning the contractual indicators provided by SNCF and RATP. This enabled us to establish where and when trains are delayed.

Where are trains delayed?

In the early 1990s the mean percentage of delayed SNCF trains (arrival at terminal station with more than 5 minutes delay) was around 4–5%. Since then punctuality has worsened significantly, and around 2001 the overall mean was approaching 9–10%. In 2004, the mean percentage of the punctuality statistics was 9,5 %. For RATP , less than 5 % of the travellers were delayed more than 5 minutes at their destination in 2004.

When values of the contractual indicators are compared between lines, it is clear that there is substantial variation around the mean: "good punctuality" lines show percentages of around 4% of delayed trains, while "poor punctuality" lines have percentages up to 18% of delayed trains. The frequency of delays does not seem to be related to frequency of service: all frequencies of delays (high/low) occur about equally often with all frequencies of service (high/low). It depends mainly on the co-existence of different type of services on the same line, especially when lines are also used by High-speed trains or Intercity services.

When are trains delayed?

There is substantial variation in the frequency of delays over time. In terms of seasonality, the SNCF train statistics show that during August 2002 less than 4% of trains were delayed, while November and December 2002 had more than 11% of all trains delayed. For the RATP trains a similar pattern is observed, but less extreme (August: 4%, December: 9%).

Analyses of delays for different days of the week also show clear differences between working days (Monday–Friday) and weekend days (Saturday, Sunday). For the RATP lines during the weekend about 4% of all trains were delayed, while over 8% of the trains were delayed on working days (2002).

When we compared SNCF frequencies of delay during morning and evening peaks it was clear that during evening peaks the delays are systematically more frequent than during morning peaks.

This is confirmed by detailed train-by-train data obtained from RATP for the period from 17 February to 22 March 2003 which is considered a representative period. In Figure 2 we show the results obtained for RER A, but the results for RER B are similar. On the x axis the difference between actual arrival time at destination and scheduled train arrival time is shown. The y axis gives the frequency of trains, or the probability of a late (or early) arrival.

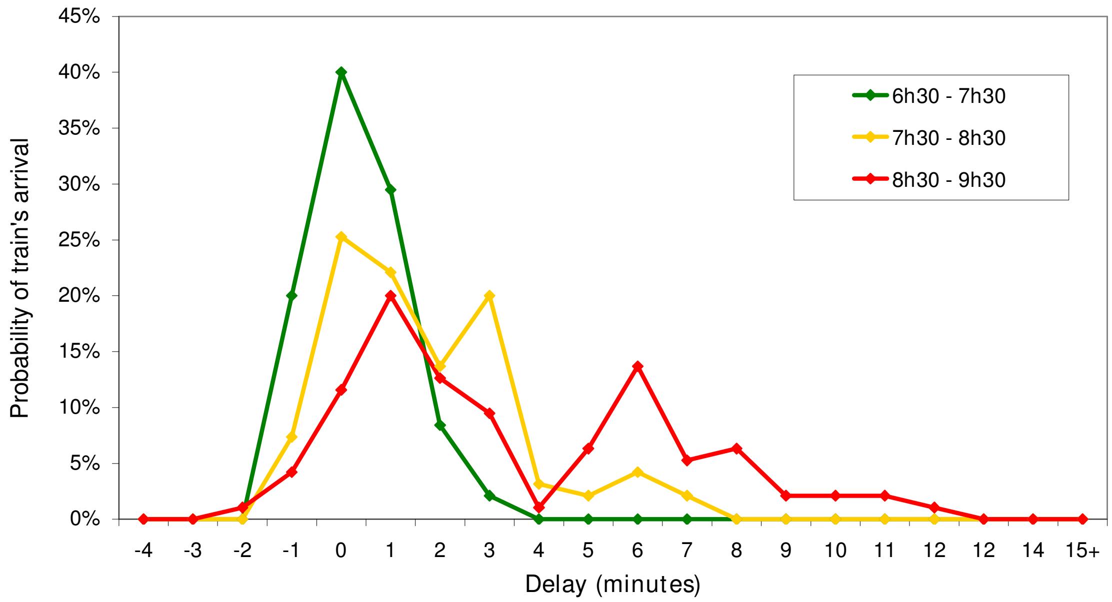

FIGURE 2 Evolution of the distribution of train delay amplitude during the morning peak period (RATP RER-A, February–March 2003)

