A MULTI-CRITERIA DECISION-MAKING MODEL FOR SELECTION OF BOT TOLL ROAD PROPOSALS WITHIN THE PUBLIC SECTOR

by

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ABSTRACT

A MULTI-CRITERIA DECISION-MAKING MODEL FOR SELECTION OF BOT TOLL ROAD PROPOSALS WITHIN THE PUBLIC SECTOR

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In recent years, governments in many countries have begun privatizing infrastructure sectors. Some of the forces driving this movement have been a scarcity of public resources, an increase in the demand for services, a political trend toward the deregulation of infrastructure, and an expansion of global capital markets.

The build-operate-transfer (BOT) approach has played a growing role in the implementation of infrastructure privatization. Due to the type, uncertainty, and high risk of BOT projects, the evaluation/selection process is a crucial part of a BOT project. To date, decision-makers within the public sector have lacked a set of complete selection criteria or a systematic process to help them make quality selections.

The main objectives of this research are to understand the details of toll road projects in order to (1) identify the major criteria and variables related to toll roads, and (2) develop an integrated decision-making process model as a framework to help the public sector make quality decisions.

The methodology of this research includes the development of a multi-criteria decision-making model based on the analytical hierarchy process (AHP) and validated by use of a California Department of Transportation (Caltrans) privatization program as a case study.

The model makes the selection process clear and able to be traced back by all parties. Because of this, it will likely encourage the private sector to bid on BOT projects. This research developed a framework that will enable the public sector to make better decisions when selecting BOT toll road proposals and also save decision-makers time and effort.

ACKNOWLEDGMENTS

"And lower unto them the wing of submission and humility through mercy, and say: My Lord! Bestow on them Your Mercy as they did bring me up when I was young" Holy Qur'an, Surah 17—Al-Isra: 24.

First, all praises and glory are due to Allah for all the bounty and support granted to me. This work would not have been done without God's endless guidance and help.

Then, this research is dedicated to:

- The memory of my father, may Allah grant him mercy, who taught me the value of education, integrity, and determination. He made education his children's highest priority.
- My mother, for her love, prayers, and continuous sacrifices.
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

In recent years, there has been a strong worldwide movement toward the involvement of the private sector in the provision of public infrastructure, especially highways. Some of the forces driving this movement have been a scarcity of public resources, a political trend toward the deregulation of infrastructure, and an expansion of global capital markets. Confronted with these forces, governments -- especially in developing countries -- have turned to privatization of infrastructure.

According to the World Bank, since 1990, a growing number of low-income developing countries have encouraged the movement toward the involvement of private operators in infrastructure. Between 1990 and 1999, the proportion of low-income countries with at least one private infrastructure project grew from 20% -- or 13 countries -- to more than 80% -- or 50 countries. Private investment in projects within low-income countries rose almost every year during the 1990s and reached in 1997 a level of $35.1 billion. In the transport sector, 20 low-income countries implemented over 190 projects during this same period, with a total investment of $23 billion.(1)*

The structure of the public/private partnership is characterized by the degree to which each party shares the risk, obligation, and benefits of a project. Among the most common public/private partnership approaches, the build-operate-transfer (BOT) concession model has become the major trend for the privatization of infrastructure projects.

The selection/evaluation process is a crucial part of a BOT project. The most common approach used in the selection of BOT toll road proposals is the competitive method. To date,

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* Parenthetical references placed superior to the line of text refer to the bibliography.

there has been no systematic process or selection criteria guiding decision-makers within the public sector to make quality selections.

Multi-criteria decision methods provide a comprehensive set of qualitative and quantitative criteria that help to justify project selection decisions. Although a large number of project proposal selection methods have been reported in the literature, no consensus has been reached regarding an effective selection methodology.(2) However, one method, Saaty's Analytic Hierarchy Process (AHP), has been found highly useful in project selection decisions by many researchers.(3,4,5,6)

This research has used AHP to create an integrated approach for modeling the selection of BOT toll road proposals within the public sector.

