Use of Models by French Consultants for Urban Transport Planning in Developing Countries

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This paper is based on a survey of 39 urban transport planning studies performed by French consultants in developing countries and on a more detailed analysis of three major cases. Presented are the local conditions that have influenced the choice of the models, the difficulties encountered, the final outcomes of the studies, and the extent to which the plans have actually been implemented. Unless they were constrained by terms of reference set by some international agency, the consultants often took shortcuts through the traditional methodology. They tended to favor straightforward unsophisticated models in which complex equations with many variables are replaced by normative inputs and in which land use forecasts are exogenous or simply taken for granted. In this approach, the role of transport demand modeling is only to ensure that the planned land use would not lead to an unbearable burden on the transport investment budget and, conversely, that planned transport infrastructures were the most suitable for the planned land use. In most cases, simple normative models proved to be quite sufficient and guaranteed good transparence and readability of the mechanisms at work. A more pressing issue is the problem of accuracy in projections of exogenous variables such as population, income, and automobile ownership. French consultants who are confronted with this problem now tend to include modeling packages and training programs with their studies. In this way, they locally install the capabilities to follow up the urban transport situation and to monitor the implementation of the plans.

French consultants have had a great deal of experience with urban transport planning in developing countries. Before computers were invented, French consultants were drawing transport plans for cities from Brazil (Curitiba, 1930) to India (Calcutta, 1949), and of course for most of the capital cities of the "Empire."

In the late 1960s, at the same time that the U.S. computer modeling techniques for urban transport planning were being introduced to France, French consultants were already using them in Santiago, Chile. Today, 40 capital cities in developing countries have had at least one transport study based on some kind of computer model designed by French consultants.

Is there anything unique about the use of urban transport planning models by French consultants abroad? Are there any lessons to be drawn from this experience?

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OVERVIEW: FRENCH CONSULTANTS' PRACTICES IN DEVELOPING COUNTRIES

French consultancy for urban transport planning abroad is mainly performed by four large consulting firms: SETEC, SCET, BEEOM, and Sofretu. Three of these companies are public; two of these three specialize in consultancy abroad; and one of these two, which originated as part of RATP (the Paris Transport Authority), specializes in urban transport planning and management.

For the purpose of this paper, a survey of the practices of French consultants in urban transport planning studies for developing countries over the last 15 years was conducted. A questionnaire was sent to the three public consulting firms. The analysis of the answers received allows us to identify some common features of the studies performed by French consultants. Short "expertise"-type missions that did not use some kind of computer traffic demand model have been omitted from the sample. The heavier layout design studies that usually take place when the decision has been made (normally on the grounds of a viability study) to construct a major infrastructure have also been deleted unless they were part of a transport study. In all, 39 cases have been included in the analysis. It is believed that these cases constitute a representative sample of the French consulting experience abroad.

Scope of the Studies

The scope of the studies ranges from short-term traffic management schemes designed for a limited area of the city to long-term overall transport plans that include large-scale projects like major urban expressways or metro systems. Figure 1 gives the distribution of the sample analyzed here, according to the scope of the study.

Of course, some studies were not easily classified by such a simple typology because they had a different emphasis on one aspect or another. For instance, traffic management schemes often include the provision of bus lanes and bus line reroutings, and road infrastructure planning often addresses the very short term.

Link with Urban Planning

If the short-term traffic management studies for which the forecasts of future land use are not relevant are excluded, some

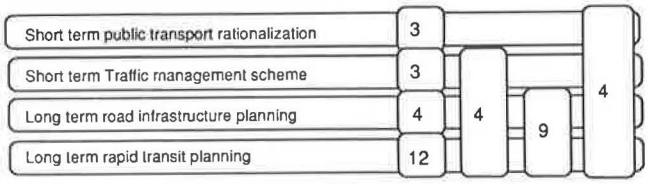

FIGURE 1 Sample distribution according to the scope of the study.

kind of Metropolitan Development Scheme already existed or was being completed at the same time by local authorities or by another consultant, in 75 percent of the cases. Different land use and transport hypotheses have been tested in only six cases, but in all but one of the cases (the exception is Santiago), projected urban form was taken as an exogenous variable. The Santiago study is, at the same time, the first study that used computer traffic modeling and the only one that included an integrated land use model. This land use model, which was of the Lowry type, was designed by an engineer who was a member of the consultant team, but it was never used again thereafter. In many cases, when no land use forecasts were available or when they were outdated, the consultants had to determine some kind of future land use pattern themselves to have the necessary inputs to the traffic models.