It can be observed that during the first morning peak hour, 06.30–07.30, most trains arrive on time or with only a small deviation (2 minutes maximum). The probability of a delay of more than 5 minutes is very small. During the next peak hour, 07.30–08.30, most trains are still (almost) on time, but a second peak in the frequency distribution builds up around 3–4 minutes late, and a third small peak around 6–7 minutes late. For the third peak hour, 08.30–09.30, most trains arrive 1–2 minutes late, and the second peak of the preceding hour seems to have moved to the right and increased in size. It is also clear that the probability of a delay of more than 5 minutes is now very substantial.

An important conclusion is that the probability of a train being on time decreases over the day: 60% of the trains arrive on time between 06.30 and 07.30, while only 17% of the trains arrive on time between 08.30 and 09.30. A similar pattern can be observed for evening peak. This pattern may be as a consequence of the narrow time slots assigned to the trains, and the related knock-on effects of delays on later trains. In other words, as soon as a train is delayed, even slightly, all subsequent trains are likely to be delayed as well.

6. SURVEY OF PASSENGERS ARRIVAL PATTERNS AT RAIL STATIONS AND PLATFORMS

The punctuality indicator for RATP is based on the number of passengers who experience delays at their destination, but for SNCF the indicator concerns the delays of trains. In order to convert unpunctuality as measured by the operator into unpunctuality as perceived by the traveller, we need to know about the traveller's waiting times. Thus it is necessary to know if passengers arrive at random at stations or if they aim at a specific train. In the latter case, unpunctuality would certainly be more disturbing for the traveller.

The research project provided an an opportunity to establish the pattern of arrival at rail stations and on platforms, and to establish statistical laws of arrival according to the level of unpunctuality and the frequency of trains.

On a sample of stations passenger counts were performed, at each access point to the platform, where arriving passengers were recorded every minute. Train departures were also recorded using hand-held computers at the moment train doors were closed. In total 292 trains were counted, with a total number of 40,928 passengers boarding.

A sample of passengers were approached for a short interview at the bottom of the access points to the platforms, so that interviews and counts could be linked together. The interviews included questions about arrival time at the station, whether or not the passenger aimed at a specific train/departure time, access mode to the station, journey purpose, and destination station. In total 1521 passengers were interviewed. The main findings of the analysis of the interviews and counts are described below.

- The percentage of passengers aiming for a specific train is strongly related to the scheduled frequency of service: for train services with headways of 15 minutes or longer around 80% of all passengers aim for a specific train, whereas for services with headways of 5 minutes or less only around 20% aim for a specific train.
- The time that passengers spend inside the stations (both on the platform and in the service areas) is about half the headway according to the timetable, plus about 4 minutes for services with good punctuality. For poor punctuality services about half the headway, plus about 5 minutes are spent in the station.

Figure 3 shows the computed distributions of the time spent by passengers on the platforms. These have been computed from the counts and the observed train departure times, and represent the net waiting time for the train. The results clearly indicate that for headways of 5 or 10 minutes, passengers arrive uniformly at the platform. For longer headways (15 minutes) about 60% of the passengers arrive within 5 minutes before departure.

