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TRANSPORTATION AND TRAFFIC ENGINEERING

SURVEYING AND MEASUREMENTS

TOWARDS BANKABLE BUILD-OPERATE-TRANSFER ROAD PROJECTS: A SYSTEM APPROACH FOR ASSESSING FINANCIAL FEASIBILITY

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ABSTRACT

This paper is concerned with developing a detailed generic systematic approach to assist in conducting a comprehensive and structured financial feasibility assessment of private investment in road projects. It particularly discusses the most widely followed forms of private finance of infrastructure utilities, namely Build-Operate-Transfer (BOT) concessions. Main stakeholders, their objectives, benefits and interactions in a BOT road project are identified and discussed. A conceptualisation of the main generic phases and stages throughout the life cycle of a BOT road project is developed and presented.

The structure of the developed system approach constitutes eight generic stages, namely defining the objectives of the project, traffic analysis, conducting Environmental Impact assessments (EIA), estimation of potential costs, forecasting of project revenues, estimation of key financial criteria and comparing these with project financial objectives so as to determine project viability. Finally, the eight stage is concerned with minimising uncertainties and risk through a three level procedure of conducing scenario analysis, followed by sensitivity tests and then risk analysis. Several conclusions are deduced, the most important of which is the importance to forecast and analyse the development of traffic flows over the life of a BOT road project. This forecast should particularly run over the time period considered for evaluating the proposed BOT scheme. The paper revealed the importance of using disaggregate traffic demand forecasting models for BOT road projects. Such quality traffic models are meant to forecast demand for different types of vehicles throughout the operation period rather than at peak periods. This is crucial for the rigor required in the forecasting of revenue which is detrimental for establishing the projects viability. Parameters identified as critical to the financial success of a BOT road project include: length of the concession period, toll categories and rates, traffic growth rates, discount rate, etc. Scenario analysis, sensitivity tests and risk analysis ought to be conduced taking into account the effect of variations in such parameters on projects viability.

Key Words: Road - BOT - Financial - Feasibility - System Approach

1. INTRODUCTION

The need for an adequate and sustainable levels of mobility and accessibility coupled with growth in travel demand and a need for provision of infrastructure to new areas and developments, all in all, have created a demand for roads with high quality and capacity. Governments across the world and particularly in developing countries are suffering from fiscal crises, limited available financial resources, and a disenchantment with public sector performance. This coupled with growing technological and regulatory changes have resulted into a fundamental shift in the role governments play. Most governments are moving away from being providers of services and infrastructure utilities such as transport, more and more, they are acting as regulators of services and infrastructure provided by private sector.

The paper starts by presenting the various primary sources available for financing road investments. These include several traditional and non-traditional sources. The paper emphasises on options available for the provision of infrastructure by the private sector. It particularly presents the most widely followed forms of private finance of infrastructure utilities, namely concessions ranging from supply and civil works contracts to Build- Operate-Transfer (BOT) and Build-Own-Operate (BOO) schemes as well as divestiture by licenses.

The eligibility of a BOT road project depends on meeting several criteria, including economic, financial, environmental, technical, and legal criteria. This paper is concerned with developing a generic system approach for conducting the feasibility assessment of privately financed road projects. Main stakeholders, their objectives, benefits and interactions in a BOT road project are identified and discussed. These include: the government and its sponsoring highway agency wanting to attract private finance to build and operate new roads thus relieving itself from heavy financial burdens and transferring risk to the private sector; the private concessionaire looking at the project in terms of generating enough income to cover capital costs, pay interest and provide enough profit equivalent to or higher than industry prevailing rate of return; financiers wanting to guarantee that the project would generate enough capital for the private concessionaire to pay his debts and the charged interests; and finally road users wanting to drive their vehicles on roads with high capacity and high levels of service and to pay toll rates which are acceptable and in line with their ability and willingness to pay.

A conceptualisation of the main generic phases and stages throughout the life cycle of a BOT road project are is developed and presented in a structured format. The core of the paper is concerned with developing a detailed generic systematic approach to assist in conducting a comprehensive and structured financial feasibility assessment of private investment in road projects. This approach encompasses the generic stages, procedure, steps and models envisaged to assist sponsors, concessionaires as well as financiers in identifying bankable road projects. The structure of the developed approach constitutes eight generic stages. The first is concerned with defining the objectives of the project to provide the necessary background against which appraisal of alternatives is performed. The traffic analysis presents the core of the second stage. The third stage involves conducting of an Environmental Impact Assessment (EIA). The fourth stage is concerned with the estimation of potential costs expected, taking into consideration the cost of environmental mitigation measures. In the fifth stage a forecast of project revenues is conducted. Stages six and seven are concerned with the estimation of key financial criteria and comparing these with project financial objectives so as to determine project viability. Finally, the eighth stage is concerned with minimising uncertainties and risk through a three level procedure of conducting scenario analysis, followed by sensitivity tests and then risk analysis. In the course of developing the system approach, potential costs and risks in a BOT road project are identified and allocated in a matrix format onto the key stakeholders.

2. SOURCES FOR FINANCING ROAD INVESTMENTS

Public sector finance of road investments through state treasury can be obtained from several traditional sources such as:

- National taxes or community fund raising by targeted local taxation
- Fuel and lubricant tax
- Driver licensing fees
- Motor vehicle taxes and fees, which include registration fees, heavy vehicle taxes, fees for vanity plates, tire taxes and personal property taxes on motor vehicles.
- Weight distance tax
- Publicly owned tolled roads where tolls represent fees for access to selective highways, bridges and tunnels
- Commercial parking taxes, where commercial parking lots are being taxed. Such taxes are borne either by the parker or by the lot operator.

Several other non-traditional sources for financing road investments exist. According to Johnson and Hoel, 1986, a typology of innovative techniques for financing transportation investments includes:

- Connector service charges are charges to owners or developers of buildings adjacent to a transportation facility, for being connected to it.
- Negotiated investment is an agreement between a developer and a public body, through which the former agrees to contribute a fixed sum towards a public improvement benefiting his development.
- Capture of land development benefits, whereby tax increment financing is applied for increasing property tax revenue, brought about by increased public and private investment near the public improvement.
- Transit/traffic impact requirements are charges and other requirements imposed on developers to mitigate and compensate for the impacts of their new developments on transit and traffic patterns.
- Land rights leasing, where a transportation agency owns land adjacent to its facilities but does not need such property for immediate uses, or where a parcel is not being utilised to its full potential, the full value of such property can sometimes be captured by leasing.
- Donations for capital improvements, where authorities have been successful in obtaining donations from the private sector to improve or expand the transport system
- Advertising and marketing, whereby transport facilities make excellent locations to market goods and services due to the large volumes of people coming into contact with them daily.
- Concessions of manned retail outlets (including newspaper stands, retail stalls, food and drink stands, etc.)
- Concessions of mechanical devices (including telephones, automated teller machines, vending machines, etc.)
- Mixed public/private finance
- Fully private finance

3. OPTIONS FOR INFRASTRUCTURE PROVISION BY THE PRIVATE SECTOR

According to Guislain and Kerf, 1996, there is a continuum of options for involving the private sector in the provision of infrastructure services. The spectrum of these options is illustrated in Figure 1. At one end is the supply and civil works contracts, where the private contractor is not directly responsible for providing the service, but instead performs specified tasks such as supplying inputs, constructing works, maintaining facilities or billing customers. Towards the middle, is the lease and operate (known as afterimage) contract, under which the private contractor is responsible for provision of the service at his own risk, including operating and maintaining the infrastructure, typically against payment of a lease fee.

Towards the end of the spectrum are concessions. A concession is the award of rights and obligations by a government agency (known as the project sponsor) to a private company (known as the concessionaire or the investor) to design, finance, build, operate, maintain public roads for defined periods of time which may be renewed or re-tendered. The term BOT (Build-Operate-Transfer) is used to refer to a concession in a stricto sensu, where the private contractor is also responsible for financing new investments and building and at the end of the concession period, the project assets are returned to the state. In arrangements such as BOT, the sponsoring agency may or may not retain ownership rights of project's assets through the concession period. These ultimately reverts to state control at the end of a BOT concession period. Terms and conditions of any such arrangement should be specified in a legal contract or license.

The BOO (Build-Own-Operate) is a similar scheme to the BOT, but does not involve transfer of assets. Finally, divestiture involves the transfer to the private sector of the ownership of existing assets and the responsibility for future expansion and upkeep. In BOO and divestiture arrangements, the concessionaire is allowed to indefinite ownership. Within these periods, concessionaires are authorised to provide public services and to collect fees from users at rates agreed with the sponsoring agency. A comparison of road concessions versus publicly financed road projects is presented in Bousquet and Fayard, 1997.

4. STAKEHOLDERS IN A BOT ROAD PROJECT: OBJECTIVES AND BENEFITS

In a BOT road project, there are several stakeholders that could be identified, namely:

- The host government
- The sponsor (in this case the roads authority)
- The concession cooperation
- The financiers (lenders)
- The road users

Each of these stakeholders would be looking at the project from a different perspective, see Figure 2.

4.1 Government Objectives

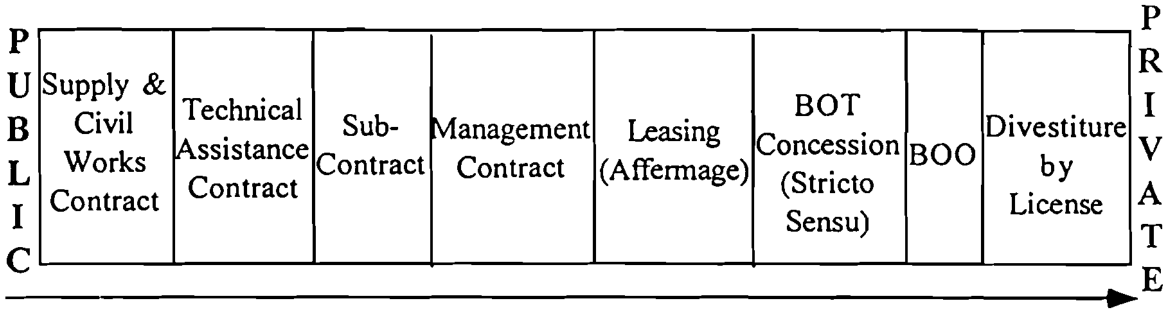
The government main objectives can be summarised in the following points.

- Attracting private finance, thus providing immediate access to a large pool of additional funds.
- Achieving efficiency gains inherent in many privatisations and contracting out projects This occurs as a result of drawing into the development process private sector skills in the design, construction, operation and maintenance of road infrastructure. These skills are bound to achieve an improvement in value for money through cost savings.
- Promoting the formation/growth of private sector industry in the design, construction, operation & maintenance of roads.
- Relieving of government capital and other resources that are committed to road activities.
- Generating the opportunity to utilise, otherwise committed, government capital & other resources in other directions.
- Transferring responsibility and risks to the private sector.
- Instigating more regional and national development.

4.2 Sponsor Objectives

From the sponsor point of view, road schemes are generically thought to achieve the following objectives:

- Providing new additional road capacities that can accommodate an increasing volume of traffic with acceptable levels of services.
- Relieving of traffic congestion on existing parallel roads.
- Causing an overall reduction in journey times as a result of improved uninterrupted traffic conditions with high average running speeds. This leads to economic savings in time costs.
- Causing savings in vehicle operating costs as a result of reductions in fuel consumption rates resulting from improved uninterrupted traffic conditions with high average running speeds.
- Achieving greater mobility through accommodating expected future traffic by acceptable levels of service in terms of average speeds, delays, and volume to capacity ratios. This is expected to induce, promote and sustain economic development, prosperity and welfare.
- Reducing the potentialities of traffic conflicts, thus causing a reduction in accident risks and an economic saving in accidents costs.



Source: Adapted from Guislain and Kerf (1996)

Figure 1: Range of Private Sector Options

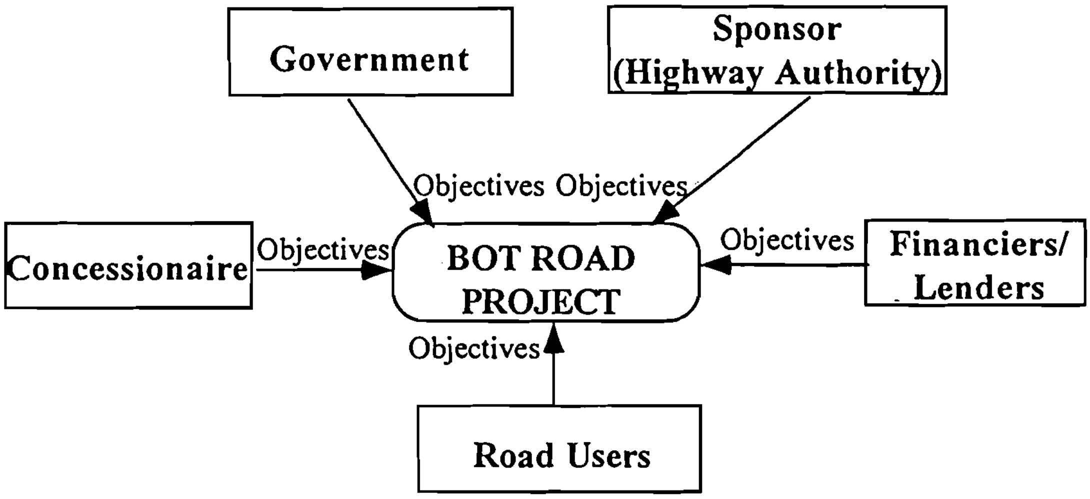


Figure 2: Main Stakeholders in a BOT Road Project with their Multi-Variable Objectives

4.3 Concessionaire Objectives

The private concessionaire, on the other hand, looks at the project in terms of:

- Generating enough revenue so as to cover capital costs, service debts, pay interest and dividends.
- Generating enough profit that is capable of providing an adequate and acceptable rate of return. An acceptable Rate of Return ROR is the one that takes into account the concessionaire risks and opportunity costs and which is equivalent/higher than prevailing industry ROR.
- Providing opportunity to mobilise available capital, human, equipment and time resources.
- Providing opportunity to expand and grow.
- Providing scope for innovation and creativity.

4.4 Financiers/Lenders Objectives

Financiers want to guarantee that such projects are capable of generating enough capital for the private concessionaire to pay his debts and the charged interests. The following are typical objectives for funding institutions such as multinational and local investment banks and companies.

- Provide opportunity to mobilise available capital.
- Provide opportunity to generate profit on borrowed capital equivalent/higher than prevailing banks' ROR.
- Improve image in society.