Structure of the Traffic Demand Model

In most cases, unless they were constrained by terms of reference set by some international agency, French consultants have been using unsophisticated four-step packages with either gravity or Fratar distribution and normative modal split. The first step of the model, the generation, is generally calculated in an aggregated manner by zone and is based on population, active population, and car-ownership rate. Attraction is based on industrial employment and employment in businesses and services. In 10 percent of the cases, trips by public transport were generated separately. In 75 percent of the cases, the distribution of trips was performed by a traditional gravity model with a distance function calibrated either with household surveys or with some kind of transportation from comparable cases. In nine cases, Fratar-type models were used.

The modal split is certainly the step in which French consultants' practice departs the most from what is done by English-speaking consultants. In only 10 percent of the cases, some kind of logit-type model was used. In some 85 percent of the remaining cases the modal split was performed by using grids. In these grids the traffic zones are grouped according to three to six generation or attraction classes, and the trips between each pair of classes are given a specific normative modal split.

The assignment of automobile trips on the road network is generally performed with standard models that take into account congestion, delays at crossings, left turns, and so on. In some simplified models the network is loaded progressively to allow for a better understanding of the effects of capacity constraints on rerouting. The assignment of public transport trips on bus or rail transit networks can be manual in some simple cases. When the networks were more complex, sophisticated assignment models, originally developed for Lyon or for the Paris region, were used.

Such a general overview does not tell much about the relevance of these practices. This is why specific examples drawn from three major cases (one study in Teheran and two different studies in Casablanca) will be used in the following sections. The local conditions that have influenced the choice of the models, the difficulties encountered, the final outcomes of the studies, and the extent to which the plans have been implemented will all be presented.

These cases have been selected because the studies are old enough that the outcomes in terms of transport policy are known and the projections of land use patterns and the traffic demand forecasts can be compared with what actually happened. In the selected cases, the French consultants, as they often do, have taken shortcuts through the traditional methodology.

The oldest of the cases, the 1972 Teheran Transport Plan study, is quite remarkable because nowhere else in the developing world has a study been immediately followed by a counter-study performed by another consultant. Another interesting case involves Casablanca, where three different consultants (two of them French) at three different times with three different sets of assumptions and three different methods ended up recommending the same erroneous solution, which was the one wanted by the client.

TEHERAN METRO CONTROVERSY (1972–1974)

In 1972, the Shah of Iran wanted his constricted capital city to be equipped with a modern metro system similar to the systems that the French were constructing in Mexico City; Santiago, Chile; and Montréal, Canada. Sofretu was called in to make an overall transport plan. In Mexico, Sofretu selected the first lines of the metro network without any form of travel demand forecast. This time, Sofretu joined a consortium with other French consultants who specialized in modeling and projections. Because household surveys are by and large the most expensive part of any such study, a method was specially designed to allow using interviews from only 4,700 households.

Sofretu based its land use projections on the 1969 master plan developed for Teheran by Victor Gruen and Associates. The Gruen Plan was devised for a projected 1991 population of 5.5 million people occupying an urbanized area of 715 km^2. Because more recent rates of population growth had shown that the Gruen Plan population forecast was a gross underestimate, Sofretu replaced it with a forecast of 8 million people in 1991. Under pressure from local authorities, however, Sofretu assumed that this larger population would be accommodated within the same geographic area assumed by the Gruen Plan.

Sofretu's analysis of current travel in Teheran was based on a home interview survey of 4,700 Teheran households in 1971, on a 151,000 screen line and cordon line interview survey, and on an interview survey of 113,500 bus passengers. Unfortunately, these surveys provided two estimates that differed by nearly 100 percent of the number of person trips made in Teheran in 1971. On the grounds of its experience in other Islamic developing countries, Sofretu concluded that the discrepancy could be explained by the underreporting of trips in the home interview survey and chose the larger estimate of trip making in 1971 as the base line for its traffic forecasts.