1.1 Research Motivation

Facing budgetary constraints and recognizing their inability to effectively provide infrastructure services, governments in many countries have opened their infrastructure sectors to private investors, often through BOT projects. In developing countries, the stock of private foreign financing for infrastructure projects grew from $0.1 billion in 1988 to $20.3 billion in 1996. As a result of this expansion, the private sector in more than a hundred countries is now involved in areas once considered the preserve of governments – e.g., power, roads, gas, telecommunications, and airports.(7)

This strong movement toward the expanded use of BOT toll projects requires governments to implement a rational and comprehensive selection process that addresses all of the aspects affecting selection of proposals. To date, decision-makers have lacked a systematic process or clear selection criteria when approaching the selection process for BOT toll road proposals within the public sector. Not only have the criteria and the decision procedure been unclear, but also previous research has rarely considered the specific needs of the public sector. Among the procedures used, the following problems are common:

- The procedure does not consider the effects of all relevant criteria and variables that could affect the BOT project.
- The procedure requires a great deal of time and effort from the public sector.
- The evaluation lacks a clear procedure with criteria known and announced in advance, thereby reducing the transparency of the evaluation.
- In order to overcome these problems in evaluation, private promoters may sometimes raise the cost of their proposals, and the public sector ends up with a project with greater cost and/or fewer benefits.
- In most countries, BOT projects present a new field for the public sector. Thus, the decision-makers lack knowledge and experience in evaluating them, especially in developing countries.

Given the problems with existing procedures, it would be of great value if this research could help develop a framework that will enable the public sector to make better decisions when selecting BOT toll road proposals while also saving decision-makers time and effort.

1.2 Research Domain and Problem Area

Privatization, alternatively called Public/Private Partnership (P/PP), is a wide-reaching phenomenon that includes P/PP infrastructure projects. Included among the various types of P/PP infrastructure systems are transportation projects, or toll highways. This research focuses on the BOT toll road domain. Figure 1 shows the specific area of the research study.

The commonly used selection process for BOT toll road proposals consists of five stages, as presented in Figure 2. The third stage of the process encompasses the research problem described above.