4.5 Users Objectives

Finally, road users would look at such projects in terms of providing better roads allowing adequate capacities and high levels of service. They would also expect to pay toll rates for such facilities in line with their ability and willingness to pay. In summary, road users are expecting roads that can provide them with the following:

- Better accessibility and higher levels of services
- Financial savings in vehicle operation costs
- Financial savings in time costs
- Reduction in potentialities of traffic accidents occurrence.

5. MAIN INTERACTIONS IN A BOT ROAD PROJECT

The main feedback interactions between the stakeholders involved in a BOT road project are depicted in Figure 3. These are discussed below.

Interaction (1): The host government conducts campaigns with the aim of explaining to the public the benefits of privatisation of infrastructure facilities. These should be carefully designed and prepared so as to build the necessary trust and public opinion support for later government actions concerned with privatisations.

Interaction (2): In parallel, the host government reviews existing laws and issue new legislation and regulations as well as amendments to existing ones. These should aim to create an appropriate legal environment within which such concessions could be achieved and sustained over the years. An important legislation would be concerned with delegation of rights and responsibilities to the appropriate government authority/agency to act as the concession sponsor and its reporting to the government.

Interaction (3): It is generally accepted that infrastructure concession projects are of huge scale and diversity. In most cases, the sponsoring agency is able to perform its role in such projects with the assistance of reputable and highly qualified consultants. These consultants should be capable of providing technical, financial, economic, environmental and legal consultations. They would be expected to assist the sponsoring agency in the preparation of all the necessary bid documents and in the negotiation stage.

Interaction (4): The sponsoring agency is expected to prepare and conduct the necessary procedural steps for awarding the concession. The agency is expected to represent the government in sharing the risks with the concessionaire. This could take the form of issuing specific guarantees to the potential concessionaire. The agency should be also responsible for ensuring the acquisition of land required for the road right of way. It should also grant the concessionaire the necessary rights for construction, operation, collection of tolls and maintenance of the road. It is also expected that the sponsoring agency would form a proper regulatory body to monitor and regulate the performance of the selected concessionaire.

The concession company constituting investors, contractors, suppliers and operators is being formed. A typical BOT road scheme would mainly involve the concession company performing the following generic activities:

- Design of the road
- Conducting an Environmental Impact Assessment (EIA) for the road taking into consideration all the current governing environmental laws and standards.
- Conducting financial studies
- Conducting legal studies
- Construction of the new road
- Operation of the road (operation of toll gates, collection of tolls, etc.)
- Maintenance of the road

Interaction (5): The concession company is expected, from the early stages, to seek the support of reputable consultants. These consultants would be involved in assessing the potentialities of projects, preparing feasibility studies necessary for the concessionaire to justify and seek financial support from lending organisations, preparing all the necessary documentation for the bidding process, and assisting in the negotiation stages with the sponsoring agency.

Interaction (6): The main sources of finance for such a concession company would depend on equity, loans and shareholders. The company would be seeking loans and equities from financiers including domestic and international banks as well as other financial institutions. In seeking these sources of finance, the concession company would support their requests by studies showing the bankability of such projects. As the project kicks off, shareholders would be expecting the concession company to pay their dividends, while banks would be expecting their debts to be serviced. In case an international bank is involved, this would mean that new investments are being pumped into the economy of the particular country where the project is located. On the other hand, in case a domestic bank is involved, this would mean that local investments are being transferred from one project to another. In this case, the sponsoring agency representing the government has to be capable of considering the opportunity cost of capital for such investments.

Interaction (7): Any financing institution, before getting involved in such projects, is bound to review and assess the feasibility of these projects. In most cases, the financing institution would also seek the assistance of reputable and highly qualified consultants.

Interaction (8): Financial institutions such as banks rely on their customers' deposits and shares. Customers of financial institutions would be expecting payment of their dividends.

Interaction (9): Financial support and/or risk guarantees can be provided by international agencies namely the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA), together referred to as the World Bank as well as the International Finance Cooperation (IFC) and the Multilateral Investment Guarantee Agency (MIGA). These could be approached by financiers, the concession company, the host government or its sponsoring agency, see Benoit, 1996a & 96b for details of such arrangements.

Interaction (10): As stated, one of the generic activities expected by the concession company is to conduct an EIA for the road taking into consideration all the current governing environmental laws and standards. These are set by the concerned government environmental agency. This EIA study is submitted to this agency for approval and permission.

Interaction (11): Finally, the concession company opens the road for traffic, thus offering its services to road users in return for toll rates being paid by traffic using the road

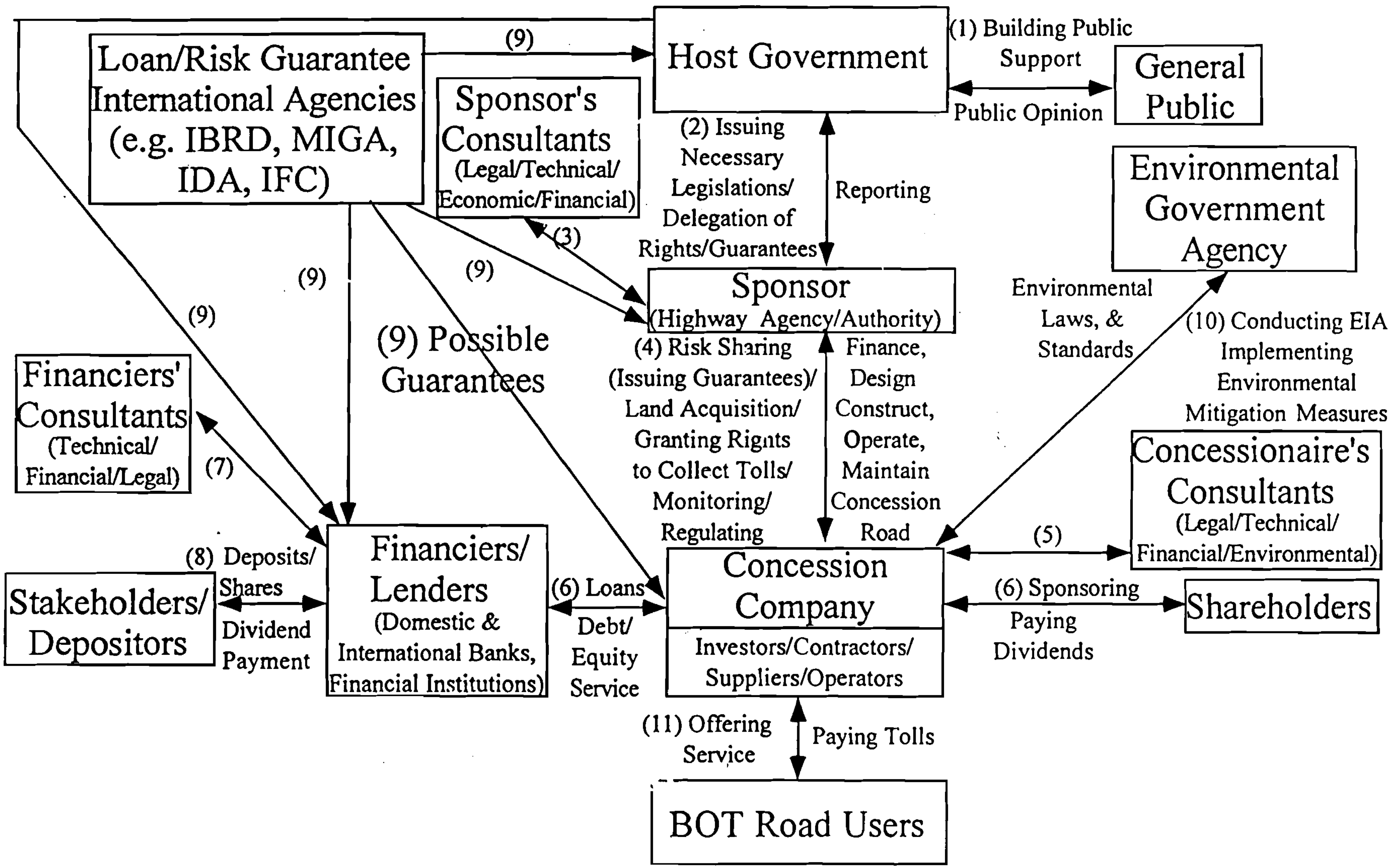


Figure 3: Main Stakeholders and Interactions in a BOT Road Project

6. MAIN PHASES AND STAGES THROUGHOUT THE LIFE CYCLE OF A BOT ROAD PROJECT

The life cycle of a BOT road project can be conceptualised through eight generic phases. Each of these phases is composed of several stages and activities. Details of this conceptualisation is depicted in Figure 4.

Phase 1: Public Outreach and Project Identification

In this phase, the concerned government has to prepare an outreach programme that explains, justifies and convinces the public of the need, benefits and fruitfulness of the privatisation program in general and infrastructure privatisation in particular. For road projects, the government has to identify a sponsoring authority usually the highway authority to act as a representative of the government throughout all the life cycle phases. Usually governments has certain land development plans as well as other development prospects, in which road infrastructure is bound to play an instrumental role. The sponsoring authority would have the task of identifying road projects and alternatives that are characterised by:

1. contributing to the country's development prospects
2. being bankable i.e. offering adequate return on capital investments that is bound to attract private investors and lenders.

In doing this. the highway authority has to conduct legal, technical, and environmental studies in addition to both economic and financial feasibility studies. The economic feasibility is meant to satisfy the first condition related to the country as a whole, see Dickey & Miller, 1984, Adler, 1987, ODA, 1988 for practices that could be followed in the economic appraisal of roads. On the other hand, the financial feasibility is meant to give assurance for the sponsoring agency that the project when announced will have a positive image among local and international private concessionaires and bankers.

Phase 2: Prequalification, Tendering and Contracting

In order to ensure the credibility, reputation and seriousness of potential bidders, a process known as prequalification is conducted. Prequalification for the project is advertised. Interested private sector applicants are to prepare and submit a prequalification document within a specified period of time. These would be evaluated against a set of announced prequalification criteria resulting in the production of a short list of potential bidders. According to UNIDO, 1996, typical information presented in a prequalification document should include: the financial capability, the experience and track record, as well as the management structures and operational capabilities of the applicant. In addition certain legal requirements should be also satisfied.

In parallel, the sponsoring agency undertakes a crucial task known as the preparation of the Request For Proposals (RFP) which involves all the necessary details and required specifications that should be taken into account by potential bidders in preparation of their tender documentation.

Once the prequalification assessment process ends, the short listed applicants are invited to draw the tender documents (RFP) and to submit their potential tenders within a specified period of time. In the process of preparing their tenders, potential applicants have to undertake five major steps, namely:

1. Conducting a legal study
2. Conducting a technical study
3. Conducting an EIA
4. Conducting a financial feasibility study, and finally
5. Putting together the final bid in accordance with the forms and structure of the RFP.

Once potential applicants submit their tenders, these are assessed by the sponsoring agency in accordance with the specified assessment criteria. Some proposals may be eliminated for failure to abide by requirements and specifications as set in the RFP. The rest of the bidders would be ranked and the selected bidder would be contacted and informed of his selection. The selected bidder and the sponsoring agency would then enter a stage known as post tender negotiation, where an agenda is set for certain issues to be discussed, clarified and possibly negotiated. Once this stage ends, a contract is being prepared by the sponsoring agency, which is usually a voluminous legal document containing all the details that has been agreed upon.

Phase 3: Legal Formation of Concession Company and Preparatory Work
Based on the contract finalisation, the selected bidder would be in a position to undertake several crucial steps. First, a concession company would be legally formed and named (this is known as the concessionaire). Such company would include contractors, suppliers, operators, shareholders, etc. Raising capital would be the first task for the concessionaire. Requests for loans from local and international financial institutions would be made. Potential financiers are bound to conduct similar technical, financial, legal and environmental studies to establish the risk of potential loans and to ensure the financial feasibility of the project.

In addition, the sponsoring authority has the obligation of acquisition of agreed project land (road right of way) and transferring such land to the hands of the concession company. In parallel, the concessionaire would be undertaking all the necessary environmental studies and submitting these studies to the concerned authorities to obtain all the necessary environmental approvals. This step would be conducted with the support of the sponsoring authority.

Before proceeding to the next phase, the concessionaire should be in a position to show the sponsoring agency the commitment of adequate capital necessary for project implementation and success.

Phase 4: Detailed Design of Road Project and Facilities
In this phase, the concessionaire prepares detailed structural and geometric designs for the road project and all its supporting facilities. In addition, detailed operation and maintenance plans are prepared. These designs and plans are to be approved by the sponsoring highway authority. From the time, the concession contract is signed, the highway authority role changes to become a regulatory body for all the rest of the phases within the life cycle of the project.

Phase 5: Construction of Road Project and Implementation of Construction Related Environmental Mitigation Measures
In this phase, the concessionaire contractors and subcontractors start construction works taking into consideration the implementation of all approved environmental mitigation measures. The highway authority is to regulate, through its technical staff, the conformity of construction works with the approved plan and design standards. In addition, the highway authority has to maintain that all quality control procedures are being strictly followed by the contracting companies. In parallel, the concerned environmental agency is to monitor, through its officers, the compliance of the contractors in implementing the approved environmental mitigation measures necessary during construction.

Phase 6: Operation of Road Project and Implementation of Operation Related Environmental Mitigation Measures
In this phase, the road is opened for traffic. Operation of the road takes places on a daily basis taking into consideration the implementation of all approved environmental mitigation measures. The highway authority is to regulate, through its technical staff, the conformity of operation with the approved plan and standards. In addition, the highway authority has to maintain that all quality control procedures are being strictly followed by the operating company. In parallel, the concerned environmental agency is to monitor, through its officers, the compliance of the operator in implementing the approved environmental mitigation measures necessary during operation.

Phase 7: Maintenance of Road Project and Implementation of Maintenance Related Environmental Mitigation Measures
In this phase, the concessionaire maintenance contractors and their subcontractors undertake maintenance works taking into consideration the implementation of all approved environmental mitigation measures during maintenance activities. The highway authority is to regulate, through its technical staff, the conformity of maintenance works with the approved plan and standards. In addition, the highway authority has to maintain that all quality control procedures are being strictly followed by the maintenance contractors. In parallel, the concerned environmental agency is to monitor, through its officers, the compliance of the maintenance contractors in implementing the approved environmental mitigation measures necessary during maintenance works.