To deal with the modal split problem, Sofretu adopted a two-step approach that was quite unconventional by U.S. standards

but not uncommon in the studies that French consultants perform in developing countries. The first step takes place in the generation equations, where different sets of equations are derived for people who possess personal means of transportation on the one hand and for people who must take some type of public transport on the other hand. The second step takes place after the distribution of trips, when people who have the choice are distributed between personal modes and rapid transit according to a logit-type model that takes into account the money, comfort, and travel time costs of making trips between different zones. As a result of the study, Sofretu recommended that a metro network be constructed with a length of 60 km by 1981 and 193 km by 1991.

In 1974, a few months after the Sofretu study was completed, the Iranian government decided to ask J. F. Kain, a Harvard professor, to conduct a counter-study. This new study, which used basically the same data but made some provisions for different interpretations, concluded that an expressway system with reserved lanes for express buses would be better suited than the metro system recommended by the French (*1*, *2*). According to Kain, the Sofretu team unintentionally introduced a systematic bias in favor of the metro solution throughout its study.

Kain used a much lower population density and a greater dispersion of jobs than Sofretu did, and he rejected Sofretu's underlying assumption that a metro network would increase population and employment along its lines. He also based his traffic forecast on a different estimate of trip making in 1971, giving more credit to the household survey. Finally, he used a more conventional four-step package that did not differentiate between motorized and nonmotorized trip makers at the generation level.

Construction work on the first metro line started in 1977 as part of a huge land development project to create a new business district north of the old CBD, halfway to a low-density, high-income residential area. A 1-mi-long tunnel had already been constructed when the revolution started. Not much has been done since then, although the project has not been abandoned.

FIRST CASABLANCA TRANSPORT PLAN (1976)

In 1975, when Transroute (a subsidiary of SCET) was asked to make a transport plan for Casablanca for the years 1982 and 1992, Morocco was experiencing a rapid growth both in per capita income (7 percent per year) and in automobile ownership rate (7 percent per year). Transroute's assignment was to create a short-term traffic management scheme to be implemented immediately and at the same time to forecast transport demand for the years 1982 and 1992 so that a projected beltway could be located and its accesses to the city designed (*3*).

The Transroute team conducted a small household survey (2,800 households) and extensive roadside interviews (58,000 interviews). They also used traffic counts to calibrate the model. Land use forecasts were provided by another French consultant (IAURP, the Paris Regional Planning Agency), which was completing the *Schéma Directeur d'Aménagement et d'Urbanisme*, a master plan for Greater Casablanca.

After Transroute had performed extensive regression analysis (taking into account distance from CBD, income, automobile and cycle ownership rates, family size, type of employment, etc.), they decided to use a simplified generation model where the 57 traffic zones were classified according to six classes of household automobile ownership rates and five classes of employment "attractivity." A specific generation or attraction coefficient by trip destination purpose (i.e., work, school, shopping and others, secondary) corresponded to each class.

The distribution model was of the gravity type. The modal split was normative. It consisted of a grid linking six classes of zones for generating trips with four classes for attracting them. Different grids were set for different trip destination purposes. When the model was compared with the traffic counts, the assignment of the origin-destination matrices reconstituted for 1975 by the model on the existing network proved that this model was fairly accurate despite the simplifying assumptions made.

For the short-term study, these matrices were used to design a traffic management scheme with minor investments and some bus reroutings. The main study addressed the long term. Projections were needed, and different policy options were to be tested.

Projections for 1982 and 1992 were also normative. The average increase in mobility was set at 3 percent per year and then modulated for the different trip destination purposes and for the different automobile ownership rates. The explicit assumption was that both households with a low automobile ownership rate and those with a very high one would have a slower rate of growth than average, according to the classical logit curve.

The modal split projections, as shown in Table 1, were made following two different hypotheses (H1 and H2) that were derived from contrasting policy options. As a result of a policy favoring the private automobile, H1 extrapolated the recently observed evolution of increasing motorization and a correlative diminishing share for public transport. In contrast, H2, which assumed a policy directed toward the provision of better public transport and some automobile usage restrictions, gave an increasing share to public transport trips in the modal split (see Table 1).