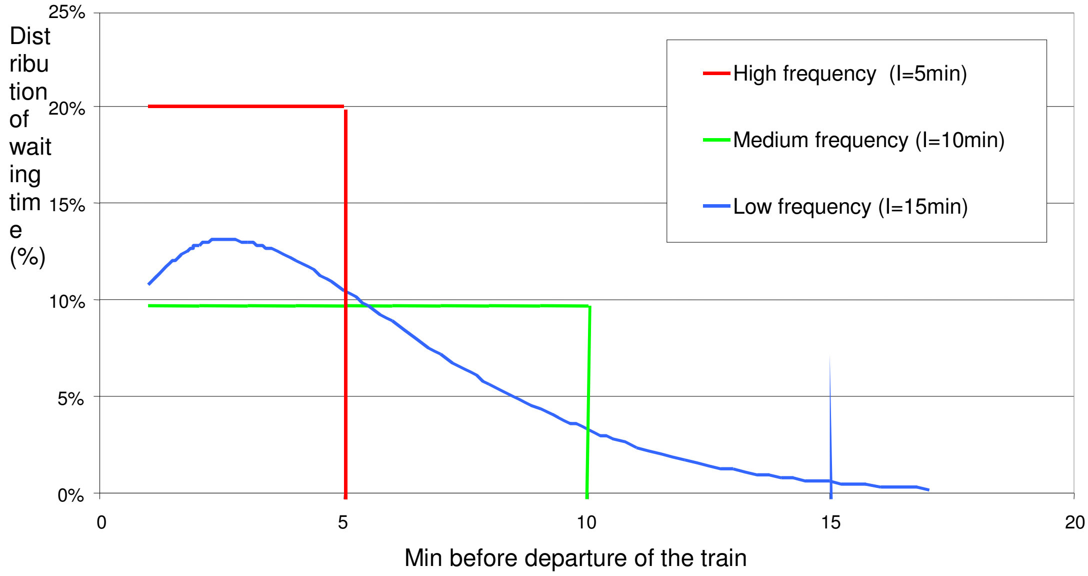

FIGURE 3 Distribution of the waiting times spent by passengers on the platform for different train frequency levels.

7. QUALITATIVE RESEARCH

For the qualitative analysis three focus groups of ten travelers each were recruited in railway stations. The travelers were selected in order to be representative of different social categories, age and characteristics of household. The three groups were composed according to journey purpose and punctuality of the service offered:

- commuters using lines of good punctuality
- commuters using lines of bad punctuality
- travelers for other purposes (irrespective of punctuality level).

The discussions of the focus groups were organized in order to identify:

- to what extent is unpunctuality acceptable or not for the traveler?
- which consequences unpunctuality has on the traveler's behavior ?

First of all, it is important to note that most travelers of the suburban railway lines in Ile de France are not dependant on public transport but chose public transport deliberately instead of using their private car because it is more convenient. Like in other major metropolitan areas traffic congestion is high during peak periods. Spontaneously, travelers say they chose the train instead of their car because of the reliability of the arrival time. As a consequence, it increases the necessity to maintain a good level of rail punctuality to keep the travelers in public transport.

Is punctuality acceptable or not for travellers?

Travelers in Ile de France consider that very short delays (under 5 minutes of delay) are quite normal. Very long delays are generally due to causes external to the transport system, like suicides, demonstrations, extreme weather. Of course, long delays have major consequences on the travelers but, as long as they remain exceptional, they can be accepted by the travelers.

Medium to long delays are the worst ones for travelers, especially as they are recurrent. Travelers using lines with bad punctuality are really disturbed by these delays, and judge them much more negatively than travelers using lines with good punctuality.

The journey purpose has also a major influence on the perception of delays, which is often linked to family constraints. Women who are generally in charge of children value delays during their return trip very negatively, especially if their children are young (they have to be on time when taking the children back from school). More surprisingly, arriving late at work is often seen as less important as most employers will accept the delay and do not oblige the employee to stay later in the afternoon. In this case, the cost of the delay is incurred by the employer and not by the traveler.

What are the consequences of unpunctuality on the traveler's behavior?

Among all the possible consequences of unpunctuality for the traveler, the main one is the arrival time at the final destination of the trip. That means that even a short delay can have important consequences, for instance if it causes the travelers to miss a transfer with a non-frequent public transport service.

Another consequence of unpunctuality is that trains become more crowded when unpunctuality is getting higher. In this case, the traveler experience reduced comfort in the train as well as the delay itself.

Uncertainty about waiting time seems less important than arriving late at destination. However, the lack of reliable information when delays occur was mentioned by many of the interviewed travelers.

Before boarding the train, information is important as the traveler can have alternative solutions to make his trip. During the trip (inside the train) information on the cause of the delay would be welcome: it would allow the traveler to estimate the size of the delay.

8. STATED PREFERENCE RESEARCH

In order to appraise a priori the monetary benefits of different possible measures to improve the regularity of the Paris suburban train network, it is necessary to know what economic value passengers attach to such quality improvements. One way to estimate this value is to conduct a "stated preference" choice experiment. In such research a sample of passengers is offered a series of choices between two (or more) hypothetical alternative train services. These services differ in their key characteristics, such as travel time, reliability, comfort level, etc. Passengers are asked to state their preference for one of the alternatives. In the Ile de France project it was decided to conduct such an experiment.