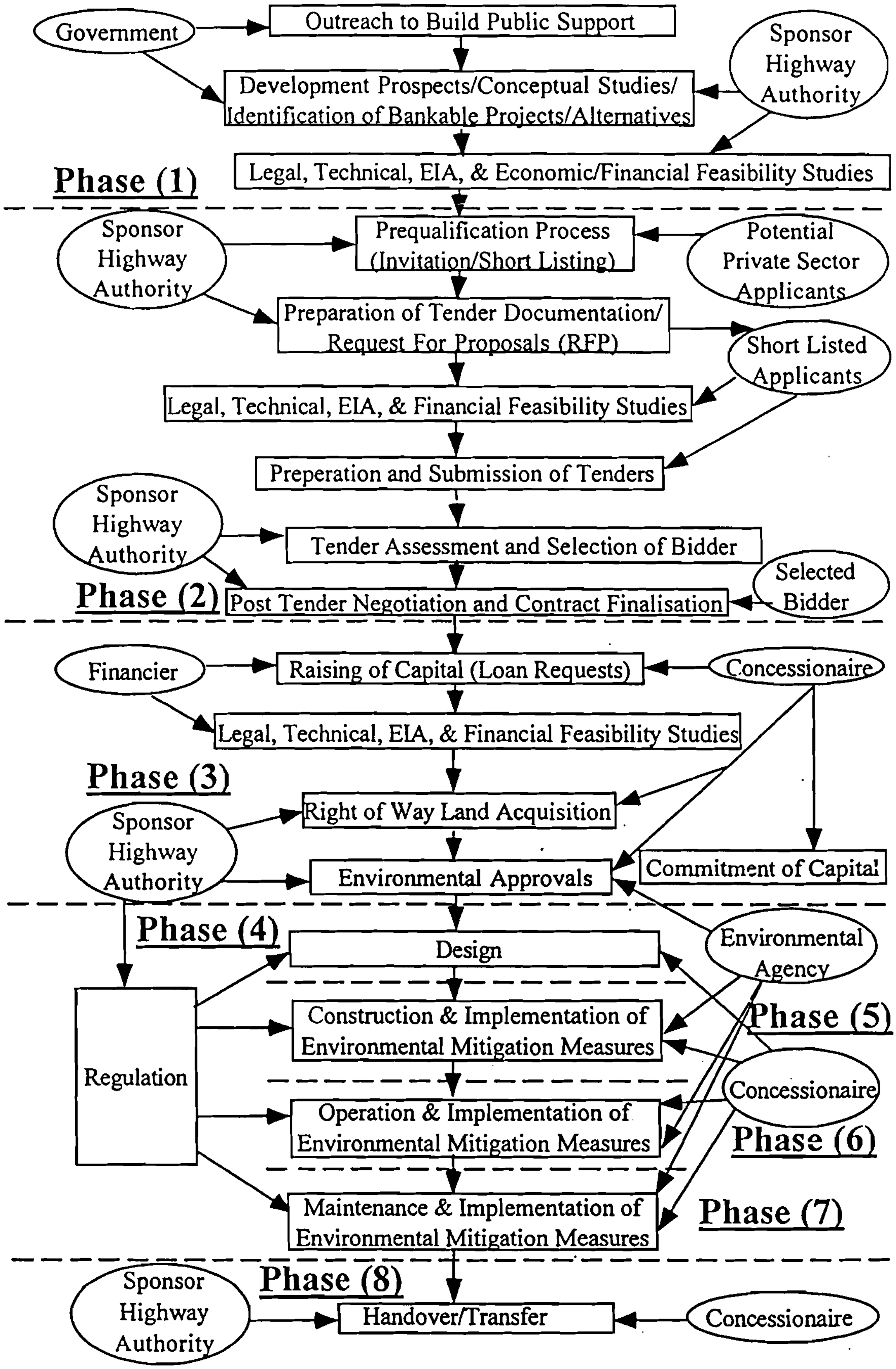


Figure 4: Generic Phases, Stages & Stakeholders Throughout the Life Cycle of a BOT Road Project

Phase 8: Concession Termination and Handover (Transfer)
At the end of the concession period, the concession company is to handover the road and all its supporting facilities to the sponsoring highway agency. This process is known as the transfer phase. The concessionaire is to transfer the road and all the relevant facilities in a condition pre-specified in the concession contract. The sponsoring agency, would then have the right to do one of three things:

1. to keep the road under its authority
2. to sign a new concession with the concession company
3. to start a new bidding process for the road

6.1 Criteria for Success of a BOT Road Project

Several factors are crucial in the success of the BOT road project throughout its life-cycle phases and stages. According to Blaiklock, 1994 key features for success of road concessions include: financial viability, availability of finance, government support. perseverance and patience. Furthermore, government support should include creating appropriate legislative framework, providing equitable regulatory environment, overcoming bureaucratic opposition, providing adequate and qualified personnel, providing clear programme for public participation, providing a clear tax regime, providing protection for a limited period from competition, ensuring support in the event of Force Majeure, minimising interference once project starts.

Key and Turner, 1996 summarised their criteria for success of privately financed road projects in: viability, full government support, required institutional and legal framework in place, responsibilities clearly defined, and adequacy of project preparation. US experience reported by Erickson, 1996 emphasises the importance of well organised and careful public outreach, establishing a formal scheduled process for private entities to conform to, demonstrated state commitment, flexibility in negotiation, and negotiated regulation. Lessons from toll road concessions in Argentina include the importance of having simple and transparent criteria for bidding, rules for re-negotiating contracts should be early and clearly spelled out, and institutional building must be taken seriously, see Estache & Carbajo, 1996.

In support of the above success criteria, problems that negatively affected the Mexican toll road program and should be avoided, see Ruster, 1997 include:

- vague project selection criteria
- inadequate tendering process and concession design
- inadequate financial discipline in government owned commercial banks
- underdeveloped local financial markets
- underdeveloped institutional capability
- legal disputes subject to local court system rather than to international arbitration
- poorly devised regulatory system

7. IMPORTANCE OF ASSESSING FINANCIAL FEASIBILITY FOR BOT ROAD PROJECTS

As shown in the previous conceptualisation of the life-cycle phases of a BOT road project, each of the parties involved is expected to incur different risks, costs and benefits. Each of the key stakeholders, namely the sponsor, the concessionaire and the financier ought to conduct a detailed feasibility study to estimate the exact values for those expected risks, costs and benefits.

The sponsoring highway agency is expected to conduct:

1. an economic feasibility study to verify the project worthiness from the society point of view, as well as
2. a financial feasibility study to justify its choice of a bankable project and to assist in negotiating the concessionaire during the bidding and contracting stages.

In addition, both the concessionaire and the financier are expected to undertake a financial assessment aimed at demonstrating the project financial viability and worthiness. The concessionaire wants to make sure that his investments would be worthwhile (establish project worthiness). On the other hand, the financier wants to guarantee project success and hence ability of concessionaire to service his debts.All three parties are expected to support such assessments with other legal, technical, and environmental studies.

Despite difficulties of definition, measurement, valuation and aggregation, a rigorous financial appraisal of a proposed BOT road scheme serves several important purposes, namely:

- It reveals relative magnitudes of costs and revenues for considered BOT road scheme.
- It indicates the likely rate of return on capital invested in the proposed BOT road scheme.
- It provides a coherent framework for justifying investment decisions in a BOT road scheme.
- It provides information necessary for public involvement/participation in planning of BOT road projects.
- It helps politicians and planners in their task of explaining to the electorates the basis on which decisions (BOT road schemes) affecting them have been taken.
- It assists decision-takers in establishing priorities and initiating new BOT road schemes.
- It provides the necessary yardsticks, standards and other constraints with which the future outcome of the BOT road scheme ought to be checked against (regulated).
- It ensures consistency in the built in values and judgments used within the field of BOT road investments.

The eligibility of a BOT road project depends on meeting several criteria, including economic, financial, environmental, technical, and legal criteria. This paper is concerned with developing a generic system approach for conducting the feasibility assessment of privately financed road projects.

8. A SYSTEM APPROACH FOR ASSESSING THE FINANCIAL FEASIBILITY OF BOT ROAD PROJECTS

This section presents the core of the research, where a system approach is developed to assist in conducting a structured assessment of the financial feasibility of private investment in an intercity road project. This approach encompasses the generic stages, procedures, steps and models envisaged to assist sponsors, concessionaires as well as financiers in identifying bankable road projects. The structure of the developed approach constitutes eight generic stages as shown in Figure 5. These are explained below.

Stage 1: Identification & Quantification of Objectives. This stage is concerned with identifying project objectives and representing these into several expected quantifiable financial indicators.

Stage 2: Traffic Analysis & Road Design. The traffic analysis is meant to produce traffic forecasts over the concession period. These forecasts act as an input serving five important purposes namely in:

1. capacity analysis and geometric design of the proposed road,
2. estimation of Equivalent Single Axle Load (ESAL) over the design life of the road and consequently in the structural design of the proposed road,
3. assessing environmental impacts of the road and cost of proposed mitigation measures,
4. estimation (forecast) of costs expected as a result of design, construction, operation, maintenance, etc. of the proposed road project
5. estimation (forecast) of revenue expected to be generated as a result of tolls collected and fees collected for services provided y the road project,

A traffic model is meant to act as an appropriate representation, through a set of mathematical equations, of the effect of changes in: the road network, the socio-economic and land-use activities of an area; on the development of travel demand. These changes form the input to the model for future planning horizons. Forecasts of traffic demand, its distribution and assignment for a particular year are obtained as outputs of the model. According to Simpson, 1992 "models followed the traditional four stage approach of traffic generation, distribution, modal split and assignment to routes on the network via the shortest or cheapest routes. During the 1980s, the models were simplified to include only generation, distribution and assignment stages". Disaggregate traffic demand forecasting models are warranted for BOT road projects. Such quality traffic models are meant to forecast demand for different types of vehicle throughout the operation period rather than at peak periods. This is crucial for the rigorous required in the forecasting of revenue which is detrimental for establishing the projects viability. A comparison showing the significance of the role transportation modelling in privately financed road projects versus public ones is detailed in Carbonaro, 1995.

Stage 3: EIA & Estimation of Cost of Environmental Mitigation Measures. In this stage a complete EIA is conducted with all its components including screening, scoping, analysing significant environmental impacts and identifying potential mitigation measures throughout the pre-construction, construction, operation and maintenance phases of the road project. As previously stated, this EIA has to be approved by the concerned environmental authority. Finally, agreed mitigation measures are quantified to represent a main component of costs incurred by the project.

Stage 4: Cost Estimation (Forecast). In this stage all types of costs are identified and thoroughly itemised. These costs are valued throughout the life of the concession taking into consideration inflation rates and shadow pricing. The main types of expected costs are costs incurred during design, construction, operation, maintenance, and implementation of environmental mitigation measures as well as debt service costs. These cost estimations are done on a year by year basis over the concession period of the BOT road project.

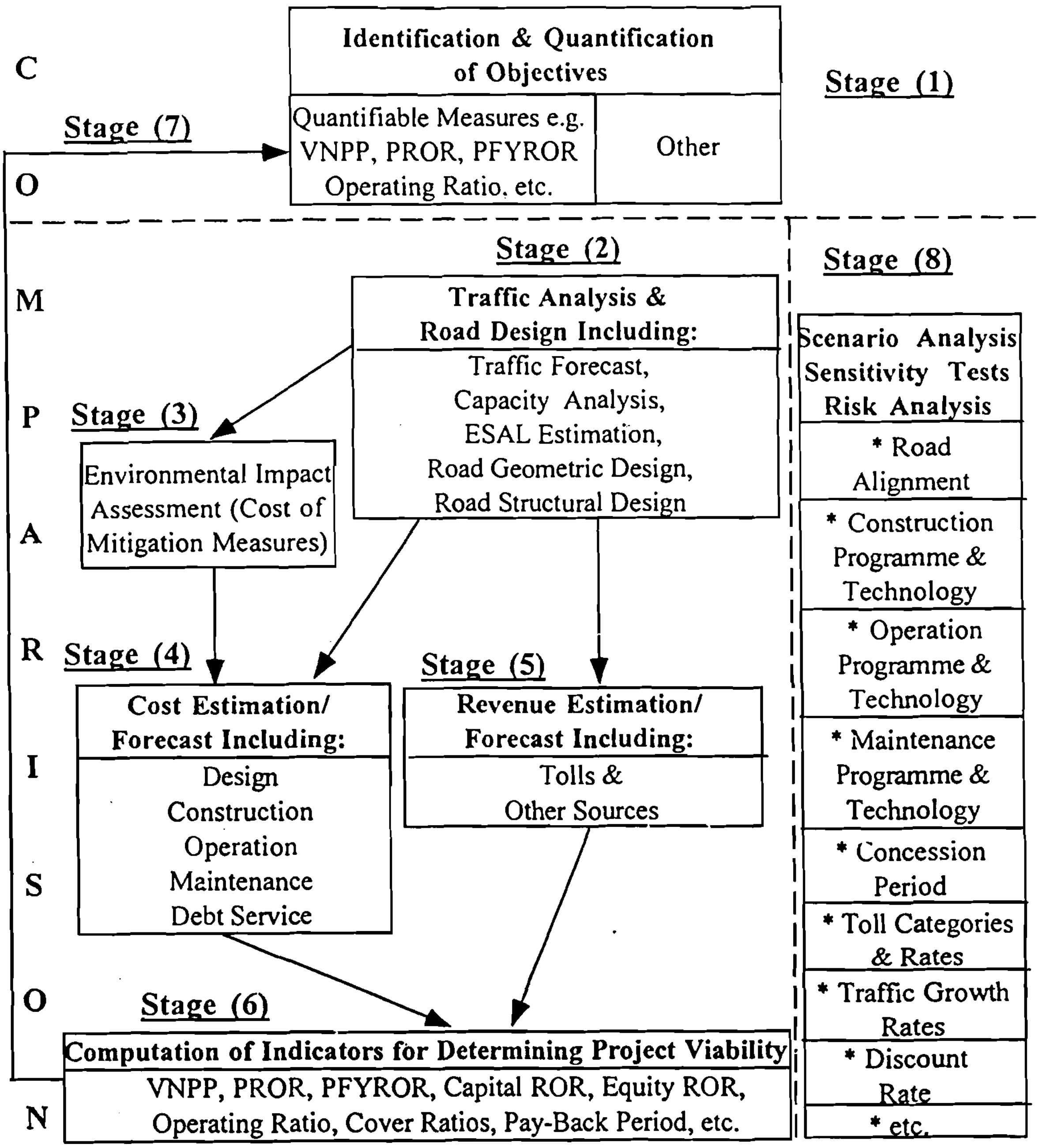
Stage 5: Revenue Estimation (Forecast). This stage can run parallel to the cost estimation stage. In this stage and depending on; traffic forecasts, toll rates proposed and toll rate indexation; revenue generated out of toll collection is estimated. In addition, revenue expected as a result of fees collected for providing other types of road services should be also estimated. These revenue estimations are done on a year by year basis over the concession period of the BOT road project.

Stage 6: Computation of Project Viability Indicators. In this stage, the financial indicators, identified in stage 1 as representative of project objectives, are computed. This is done using both the cost and revenue streams across the concession period. These streams are discounted using appropriate discount rate that reflects expected opportunity costs and risks.