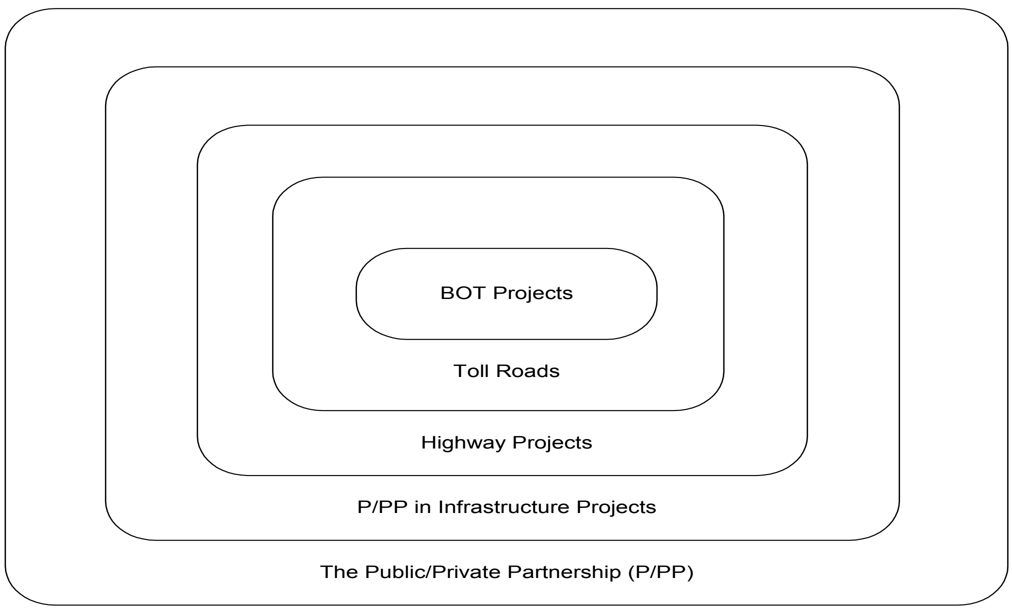


Figure 1 Research Study Domain

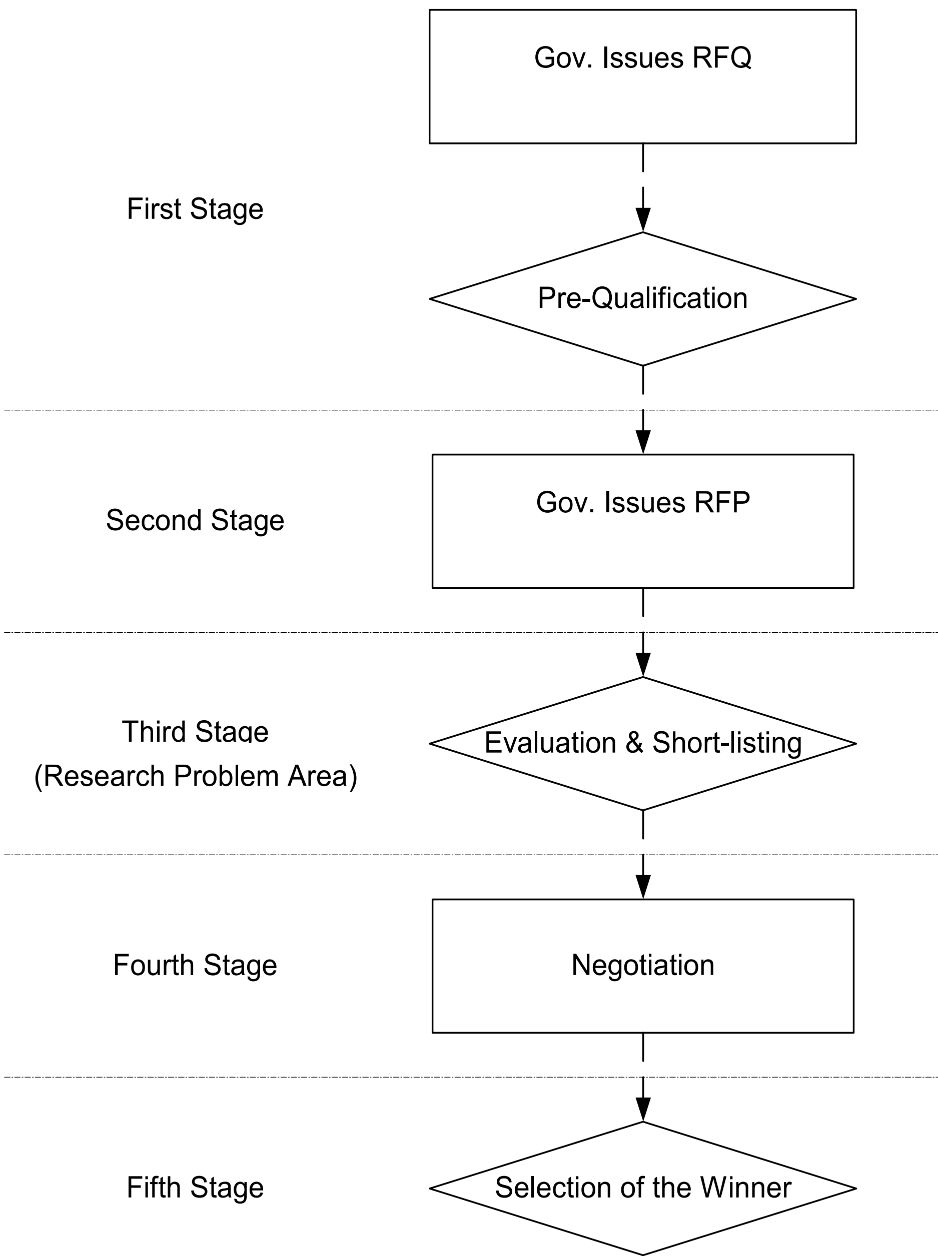


Figure 2 Stages of BOT Proposal Selection Process

(Note: Research Problem Area is at Stage 3)

1.3 Previous Work

Research to date dealing with the tendering of BOT projects has failed to consider many essential aspects of such projects. Often, research on this topic has been limited and/or has relied heavily on surveys. For example, Tiong[8,9] identified: a number of critical success factors for winning BOT projects, Evaluation process for BOT projects, and discussed the importance of the financial package and the equity level. Also, Zhang[10] and Tam[11] studied BOT cases in China and highlighted the government's role and the risk management of BOT projects. Other research has considered solely the financial aspects of the evaluation process. For example, Shih[12] developed an evaluation framework for the financial aspect alone. Still other research has investigated the evaluation process solely from the private sector's point view (Jong[13] and Sanchez[14]).

1.4 Research Objectives

The main objectives of this research are to understand the details of toll road projects and to develop an integrated decision-making process model as a framework to help the public sector make quality decisions.

Specific objectives include:

- Identifying the criteria and the variables related to toll roads.
- Developing the sequence of steps in the decision process.
- Developing a systematic selection approach by utilizing a powerful multi-criteria decision-making tool (i.e., the analytical hierarchy process, or AHP).

- Developing a model that will reduce excessive expenditures of time and effort by the public sector.

- Making an easy and practical model which can be used within the public sector. This model should:

- be based on a simple data acquisition system and use an appropriate analytical tool;
- be able to be clearly interpreted by the decision-makers;
- include and weigh all the criteria affecting the project, both tangible and intangible;
- be capable of making clearly derived decisions that can be traced back through the different stages of the process by all parties;
- be able to accommodate any number of criteria and any number of proposals.