Design and realisation of the stated preference survey

The design of the stated preference survey was based upon the conclusions of the literature review and the qualitative analysis. It also took into account the nature of available statistics concerning unpunctuality. These were two key points that we respected in order to be able to apply the results of the stated preference survey in practical research.

The choice of variables

Traveler's behavior towards unpunctuality seems to be different according to the length of delays and their frequency. Therefore, it was decided to use two different variables to describe unpunctuality, frequency of short delays (between 5 and 15 minutes) and frequency of long delays (above 15 minutes).

Comfort and information are key issues for passengers but the description of these variables was not obvious, especially as a link with existing available statistics was required. It was finally decided that the level of comfort was specified using three levels: "seated"; "standing"; or "standing in a crowded environment".

The information about delays was presented as "announcement of disturbances"; "announcements of disturbances and their causes"; "announcement of disturbances, their causes and the expected amounts of delay".

How to present the punctuality variable?

In order to test and validate the different possible ways to present the selected key variables in the stated preference experiment, qualitative research was carried out. This involved a group discussion with rail passengers, during which three different types of stated preference questionnaires were presented. It turned out that frequencies of train delays per month presented as x times out of 20 was understood best, and was most clear to the majority of all passengers. Consequently, this presentation was retained in the stated preference survey.

The sample

More than 1,200 rail travelers participated in the stated preference survey. They were recruited on platforms of a selection of train stations in Paris, or inside the trains between these stations. The recruited travelers were spread over the different passenger segments that were under investigation. These segments differed by:

- journey purpose (commute/education or other);
- frequency of service of the line where the traveler was recruited (high or low);
- regularity of the line where the traveler was recruited (good or bad); and
- direction of the trip (to or from Paris).

The recruited train travelers received a personalized questionnaire by surface mail, based upon their reported travel characteristics. A few days later they were phoned by the fieldwork agency to conduct the interview and record the answers. These interviews were conducted in the last week of June and the first weeks of July 2004.

The choices

Each interviewed train traveler was asked to make 19 choices, each time between two alternative train services. Each train alternative was described by:

- the travel time for the train trip;
- the frequency of short delays (delays between 5 and 15 minutes);
- the frequency of long delays (delays of more than 15 minutes);
- the comfort level for the train trip; and
- the level of information provided on delays.

The value of these attributes varied between a low, a base and a high level. The base levels of travel time and frequency of the short and long delays were equal to the current levels as perceived (reported) by the traveler. The low and high level of the travel time differed 5%, 10%, 20% or 30% (determined by random draw) from the current level. The low level of the frequency of delays was about half the current level, the high level was about double the current level.

The level of comfort could be either of three options: "seated"; "standing"; or standing in a very crowded environment. The information about delays was presented as "announcement of disturbances" (level 1); "announcements of disturbances and their causes" (level 2); "announcement of disturbances, their causes and the expected amounts of delay" (level 3).

Figure 4 shows an example of a choice card as used in the interviews.

