Evaluation of Urban Fixed-Track Public Transport: Method and Content

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Abstract

For about twenty years, but particularly since the law made them compulsory in France, ex-post evaluations have been undertaken for urban public transport infrastructure investments. We first review the main objectives of such studies and then deal with the principal methods used. These are:

- 'before-and-after' analysis: recording of the data before investment in infrastructure and again after the new facility begins operation; the impact of the investment is inferred from comparison of the two sets of data;
- 'after' analysis: the actors (users, technicians, shopkeepers etc.) are interviewed about how their behavior has changed and the way other actors' behavior has changed; these opinions are then related to the characteristics of the new transport facility;
- analyses based on the 'congruence' concept: the new transport infrastructure is part of an evolving urban space. They reveal these changes and amplify the action on those changes. The actors' strategies must then be studied in dynamic situations.

This overview leads us on to question the idea of 'effect or impact' in terms of direct causality of the PTSP on its environment, because it does not interfere with static environment. It is preferable to carry out an overall diagnosis for the whole urban system.

We then propose a hierarchy for the numerous elements that make up the monitoring system. We start with the actors in the urban system, their function, and their stake in the new infrastructure. This analysis is carried out for all the sub-systems that make up the urban system. In this way we can structure the monitoring system and, at the same time, fix the priorities for the phenomena and evolutions to be observed according to the objectives that have been identified for monitoring.

Introduction

When the new fully-automated underground line opened in Lyon (France), the SYTRAL (SYndicat des TRansports en commun de l'Agglomération Lyonnaise) <the Lyon Area Public Transport Authority> asked the SEMALY and the Transport Economics Laboratory (LET) to propose a method to monitor the 'effects' of this new public transport infrastructure. This article reviews the elements of the methodology developed to do this.

In France, there have been many evaluations of the operation of new urban fixed-track public transport, thanks to the 'Loi d'Orientation des Transports Intérieurs' (LOTI) of the French Government, which has made them compulsory when there is major investment of public funds in public transport. Therefore, we felt that a good starting point would be to analyze the methodologies used in these studies.

This critical review led us to develop a classification based on three major methodologies: 'before-and--after' studies; 'after' studies, and studies based on the concept of congruence. Our analysis of each of

these methods enabled us to work out our own methodology. Furthermore, the very large number of fields covered by these studies convinced us of the need to put the numerous monitoring indicators into some sort of order. To do so, we decided upon a systemic approach for urban areas crossed with the identification of the stakes of new infrastructure for the principal actors. This enabled us to propose an overall hierarchical approach for the selection of monitoring content.

Our paper is in three major sections. We first determine the main objectives for monitoring. Then we specify the way we chose to carry out the bibliographical analysis. Finally, we discuss what we have learned (from this analysis) about how to organize evaluation studies.

1 - Main objectives of evaluation

Monitoring of urban transport infrastructures has been going on for many years now. Its importance increased considerably throughout the 1970s as the state intervened more and more in the organizing and financing of urban transportation. In the 1980s, this trend was reinforced by the introduction of LOTI and by the construction of fixed-track public transport in the major provincial cities. Such monitoring became automatic for all major investments made with the help of public funding in accordance with Article 14 of the LOTI.

Besides these general considerations we can classify the main objectives of evaluation as follows:

- **to provide the basis for an a posteriori evaluation.** The uncertainties of a priori evaluation (particularly traffic forecasting) have caused those in charge to launch monitoring programs. A particular aim is to check the accuracy of the forecasting. The objective requires observation of indicators regarded as pertinent for the estimation of the 'effect' of the new infrastructure on its environment;

- **to improve both forecasting methods and methods for choosing investments**. This objective is linked to the foregoing one. It requires a comparison between forecasts and outcome. The differences must be analyzed with a view to explaining them. They can come from the forecasting methods themselves, which must then be improved, or from environmental hypotheses, which may not have been evaluated properly. Those in charge may also be interested in an analysis of the impact (of the investments made or the policies decided) upon the urban area, since a priori evaluation studies do not completely cover all the fields affected by the investment. Such analysis can be used as a guide for future projects or to guide on-going policy;

- **to improve the manner of use of the investment**. The aim here is rather to analyze the functioning or use of the transport system or the way in which it is perceived, than to measure the evolution of behavior or the 'effects'. Such analysis can then be used to improve the operation of the transport system or to design a promotional campaign to encourage more use to correct undesirable evolutions;

- **to gain a better understanding of urban travel habits or the relationship between transportation systems and the urban environment**. When some major transport infrastructure comes into service, there are changes in travel behavior. We often also observe changes in the project's environment whether it be in trade, housing costs, building, etc. We can therefore get a deeper knowledge of the parameters for transport demand or choice of mode, or of the interactions between the transport supply and its urban environment, or even the process of evolution of this environment (BOURGIN C., 1978; BONNAFOUS A. and alii, 1981).