Stage 7: Judgment of Project Viability. In this stage a comparison is made between expected and output values of the identified financial indicators. These are utilised to judge the feasibility, viability and effectiveness of the project.

Stage 8: Scenario Analysis/Sensitivity Tests/Risk Analysis. Where a project is ill defined, scenario analysis has to be conducted where a range of scenarios covering future strategic possibilities that are likely to occur are examined. Possibilities involve changes in road alignment, construction programme & technology, operation programme & technology, maintenance programme & technology, etc. Within each of the proposed scenarios, values of various key input parameters is varied so as to examine the sensitivity of project financial outputs to such variations. Where several parameters are identified through sensitivity tests to affect the project outcome, these should be varied in several different combinations to show their net effect and the likelihood of changes occurring together. This is known as risk analysis, see Pouliquen, 1970 for a review of risk analysis in project appraisal. Parameters identified as critical to the financial success of a BOT road project include: concession period, toll categories and rates, traffic growth rates, discount rate, etc.

The main stages of this systematic approach are detailed in Figures 6 through 9. Detailed steps, procedures and models of these stages are thoroughly discussed in the following sub-sections, which are meant to be read in conjunction with Figures 6 through 9.



VNPP=Value of Net Present Profit
PROR=Project Rate of Return
PFYRR=Project First Year Rate of Return
Operating Ratio=Discounted Revenue/Discounted Cost

Figure 5: Main Generic Stages Constituting System Approach for Assessing Financial Feasibility for BOT Road Projects

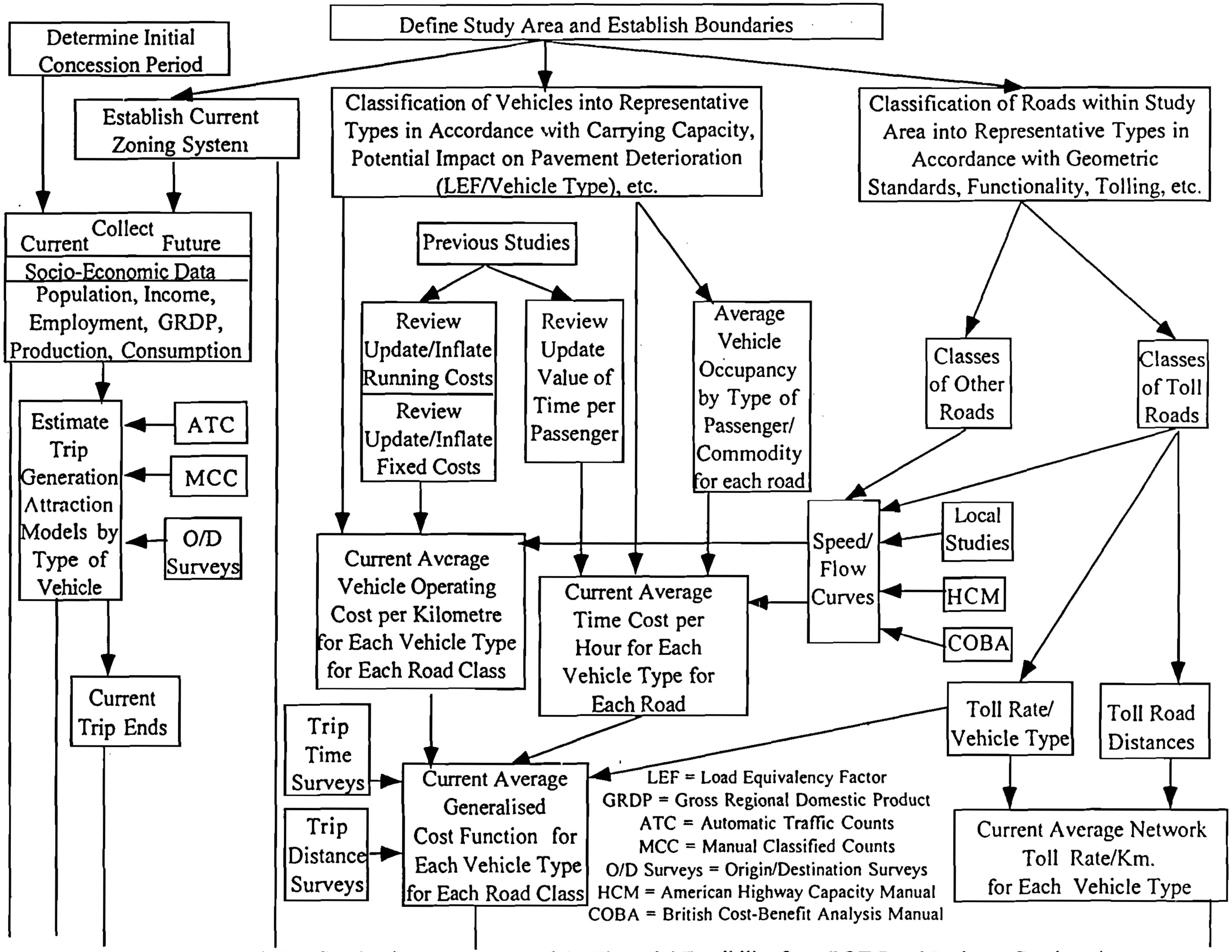
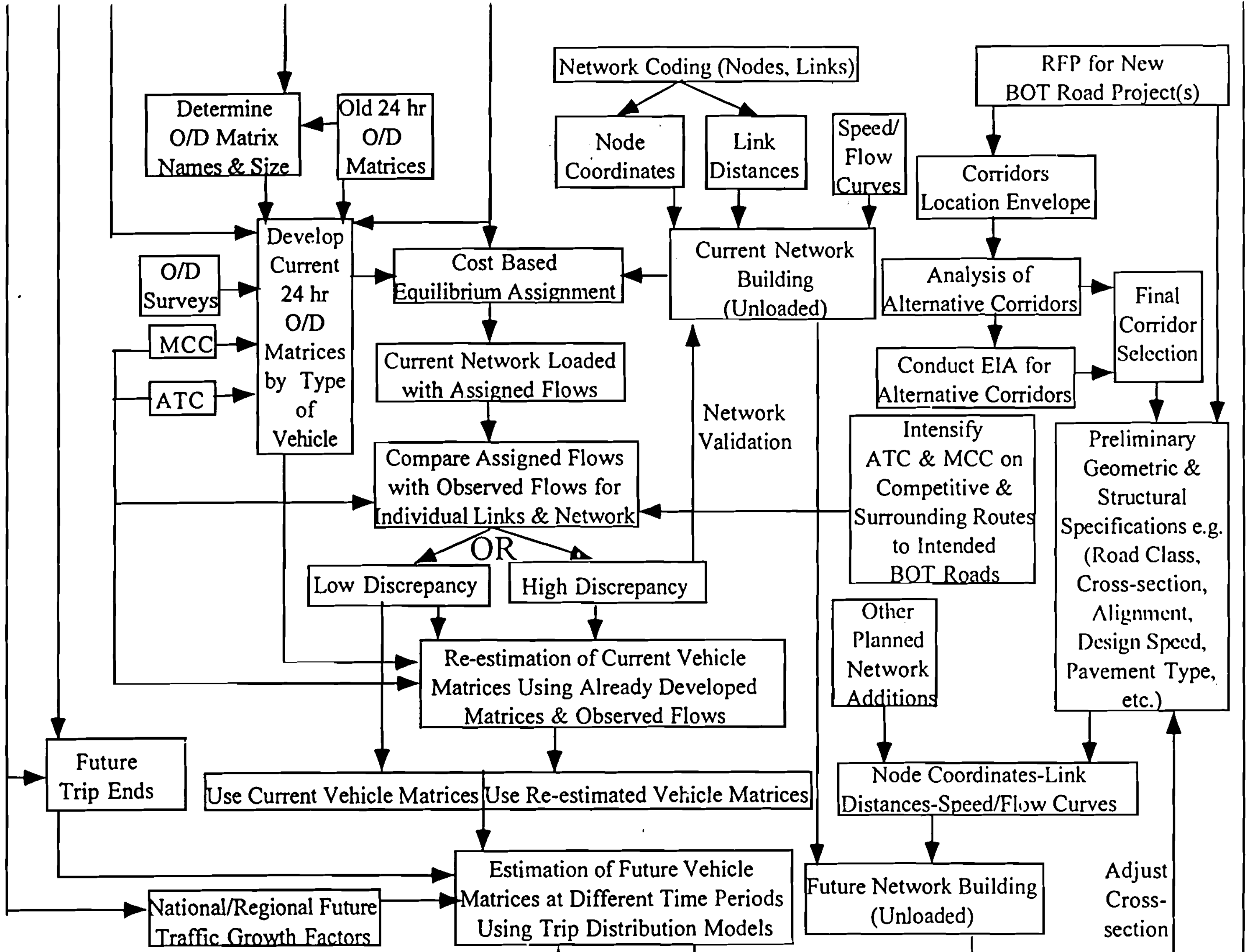


Figure 6: A System Approach For Conducting Assessment of the Financial Feasibility for a BOT Road Project: (Continued)



RFP = Request for Proposals
EIA = Environmental Impact Assessment

Figure 7: A System Approach For Conducting Assessment of the Financial Feasibility for a BOT Road Project:(Continued)

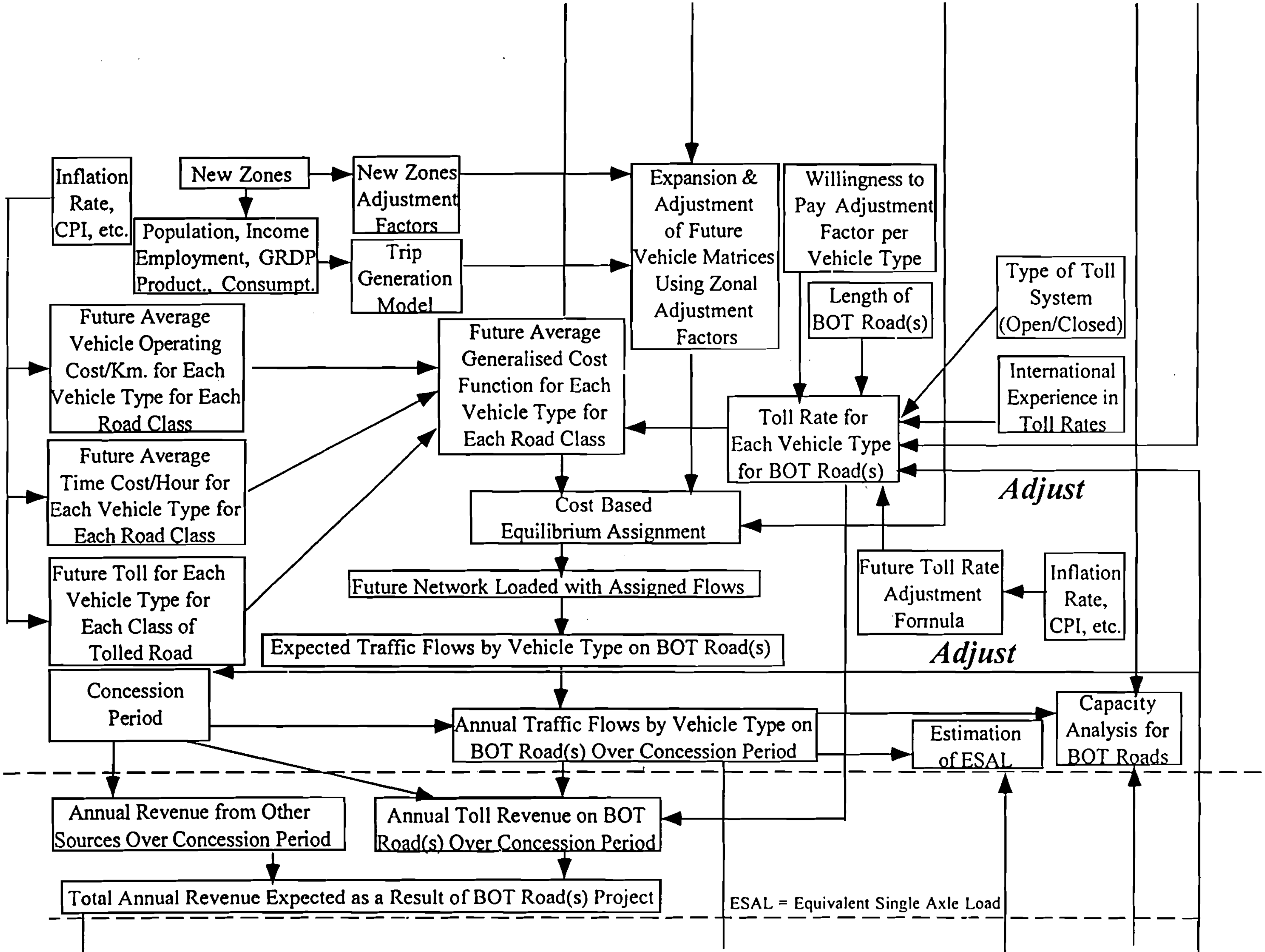


Figure 8: A System Approach For Conducting Assessment of the Financial Feasibility for a BOT Road Project (Continued):