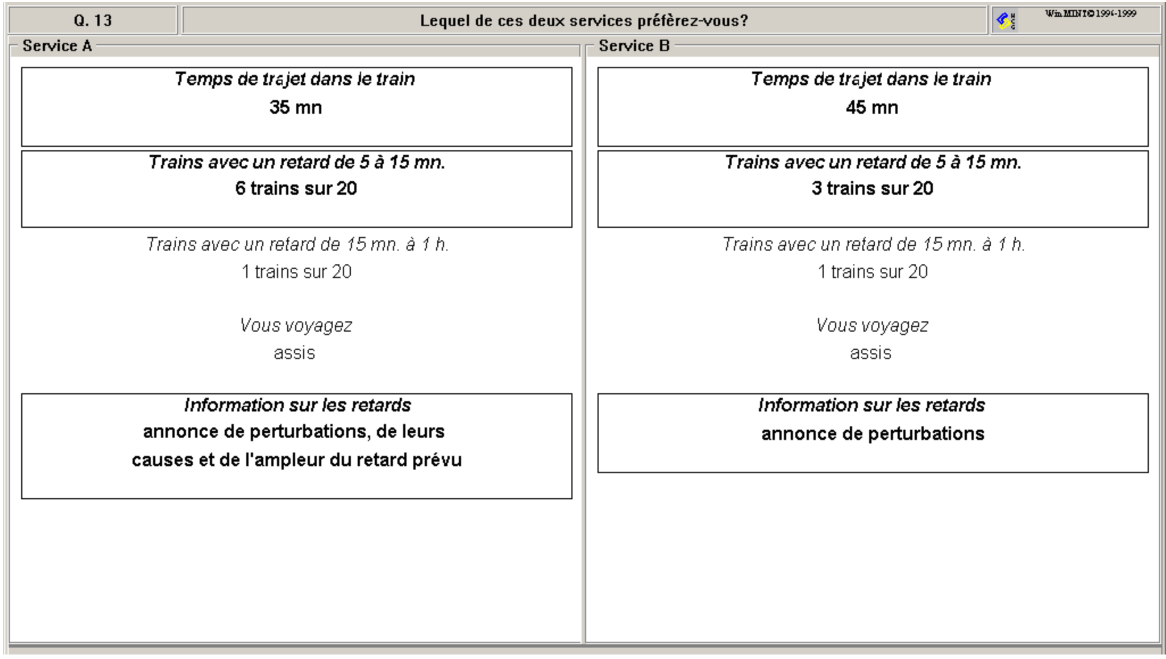

FIGURE 4 Example of an SP choice card (as seen by the interviewer)

Statistical analysis

The stated preferences (or actually: hypothetical choices) provided by the train travelers in the SP survey were analyzed to infer the utility weight of each of the service quality variables using discrete choice analysis methods - in this case logit analysis based upon maximum likelihood estimation.

All estimated coefficients obtained in the final models have the expected sign, and a plausible size. Separate coefficients were estimated for people traveling with different journey purposes (commuting, education or other). The final results are shown in Table 1. For a complete overview of the model results (including the significance of each of the coefficients) we refer to our Technical Report on the stated preference data analysis (*1*).

Conclusion of the statistical analysis

Table 1 indicates the value of each parameter relative to one minute of travel time. For example, a person traveling from Paris on a commute trip on a line with good punctuality values a 5% probability of having a short delay (1 out of 20 trains) equal to 4.6 minutes of travel time. So the value of reducing the frequency of short delays from, say, 10% (2 out of 20 trains) to 5% (1 out of 20 trains) for a commuter is equivalent to a travel time saving of 4.6 minutes.

If this person is traveling for another purpose (not commute/education), he values this delay probability equal to 6.2 minutes of travel time. It may seem counter-intuitive that passengers that go to work value punctuality as less important than travelers that go shopping, for instance. However, it was already observed in the group discussions that for commuters unexpected train delays were often accepted as a valid excuse for arriving late at their work. So part of the disbenefit of being late could be transferred to the employer, which may explain this result.

The coefficients for long delays are higher: for commuting/education 6.7 minutes of travel time, for other purposes 8.9 minutes. Note that the actual frequency of such long delays is much lower than the frequency of the short delays, but that the expected duration of such a delay is considerably longer. The net effect, however, is that the utility of reducing longer delays is higher than that of reducing short delays.

Two other variables that were included in the SP experiments were comfort/crowdedness and information about delays. For comfort we found that not having a seat is equivalent to an additional 5-14 minutes of travel time: 5 on lines with good regularity, and 14 on lines with bad regularity. In addition to that, this value increases with the length of the journey. The disutility increases sharply when passengers have to stand in a crowded/packed train: this is valued as equivalent to a 27 minute increase in journey length.

For information about delays we found that providing extra information about the duration of delays is worth about 10 minutes of travel time. Note that the values for the information level are negative: this indicates that extra information about the size of the expected delay is valued equally as a reduction of the travel time.

The results that have been obtained here have been implemented in a practical tool that has been used in the case study described in the next chapter.