TABLE 1 AVERAGE MODAL SPLIT PROJECTIONS IN THE 1976 TRANSROUTE STUDY FOR CASABLANCA (*3*)

		1982		1992	
	1975	H1	H2	H1	H2
Private automobile	39	50	35	60	30
Public transport	37	30	45	25	55
Cycles	24	20	20	15	15
Total	100	100	100	100	100

NOTE: H1 and H2 are the contrasting policy hypotheses described in the text.

Six different road networks, designed specifically to serve the road traffic resulting from the two policies, were tested and evaluated in a cost-benefit analysis based on social and private costs of travel time, vehicle operation, accidents, and investment. Three different patterns of urban growth were also tested, but these patterns were shown to have a much smaller impact

on travel demand and total costs than the transport policy variables.

Ten combined bus-LRT (light rail transit) networks were also evaluated by the same procedure. The study arrived at several recommendations. For the short term, aside from the usual one-way street systems and minor redesigning of street crossings, the study recommended that (a) exclusive counterflow busways should be implemented on most heavily traveled corridors, (b) parking charges should be introduced, and (c) several underground crossings should be constructed on one inner street, Boulevard Zerktouni.

For the long term, the study recommended that the H1 policy be rejected and instead presented an implementation schedule for the optimum road network and for one LRT system at ground level. Because there was some pressure from part of the local administration in favor of a metro system, a further simulation was conducted for the year 2002 to check whether a metro would not be more suitable than an LRT in the long run. Citing the results of this simulation, the consultant strongly advised that the metro project be rejected.

Before the study was even completed, work had already started on Boulevard Zerktouni, but the traffic management scheme was implemented 3 years after the consultant had left. After 1 week, the most important part of it—the exclusive bus lanes—was recalled under the pressure of car owners and shopkeepers. A story has circulated that His Majesty the King of Morocco was once caught in a traffic jam caused by the newly implemented traffic scheme and said, "Let it be back to what it was before." According to public opinion, the traffic scheme was just another one of those technocratic decisions made with no regard for common sense. From the foreign consultant's viewpoint, the plan was ineptly applied all at once without any sort of information campaign. Some parking meters had also been installed, but because of a lack of proper maintenance and real enforcement, the meters were out of order very soon and were finally removed and sold to a junkyard. The expressway was constructed 6 years later.

CASABLANCA METRO REVISITED (1983)

Seven years later, in 1982, Sofretu was asked to make an evaluation and draw up a detailed project for an LRT system along the line indicated by the Transroute study. The Sofretu team had the opportunity of comparing the traffic forecasts and plans established by Transroute with what had actually happened (*4*, *5*). They could see that the plans were basically sound and accurate in their intentions. Sofretu noted that the order of priorities should remain exactly the same, but that the plans were several years ahead of their time.

One reason for this overshooting was obvious at the time the Sofretu study started. Because of the war in the Sahara and bad conditions for Moroccan exports on world markets, per capita income had actually declined from 1976 to 1982 instead of continuing to grow at the yearly rate of 7 percent predicted by the Transroute study. As a result, the automobile ownership rate had not increased and had probably declined slightly over the period. The other reason only surfaced after Sofretu was already halfway into its work, when the data from the 1982 census began to appear. Because of underreporting in a poorly managed census in 1960, the demographic projections for Casablanca derived from the 1960 and 1971 censuses were overestimated by 20 percent for 1982 and probably by 40 percent for 1992.

The Sofretu study started with nine screen line surveys of road traffic and a survey of public transport trips along the bus lines adjacent to the projected LRT line. Just as the study started, however, another group of experts was being appointed to draw a completely different master plan for Greater Casablanca. This new plan chose to halt the natural expansion of the city toward unsuitable lands east of the city and favored urbanization along the coast toward Mohamedia, an industrial harbor 10 mi northeast of the city. With this new orientation of city development, the LRT system, with its huge over-capacity toward the southeast, was no longer justified. Nevertheless, the Sofretu consultant continued with what he had been asked to do: (a) forecast the demand for trips by LRT, (b) compute the costs of constructing and operating the system, and of course, (c) conclude that it was viable. When, for aesthetic reasons, the client asked that the project be buried underground for half of its total length, the consultant computed the new investment cost without pointing out that it would not be reasonable to construct such a high-capacity system for only 10,000 passengers on the most heavily traveled segment at peak hour.