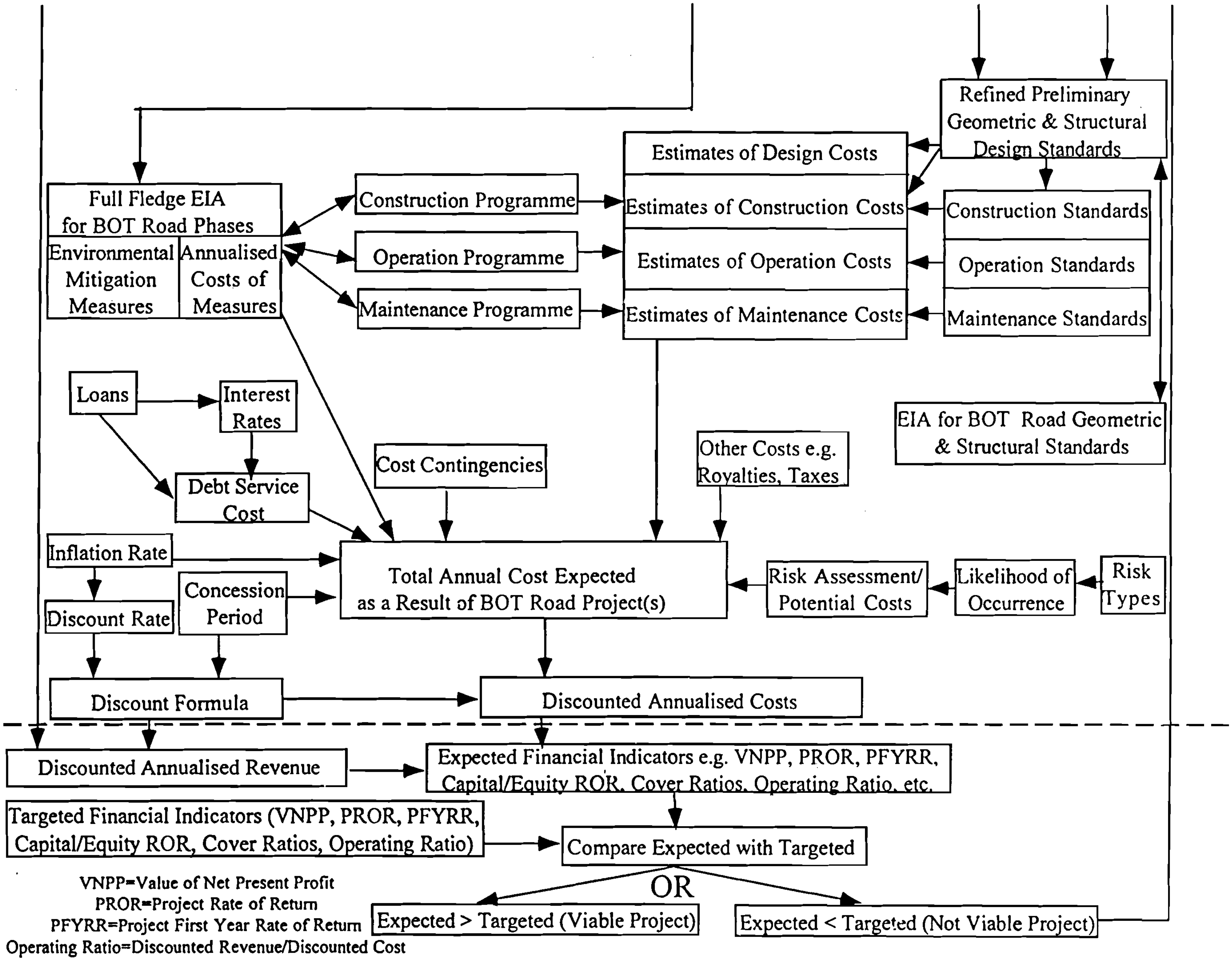


Figure 9: A System Approach For Conducting Assessment of the Financial Feasibility for a BOT Road Project

8.1. Define study area and establish boundaries

This is considered as a crucial initial step as it sets the scene as to the level of required work and detail. The study area should include all roads affecting and affected by the new BOT road project. It should include all land use zones being served by such a network. Boundaries of the study area could be either imaginary lines or actual physical boundaries such as rivers, mountains, sea, road, etc. It should take into account the already established administrative divisions and their boundaries.

8.2. Development of a base year zoning system

In order to correctly model the way trips are made throughout a study area, a zoning system should be developed, whereby the study area is divided into several internal representative divisions, known as internal traffic zones. These would mainly conform with already established administrative boundaries subject to modifications and adjustments to be tailored to the projects scope. In addition, a number of external zones are determined to represent the effect of areas outside the designated study area. These are considered as the main basic units used for simulating trip generation and attraction within a study area. The number of zones in a study area affects the data collection task as well as the estimation of components of the traffic model. Socio-economic and travel pattern data used to estimate trip generation models is collected for each of the considered traffic zones.

8.3. Classification of roads into representative types

In this step, the road network within the study area is thoroughly reviewed. Such a network should be classified either in accordance with already established classifications or being reclassified for the purpose of the study. Road classification is basically dependent on the existing geometric characteristics, level of access control, average travelling speeds, type of traffic, length of trips, functionality, ..etc. Typical American classifications include freeways, multilane and two lane highways, see HCM, 1995. Recently. the UK Department of Transport (DOT) provided a comprehensive classification and sub-classification of roads according to their functionality. The main DOT road classification are urban (6 sub-classifications), suburban (6 sub-classifications), and rural (9 sub-classifications) roads. Furthermore and in order to serve the objective of conducting the financial feasibility for a BOT road project, all tolled roads within the study area and even beyond should be identified and classified.

8.4. Classification of vehicles into representative types

This step is also concerned with the classification of vehicles, using the road network within the study area, into representative types. There are several basis for such classification, each depending on the objectives of the analysis. In the context of conducting a financial feasibility study for a tolled BOT road, vehicles ought to be classified in accordance with their carrying capacity and their potential impact on pavement deterioration (represented by Load Equivalency Factor/Vehicle Type). These two parameters are considered as the most significant in affecting the choice of appropriate toll rates as these assist in determining potential benefits that vehicles incur and damage that vehicles may cause. Typical generic classifications would include: passenger cars, buses, and several types of heavy goods vehicles

8.5. Determination of a Concession Period

In a BOT road project, the period over which the financial evaluation and hence the traffic forecasts are conducted, is expected to be equal to the concession period. In the UK, road schemes benefits and costs are assessed over a 30 year period from scheme opening. It is also common practice to consider the concession period for a BOT road scheme to be in the range of 30 years from initial year of opening to traffic. However, in the course of conducting the financial feasibility, this period can be adjusted in accordance with the results of the financial feasibility in terms of the expected extent of achievement of required rate of return on invested capital.

8.6. Collection of socio-economic data & conducting traffic and travel surveys

In order to develop and estimate trip generation and distribution models, the following data should be collected for each of the traffic zones in the study area.

- Socio-Economic Data: Collection of current socio-economic data, based on available information. In addition future socio-economic data should be either obtained or estimated depending on the economic status of the nation, the study area as a whole and alternative development scenarios. A typical set of socio-economic data include population, income, employment, Gross Regional Domestic Product (GRDP). production and consumption.

- Current trip patterns. These can be obtained by conducting Automatic Traffic Counts (ATC), Manual Classified Counts (MCC) and Origin/Destination O/D surveys. ATC are concerned with counting link volumes. MCC are concerned with classifying link flows into vehicle classification groups. O/D surveys are concerned with characterising trips in accordance with their pair of origin and destination, frequency, purpose, time, in addition to other factors affecting trip patterns. Traffic counts are carried out in order to assist in model calibration and validation against synthesized model flows. In addition, it provides data on the breakdown of traffic flows by vehicle type across the road network within the study area.

8.7. Development (Calibration) of trip generation/attraction models

Based on the above collection of; socio-economic data, traffic counts and travel surveys; trip generation models by type of vehicle can be developed. A trip generation model is meant to simulate the generation/attraction of zonal trips (i.e. number of trips generated from/attracted to a particular zone). Several methods exist for estimating trip generation/attraction models. These include, simple traffic growth rate models, elasticity models showing changes in travel demand with respect to changes in socio-economic parameters, regression models and category analysis based models. It is common practice to develop trip generation/attraction models using multiple regression formulation, where the number of trips originating/attracted is the dependent variable which varies with changes in the independent socio-economic variables such as population, employment, GRDP, ..etc. The number of points used to develop the regression model is equal to the number of internal and external zones representing the study area.

$$\text{Trips Generated}_{(i,\,VT)}^{(P)} = a_{(VT)}*\text{population}_{(i)}^{(P)} + b_{(VT)}*\text{GRDP}_{(i)}^{(P)} + \text{constant-G} \quad (1)$$

$$\text{Trips Attracted}_{(i,\,VT)}^{(P)} = c_{(VT)}*\text{employment}_{(i)}^{(P)} + d_{(VT)}*\text{working area}_{(i)}^{(P)} + \text{constant-A} \quad (2)$$

Where: $i = 1, ..Z$ (Number of Trip Generating Zones) $j = 1, ..Z$ (Number of Trip Attracting Zones)
a, b, ,c , d = calibration parameters showing the effect of each of the independent variables on the generation/attraction of trips. VT = Vehicle Type (1,.......NVT) P = Present Values
constant-G/-A= Constant values representing the unexplained part of the variation in trips generated/attracted

8.8. Development of appropriate speed/flow curves

A major component of describing a road network is to establish the capacity and speed/flow relationship representing the traffic conditions for each link constituting the network. If local studies exist that classified the national road network into different classifications as well as developed local speed/flow relationships for each road classification, these should be carefully examined and possibly adopted. However, in most developing countries, such studies either do not exist or are currently being undertaken. In such circumstances. speed/flow curves of the American Highway Capacity Manual (HCM), 1995 or those of the British Cost Benefit Appraisal Manual (COBA), 1991 can be adapted to suit local conditions. For each road classification and sub-classification, these manuals, through long research experience, provide representative speed/flow curves.

8.9. Estimation of base year (current) average Vehicle Operating Cost (VOC)

The estimation of VOC serves three purposes:

1. It constitutes one of the main components used in formulating the Generalized Cost Function (GCF). GCF is used to represent the deterrence factors faced by drivers in making their route choice decisions. The GCF is a necessary component of the assignment model used to simulate drivers' behavior.
2. It is used in the computation of economic benefits in terms of society savings in vehicle operation costs as a result of construction and operation of the proposed BOT road scheme.
3. It is used for computation of road users benefits in terms of savings in vehicle operation costs. This acts as a main input in assisting the concessionaire to determine potential toll rates covering such benefits and generating extra income.

Components of VOC can be categorised into two main categories, namely fixed and running costs, these are detailed in Table 1. Fixed costs are time dependent. On the other hand, running costs depend on: rates of consumption such as fuel consumption, or rates of wear and tear such as tyre wear and tear, or rates of utilisation such as battery utilisation. All these rates are kilometre based. Values of such rates vary in accordance with travel conditions on the different road classes. In particular these values are speed dependent. Several studies exist that show the variation of such rates with varying speed, see Claffey, 1971 for US experience and Watanatada et al, 1987 and Abaynayaka et al, 1976 for experience in developing countries. It is always recommended to conduct local studies to capture such variations, however this is not usually possible due to time and other resource constraints. In most cases, values from other studies are borrowed and adapted. For ease of computation, it is common practice to convert running costs into kilometre based costs.

Table 1: Generic Categorisation and Itemisation of VOC

Vehicle Operation Costs (VOC)	
Fixed costs	**Running costs**
Capital costs (depreciation)	Fuel costs
Long term interest costs	Oil costs
Overhead costs	Lubricant costs
Crew costs	Tyre costs, Battery costs
Licensing fees	Maintenance (spare parts costs)
Insurance fees	Maintenance (labor costs)

In case previous studies exist that estimated average VOC by type of vehicle, these values should be revised and updated/inflated to account for current and future conditions. In case no studies exist that have tackled VOC, a VOC estimation study ought to be initiated. The following is a representation of computation of VOC/Km taking into consideration variations in accordance with vehicle and road classifications.

$$VOC_{(VT,RT)}^{(P)} = \text{Fixed Costs}_{(VT)}^{(P)} + \text{Running Costs}_{(VT,RT)}^{(P)} \quad (3)$$

Where. RT = Road Type (1, ...NRT)

8.10 10: Estimation of base year average Value Of Time (VOT)

Time costs is an important component of travel cost. The derivation of a representative VOT for each vehicle type is a vital step that serves the following purposes:

1. It constitutes one of the main components used in formulating the GCF. GCF is used to represent the deterrence factors faced by drivers in making their route choice decisions. The GCF is a necessary component of the assignment model used to simulate drivers' behavior.
2. It is used in the computation of economic benefits in terms of society savings in time costs as a result of construction and operation of the proposed BOT road scheme.
3. It is used for computation of road users benefits in terms of savings in time costs. This acts as a main input in assisting the concessionaire to determine potential toll rates covering such benefits and generating extra income.

In case previous studies exist that estimated VOT by type of vehicle, these values should be revised and updated/inflated to account for current and future conditions. In case no studies exist that have tackled VOT, a VOT estimation study ought to be initiated. In developing countries, little research has been carried out to derive VOT. It is common to base estimates on research undertaken in developed countries. The conventional approach used depends upon whether time savings are expected to result in increased production or increased leisure time. Time savings are, therefore, normally divided into working time savings and non-working time savings.

Working VOT

If an individual saves travel time in the course of working activities, it is assumed that this time saving will be translated into increased output. The valuation of the travel time savings is, therefore, determined by the marginal cost of employing the individual, as it is assumed that the marginal output and cost are equal. Average wage rates for different groups of road users can be estimated on the basis of the average monthly income per household and the average number of employed persons per household. Monthly incomes can then be converted to effective hourly wage rates by assuming that wages form the most significant component of income.

Non-Working VOT

The value of non-working time, which includes travel time to and from work, is usually determined on the basis of empirical studies of the willingness of individuals to pay for such savings. These studies attempt to determine the effective price that people are prepared to pay for saving time, and the results of most studies have indicated values of non-working time savings between 25-35% of the individual's wage.

In addition, time savings by type of freight commodity transported should be also investigated. It is also important to determine the average occupancy by type of passenger per passenger vehicle as well as the average load by type of commodity per Heavy Goods Vehicle (HGV) on each road and for each type of passenger and freight vehicles. The following is a representation of VOT computation for a passenger type vehicle and a freight type vehicle.

$$VOT_{(PV,R)}^{(P)} = (ANPW_{(PV,R)} * WVOT^{(P)}) + (ANPNW_{(PV,R)} * NWVOT^{(P)}) \quad (4)$$

Where: PV = Passenger Vehicle by type (1,....... NPV) R = Road
ANPW = Average Number of Passengers in a Working Trip
ANPNW = Average Number of Passengers in a Non-Working Trip
WVOT = Working Trip Value of Time NWVOT = Non-Working Trip Value of Time

$$VOT_{(FV,R)}^{(P)} = (ANPW_{(FV,R)} * WVOT^{(P)}) + (AFT_{(FV,R)} * FVOT_{(CO)}^{(P)}) \quad (5)$$

Where: FV = Freight Vehicle by type (1, ..., NFV)
AFT = Average Freight Tonnage FVOT = Freight Value of Time
CO = Commodity Type (1, ..., NCO)

8.11. Estimation of base year average GCF

The GCF is used to simulate the deterrence factor faced by drivers in making their route choice decisions. It is necessary for running the traffic assignment model and predicting the extent of traffic expected to use the various routes constituting the road network. The average GCF per vehicle type on a particular road link is computed as the summation of the average VOC multiplied by the travelled distance, average VOT multiplied by travel time, and average toll rate (if applicable i.e. road is tolled) of this vehicle type. In order to obtain such values two types of surveys ought to be conducted for components of the road network, namely trip distance and trip time surveys. The following is a representation of GCF computation for each link on the road network taking into consideration variations in accordance with vehicle and road classifications.

$$GCF_{(VT,R)}^{(P)} = VOC_{(VT,RT)}^{(P)} * TD_{(R)} + VOT_{(VT,R)}^{(P)} * TT_{(VT,R)} + [\text{Toll Rate}_{(VT,R)}^{(P)} \text{ if applicable}] \quad (6)$$

Where: TD = Trip Distance in Kilometres TT = Trip Time in Hours

8.12 12: Estimation of base year average network toll rate

The derivation of a representative average network toll rate is a vital step that serves the following purposes:

- It is used as a guide and basis for the determination of toll rates for the BOT road project.
- It constitutes one of the main components used in formulating the GCF. GCF is used to represent the deterrence factors faced by drivers in making their route choice decisions. The GCF is a necessary component of the assignment model used to simulate drivers' behavior.
- The toll rate can act as a representative bench mark to simulate the sensitivity of travel behaviour and toll revenue as a result of changes in this basic toll rate.
- The toll rate is used in the financial analysis to arrive at the expected toll revenue that would be generated as a result of tolling the proposed BOT road.
- The toll rate can be used in the economic analysis to represent a component of the costs that society might incur in case a private concessionaire is a foreign entrepreneur who is expected to transfer his toll revenues abroad.