1.5 Research Hypothesis

Based on the research motivation and objectives, the following hypothesis is proposed:

Decision-makers in the public sector can make better decisions by using a comprehensive and analytical decision-making model that includes all criteria affecting BOT toll road projects. This model will save decision-makers time and effort. It will also clarify the decision-making process and should, therefore, encourage the private sector to bid on projects through a clear and fair selection process.

1.6 Research Methodology

This research developed a multi-criteria decision-making model for selection of BOT proposals by the public sector. The methodology, as presented in Figure 3, consists of six steps:

- Step one: a literature review that is both intensive and comprehensive and that covers the following: (1) trends of privatization regarding public/private partnership for toll roads; (2) review of BOT projects -- including concept, structure and process -- and applications; and (3) review of multi-criteria decision-making processes.
- Step two: identification of (1) the problem, (2) decision process for selecting the best BOT proposals, and (3) selection criteria and sub-criteria.
- Step three: structuring the decision process as a hierarchy.
- Step four: developing the preliminary model and refining the decision-making procedure.
- Step five: validation of the model using a case study.
- Step six: discussion and conclusions.

The methodology will be discussed in greater detail in Chapter 6.

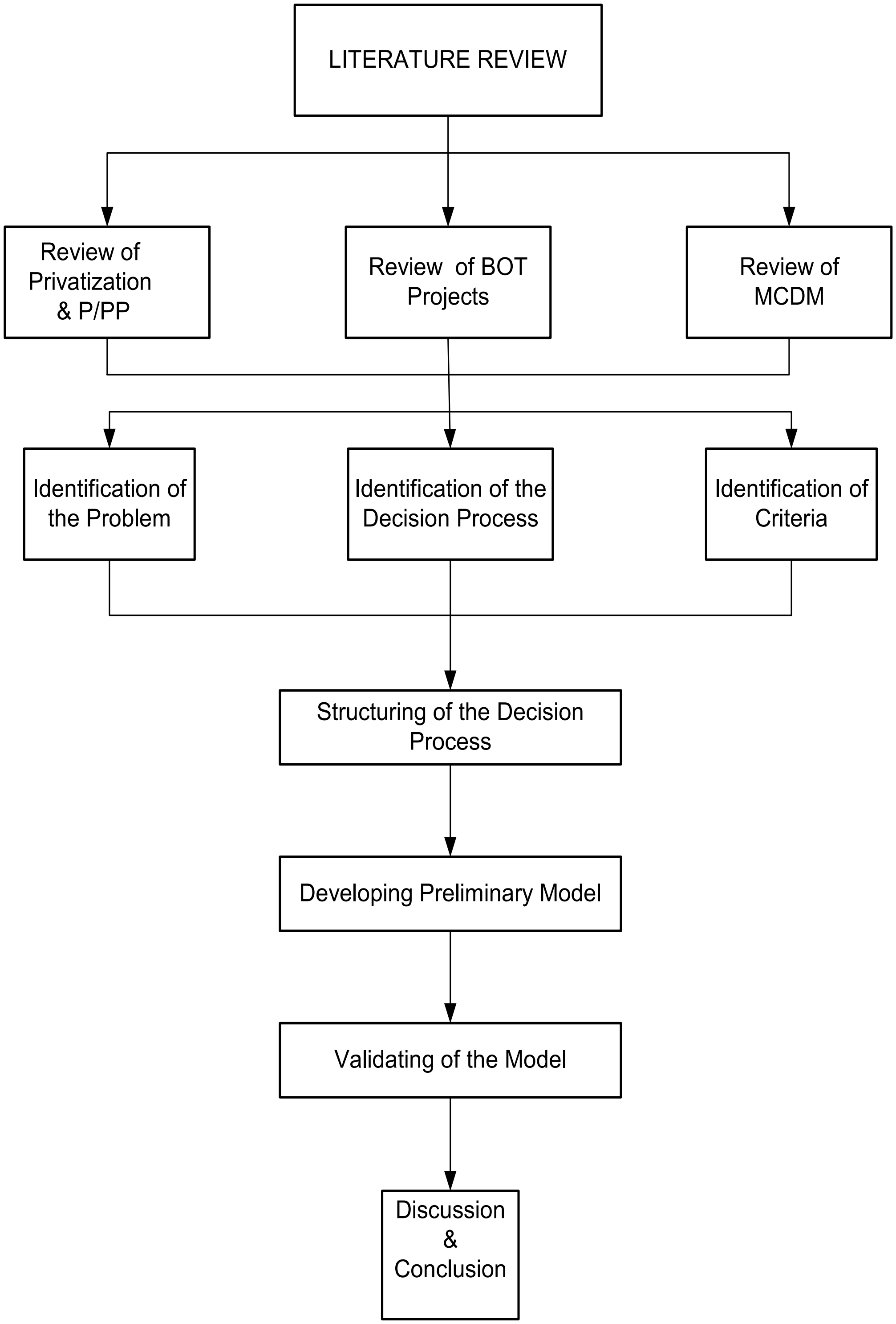


Figure 3 Research Methodology

1.7 Organization of the Dissertation

This section briefly describes the organization and the contents of the remaining chapters of this dissertation.

Chapter 2 provides background on privatization in general and on public/private partnerships in particular. It discusses the factors, trends, and structure of this type of partnership.

Chapter 3 describes the key concepts and the elements of a BOT project, highlighting the advantages and the financing techniques of this approach. It also states the factors that increase the success of BOT projects.

Chapter 4 describes the decision-making process in general and comments on a variety of multi-criteria decision-making theories. Group decision-making is then explained, and the chapter ends with a general description of a decision support system and the specific software used in this research.

Chapter 5 focuses on the methodology and the advantages of using the analytical hierarchy process (AHP). It describes how the user of this method can structure the hierarchy, do prioritization through pairwise comparison, and then check the consistency of the resulting judgments.

Chapter 6 describes the research methodology used. It includes: the research approach and problem area; description of the selection process and the evaluation techniques used; and identification of the research problem.

Chapter 7 describes the model formation and explains the procedures of the decision process using this model. It identifies all the important criteria affecting BOT toll road projects. It also describes the decision hierarchy and explains the group decision-making process.

Chapter 8 describes the case study used to validate this model and analyzes the results of the validation. It also discusses how the decision was affected by using all criteria, and considers the limits of the criteria.