	Commute / education trips								Other trips							
	Travelling from Paris				Travelling towards Paris				Travelling from Paris				Travelling towards Paris			
	Good regularity	t-ratio	Bad regularity	t-ratio	Good regularity	t-ratio	Bad regularity	t-ratio	Good regularity	t-ratio	Bad regularity	t-ratio	Good regularity	t-ratio	Bad regularity	t-ratio
Travel time																
for each minute of traveltime	1.0	(*)	1.0	(*)	1.0	(*)	1.0	(*)	1.0	(*)	1.0	(*)	1.0	(*)	1.0	(*)
Short delays (5-15 minutes)																
1 out of 20 trains	4.6	(10)	4.6	(10)	4.6	(10)	4.6	(10)	6.2	(8)	6.2	(8)	6.2	(8)	6.2	(8)
2 out of 20 trains	9.2	(10)	9.2	(10)	9.2	(10)	9.2	(10)	12.3	(8)	12.3	(8)	12.3	(8)	12.3	(8)
3 out of 20 trains	13.8	(10)	13.8	(10)	13.8	(10)	13.8	(10)	18.5	(8)	18.5	(8)	18.5	(8)	18.5	(8)
4 out of 20 trains	18.0	(13)	18.0	(13)	18.0	(13)	18.0	(13)	24.1	(10)	24.1	(10)	24.1	(10)	24.1	(10)
5 out of 20 trains	22.2	(14)	22.2	(14)	22.2	(14)	22.2	(14)	29.7	(11)	29.7	(11)	29.7	(11)	29.7	(11)
6 out of 20 trains	26.4	(15)	26.4	(15)	26.4	(15)	26.4	(15)	35.3	(11)	35.3	(11)	35.3	(11)	35.3	(11)
7 out of 20 trains	29.0	(17)	29.0	(17)	29.0	(17)	29.0	(17)	37.2	(12)	37.2	(12)	37.2	(12)	37.2	(12)
+ for each extra delayed train out of 20	2.6	(14)	2.6	(14)	2.6	(14)	2.6	(14)	1.9	(5)	1.9	(5)	1.9	(5)	1.9	(5)
Long delays (15+ minutes)																
1 out of 20 trains	6.7	(17)	6.7	(17)	6.7	(17)	6.7	(17)	8.9	(10)	8.9	(10)	8.9	(10)	8.9	(10)
2 out of 20 trains	13.3	(17)	13.3	(17)	13.3	(17)	13.3	(17)	17.8	(10)	17.8	(10)	17.8	(10)	17.8	(10)
3 out of 20 trains	20.0	(17)	20.0	(17)	20.0	(17)	20.0	(17)	26.7	(10)	26.7	(10)	26.7	(10)	26.7	(10)
4 out of 20 trains	25.3	(21)	25.3	(21)	25.3	(21)	25.3	(21)	33.9	(12)	33.9	(12)	33.9	(12)	33.9	(12)
+ for each extra delayed train out of 20	5.4	(16)	5.4	(16)	5.4	(16)	5.4	(16)	7.2	(9)	7.2	(9)	7.2	(9)	7.2	(9)
Comfort level																
Standing	4.9	(2)	14.0	(6)	4.9	(2)	14.0	(6)	6.5	(2)	18.7	(5)	6.5	(2)	18.7	(5)
+ for each minute of traveltime	0.3	(4)	0.1	(2)	0.3	(4)	0.1	(2)	0.4	(4)	0.1	(2)	0.4	(4)	0.1	(2)
Standing in a crowded environment	27.2	(14)	27.2	(14)	27.2	(14)	27.2	(14)	36.3	(9)	36.3	(9)	36.3	(9)	36.3	(9)
+ for each minute of traveltime	0.2	(5)	0.2	(5)	0.2	(5)	0.2	(5)	0.3	(4)	0.3	(4)	0.3	(4)	0.3	(4)
Information level																
Announcement of perturbation and cause	0.0	(*)	0.0	(*)	-4.4	(6)	-4.4	(6)	0.0	(*)	0.0	(*)	-5.9	(5)	-5.9	(5)
+ for each shortly delayed train out of 20	-0.9	(3)	-0.9	(3)	0.0	(*)	0.0	(*)	-1.3	(3)	-1.3	(3)	0.0	(*)	0.0	(*)
Announcement of perturbation, cause and size	-9.9	(10)	-9.9	(10)	-9.9	(10)	-9.9	(10)	-13.2	(7)	-13.2	(7)	-13.2	(7)	-13.2	(7)

TABLE 1 Results of the stated preference research, indicating for each segment how passengers value a certain quality level with respect to one minute of travel time and the corresponding t-ratios

9. APPLICATION TO THE "RER B NORD +" PROJECT

Context and issues

RER B is a heavy rail line that serves the suburbs of Paris, and crosses the city from North to South. Part of it is operated both by RATP (south of Gare du Nord), another part by SNCF (north of Gare du Nord, see. Figure 5).

