Minimizing uncertainties in master planning the transport sector of a developing country

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INTRODUCTION

Transportation provides the basic infrastructure for economic and social development. Clearly, the services of transportation are not ends in themselves. They are means to other objectives. These objectives are economic as well as non-economic. Non-economic objectives include promoting political cohesiveness, strengthening national defenses or bringing about socially desirable demographic patterns. These classes of objectives, whether economic, social or defense related, are often in conflict within and between themselves. The development of an overall transportation plan is an outcome of the resolution and conciliation of these conflicts within the existing and expected budgetary and administrative constraints.

This paper is based on the work done to evaluate and prioritize the transportation projects proposed by the Iraq Ministry of Transportation and the Iraq Ministry of Communications, Baghdad, Iraq and the development of five year transport plan for Iraq ending year 1980 *. The proposed projects, which comprised about 75 individual undertakings, covered all modes including rail, air, land, river, coastal and sea and were mostly related to facility improvements and equipment acquisition.

A necessary ingredient to a sound evaluation and analysis is a well formulated and developed overall national framework within which individual transportation projects are assessed and their priorities ordered.

In the light of the foregoing need, the objectives of the study were to:

1. Develop a framework of national transportation requirements.
2. Evaluate and rank the proposed projects.
3. Identify modal and intermodal gaps, inconsistencies and new projects, and reorder priorities in light of the requirements of national transportation plans.

This paper will focus only on the planning methodology used in this study, and will highlight at the end some of the topics that need to be researched to enhance the transport planning in developing countries.

METHODOLOGY

The systems approach followed in the study as shown in Figure 1 consists of three major tasks. Task I concerns with the development of a feasible physical network based on the existing and proposed projects. Task II, performed in parallel with the foregoing task, concerns with the development of the hypothetical network based on the projected national requirements for transportation. Task III, a concluding task for the study, accomplished the evaluation, ranking and ordering of the total set of feasible projects after the combatibility of the physical network and the hypothetical network had been checked.

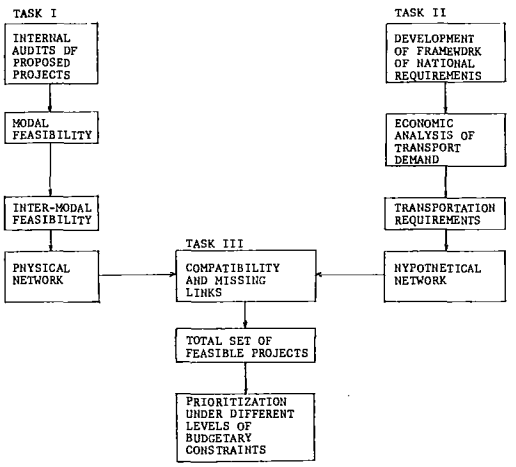

Figure 1 - Schematic of overall study approach

This approach followed in the study to achieve the above objectives, did not only define and evaluate the projects within the context of national development goals and ends, but it also avoided internal contradictions, blind spots, and consequent serious error of omission. Moreover, the systems approach used, avoids the tendency to suboptimize at the national expense.

Task I is based on three rings of analysis. The first and smaller ring consists of engineering and cost review of the specific projects proposed. This task is confined to internal engineering and technical auditing of proposed projects with respect to accuracy, adequacy and reliability of assumptions and of the data utilized in each project. At this level, each project is examined independently with respect to the respective economic and engineering parameters and to the soundness of the conclusions affecting its successful initiation and completion. The following tasks were performed on each individual transportation project:

1. Adequacy of engineering specifications.
2. Listing and analysis of possible alternatives.
3. Sufficiency of project supports.
4. Reasonableness of cost estimates.
5. Expected earnings and effectiveness.

The second level of analysis or the middle ring which encompasses the first one, evaluates the projects within their respective modes. It provides a compatibility analysis of each project within its existing and proposed modal network. In the case of a new airport development, compatibility is examined in the light of the total aviation system network, and its modal feasibility is consequently determined. At this stage, any missing links, or gaps in the modal network are identified and new lists of projects within the mode are formed and examined. Part of the test of modal feasibility is the time phasing of the project. If the project is part of an existing or planned network, it is important to determine whether its schedule of completion will coincide with the operations of the existing or planned system. This test of time phasing of projects is also carried out in the third level of analysis, where intermodal dependence of projects is determined essential to the completion of a project.

The third level of analysis or the larger ring determines the intermodal compatibility of the proposed projects within the existing and proposed transport system network. Inconsistencies and gaps in the total network are identified which resulted in the rejection and re-evaluation of certain projects and the formulation and analysis of new ones. The result of this analysis is a feasible and compatible network based on the existing and planned system.