These different objectives are not mutually exclusive: in any particular monitoring study, two or more objectives may rest side-by-side. However, different objectives may require differing methodologies.

2 - Review of the Evaluation Studies

Many of the numerous evaluation studies have been relatively unsuccessful in measuring the 'effects' of new transport infrastructure. This failure led us to undertake a wide-ranging bibliographical analysis in which we identified the various methodologies and the phenomena (or indicators) that were studied in an attempt to learn how the practice could be improved.

a - The objectives of the bibliographical analysis

Since the beginning of the 1970s, first with the renewal of public transport and then with the LOTI, the amount of monitoring has increased considerably. This increase has not really led to a methodological corpus that is common to all studies. The fields dealt with are varied widely from one city to another. There has also been difficulty in finding clear relationships as the following examples show.

The authors of a monitoring study of the Lyon underground conclude: 'Most of the changes between the two periods are seldom totally unconnected to the arrival of the underground, but they are rarely fully linked to it. This follows from the fact that the situations before and after the introduction of the underground are not totally identical in other respects'. (BONNAFOUS A. and alii, 1981).

Another study carried out in Rennes by INRETS comes to a similar conclusion, viz.: 'The motivations expressed to explain behavioral change are generally foreign to the improvements in public transport (even if this does not mean that they are of no importance in explaining it) but the motivations are often linked to the position in the life cycle' (BOURGIN C., 1978).

The studies carried out in Lille when the fully automatic VAL underground system was opened confirm these conclusions. (CETE, CUDL, 1985).

Nevertheless, in each of these studies, it was possible to identify evolutions within the fields studied even if their analysis and interpretation would appear to be problematical. This leads us to believe that it is first necessary to review the evaluations carried out over the last twenty years. This should enable us to learn much about how to define a methodology that could be adapted to the specific question posed and also allow us to assess the relevance and importance of the various measures.

b - Definition of an appropriate reading grid

In studying over forty reports, we found it necessary to establish a reading grid (Bonnel P. and Thibaud S., 1991), which contains the following headings:

- objectives of the study;
- methodology used for evaluation;
- principal phenomena studied, and choice of indicators for these phenomena.

Although the results usually take up the main section of reports, we decided not to apply our reading grid to them or, to be more precise, we considered them in the light of the methodology used. The results of this bibliographical analysis are presented in the following two sections. First we describe the three

methods we identified - critical analysis of these three leads us to propose an appropriate methodology. We then go on to consider the principal phenomena that have been examined in the studies; the multiplicity and diversity of the indicators leads us to create a hierarchy to order this information.

3 - The Analytical Methodologies

Despite the considerable development of evaluation studies since the beginning of the 1960s, the methodologies have not evolved a great deal. The INRETS comments on the idea of 'congruence' are the exception as we will see later. However, the fields that are investigated and the techniques of measurement have been enlarged and improved.

Schematically, monitoring can be classified into three groups:

- 'before-and-after' studies;
- 'after' studies;
- studies based on the concept of 'congruence'.

a - 'Before-and-after' studies

These measure the same set of phenomena before and after construction of transport infrastructure. The comparison of the two sets of measures leads to identification of the 'effects' of the infrastructure. The underlying hypothesis in this methodology is that the differences between the two measures are due to the new infrastructure. It is then supposed that there is a link from cause to effect between the investment and the evolutions observed.

Experience, however, tends to show that this is not always so. Major investments in public transport take place in a socio-economic environment that is itself in evolution. These changes are extremely variable and can have varied consequences on travel behavior or on other data used in the investment evaluation. Economic growth is a perfect example. It acts on the level of mobility and on the modal distribution; and, hence, it acts directly on the use of transport infrastructure. The rate of economic growth also acts on the construction of housing, the level of rent, real-estate transactions, trade, industry, etc., and these, too, are indicators used for monitoring the effects of an infrastructure. Many other examples can be given such as the evolution of ways of life, demography, the level of employment, etc.

These evolutions as a whole interfere with the measurement of the 'effects'. To neutralize them, we can try to measure them. We do, however, come up against three major difficulties:

- a very large number of measures have to be made because of the diversity of the fields that are liable to interfere with the infrastructure monitoring;
- certain aspects are difficult to measure or pose so many problems that is difficult to measure them in the present state of our knowledge;
- above all, even if the first two obstacles can be overcome, we then have to be able to evaluate the impacts of these changes of the socio-economic environment on the indicators that have been chosen for the evaluation - we are obliged to admit that at the present we are far from being able to do so.