The forecasting method was quite simple. A survey of bus patronage was conducted on the bus lines that would be affected by the LRT project, and a very simple Fratar-type model was used to update the Transroute projections and take into account the new population and employment densities scheduled in the last master plan.

CASABLANCA METRO REVISITED AGAIN (1987)

The Greater Casablanca master plan team firmly opposed the Sofretu project, stating that it would jeopardize the whole master plan by giving an excess capacity in an unwanted direction. Finally, the study's conclusions were rejected when the King of Morocco realized that an underground system would not be feasible given the fact that the underground water level was *only 6 ft deep*. As a consequence, a Japanese consultant was called in to devise a new plan for an elevated monorail that would still be on the very same corridor proposed by Transroute, studied by Sofretu, and rejected by the master plan.

The Japanese team conducted a remarkable study with a thorough household survey and a very elaborate modeling package. They arrived at roughly the same figure that Sofretu did for peak hour travel demand. Just as in the Sofretu case, as the study was going on, the Japanese consultants were progressively asked, for aesthetic reasons, to bury their elevated LRT project into an expensive underground rapid transit system. The Japanese study confirmed the viability of such a system, despite the fact that the projected demand (8,700 passengers at peak hour in 1993) could easily be accommodated by regular buses on exclusive right-of-way.

CONCLUSION

This general review of French consulting practices abroad has shown that the consultants tend to favor straightforward, unsophisticated models, in which complex equations with many

variables are often replaced by normative inputs and in which land use forecasts are exogenous or simply taken for granted. Where does this practice come from? Is it an adaptation to the situation in developing countries?

The simplified approach used by French consultants abroad is very similar to the standardized approach that has been used in most French cities. The urban transport planning technique was imported from the United States to France in the 1960s at the initiative of the French Ministry of Transport by the Ingénieurs des Ponts et Chaussées. It was adapted and standardized, and then the central government required that French cities prepare urban transport plans elaborated according to this method as a prerequisite for obtaining central government transport investment subsidies.

These transport studies, called EPIT (Etude Préliminaire d'Infrastructures de Transport), were to be combined with a master plan, the SDAU (Schéma Directeur d'Aménagement et d'Urbanisme). Because public authorities in France generally have firm control of land use through land development permits that are granted according to the SDAU, there was no pressing need for developing models that were able to forecast the land use patterns that were the "natural" results of transport plans. Rather, local governments were asked to use the models to test two contrasting transport policy options for the long term: one in favor of the development of the automobile as a means of transportation, the other one favoring the use of public transport.

The role of modeling transport demand was thus to ensure that the planned land use would not lead to an unbearable burden on the transport investment budget and, conversely, to ensure that planned transport infrastructures were the most suitable for the planned land use.

One of the objectives of transport studies in developing countries might not be too far from the purposes of the studies in France. In this case, simple normative models have proved to be quite sufficient and guarantee a good transparence and readability of the mechanisms at work.

Another objective of transport studies in developing countries was well illustrated by Gakenheimer in 1982 for the case of Cairo, where the study was used by a special-interest group as a means of having its project be "written on a slate," that is, to exist and be taken into account when transport policies are discussed among decision makers (*6*). For this use, the accuracy of the simulation is not an important feature per se. The reputation of the consultant and the volume of the study are of greater importance: the bigger and the broader in scope, the better. Here, complex models and sophisticated equations are welcome, but they can be balanced by the reputation and references of the transport consulting firm. This is often the case when Sofretu or Deutsch-Eisenbahn Consult is called in.

A more relevant issue is the problem of accuracy in projections. In Teheran the over-optimistic income projection imposed on the Sofretu team, and reluctantly adopted, probably proved to be below that which actually occurred with the rise in petroleum revenues. Inversely, in Casablanca, the reasonable projections made by Transroute completely failed to materialize because of an unpredicted slump in Moroccan export revenues.

After similar experiences in other developing countries, French consultants now tend to include modeling packages and training programs with their studies. These materials allow local transport engineers to follow up the urban transport situation and monitor the implementation of the plans. Sofretu followed this procedure in Algiers, and recently proposed it for Morocco.

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