The following represents a two step procedure used to derive initial representative toll rates for each type of vehicle.
First: Existing toll roads are reviewed, whereby toll rates per journeys of different lengths for different types of vehicles are obtained.
Second: Average toll rates per kilometer are computed for each journey for every vehicle type.

The following is a representation of computation of average network based toll rate per kilometre by type of vehicle.

$$NBTR_{(VT)}^{(P)} = \left(\sum_{(TR=1)}^{(TR=NTR)} \text{Toll Rate}_{(TR,\,VT)}^{(P)} \,/\, \text{Length of Toll Road}_{(TR)}\right) / NTR \qquad (7)$$

Where: NBTR = Network Based Toll Rate   TR = Toll Roads Considered (TR = 1,.....NTR)

8.13. Building of base year road network

A representation of the existing road network should be developed. To facilitate this step, the network is usually coded into nodes and links. Information for each link include link coordinates, distance, class, appropriate speed/flow curve and generalised cost function. On the other hand, a node is used in network description to represent either a change in link alignment or an intersection. A node is positioned in the network with X & Y coordinates depicting the relative location of each node.

8.14. Development of base year 24 hour O/D matrices

This stage is concerned with developing squarised 24 hour O/D matrices that represent the current main directional Annual Average Daily Traffic (AADT) by vehicle type within the study area. In building such matrices, one should first determine the size and the exact names of trip origins/destinations. The size is a squarised matrix equal to the number of internal and external zones constituting the study area. In order to obtain complete base year O/D matrices, several methods can be followed, namely:

1. Collection of O/D data for each zonal pair
2. In some cases, financial, human and time resources could be limited to conduct a complete set of O/D surveys. In such cases, synthetic gravity models can be used to estimate trips for each cell in the matrix without using observed trip patterns. Such models rely on having a good matrix representation of Generalised Cost (GC), in addition to observed trip ends. The classical representation of a gravity model can take the following form, see Ortuzar and Willumsen, 1996:

$$T_{(ij)}^{(P)} = A_{(i)}^{(P)} O_{(i)}^{(P)} B_{(j)}^{(P)} D_{(j)}^{(P)} f(GC_{(ij)}^{(P)}) \qquad (8)$$

Where: $T_{(ij)}$ = Number of trips generated from zone (i) and attracted to zone (j)
$A_{(i)}$ = proportionality factor for origin trip end $O_{(i)}$ = Origin trip end
$B_{(j)}$ = proportionally factor for destination trip end $D_{(j)}$ = Destination trip end
$GC_{(ij)}$ = Generalised Cost of travel from zone (i) to zone (j)
$f(GC_{(ij)})$ = a function of generalised cost with parameters for calibration, where there are three classical forms, namely: Exponential function: $f(GC_{(ij)}) = \exp(-\beta GC_{(ij)})$ or
Power function: $f(GC_{(ij)}) = (GC_{(ij)})^{-n}$ or Combined function: $f(GC_{(ij)}) = (GC_{(ij)})^{-n} \exp(-\beta GC_{(ij)})$ (9)

3. In other cases, O/D surveys are conducted, however, due to survey cost constraints, partially filled matrices are constructed. These can be completed using old matrices (if available) which could be updated, and synethesising the incomplete cells of the matrices using a form of gravity models.
4. In case no (or a few) O/D surveys are carried out, a widely used technique, known as matrix estimation from traffic counts can be utilised to construct O/D matrices, see Willumsen ,1978 for a through review of this technique. This is based on identifying paths followed by the trips from each origin to each destination. This is followed by conducting ATC and MCC to obtain current traffic movements by type of vehicle between study zones. Such technique can be mathematically represented as follows:

$F_{(L)}^{(P)} = \sum_{ij} T_{(ij)}^{(P)} Prop_{(ij)}^{L(P)}$ $0 \leq P_{(ij)}^{L} \leq 1$ (10)

Where: $F_{(L)}$ = Traffic Flows in a particular Link L = Link

$T_{(ij)}$ = Number of trips generated from zone (i) and attracted to zone (j)

$Prop_{(ij)}^{L}$ = proportion of trips travelling from zone (i) to zone (j) using link (L)

To estimate missing parts of a trip matrix, four main inputs are required:

- An unloaded road network
- An initial O/D matrix. The initial O/D matrix used in this stage can be an empty or a partially filled matrix with the missing cells set at unity
- Observed/Recorded traffic counts
- Trip end constraints

The maximum number of unknown O/D pairs is equal Z^2 where Z is the number of traffic zones. The proportion of trips travelling a particular link can be obtained using a form of trip assignment techniques. Given such proportions and observed traffic counts, there will be a number of simultaneous linear equations equal to L, where L is the number of link traffic counts. In practice, where the number of equations are less than the unknowns, a number of constraints can be imposed through trip ends so as to obtain a feasible solution.

8.15. Application of an assignment model to assign current O/D matrices as flows onto current road network

The basic objective of an assignment techniques is to assign current O/D pairs within the 24 hour matrices and load these as flows onto current unloaded road networks, thus producing a road network loaded with current traffic flows. The choice and application of appropriate assignment models is vitally important. Several methods exist and can be classified in accordance with their consideration of congestion and stochasticity effects. At one end, the simplest of these models is the All-or-nothing assignment, while at the other end the most sophisticated is the stochastic user equilibrium assignment. For the BOT road projects, being tolled roads in a rural relatively uncongested areas and networks, a pure stochastic cost based assignment method seems appropriate. Such methods are sometimes referred to as simulation based methods. They use Monte Carlo simulation to represent the variability in drivers' perception to link costs, see Burrell, 1968. This assignment technique assumes that a driver route choice is based on his/her perception and trade off of a generalized cost function over all alternative possible routes.

8.16. Validation of traffic model

As stated, base year 24 hour O/D matrices are initially assigned to the network using cost-based equilibrium assignment. Several runs are performed on the computer. For each computer run the assigned (estimated) flows are compared against the observed traffic counts. This process is known as traffic model validation. It should be noted that an intensification of traffic counting stations is contemplated specifically on competitive and surrounding routes to the intended BOT road project. If the comparison shows a low tolerable discrepancy, then the already calibrated O/D matrices representing current traffic flow patterns can be further utilised. On the other hand, if the comparison shows a high unacceptable discrepancy, this can be attributed either to errors in network representation or to inaccuracies in calibrated matrices.

8.17. Validation of base year network

All efforts are undertaken to correct any errors or inaccuracies in network representation. Locations of high discrepancies in the network are determined, the network is checked for any logical errors, and a better network representation is attempted. This process is known as network validation. Once the network is validated, assignment re-runs are undertaken to re-assign the calibrated matrices onto the newly validated network. Once more, a comparison of assigned flows versus observed flows is conducted. If still a high discrepancy exists, it is probable to deduce that these discrepancies can be attributed to inaccuracies in developed matrices.

8.18. Re-estimation of base year matrices from traffic counts

Using matrix estimation techniques, attempts are made to modify O/D pairs in accordance with actual traffic volumes, specially those traffic counts taken in the vicinity of the location of the intended BOT road project. Sometimes, it might be necessary to support this step with more traffic and travel surveys. Runs are reiterated until a satisfactory matching between estimated and observed flows is reached i.e. an acceptable root mean square error.

8.19. Corridor analysis of new BOT road projects

An initial step in the construction of a road is to make site investigations and consider a corridors location envelope that is meant to link trip origins and destinations and generally satisfy desire traffic lines. Within such an envelope, several alternative corridors can be identified. These are further investigated in accordance with a set of corridor analysis criteria such as, minimisation of excavation works, gradients and curves, not to cross flooding lines, not to pass through important man made or natural environments, etc.

8.20. EIA of alternative corridors

The previous corridor analysis should be supported by conducting an EIA of alternative corridors. Such assessment would judge the environmental feasibility of alternative corridors with reference to their effects on components of baseline environmental contexts including physical, biological, ecological, cultural, social, and man made environments, etc. Based on conventional corridor analysis procedure as well as on conducted EIA, a final selection is made of preferred corridor.

8.21. Determining preliminary geometric and structural standards

In accordance with the RFP, preliminary geometric and structural specifications are outlined. These would probably include specifications relating to road class, cross-section, alignment, design speed, pavement type, etc. These ought to be considered as an input until further analysis is conducted and such specifications are accordingly refined.

8.22. Building of future road network

In this stage, a representation of the future road network is developed. This is mainly done by updating the base year validated network through the addition of nodes and links representing :

- already committed and planned future road projects, as well as
- the considered BOT road projects.

The development of the future road network is meant to provide a representation of expected capacities and levels of service that the future road network can accommodate. Ultimately, this step would result into the formation of unloaded future road network within the study area.

8.23. Forecast of future trip ends

In this step, a forecast of future trip ends is undertaken. Four types of traffic should be thought of, namely:

- Normal traffic which is expected to use the existing road network regardless of the construction of new BOT road projects.
- Generated traffic which is expected to be generated as a result of new developments and provision of new and improved accessibility options.
- Diverted traffic which is traffic reassigned from parallel roads and attracted to new BOT road projects as a result of better levels of service offered by BOT roads.
- Released traffic which was suppressed due to unfavourable travelling conditions being improved by the implementation of the new BOT road project

Forecast of future trip ends can either rely on a simple technique such as growth rate modelling, where future trips attracted to or generated from a particular zone is a product of current trips attracted to or generated from that zone multiplied by a growth rate. This growth rate is estimated as representing the future values of factors affecting the zonal trip making patterns such as population, income, car owner ship as related to their present values. The general form of such trip generation/attraction models can be represented as follows:

$T_{(i)}^F = GR_{(i)}T_{(i)}^P$ (11) $T_{(j)}^F = GR_{(j)}T_{(j)}^P$ (12)

Where: $T_{(i)}^F$, $T_{(j)}^F$ = Number of Future Trips generated from zone (i)/attracted to zone (j)

$T_{(i)}^P$, $T_{(j)}^P$ = Number of Present Trips generated from zone (I)/ attracted to zone (j)

$GR_{(i)}$, $GR_{(j)}$ = Growth Rate in factors affecting generation of trips from zone (i) / attraction of trips to zone (j) - these can take any of the following forms:

$GR_{(i)} = Pop_{(i)}^{(F)} / Pop_{(i)}^{(P)}$ or $GR_{(i)} = Inc_{(i)}^{(F)} / Inc_{(i)}^{(P)}$ or $GR_{(i)} = CarO_{(i)}^{(F)} / CarO_{(i)}^{(P)}$ or

$GR_{(i)} = Pop_{(i)}^{(F)} * Inc_{(i)}^{(F)} * CarO_{(i)}^{(F)} / Pop_{(i)}^{(P)} * Inc_{(i)}^{(P)} * CarO_{(i)}^{(P)}$ (13)

Where: $Pop_{(i)}^{(F)}$ = Future Expected Population in Zone (i) $Pop_{(i)}^{(P)}$ = Present Population in Zone (i)

$Inc_{(i)}^{(F)}$ = Future Expected Income in Zone (i) $Inc_{(i)}^{(P)}$ = Present Income in Zone (i)

$CarO_{(i)}^{(F)}$ = Future Expected CarOwnership in Zone (i) $CarO_{(i)}^{(P)}$ = Present CarOwnership in Zone (i)

Alternatively, the calibrated trip generation/attraction regression based models can be utilised. These models are provided with expected values for future socio-economic parameters for each study zone, and future values of trip ends are then computed. The mathematical representation of such equations can take the following form:

$Trips\ Generated_{(i,\ VT)}^{(F)} = a_{(VT)}*population_{(i)}^{(F)} + b_{(VT)}*GRDP_{(i)}^{(F)} + constant\text{-}G$ (14)

$Trips\ Attracted_{(j,\ VT)}^{(F)} = c_{(VT)}*employment_{(j)}^{(F)} + d_{(VT)}*working\ area_{(j)}^{(F)} + constant\text{-}A$ (15)

8.24. Forecast/Estimation of future O/D matrices

Forecasts of future expected interzonal trips is vital as these are meant to represent the demand expected to utilize the road network whether as it stands at its present condition (normal growth) or whether with the construction of the intended BOT road project as well as other committed projects (generated, diverted and released demand). Short (5 years), medium (10-15 years) and long (15 -30 years) range high (optimistic) and low (pessimistic) traffic forecast scenarios can be developed.

A simplistic approach is to develop such scenarios based upon growth factors taking into account the future development in socio-economic parameters such as population, employment, GRDP, etc. Future matrices can be then produced each representing the expected trips at the final year of the particular scenario. These matrices are obtained by multiplying all cells in the base year (current) matrices by the respective growth factors for each of the scenarios. The formulation of such computation is represented below.