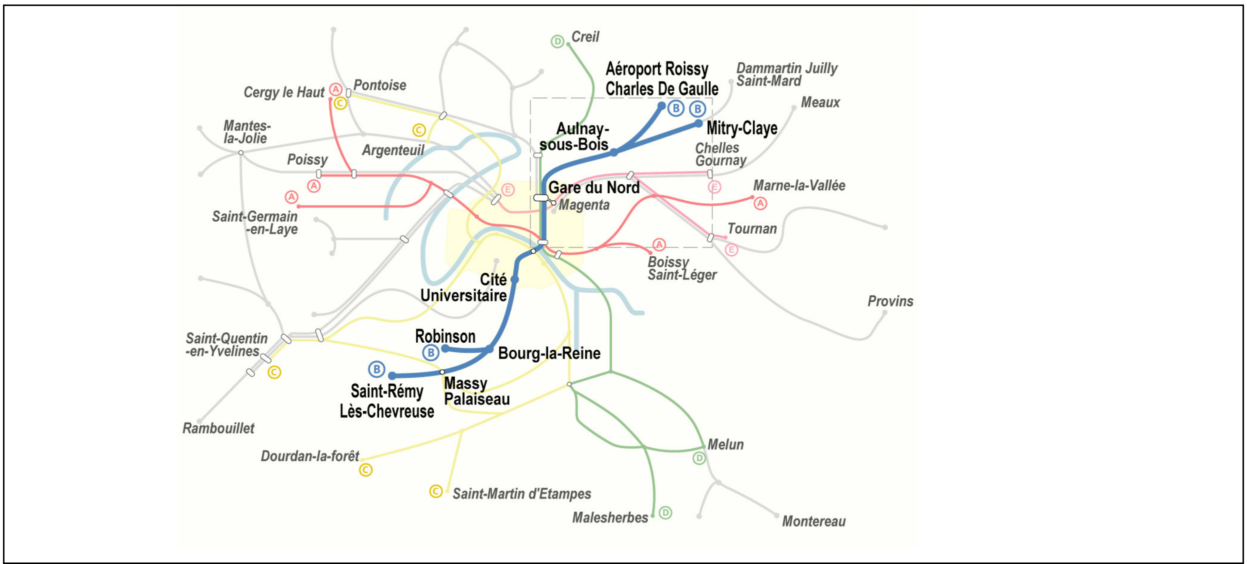

FIGURE 5 The RER-B line (blue line)

Several types of rail services are run on the common section of this line: some trains serve every station of the line, some trains are direct between Aulnay-sous-Bois and Gare du Nord, and some others serve only main intermediate stations. During peak hours the frequency is twenty trains per hour in the most crowded direction. The tracks of this part of the line are owned and maintained by RFF.

RER B Nord currently carries 245,000 passengers per day. Patronage of some stations is growing significantly, for instance at the new station serving Stade de France (the main football stadium in France, located in an area in important urban regeneration).

The line suffers from poor punctuality. In 2003, the proportion of trains delayed by more than 5 minutes at their destination was 10.8%. This figure is higher than the 2002 and 2001 statistics (7.9% and 8.5%) and is also higher than the average for all SNCF lines in 2003 (9.8%).

The delays have various causes such as rolling stock failure, non-availability of staff, ill passengers, accidents, vandalism. However, the technical characteristics of the line have a worsening impact on service operation:

- There are four tracks, two in each direction. RER B trains share some portions of the rail tracks with other rail services: regional trains, interurban trains and freight trains. These trains have different speeds, priorities and operating constraints, which leads to conflicts in the use of infrastructure.
- In order to shift from one track to another, RER B trains may have to cross the opposite tracks and then insert between two other trains. The situation is worsened in some cases where there are only 3 tracks instead of 4. In this case, on the same track, trains can run alternatively in one direction and another.
- On the Charles de Gaulle branch, there is no installation that allows trains to change their direction, or installations that allow trains to overpass a stopped one. Any problem on this branch can lead to a total disruption of traffic.