To overcome this difficulty, certain authors (BOURGIN C. & ANDAN O., 1978) advise the use of 'control groups'. The objective here is to single out a population that is subjected to the same socio-cultural changes but is not affected by the transport change. By comparing before-and-after data for the two groups, it is hoped that it will be possible to allow for the effects of the socio-economic changes and, hence, isolate the effects of the new transport infrastructure. However, there are not many studies where the authors have chosen this methodology. This can be explained by several different factors:

- the two groups must be comparable; that is to say, they must be subject to the same environmental changes apart from the investment we are trying to evaluate. In practice, it is difficult to apply this requirement rigorously;

- if the monitored population is large and sub-samples are to be studied, there must be a 'control group' that is large enough to allow for the same disaggregation. The conditions for the statistical validity of the results then impose large samples, which the available budgets do not usually permit;

- the changes we are trying to measure are not very substantial. It is not rare for them to be no larger than the uncertainties in measurement, especially because comparison between two groups involves measurement errors on both sides of the comparison;

- more fundamentally, the idea of 'congruence' throws doubt on the principle of control groups as will be argued later.

Despite these limits, the 'before-and-after' method is widely used in monitoring, even if no one insists on a highly mechanical link between the investment and the changes measured.

b - 'After' studies

To avoid these difficulties, certain studies take measures only after the transport investment is in place. This method, however, is limited to the polling of individuals who are participants in or users of the urban system. The 'after' method is often used in conjunction with the 'before-and-after' method for a certain number of measurements. The studies carried out during 'after' monitoring can be divided into two main groups:

- polling of transport users;

- polling of participants in the urban system.

The polling of users usually concentrates on the use of the new transport infrastructure that is being studied and on the changes in behavior that are linked to this use. In certain cases, the survey will try to analyze the causes of such changes to measure the importance of the new transport facility. Such investigations use both questionnaires and in-depth interviews.

The polling of participants in the urban system has slightly different objectives. The poll no longer tries to measure changes in use; rather, it questions the participants on their perception of the new transport facility and, in particular, on its effects on the urban system or in their action strategies. To secure this insight, the in-depth interview is much more frequently used here.

'After' studies thus try to go much farther than 'before-and-after' studies. They try to determine the effect of the transport project in behavior change by questioning the participants in the urban system. However,

this method also has its limitation:

- 'after' studies usually poll only those who are using public transport after the change. This choice can easily be explained by simple financial considerations. People who no longer use public transports for one on more reasons (some of which may be linked to the new project) can be tracked down only at great expense. As a result of the limitation, such studies tend to overestimate the 'effect' of the new project;

- Respondents are asked to compare travel behavior 'after' with what they did 'before' in making 'the same trip'. Often it is left to the respondent to choose how to define 'the same trip', and this can lead to uncontrolled differences in approach. Alternatively, the investigator may define the same trip as one with identical characteristics apart from transport mode. But this approach will rule out more complex changes, including change of residential location, change in the time of travel, and re-organization of trip patterns;

- interviews of participants in the system can provide interesting information about the new facility and about its place in the evolution of the urban environment. On the other hand, they do not enable us to quantify. These studies, therefore, are complementary to others and help to interpret data which has been gathered elsewhere.

c - The 'congruence' approach

This concept comes from the critical analysis of 'before-and-after' monitoring, which considers transport supply as the cause of the changes observed. The author (OFFNER J. M., 1985) rejects classical methodology that results in a deceptive linear causality that 'tries to isolate the transport 'effect' to neutralize outside variables that are liable to disrupt it by using 'pure' examples, control zones, and stable populations in 'before-and-after' comparisons.'

To replace this logic of 'effects', the author proposed a logic of fusion, of 'congruence,' which is both structural from the point of view of the major tendencies and dependent upon the circumstances from the point of view of the strategies of the participants or actors. Urban transportation projects have to be taken into consideration in a structural evolution (major tendencies) with social, urban, and technological aspects since they take part in this type of evolution. They act as developers, accelerators, and amplifiers of pre-existing change tendencies.

In parallel to its primary function of amplification and acceleration of structural transformations, the modification of the transport system also fulfills a second function as a godsend for the social actors who either know how to or can actually use environment transformations for their benefit since they can perfectly integrate change.

It is no longer a question of measuring the 'effects' at a specific moment in time after the introduction of a new transportation supply, but rather of analyzing dynamic situations. Since the change takes on its real dimension only when there are transformations that go along with the changes in transportation supply, it will be more interesting to concentrate on studying those situations that have a high mutation potential. Thus, for the analysis of individual mobility behavior, it is necessary to deal in priority with those people who are going through a transition phase in their professional or residential ways of life. To analyze these groups, those who are unstable socially and geographical zones where building operations are under way or projected will be dealt with preferentially.

Research carried out in two residential areas crossed by the VAL underground railway in Lille provides

a good illustration of the advantages of the method. The chosen areas are residential zones on the outskirts of the city; this choice simplified the analysis. Besides observing the direct transport consequences, the study needed to evaluate the ability and willingness of various parties to make concomitant changes. To do this, the researchers chose five aspects of the urban situation — trade, housing, equipment, population, and community life — and specific indicators were selected and measured for each of these.