$T_{(ij)}^F = GF * T_{(ij)}^P$ (16)

Where: $T_{(ij)}^F$ = Number of future trips generated from zone (i) and attracted to zone (j)

$T_{(ij)}^P$ = Number of present trips generated from zone (i) and attracted to zone (j)

GF = Growth factor reflecting future development in socio-economic parameters

Alternatively, and more accurately is to develop and utilise growth factor trip distribution models. Such models basically rely on computing growth factors relating the future trip ends resulting from forecasts of trip generation models to current trip ends. Cells in the present base year matrices are then multiplied by appropriate factors and the future trip matrices are produced. Four growth factor methods are available, namely: constant factor method, average factor method, Fratar method, see Fratar, 1954, and Furness method, see Furness, 1965. All of these methods are based on iterative application until a convergence is reached between forecasted trip ends and estimated trip ends of the projected matrices. Mathematically, these are represented as follows:

$T_{(ij)}^{F} = T_{(ij)}^{P} * GF$ Constant Factor Model (17)

$GF = \Sigma_{ij} T_{(ij)}^{F} / \Sigma_{ij} T_{(ij)}^{P}$ (18)

Where: $\Sigma_{ij} T_{(ij)}^{F}$ = Total future traffic flows generated from origins 1 to i and attracted to destinations 1 to j

$\Sigma_{ij} T_{(ij)}^{P}$ = Total base year traffic flows generated from origins 1 to i and attracted to destinations 1 to j

$T_{(ij)}^{F} = T_{(ij)}^{P} * [(GF_{(i)} + GF_{(j)})/2]$ Average Factor Model (19)

$GF_{(i)} = GT_{(i)}^{F} / GT_{(i)}^{P} \quad GF_{(j)} = AT_{(j)}^{F} / AT_{(j)}^{P}$ (20)

$GT_{(i)}^{F}$ = Future number of trips expected to be generated from zone (i)

$GT_{(i)}^{P}$ = Present number of trips generated from zone (i)

$AT_{(j)}^{F}$ = Future number of trips expected to be attracted to zone (j)

$AT_{(j)}^{P}$ = Present number of trips attracted to zone (j)

$T_{(ij)}^{F} = T_{(ij)}^{P} * GF_{(i)} * GF_{(j)} * [\Sigma^{N} t_{iN} / \Sigma^{N} (AT_{(j)}^{F} / AT_{(j)}^{P}) * t_{iN}]$ Fratar Model (21)

$[\Sigma^{N} t_{iN} / \Sigma^{N} (AT_{(j)}^{F} / AT_{(j)}^{P}) * t_{iN}]$ = balancing/normalising factor

N = Total number of traffic zones

$T_{(ij)}^{F} = T_{(ij)}^{P} * GF_{(i)} * GF_{(j)} * BF_{(i)} * BF_{(j)}$ Furness Model (22)

$BF_{(i)}$ = Balancing/normalising factor dependent on generated trip ends applied through iterations

$BF_{(j)}$ = Balancing/normalising factor dependent on attracted trip ends applied through iterations

Another important alternative for the estimation of future O/D matrices is to use synthetic gravity models. As previously stated, this method rely on:

- having a good matrix representation of future GC which requires forecasting components of GC based on present base year GC and including initial and adjusted toll costs of proposed BOT road projects, in addition to
- having forecasted trip ends.

It can be mathematically represented as follows:

$$T_{(ij)}^{(F)} = A_{(i)}^{(F)} O_{(i)}^{(F)} B_{(j)}^{(F)} D_{(j)}^{(F)} f(GC_{(ij)}^{(F)}) \quad (23)$$

8.25. Adjustment of future vehicle matrices to account for new or inadequately represented areas

This step is only carried out in case where considered BOT road projects are passing through newly developed areas or areas which are not adequately represented in the current zoning system. In this case, an expansion of the zoning system is warranted. A specific trip generation model is developed to represent the expected trip patterns in relation to the expected socio-economic characteristics such as population, employment and GRDP of these new areas. The expansion of the zoning system is reflected in the size of the O/D matrices. In addition, certain cells in the already estimated future matrices would be adjusted using adjustment factors that are meant to reflect the share of the newly added zones in the trip patterns of these O/D cells.

8.26. Estimation of toll rates for considered BOT roads

The estimation of toll rates to be applied for the considered BOT road projects is a difficult task. If this matter is not handled with care, it could lead to financial losses for the concessionaire. This could be attributed either due to toll rates being set lower than those rates reflecting the ability and willingness to pay of potential road users or to high toll rates causing the reassignment of drivers to alternative routes. In all cases, the objective is to achieve an optimum or semi-optimum toll rates that eventually lead to acceptable rates of return.

In deciding the accepted toll rates, several factors have to be taken into consideration. A good start is to adapt the computed representative average network toll rates. These rates could be adjusted taking into consideration:

- studies using methods such as stated preference techniques to determine the willingness to pay tolls of potential BOT road users so as to save journey time, VOC and enjoy ingredients of better riding quality and levels of service.
- type of toll system operation i.e. flat rates for open toll collection system and vehicle kilometer based rates for closed toll collection systems

- review of international toll rates of similar road standards
- the concessionaire perception of toll rates
- the results of the financial feasibility in terms of the expected extent of achievement of required rate of return on invested capital.

8.27. Adjustment of toll rates

An index needs to be established as a basis to adjust toll rates in the future so as to be in line and harmony with expected future changes. Several indexes can be used such as inflation rates, Gross Domestic Product Changes, construction, land and Consumer Prices Indexes denoted (CPI), .. etc. CPI is thought to be more appropriate to use than other indexes, as it reflects in a better way the ability of the potential road users to pay, and at the same time the changes in the cost of maintenance and operation. It is proposed to adjust toll rates on an annual basis. The proposed toll indexation formula can take the following form:

$$\text{Toll Rate}_{(VT)}^{(F)} = \text{Toll Rate}_{(VT)}^{(P)} * (CPI^{(F)} / CPI^{(P)}) \qquad (24)$$

8.28. Estimation of expected future GCF

The expected future GCF is used to simulate the future deterrence factor faced by drivers in making their route choice decisions. It is necessary for running the traffic assignment model and predicting the extent of traffic expected to use the various routes constituting the road network. Taking into account the effect of changes in inflation rates and CPI, current VOC and VOT can be updated to reflect expected future scenarios. The expected future GCF per vehicle type on a particular road link is then computed as the summation of the adjusted VOC multiplied by the travelled distance, adjusted VOT multiplied by travel time, and adjusted future toll rate (if applicable i.e. road is tolled) of this vehicle type. The following is a representation of future GCF computation for each link on the road network taking into consideration variations in accordance with vehicle and road classifications.

$$GCF_{(VT,R)}^{(F)} = VOC_{(VT,RT)}^{(F)} * TD_{(R)} + VOT_{(VT,R)}^{(F)} * TT_{(VT,R)} + [\text{Toll Rate}_{(VT,R)}^{(F)} \text{ if applicable}] \qquad (25)$$

8.29. Application of an assignment model to assign future O/D matrices as flows onto future road network

Using proper traffic assignment techniques, future O/D matrices would be assigned onto the developed representation of future road network. As stated earlier, for the BOT road projects, being tolled roads in a rural relatively uncongested areas and networks, a pure stochastic cost based assignment method seems appropriate. This assignment technique assumes that a driver route choice is based on his/her perception and trade off of the estimated future GCF over all alternative possible routes.

In order to model the effects of possible congestion that will develop during the later forecast years, a capacity-restraint equilibrium assignment can be used, see Wardrop, 1952. Such assignment techniques assume that a driver route choice is based on his/her perception and trade off of congestion costs mainly represented by the cost of in vehicle time. The development of proper speed - flow curves for each link is crucial for the utilisation of these methods.

As a result of this step future demand would be loaded as traffic flows on the expected future network. Traffic flows by vehicle type for each considered BOT road would be identified. For each year of the evaluation period (concession period), annual traffic flows using the BOT roads would be forecasted or estimated using ratio and proportional between future and present matrices.

8.30. Capacity analysis for BOT roads
A capacity analysis need to be conducted so as to evaluate and demonstrate the expected levels of service on the BOT road projects. Such analysis comprises several steps which differ in accordance with the road type and classification. Several countries have standards and procedures for conducting such analysis. These standards and procedures are results of many years of research concerning the relation between geometric and traffic conditions, see for example HCM, 1995.

It would be expected that BOT roads would be classed as freeways or highways. In both cases, capacity of the road is determined in accordance with its geometric features, such as number of lanes, lane, shoulder and median widths, slopes, gradients, access control, etc. Such information would have been already specified in accordance with RFP. In addition, knowledge of traffic composition i.e. percentages of different types of heavy vehicles is crucial for the computation of capacity. Traffic composition is based on conducted assignment runs. The computed capacity is meant to be used as a reference to determine the degree of utilisation of the road by the forecasted traffic flows. In accordance with HCM, five levels of services are included spanning from A to F. Levels A and B are considered extremely acceptable, while most of the roads run at level C. Starting from level D, intervention measures have to be considered. For BOT roads, accepted LOS are expected to be specified by the sponsoring agency. If during the appraisal stages, it was found that the selected geometric standards are not sufficient, these should be upgraded so that the consequent costs can be estimated.

8.31. Estimation of ESAL
In order to conduct the structural design of the pavement in terms of number, thickness and material composition of road layers, it is crucial to determine the expected ESAL over the appraisal (concession) period. An important input to ESAL computation is the forecasts of future traffic by type of vehicle. Actually, it is the HGV that cause most of the expected road deterioration that pavements have to endure. Other important considerations in the computation of ESAL, some of which might have been specified in the RFP, include:
- Type of pavement (Flexible, Rigid, Composite)
- Assumed Terminal Serviceability
- Assumed structural number in case of flexible pavement or slab thickness in case of rigid pavement
- Axle Configuration by type of vehicle
- Axle load by type of vehicle

8.32. Estimation of toll revenue
For each year of the evaluation (concession) period, toll revenues are estimated. These are computed as the summation of the toll revenues collected for each type of vehicle on a particular BOT road. Toll revenues are computed as the multiplication of traffic flows for each type of vehicle by the respective toll rate (determined in accordance with type of vehicle and adjusted to account for time effect). Such computation can be mathematically represented as follows:

$$TRev_{(R)}^{(F)} = AADT_{(VT,R)}^{(F)} * 365 * \text{Toll Rate}_{(VT,R)}^{(F)} \quad (26)$$

where: TRev = Toll Revenue at a particular point of time in the future (F)
AADT = Annual Average Daily Traffic (Forecasted)
365 = Number of Days within a year

8.33. Estimation of other sources of revenue
Several other sources of revenue can be obtained by the concessionaire. These include:
- publicity and advertisement rates along the road
- fees collected for services provided along the road such as petrol stations, rest houses, hotels and motels, etc.
- other non traditional sources

For each year of the evaluation (concession) period, such sources of revenue are estimated.

8.34. Estimation of total revenue

For each year of the evaluation period (concession period), total revenues are estimated. These are computed as the summation of toll revenues and other sources of revenue. Such computation can be mathematically represented as follows:

$TotRev_{(R)}^{(F)} = TRev_{(R)}^{(F)} + ORS_{(R)}^{(F)}$	(27)
where: TotRev = Total Revenue at a particular point of time in the future (F)	
OSR = Other Sources of Revenue	

8.35. Refinement of preliminary geometric and structural design standards

In accordance with outcomes of the capacity analysis and estimation of ESAL, fine tuning and refinement of preliminary geometric and structural standards is undertaken.

8.36. EIA of preliminary geometric and structural standards

Another EIA ought to be carried out to assess the environmental consequences of refined geometric and structural standards. Such EIA would judge the environmental feasibility of such standards in relation to other standards. Based on; capacity analysis, ESAL computation and conducted EIA; a final refinement is made of preliminary geometric and structural design standards.

8.37. Construction, operation and maintenance standards

All construction, operation and maintenance components of the BOT road project ought to be designed in accordance with standards, specifications, guidelines and practices set in the RFP or known to be approved by the sponsoring authority. Examples of international standards that can be followed include AASHTO, ASTM, etc.

8.38. Construction, operation and maintenance plans (programs)

In this step, plans and programs should be devised to address issues such as:

- detailed time schedule of all construction stages and considered maintenance types indicating start and completion date of each activity
- proposed methods for undertaking construction, maintenance in terms of mobilisation, location of contractors' yards, construction crew allotments, fabrication yards, equipment and material supply depots, equipment fleet, quarries, etc.
- traffic management issues at construction and maintenance sites
- quality assurance procedures
- toll facilities and equipment
- methods for toll collection and enforcement
- etc.

8.39. Full fledged EIA of BOT road phases

A full fledged EIA ought to be carried out to assess the environmental feasibility of BOT generic road phases. These include preconstruction (mobilisation), construction, operation and maintenance phases. For each of these phases, generic activities are identified. In addition a baseline context is drawn of all generic components constituting the natural and man made environments. Following this an EIA procedure is carried out, see Sadler, 1996 for the state of the art EIA procedure and see ECMT, 1998 for the state of the art review of EIA in the transport sector. The objective of this EIA is to assess the magnitude and significance of impacts of these activities on components of the environment. This is followed by identifying the most significant impacts, and analysing these with the objective of suggesting a set of mitigation measures to relieve the impacts of these activities. The costs of these measures is then estimated and included in the costing exercise of the BOT road project.

8.40. Estimation of costs expected as a result of BOT road project

The cost of a road scheme consists mainly of both the total initial capital design and construction costs and the subsequent maintenance and operation costs, etc.

Consultancy & Design costs

These are costs incurred as a result of hiring reputable consultants to conduct various different studies, i.e. legal, technical, traffic, environmental, financial, etc. leading to the consultants final design of components and details of road construction, maintenance and operation. "Preliminary design and feasibility are often simultaneous, but detailed design which can be very costly usually follows commitment to the project", TRRL, 1988.

Construction Costs

Construction costs used in the financial assessment of roads are normally derived using item rates from comparable schemes previously quoted by contractors. It is usually necessary for original estimates to be updated at different stages in the scheme development. The construction costs need also to be allocated to each year during which construction takes place. This period is known as the years before opening the road to traffic, where only capital construction costs are encountered and no revenues are materialized.

Maintenance Costs

Maintenance costs are normally regarded as a stream of costs arising in each year of the assessment (concession) period, in addition to bulky expenditures incurred at infrequent intervals. Maintenance costs can be divided into two broad categories i.e. non-traffic related costs and traffic related costs. Non traffic related costs (referred to as routine maintenance) comprise expenditures which are not mainly due to traffic such as maintenance of safety barriers and fences, remedial earthworks, road sweeping and gully emptying, traffic signals and signs, road lighting, roadstuds and markings. These maintenance costs are generally described as an annual cost per unit length of road or as an annual percentage of construction costs.

The traffic related costs comprise maintenance expenditures that result from traffic flows. Typical examples of this type of cost are: overlay strengthening of the road structure; surface treatment, resealing of joints, resurfacing of hard shoulders, local patching, etc. These maintenance activities can be generally grouped under the heading periodic maintenance. Periodic maintenance costs can be computed either as a cost per unit length of road or as a periodic percentage of construction costs. These are considered as periodic interventions to prevent the road from further deterioration to fair or poor condition and bring the road status back to good condition. Another traffic related maintenance type is known as rehabilitation/overhaul. This is also applied at long time intervals. These are meant to prevent the road from further deterioration to poor condition and to bring the road status back to fair or good condition.

A detailed itemization of expected BOT road related costs allocated, in generic matrix format, into the key stakeholders interacting in a BOT road project is presented in Table 2.