This network which is developed from the physical systems approach, namely "network feasibility", is then checked against the hypothetical network developed from the framework of projected national requirements for transportation. The hypothetical network involves a broader systems approach to include economic analysis of the demand for transportation and the feasibility of various alternatives to satisfy the demand such as to yield optimal solutions.

The economic analysis of the demand for transportation comprised the following major tasks in this study:

1. Determination of national objectives for development in terms of short range (five years) and long range (twenty-five years). It is more respect to the long range plans that national development goals impact the planning of transportation projects. These projects have a long life, as a rule, and their impact and value must be justified in the long term as well as in the immediate or near term.
2. Development of a forecast of basic sector activities and growth. The basic sectors included services, agriculture, industry, mining and petroleum, import, tourism and transit goods.
3. Determination of a demand profile utilizing present flows of passenger and goods.
4. Development of costs of transportation for passenger and freight by relevant modes.
5. Development of additional economic aspects of demand for transportation such as price elasticity and related economic considerations which contributed to the final analysis of prioritizing the projects

The national objectives for development included other than primary economic objectives, such as social and defense goals. These objectives were then detailed and specified as they affect the development of the transportation infrastructure of the five-year plan.

The economic analysis determined the growth of the basic sector activities and the growth of demand for transportation over a twenty-five year period. The development of forecasts for basic sector activities and growth consisted of two elements:

The first involved identification of economic development plans and evaluation of probable exogenous impact of these development plans upon the transportation sector during the twenty-five-year period and more specifically during the five-year period under study.

The second element consisted of generating basic economic sector activity projections from historic trends utilizing statistical multiple correlation techniques relating the basic economic activities to appropriate dependent variables. Micro-econometric models and input/output models were not used due to unavailability of data and limitation of time.

The forecasts of demand for transportation utilized existing patterns of flows modified by exogenously planned activities super-imposed upon historic patterns. Passenger projections were made based on projections of population demographic patterns. In the projection of demand three levels were included; high, low and intermediate.

Given the growth of the basic sector activities, and the growth of demand for transportation, the operational flow of passengers and goods were determined by spatial distribution of surpluses and deficits using linear programming. Transportation flows were assigned from surplus regions in Iraq to deficit ones utilizing linear programming techniques whose objective function is to minimize the transportation distance between sources and links. The final results of projected flows were reallocated by mode based on cost effectiveness of each mode.

Shipper costs by mode were developed by leading commodity classes. Cost data were generated from available records and supported by data available from other sources than Iraq. For freight movements, five commodity groups were used to distinguish between value of goods transported, type of handling and equipment needed, and desirable transit times. For passenger movement, three classes of movements were considered to reflect differences between demand for passenger transportation for motor, air and rail transport.

The developed physical systems network is then checked against the hypothetical network, which is based on projected demand for transportation. Gaps in the present and proposed supply of transportation are identified. Present or proposed links that dit not have sufficient capacity or desirable features, or the absence of feasible links became transportation gaps to be evaluated in the context of the projects proposed.

The final step in the systems analysis approach is the prioritization of the total feasible set of projects. Prioritization of projects is not a sole function of one criterion but the combination of several criteria. Projects that are less economically justifiable than others may nevertheless have a higher priority because they constitute an integral part of other feasible projects in existence or planned.

The prioritization of projects is based on assigning ordinal values to each project for the following criteria:

1. Cost/Benefit and Internal Rate of Return Analysis:

The stream of benefits for each project included both direct and indirect benefits. Indirect benefits include the project social and military values, and its impact upon primary sectors. The impact areas and sectors of each project are determined and the "opportunity cost" of not having that project undertaken and completed is assessed. A rate of return analysis is also made for each project. It is based on a time profile of the discounted flow of costs and patterns under the lifetime of each project.

2. Physical Network Value:

The importance of each project within its mode and within the system to provide a compatible and feasible network is determined.

3. Relationship to Expressed National Goals and Objectives.

4. Likelihood of Completion and Successful Operation:
The success of completition and operation of each project is determined in terms of the ease of acquiring the construction equipment and materials and availability of contractors, in terms of the ease of operating and maintaining the project as specified, and in terms of the cadre and technical support required.

A second level of prioritization of projects is considered assuming only a certain percentage of the budget requirements is made available. Two levels of funding were assumed, 80% and 60% of the total sum of requested funds. Under each level of funding, a subset of the total projects is selected and consequently prioritized.

This two-way systems approach to master planning the transport sector of a developing country, which starts at one-end from the physical systems network and at the other-end from the projected hypothetical network to develop an integrated and feasible set of transport projects, minimizes the uncertainties facing the transport planner and provides the decisionmaker with alternative transportation plans under different budgetary and administrative constraints.