Two angles of analysis were chosen: structural dynamics and actors' strategies. 'Structural dynamics are not only made up of those transformations that are under way, but also of those that are liable to be introduced according to circumstances. Actors' strategy must distinguish overall behavior and actions or specific expectations with the arrival of the underground.' (OFFNER J. M., 1985)

One result of the analysis was this finding: although the two residential areas seemed (from a static viewpoint) to have reached a similar condition before the underground railway was built, their dynamics were very different. In one, Wazemmes, there was a latent potential for significant urban transformation, and the underground railway served to bring the area closer to the city center physically, mentally, and socially. In contrast, in the other area, Fives, the social structure remained relatively stable, and there was even a continuation of a slight rate of decline. Thus the impacts of the new transport infrastructure varied according to the dynamic socio-economic characteristics of the two areas; the congruence method emphasizes the need to study the interactions between transport changes and on-going changes in other factors.

d - Problematic to be renewed for monitoring

The idea of 'effect' in the sense of direct causality with the new infrastructure must be relinquished. There is no point in trying to identify the mechanical 'effect' on a transport infrastructure that can be reproduced in other situations where a comparable supply was to be introduced. This comment does not mean that no change occurs as a result of the introduction of a new transport supply. Experience shows the contrary. It means that it is not possible to lay down laws as in physics - we cannot set up an experimental plane where it would be possible to vary one parameter to measure the influence on the others.

Nor can we conclude that no regular phenomenon can be identified as a result of the introduction of new infrastructure. Thus, for example, the opening of an underground railway almost systematically leads to an increase in the use of public transport. On the other hand, if we try to analyze the causes for this increased use as far as underground users are concerned, we can usually discover a conjunction of factors in which the underground will certainly find its place, but among other factors. Furthermore, if the use of public transport generally increases, the size of the increase varies according to local circumstances. We can thus discover constant parameters for the evolution of certain indicators at the macro economic level. On the other hand, there is no such regularity for the quantification of phenomena. Finally, as soon as one goes from macro to micro level, this regularity disappears.

Furthermore, the new transport infrastructure is often introduced at the same time as other exogenous changes are made. Recent urban transport schemes in France provide examples of this: in Grenoble, building of the tramway was accompanied by new planning decisions intended to change the urban form in the city center and in some other parts of the city; in Lyon, new urban developments were created around the stations of the most recent underground line.

To replace the logic 'effect', we return to the terminology of 'congruence' used by OFFNER J. M.. 'Congruence' is the quality or state of agreeing or coinciding. Thus, a congruent response will be a response that agrees or coincides with a given set of circumstances. This definition would seem to lead us to a methodology worth developing. On the one hand, we must identify the characteristics of the

response and, on the other hand, the circumstances that are linked to this response.

In other words, the monitoring must not limit itself to the indicators or fields whose evolution we wish to measure. It must also take the new infrastructure environment into account, i.e. all the evolutions that are concomitant to the introduction of the new infrastructure. These evolutions can have an influence on the indicators or fields selected for the measurement of the responses. We can thus specify the conditions in which these changes took place, since the new infrastructure is often no more than one of the factors which led to the mutations observed. This leads to the creation of an observatory for the urban system enabling us to follow its evolutions.

To lighten the creation of such an observatory, it is useful to begin by drawing up the inventory of the available data sources before starting further compilation. It is also possible to look for the synergy with other objectives so that the point of the observatory will not be limited to monitoring. However, we will not go into these dimensions here, since they go beyond the grounds of this study. On the other hand, the themes that can be considered in an observatory are so many and varied that it is essential to organize them carefully.

4 - The Necessity for a Hierarchy in the Elements that Comprise a Monitoring System

a - An overall system constructed in a hierarchical manner

Within the general framework of monitoring, we have highlighted the necessity for no longer working in terms of effect logic, but rather with reference to the concept of congruence. The major consequence for monitoring is that these studies must enable us to specify the conditions in which the changes were carried out and they must also refer to the evolutions that accompany the introduction of new infrastructure.

To be able to take the transformations of the urban space into account, the elements which go to make up the monitoring system must be diversified. Consequently, the monitoring of a new infrastructure requires an overall diagnosis to be carried out.

However, it is absolutely necessary to order this diversity and to establish a hierarchy among the various aspects of evaluation after a public choice. This is what we propose to do by coming back to the principal articulations of the urban system and to an understanding of the city that is now considered traditional but which is very useful for the structuring of the analysis (BONNAFOUS A. & PUEL H., 1983).

As a basis we will take the following three systems that go to make up urban space:

- **the transportation system**, which includes both the new public transport supply in situ proprio and the other elements of the transportation system, from the public transport network to general traffic conditions in the city;

- **the system of the location of activities** — the way activities are organized and which indicate the transformations carried out by the transport system on space, on the distribution of employment, of housing, both from the physical point of view and from the point of view of the way in which it is perceived;

- **the system of social relationships**, which shows the socio-spatial functioning of the city and shows as far as urban behavior is concerned, viz. the behavior of city-dwellers from the point of view of travel, shopping, etc.