For each of these costs, appropriate contingency factors ought to be applied to represent contingency allowances that are adequate to cover unexpected cost escalation. Taking into consideration such contingency factors as well as appropriate inflation rates to account for differential price changes across time, these costs are annualised over the assessment (concession) period. Finally, such annualised costs are summed together. The mathematical representation of such computation is detailed below.

$$TotCos_{(R)}^{(F)} = \sum_{(C=1)}^{(c=N)} [C_{(R)}^{(F)} * CCF_{(C,R)}^{(F)} * IR_{(C)}^{(F)}] \quad (28)$$

Where: TotCos = Total Annualised Cost for a particular road (R)
C = Specific Type of Cost
N = Number of Specific Costs Considered
CCF = Specific Cost Contingency Factors
IR = Inflation rate

Table 2: A Generic Cost Allocation Matrix for a BOT Road Project

Main Stakeholders Itemisation of Costs	Government	Sponsor	Concessionaire	Financier	Users
Building Public Support	(*)				
Conceptual Studies		(*)			
Legal Studies		(*)	(*)	(*)	
Technical Studies		(*)	(*)	(*)	
Environmental Studies		(*)	(*)	(*)	
Financial Feasibility Studies		(*)	(*)	(*)	
Economic Feasibility Studies		(*)			
Prequalification Process		(*)	(*)		
Request for Proposals		(*)	(*)		
Bidding			(*)		
Selection Procedure		(*)			
Loan Request Procedure			(*)		
Loan Approval Procedure			(*)	(*)	
Right of Way Land Acquisition		(*)	(*)		
Environmental Approval Procedure	(*)		(*)		
Design			(*)		
Construction			(*)		
Operation			(*)		
Environmental Mitigation			(*)		
Environmental Monitoring	(*)				
Maintenance			(*)		
Regulation		(*)			
Tolls					(*)
Cost of Capital (Debt service cost)			(*)		
Other costs (royalties, taxes, etc.)			(*)		
Handover		(*)	(*)		

(*) = Party Incurring Cost

8.41. Risk assessment and estimation of costs of potential risks

In this step different risk types related to the BOT road project are identified. Generally risks related to BOT road projects can be categorised into political, financial, construction, operation, commercial, see OECD, 1987. A detailed itemization of expected risks allocated, in a generic matrix format, into the key stakeholders interacting in a BOT road project is presented in Table 3. For each of the risks incurred by the concessionaire, the potential likelihood and timing of occurrence is estimated. This is followed by estimation of expected costs in case of occurrence. The following is a mathematical representation of computation of risk costs

$$TotRC_{(R)}^{(F)} = \sum_{(Risk=1)}^{(Risk=N)} LOR_{(R,\,Risk)}^{(F)} * RC_{(R,\,Risk)}^{(F)} \qquad (29)$$

Where: TotRC = Total Risk Costs Risk = Specific Type of Risk
N = Number of Specific Risks Considered
LOR = Likelihood of Occurrence of Risk
RC = Risk Cost

Table 3: A Generic Risk Allocation Matrix for a BOT Road Project

Main Stakeholders / Itemisation of Risks	Government	Sponsor	Concessionaire	Financiers	Users
Project Development (Non-Bankable)	(S)	(C, I)			
Unsuccessful Bidding			(C, I)		
Project Cancellation		(C)	(C, I)		
Design Cost Overruns			(C, I)		
Design Time Overruns			(C, I)		
Inadequate Design		(S)	(C)		(I)
Unsuccessful Credit Raising			(C, I)	(C)	
Credit Raising Time Overruns			(C, I)	(C)	
Transfer Delays		(C)	(I)		
Construction Cost Overruns			(C, I)		
Construction Time Overruns			(C, I)		
Inadequate Construction		(S)	(C)		(I)
Opposition of Public Opinion	(S)	(S)	(I)		
Overruns of Implementation of Environmental Mitigation Measures			(C, I)		
Operation Cost Overruns			(C, I)		
Over-prediction of Traffic			(C, I)		
Revenue Shortfall			(C, I)		
Maintenance Cost Overruns			(C, I)		
Maintenance Time Overruns			(C, I)		
Inadequate Maintenance		(S)	(C)		(I)
Inability to Service Debt Interest Payment)			(C, I)		
Inability to pay Debt			(C, I)		
Project Collapse (Concessionaire Insolvency)			(C, I)		
Difficulties/Delays in Settlement of Disputes	(C, S)	(S)	(I)		
Interference in Toll Structure		(C)	(I)		
Withdrawal of guarantees	(C)		(I)	(I)	
Expropriation (nationalisation Sequestrate)	(C, S)	(C, S)	(I)		
Repatriation	(C)	(S)	(I)		
Termination		(C, S)	(I)		
Instability, Convertibility, Transfer of Local Currency	(C)	(S)	(I)		
New Fiscal/Economic Legislation & Policies (Taxation, Import Duty, inflation rates, ..etc.)	(C)	(S)	(I)		
New Specific Legislation (Construction, Maintenance, Environmental Standards)	(C)	(S)	(I)		
Tort (accident) Liability	(C)	(S)	(I)		
Environmental Liability	(C)	(S)	(I)		
Losses due to war, riot, hostilities, insurrection			(I)		
Force Majeure Act of God (e.g. Earthquakes)	(S)	(S)	(I)	(S)	

(C) = Party Causing Risk (I) = Party Incurring Risk (S) = Party Sharing Risk

8.42. Discounting of annualised costs and revenues of BOT road project

In order to compare the costs and revenues of a proposed BOT road scheme, the change in monetary values as a result of time change has to be eliminated. This is achieved by discounting the annual costs and revenues of the project to current year. This is done using a discount rate which is considered acceptable and reflects such scale of projects that involve such high capital costs and risks and where sufficient revenues materialize over a long period of time. Such discount rate should also take into account the opportunity cost of resources employed by the project. In addition a discount formula is used. The basic discount formula, used is known as Present Worth Factor. The following represents the mathematical computation followed in order to discount total revenues and costs.

$$PVR_{(R)}^{(F)} = TotRev_{(R)}^{(F)} * (1 / (1 + DR)^{F-P}) \quad (30)$$

Where: PVR = Present Value of Revenues

$(1 / (1 + DR)^{F-P})$ = Discount formula known as Present Worth Factor

DR = Discount rate used to reflect preference of present value

F-P = Time difference between future year of materialisation of revenue and present year

$$PVC_{(R)}^{(F)} = (TotCos_{(R)}^{(F)} + TotRC_{(R)}^{(F)}) * (1 / (1 + DR)^{F-P}) \quad (31)$$

$$PVCC_{(R)}^{(F)} = CC_{(R)}^{(F)} * (1 / (1 + DR)^{F-P}) \quad (32)$$

Where: PVC= Present Value of Costs including risk costs

CC = capital costs spread over construction period

PVCC = Present value of capital costs

8.43. Computation of financial indicators for BOT road project

A set of financial indicators are available through which judgment can be made regarding the financial viability of the BOT road project. Typical indicators reported in the literature; see Beltrandi, 1995 and Gannon & Brown, 1995; include:

- Value of Net Present Profit (VNPP)
- Project rate of Return (PROR)
- Project First Year Rate of Return (PFYRR)
- Capital Rate of Return (CROR)
- Equity Rate of Return(EROR)
- Operating Ratio (OR)
- Cover Ratios (CR)
- Pay Back Period (PPB)

The following is a representation of the generic computation of VNPP for the BOT road project. VNPP is measured as the present value of revenues less the present value of costs. VNPP is considered as one of the most appropriate yardsticks for comparing the worthiness of projects.

$$VNPP_{(R)} = \sum_{1}^{AP} PVR_{(R)}^{(F)} - (PVCC_{(R)}^{(F)} + PVC_{(R)}^{(F)}) \quad (33)$$

where: AP = Assessment (concession) period

The following represent the mathematical formulation used for computing other key financial indicators.

$$OR_{(R)} = \sum_{1}^{AP} PVR_{(R)}^{(F)} / (PVCC_{(R)}^{(F)} + PVC_{(R)}^{(F)}) \quad (34)$$

$$PROR_{(R)} = \sum_{P}^{F-P} [(TotRev_{(R)}^{(F)} - (CC_{(R)}^{(F)} + TotCos_{(R)}^{(F)} + TotRC_{(R)}^{(F)})) * (1/(1 + DR)^{F-P})] = 0 \quad (35)$$

PROR is equal to DR that satisfies the above formulation

$$PFYRR_{(R)} = \sum_{P}^{F-P} [TotRev_{(R)}^{(F)} / (TotCos_{(R)}^{(F)} + TotRC_{(R)}^{(F)} + CC_{(R)}^{(F)})] \quad (36)$$

The maximum value of F would be the year of first year of traffic running on the BOT road project

8.44. Determination of financial viability of BOT road project

The determination of financial viability of a BOT road project relies mainly on the comparison of expected versus targeted financial indicators. Two possible outcomes can result, the first is the favourable where expected indicators are equal to or higher than targeted indicators, hence the project is considered viable. The other outcome is where expected indicators are less than targeted ones, hence the project might be considered not viable. Break-even values as well as minimum targeted values for the key financial criteria are detailed in Table 4. The table also shows the logical interpretation of achieving such minimum targeted values.

Table 4: Summary of Cost-Revenue Criteria Used for Financial Appraisal of BOT Road Project

Financial Criteria	Break-even Values	Minimum Targeted Values	Judgment
VNPP	zero	Positive	Positive net profit
Revenue/Cost Ratio	1	≥ 1	Efficient Investment
PROR	DR	≥ DR	OK
PFYRR		Approaching DR	High short term return

In case expected indicators are lower than targeted ones, a number of adjustments can be made, namely:

- adjustments to the structure of toll rates (main revenue source) as well as
- adjustments to the concession period (time over which revenue is materialised).

9. SUMMARY AND CONCLUSIONS

This paper started by presenting the various primary sources available for financing road investments, including traditional and non-traditional sources. It particularly presents the most widely followed forms of private finance of infrastructure utilities, namely BOT concessions. Main stakeholders, their objectives, benefits and interactions in a BOT road project were identified and discussed. A conceptualisation of the main generic phases and stages throughout the life cycle of a BOT road project was developed and presented.

The eligibility of a BOT road project depends on meeting several criteria, including economic, financial, environmental, technical, and legal criteria. The core of the paper was concerned with developing a detailed generic systematic approach to assist in conducting a comprehensive and structured financial feasibility assessment of private investment in road projects. The developed approach encompasses the generic stages, procedure, steps and models envisaged to assist sponsors, concessionaires as well as financiers in identifying bankable road projects. The structure of the developed approach constitutes eight generic stages. The first is concerned with defining the objectives of the project to provide the necessary background against which appraisal of alternatives is performed. The traffic analysis presents the core of the second stage. The third stage involves conducting of an Environmental Impact Assessment (EIA). The fourth stage is concerned with the estimation of potential costs expected, taking into consideration the cost of environmental mitigation measures. In the fifth stage project revenues are forecasted. Stages six and seven are concerned with the estimation of key financial criteria and comparing these with project financial objectives so as to determine project viability. Finally, the eighth stage is concerned with minimising uncertainties and risk through a three level procedure of conducting scenario analysis, followed by sensitivity tests and then risk analysis.

Several conclusions can be deduced:

1. It is vital for host governments to conduct public awareness and acceptability campaigns for privately financed projects. In parallel, existing laws should be reviewed and new encouraging legislation issued.

2. Consultants play a significant role in BOT road projects as they conduct technical, financial, economic, environmental and legal studies for the different concerned parties, namely sponsoring agency, the concessionaire and the financier.

3. The sponsoring agency is expected to prepare and conduct the necessary procedural steps for awarding the concession as well as carrying the responsibility of regulating the performance of the concessionaire.

4. Main sources of finance for a road concession company would depend on equity, loans and shareholders. On the other hand, financial institutions such as banks rely on their customers' deposits and shares. Customers of financial institutions would be expecting payment of their dividends.

5. Financial support and/or risk guarantees can be provided by international agencies such as IBRD, IDA, IFC and MIGA. These could be approached by financiers, the concession company, the host government or its sponsoring agency.

6. In a BOT road project, the sponsoring highway agency is expected to conduct an economic feasibility study to verify the project worthiness from the society point of view, as well as a financial feasibility study to justify its choice of a bankable project and to assist in negotiating the concessionaire during the bidding and contracting phases..

7. In addition, both the concessionaire and the financier are expected to undertake a financial assessment aimed at demonstrating the project financial viability and worthiness. The concessionaire wants to make sure that his investments would be worthwhile (establish project worthiness). On the other hand, the financier wants to guarantee project success and hence ability of concessionaire to service his debts.

8. Identification of BOT road project objectives and representing these into several expected quantifiable financial indicators is a crucial initial step towards any financial assessment.

9. It is of vital importance to forecast and analyse the development of traffic flows over the life of a BOT road project. This forecast should particularly run over the time period considered for evaluating the proposed BOT scheme. In order to accurately forecast traffic flows for a BOT road project, a computer-based simulation model ought to be developed. A traffic model is mainly expected to serve the following analytical purposes:

- It allows the simulation of current and future traffic conditions on existing network (do nothing) and specially parallel roads to expected BOT road scheme.
- It allows the simulation of future traffic conditions on expected network (do something) and especially traffic expected on the proposed BOT road scheme.
- It provides necessary comparative traffic estimates and network utilisation statistics required for conducting economic and/or financial feasibility assessments. Network utilisation statistics include vehicle kilometers and vehicle hours for current and future networks and their associated traffic conditions.
- It acts as a quick test vehicle for exploring alternative scenarios. A scenario can be composed of alternative network configuration, traffic growth rate, toll rate, ..etc.

10. Disaggregate traffic demand forecasting models are warranted for BOT road projects. Such quality traffic models are meant to forecast demand for different types of vehicle throughout the operation period rather than at peak periods. This is crucial for the rigorous required in the forecasting of revenue which is detrimental for establishing the projects viability.

11. For a BOT road project it is necessary to conduct an EIA at three levels, namely for corridor analysis and selection, selection of environmentally friendly geometric and structural standards, and finally at the pre-construction, construction, operation and maintenance phases. For each of these EIA a number of significant impacts are identified, mitigation measures are suggested and their costs estimated

12. Estimation of costs should take account of the life of the concession, inflation rates and shadow pricing. The main types of expected costs are costs incurred during design, construction, operation, maintenance, and implementation of environmental mitigation measures as well as debt service costs. These cost estimations are done on a year by year basis over the concession period of the BOT road project.

13. Estimation of revenue is dependent on traffic forecasts, toll rates proposed and toll rate indexation. In addition, revenue expected as a result of fees collected for providing other types of road services such as publicity, petrol stations should be also estimated. These revenue estimations are done on a year by year basis over the concession period of the BOT road project.

14. Costs and revenues should be annualised and discounted across the concession period using appropriate discount rate that reflects expected opportunity costs and risks.

15. Judgment of project viability is based on a comparison between expected and output values of the identified financial indicators. These are utilised to judge the feasibility, viability and effectiveness of the project.

16. Parameters identified as critical to the financial success of a BOT road project include: length of the concession period, toll categories and rates, traffic growth rates, discount rate, etc. Scenario analysis, sensitivity tests and risk analysis ought to be conducted taking into account the effect of variations in such factors on projects viability.

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