The basic advantages of this methodology could be summarized as follows:

1. It considers and utilizes the projects proposed by the local governments and the Ministry of Planning.
2. It familiarizes the transport planner with the importance as well as the difficulties of each project.
3. It provides two independent approaches of analysis. One approach assumes that the proposed projects are justified, and determines the improvements needed to produce a feasible and sound network. The second approach determines another network based on the economic analysis of national requirements for transportation. This dual analysis provides a safeguard against the failures in any of the approaches.
4. It avoids the serious errors of omission, internal contradictions and blind spots.
5. It considers in the analysis the time phasing of projects and the likelihood of their successful completion.
6. It evaluates and prioritizes different sets of feasible projects under different levels of budgetary constraints.
7. It requires less time for execution in comparison with similar studies.

RESEARCH TOPICS

In conducting this study, many areas in the transport sector of a developing nation are found to need extensive study and research to improve the total master planning efforts. Among these areas are the following important topics:

1. Basic Data Requirements for Transport Planning
The lack of basic transport data (such as inventories of demand, characteristics of the transport system, transport socio-economic indicator, etc.), on the urban and on the national scale hinders and limits the scope of analysis of transport planning and subjects the transport planner to personal evaluations and rough estimations. Although the data may vary with the planning methodology used, yet there is basic data requirements which is common to most planning methods, and which should be stored in the data bank and available for updating the five-year transport plans of the developing countries. This research activity should investigate and identify the types of data needed, the mechanism and the methodologies of collection and storage required.

2. Impact Studies of Commuter Railroads and Urban Freeways
Little has been done to assess the socio-economic and environmental impacts of different modes of transport in developing countries. The socio-economic impacts of feeder roads are under study by the World Bank, but other impacts are as necessary and urgent as well, such as commuter railroads, and urban Freeways. They are very useful in the evaluation of the mode itself and in the comparison between two alternative modes. The purpose of this research should be to determine the socio-economic and environmental impacts of these two modes.

3. Minimize Risk of Transport Investments Under Uncertainties of Planning Conditions
Abrupt and unforeseeable changes in the transport conditions could easily occur in a developing nation (such as the discovery of a new ore, the opening of a new border due to the relief of hostilities between two neighboring nations, etc.). These new conditions of demand may upset the transport master planning of the nation and may require some costly changes in already invested projects. The planner in planning for total transport investments, which may amount to 25% of the gross national product of the nation, may want to minimize the risk involved in these investments under the uncertainties of demand. This research should investigate and develop ways of determining these uncertainties and incorporating them in the master planning efforts.

4. Low Cost Solutions to Traffic Problems in Urban Areas
High capital investment solutions to urban traffic problems are practically unfeasible in most developing nations. Most city officials are looking to low-cost solutions to their traffic problems. Solutions that require low-key investments and that maximize the use of the existing transport facilities and equipments. Techniques to help solve traffic problems in developing urban centres at low costs are needed. Techniques in traffic management and operations, such as, banning the private car from certain congested sectors of the town, higher pricing of parking facilities in downtown areas, preferential treatment of buses (special bus lanes), the use of high-capacity buses (articulated-bus), the use of trolley cars, these and other techniques should be researched and developed.

5. The Role of Low-Cost Airports in Interurban Transportation Systems
Air transport would provide a faster and cheaper mode of travel in low density corridors of most large-area developing nations, such as Sudan and Saudi-Arabia. A research to help investigate the feasibility of these low-cost airports for different travel and environmental conditions, and to determine the necessary physical and operating requirements is also needed.

6. The Role of River Transport in Intra-Urban Passenger Transportation Systems
Most cities of developing nations are built around rivers, where they still constitute a high density corridor of travel, yet the river itself is no more being used for passenger transport, such as the Nile River in Cairo, Egypt. The purpose of this study is to investigate the potential use of river transport in intra-urban passenger transport and to determine the feasibility of its implementation.

7. Transportation Information Centres
Most neighboring developing nations, that geographically formulate a transportation region, depend on one

another's transportation facilities for the movement of passengers and goods. Bottlenecks occurring at the seaport or at the over-land transport of one nation may halt the development of its sister nation that depends on these facilities. To better utilize the existing transport facilities and to better schedule the transport traffic among these nations, the exchange of transport information is becoming a necessity. A transportation Information Centre in the region would collect, classify and distribute this information.

The proposed research should be directed basically to determine the feasibility of such a concept and to establish the different elements needed to develop such a transportation centre.

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FOOTNOTE

* "Evaluation and Prioritization of Transportation Projects and Development of Five Year Transport Plan Ending 1980". Three Volumes, Iraq Ministry of Planning, Baghdad, Iraq, 1975.