Each of these systems is made up of various actors who do not have the same logic for action and for whom the NEW INFRASTRUCTURE line does not represent the same stakes.

From these two parameters - the sub-systems and their actors - it is interesting to adjust the analysis according to the stakes of the participants with reference to the new infrastructure. This enables us to understand and define the transformations which we then have to follow, taking into account the role played by each of the actors in the system. This approach has the advantage of suggesting a system of hierarchy for the parameters which has to be integrated into monitoring.

Within the transportation system, the new infrastructure stakes are relatively easy to identify by starting from the functions of the different actors in the system. (See Figure 1.) The transport operator, who is part of the service industry, is especially concerned about the running conditions of the public transport network and by the performances recorded by the network and the company. For the user, the principal element at stake in the new infrastructure is the service that is rendered to him or her by the network, by its attractiveness, and above all by the competitiveness of the service offered by comparison with its main competitor - the private car.

The local authority is the organizer of the transport, and it is responsible for both organization and financing. Thus, what is most at stake for it is that the introduction of a new infrastructure be economically and socially efficient for the public. In other words, what is at stake is the efficiency of public expenditure on the one hand and the efficiency of the service from the point of view of the adequacy of supply and demand on the other hand both sector by sector (the quality of public transport) and from a more general point of view (transportation and traffic conditions in the city).

As far as the system for localizing various activities in the city is concerned, the introduction of the new infrastructure represents stakes that are difficult to identify with reference to the actors. They are many and varied and are not dependent upon an institutional framework that is as highly structured as public transport. (See Figure 2.) However, the main stakes which appear in space are:

- the localization of people and jobs, viz. economical activities (the evolution of the urban texture, both commercial and industrial);
- the upward re-evaluation of housing;
- the perception of space.

In the same way, the system of social relationships is concerned by the introduction of the new infrastructure through the changes which are to be observed in people's urban habits such as travelling or shopping. The new infrastructure enables city-dwellers to reach new areas and change a certain number of their activity habits. The principal stakes, both for local authorities and for the economic actors, concern the urban habits of city-dwellers. (See Figure 3.)

b- Fields of observation connected with the new infrastructure stakes

The definition of the elements that make up new infrastructure monitoring requires the development of a detailed list of the indicators that it would be advisable to monitor and the specification of the measurement methods used to obtain the required information. This would have to be carried out for each aspect. However, since our main objective is to throw light on the steps that should be taken in monitoring and to order a very wide monitoring content, we intend to point out what goes to make up the areas of observation by briefly specifying the main indicators and methods of measurement for each of them.