Improvement proposed

In order to improve this situation, a project called "RER B Nord +" has been proposed jointly by SNCF and RATP, and was approved by the board of STIF in February 2005. This project consists of improving the overall quality of service for this line, including the stations, rolling stock, comfort, level of service, the interchanges and punctuality.

Different technical measures are proposed in order to improve the punctuality. RER B trains will run on two dedicated tracks, one for each direction. This will suppress all crossing conflicts and mixed use of infrastructure. Specific installations will be built on Charles de Gaulle branch allowing trains to run in the opposite tracks so as to overpass a stopped train. Installations will also be built to allow the reversal of trains when the line is out of service beyond a certain point, in case of accident for example.

The consequence of the dedication of tracks is that the timetable must be changed because it is impossible to have direct and omnibus trains operating on the same tracks. Therefore, it has been decided to have all trains serving all the stations ("omnibus trains"). The number of trains per hour will remain the same on the whole (20 per hour), but at some stations the frequency will be much higher than today. Of course, travel time for travelers going from the terminal stations to Paris will be longer than today, but time losses will be smaller than waiting time savings.

The total investment cost of the project amounts to 324 million € (all amounts are in € 2004). An initial cost benefit analysis has been conducted taking into account as benefits mainly the travel time savings due to the new service and the passenger-kilometers shifted from private car to rail. Travel time benefits have been estimated at 31 million Euro/year in 2010, savings from modal shift alone amount to 11 million Euro/year.

Appraisal of the punctuality benefits of the project

The initial cost benefit analysis of the project had already demonstrated its interest. However, the total benefits are higher when the punctuality improvements are also taken into account (note that the results of the present study were not available at the moment when the initial cost-benefit analysis was carried out).

As we have seen in the previous chapter there are two options to estimate the punctuality benefits: (1) using more global estimates of the average effect per passenger, or (2) using the results from a detailed train operation simulation model, such as operated by RFF.

Simulations of trains operation have been made by RFF and SNCF. They describe how external causes impact the theoretical timetable in the current situation, and in the future situation for morning peak hours. To appreciate the savings due to enhancement of punctuality, a basic calculation has been done. The inputs to the punctuality appraisal can be summarized as follows:

- Existing regularity level: 10.8% delays 5-15 min
- Regularity level after project: 7.9% delays 5-15 min (equal to the 2002 value)
- Commute and education: 84%
- 20,000 passengers per hour during peak hour for the most crowded direction
- 217 days per year
- Value of travel time 16.19 Euro per hour (for the year 2010)

With these inputs, the assessment tool estimates an equivalent punctuality time saving per trip of 2 minutes and 50 seconds. The peak hour results have been expanded to all morning and evening peaks during a whole year, and converted into monetary units. The resulting total punctuality benefits for "existing" passengers are 9.9 Million Euro per year (in Euro 2004, using Value-of-Time for 2010). This is about 32% of the 31 million Euro benefit due to travel time reduction. Total benefits related to travel time plus punctuality improvements amount to 41 million Euro.

10. CONCLUDING REMARKS

In this paper we have described the results of a research project that aimed to provide a robust operational methodology to assess the perceived benefits of investments to improve punctuality of suburban rail services to and from Paris. The project has succeeded in establishing the value of punctuality for the passengers involved, and has demonstrated that at least for one specific case study, the RER B Nord+ project, the punctuality benefits added substantially (about 10 Million Euro) to the benefits of travel time savings (about 31 Million Euro).

The results of the study can also be applied to other projects to quantify the benefits of punctuality improvements. For projects involving similar rail services in the same region (Ile de France) there is no reason to assume that passenger valuations would be different. Indeed the STIF intends to use the methodology in a range of new projects, including RER lines C and D. The results can also be extended to contexts outside the Ile de France region. In the absence of any local empirical evidence the results obtained here can be used as a first estimate. Of course it is desirable to conduct similar research, to test whether or not the local valuations are the same as those obtained in the Ile de France, and to modify the parameters if necessary.

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