Figure 1: System of Location of Activities New Infrastructure: The Stakes

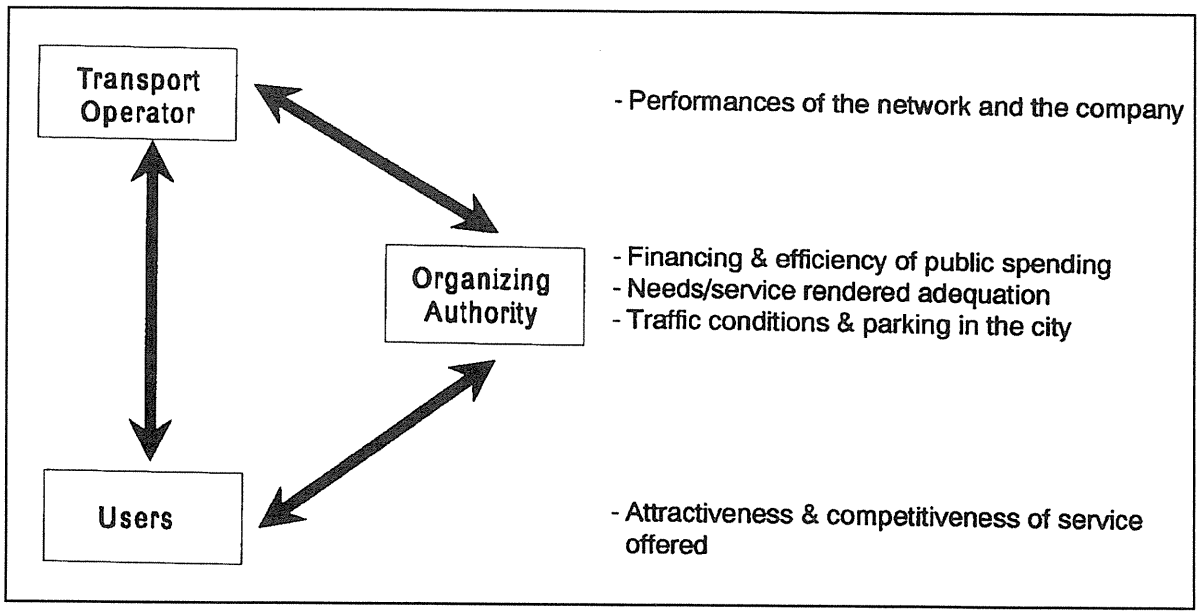
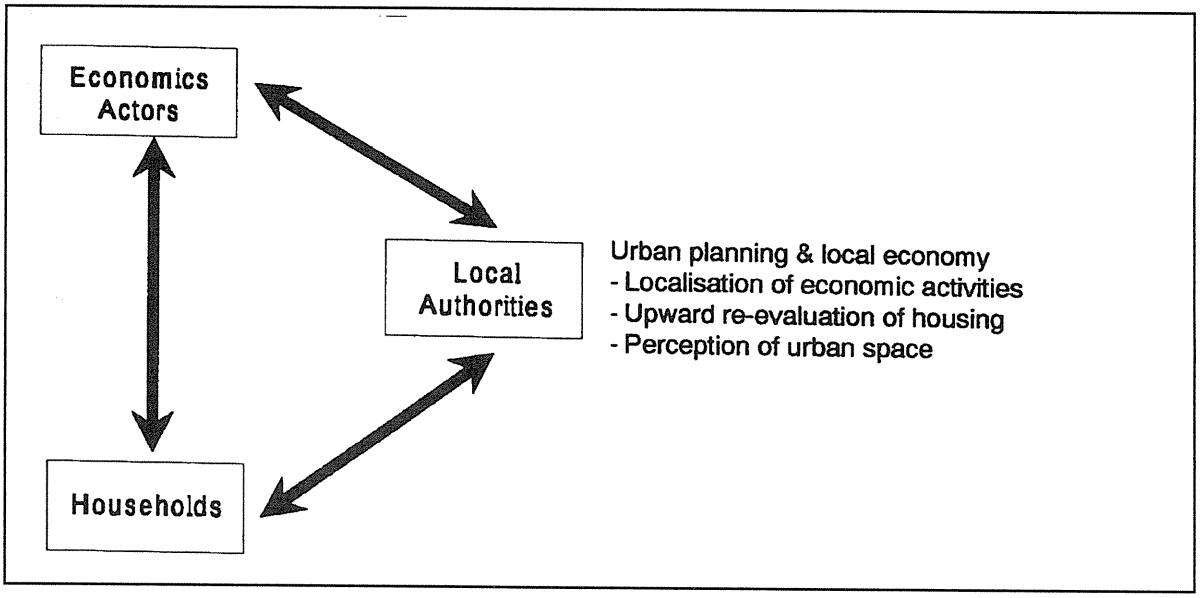


Figure 2: System of Location of Activities New Infrastructure: The Stakes

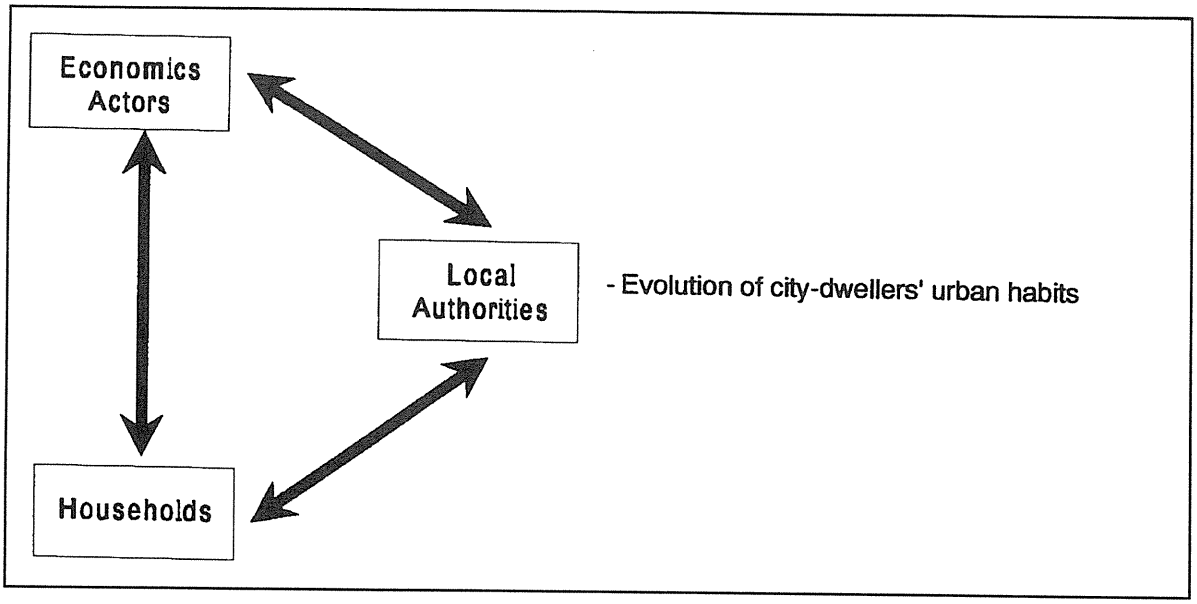


As far as the indicators are concerned, we need to point out that within the framework of new infrastructure monitoring that makes up an a posteriori investment evaluation as well as the descriptive indicators, it appears necessary to deal in priority with the indicators that give us information about the efficiency of the action and thus about the adequacy of the means deployed and the needs or results recorded.

⇒ **The performance of the network and the company.** To judge the performance of the network and the company after the introduction of new infrastructure, three specific aspects must be considered:

- the supply or the physical characteristics of the network;

Figure 3: System of Social Relationships



- the use of the network;
- the exploitation results.

It is obvious that the transport operator obtains part of the monitor indicators from exploitation data. It would therefore seem necessary for the organizing authority to get the transport operator to monitor and transmit a certain number of indicators contractually. (See Table 1.)

⇒ **Financing and efficiency of public spending**. The organizing authority must:

- calculate the repercussions of the investment on its financing possibilities;
- carry forward the financial effort made to the evolution of the use of the network. As we have already seen, knowledge of the use of the network also interests the transport operator. (See Table 2.)

⇒ **Adequacy of the service relative to needs**. The appreciation of the quality of the public transport supply and its adequacy with regard to trip needs require an excellent knowledge of the use of the network and the real supply but also the level of satisfaction of users. (See Table 3.)

⇒ **Traffic in the city and parking**. These considerations will enable us to get a good idea of the transport environment of the new infrastructure in the city and to get to know the evolution of vehicle traffic as well as the use of highways and car parks. (See Table 4.)

⇒ **Attractiveness and competitiveness of the service offered**. The recommended indicators here concern daily use of the network. We wish to evaluate the relative interest of the new public transport with reference to the competitive modes and the preceding public transport system. (See Table 5.)

⇒ **Urban planning and local economy**. Since we are dealing with urban space as a whole and with its evolution, it is difficult for us to speak of socio-economic efficiency for this field of observation. (See Table 6.) Here, the objective of monitoring is to throw light on the orientations which are under way in

Table 1

RECOMMENDED INDICATORS	MEASUREMENT METHODS
Physical characteristics of the network - vehicles per km - seat kilometer supply - real commercial speed (per line and/or section) - peak and off-peak frequency - real and theoretical trip time - spatial cover - regularity index - breakdown and accident rate - % km lost	- In general these indicators are data from exploitation and must be respected by the transport operator. - Follow-up and availability of information may be planned in the exploitation contract. - Two methods: - exploitation data - in-situ survey to know real supply.
Use of the network - traffic per line, traffic in stations and at inter-network connection points - correspondence rate - tickets used - zones of influence of stations - network access modes - importance of new trips in public transport and new infrastructure - evolution of trips/km per inhabitant - user satisfaction level	number of tickets "punched" counts in buses, stations, at stops origin - destination studies specific surveys population polls user surveys
Exploitation results - exploitation receipts - exploitation expenditure (per post and/or line) - productivity ratios and analysis of exploitation costs - ratio of cover - receipts per km and per trip - expenditure per km and per trip	ticket sales analytical accounting

Table 2

RECOMMENDED INDICATORS	MEASUREMENT METHODS
Use of the public transport network	same indicators as previously
Local authority's financing possibilities - evolution of public deficit - evolution of "Versement Transport" (local taxes for transport paid by enterprise) - evolution of participation of local authorities to cover the exploitation deficit - interest on the debt - auto financing	- calculation of public transport consolidated accounts - analysis and financial forecasting
Financial effort/use - per annum expenditure per inhabitant - running and investment expenditure per inhabitant - expenditure per extra trip on the public transport network - per annum trips per inhabitant	set up indicators on use of the network and data on financing and exploitation of the network.

Table 3

RECOMMENDED INDICATORS	MEASUREMENT METHODS
o **Public transport supply data**	same methods and indicators as previously
o **Public transport network use**	same methods and indicators as previously
o **User satisfaction level**	- interviews with local actors (user associations, MPs, etc.) - opinion polls
o **Adequacy of public transport supply with trip flow**	household polls

Table 4

RECOMMENDED INDICATORS	MEASUREMENT METHODS
Traffic	
- vehicle traffic on main roads	- household surveys
- evolution of points of congestion (traffic/highway capacity)	- cordon surveys
- use of private cars (vehicle occupation rate)	- numbering
- household equipment and motorization rate	- censuses of vehicle occupation rate
Parking	
- public car parking supply (pay off-street car parks, pay or free on-street parking - legal or illegal) and private car parking	- exploitation data from companies running car parks and pay on-street parking systems
- use of parking facilities (vehicle rotation and occupation rate)	- hour by hour census to measure occupation and rotation (on-street parking)
- supply and use of overflow parking facilities	- polling of private car drivers using park-and-ride and underground

urban texture. The advisable monitoring indicators deal specially with three aspects:

- the localization of economic activity;
- the upgrading of housing in these areas;
- the perception of urban space.

⇒ **Evolution of the urban habits of city dwellers**. The new trip conditions and the urban texture evolutions that go with them often mean changes in the activity habits and the use of urban space by city-dwellers. In return, these evolutions can influence the functioning of the urban system. We will thus try to discover the evolution of the urban habits of city-dwellers, notably through the analysis of the activities carried out and the places visited. (See Table 7.)

Finally, it is important to underline that, following the fields of observation, the monitoring of a new

Table 5

RECOMMENDED INDICATORS	MEASUREMENT METHODS
Evolution of private car/public transport trip time for users	Origin/destination survey
Evolution of the quality of service (frequency, coverage, accessibility of zones to downtown, ease of interconnections (urban/interurban rail, roads)	Supply data
Adaptation of tariffs to trip type	Semi-directive interviews with users
User satisfaction level - network image - information, comfort	Opinion polls

Table 6

RECOMMENDED INDICATORS	MEASUREMENT METHODS
Localization of economic activities - evolution of population and density - residential mobility - evolution of household localizations - evolution of commercial and industrial activities	- French government statistics - household surveys - follow-up of domiciles and changes of address (Chamber of Commerce statistics)
Upgrading of housing in these areas - evolution of housing prices - evolution of housing available - evolution of requests for planning permission - evolution of constructions	- local authority statistics on new housing prices - classified housing sale ads - French government housing statistics - council estate statistics - planning permission files

Perception of urban spaces
- image and qualification of zones
- change in urban areas
	- specific interviews of urban actors
	- monitoring of turnover of shops and other companies (Chamber of Commerce statistics)
	- Other specific surveys can be added to these permanent studies by use of the methodology of dynamic diagnoses using:
	  - interviews with urban actors,
	  - various statistical analyses

infrastructure does not refer back to the same temporal or spatial dimensions. For example, the evolution of urban habits and individual's mobility habits concern the whole conurbation and can be observed as time goes by and with the use of the new transport infrastructure. On the other hand, the phenomena of the localization of activities and the upgrading of housing in urban areas rather depend on the anticipations of the actors and often precede the introduction of the new infrastructure. Furthermore, these phenomena are much more limited spatially. Each monitoring observation field has to be analyzed with reference to the time and space dimensions which are specific to them.

Table 7

RECOMMENDED INDICATORS	MEASUREMENT METHODS
- impact of the PTSP on the behavior and life styles of inhabitants - the way of using space - activity habits and trips proposes: - modal transfers - number of trips and induction All of the fields developed here can be seen from the point of view of the socio-economic characteristics of the individuals or social groups.	- dynamic diagnoses method - household and individual studies: - household surveys, - activity pattern surveys, - buying habit surveys, - in-depth interviews ...

Conclusion

The main objective for monitoring is often to lay down the bases for an ex post evaluation of a public choice which will enable the negative repercussions of such projects to be corrected through a better understanding of the interactions between the transportation system and the urban environment.

Various analysis methodologies exist for monitoring: 'before-and-after' studies, 'after' studies, and the methodologies based on the concept of 'congruence'.

Now that we have given an overview of the existing methodologies, we would point out that, if we have instruments to measure situations and evolutions, it is illusory, if not indeed simply wrong, to try to isolate the 'effect' of a transport infrastructure and link in a mechanical fashion the investment to the changes measured. Since the new infrastructure is not introduced into a fixed urban environment, it is often nothing more than one of the factors which has led to or made easier the changes which are to be observed. Moreover, the new infrastructure is often integrated into an overall urban planning policy.

In consequence, we can say that monitoring studies give an overall diagnosis of urban space to account for the evolutions that go along with the introduction of the new infrastructure. In this context, the elements that make up the monitoring system are widely varied and come into contact with the various dimensions of the urban system.

If monitoring is to conserve an operational character, it would seem to be essential to organize the multiplicity of elements that make it up. It is with this aim in mind that there is a very considerable point in starting with the actors in the urban system, their role, and their stakes in the new infrastructure. This way of functioning actually establishes the bases for a reasonably operational organization of the elements that make up the monitoring as well as for a distribution of the monitoring work according to the actors present. Depending upon the objectives that have been assigned to the monitoring study, this also enables priorities to be fixed for the phenomena and evolutions to be measured.

In concrete terms, this organization, based on a systemic approach to the city, leads us to analyze the various indicators and measurement methods for each field of observation.

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