Chapter 9 includes the conclusions, discusses the contributions of the research, identifies the limitations of the study, and briefly describes areas of future research.

2.0 PUBLIC/PRIVATE PARTNERSHIP AND TOLL ROADS

In recent years, there has been a strong worldwide movement towards the involvement of the private sector in the provision of public infrastructure, especially highways. Some of the forces driving this movement have been a scarcity of public resources, an increased demand for infrastructure projects, a political trend towards the deregulation of infrastructure, and the expansion of global capital markets.

Facing budgetary constraints and recognizing their inability to provide infrastructure services efficiently, governments in many developing countries have opened their infrastructure sectors to private investors. The stock of private foreign financing for infrastructure projects in developing countries grew from $0.1 billion in 1988 to $20.3 billion in 1996. In more than 100 countries, the private sector is now involved in areas once considered the preserve of governments -- power, roads, gas, telecommunication, and airports.(7)

2.1 Privatization

Privatization can assume many different forms, but three are most common: sale of an existing state-owned enterprise; use of private rather than public financing and of private management rather than public for new infrastructure development; and outsourcing (contracting out to private sectors) of public services previously provided by government employees. A wide variety of competitive, regulatory, and subsidy policies have developed along with these forms of privatization.

E. S. Saves, an academic pioneer in this field, offers three definitions of privatization:

1. Relying more on the private institutions of society and less on government to satisfy citizens' needs.
2. Reducing the role of the government or increasing the role of the private sector in an activity or in the ownership of assets.
3. Transferring government enterprises or assets to the private sector.

Saves classifies forms of privatization as follows:

1. Divestment - sale, free transfer, and liquidation.
2. Delegation - contract, franchise, grant, voucher, and mandate.
3. Displacement - default, withdrawal, and deregulation.

Privatization in transportation deals with the following sectors: airports (and airlines), water ports, roads, mass transit, and rail(15). In this research we deal with toll roads only.

2.1.1 Trends of Privatization

The drive for privatization of public services has been apparent at every level of government. Privatization involves deregulation, policy decentralization, downsizing of government, out-sourcing of public services, and privatization of natural monopolies, including gas, electricity, and so forth.(16)

2.2 Road Financing Options

The financing of roads can come from different sources. The three major types are public funding, private funding, and combined public/private funding.(17)

2.2.1 Public-Sector Funding

The roads in the public sector can be funded by a central government, local or regional governments, or by a specific authority. Public funding can come from general taxation, from specific taxation, from general borrowing or from specific borrowing. About 90% of all funding for infrastructure is supplied by governments, which bear almost all project risks. Many countries have made remarkable progress in infrastructure expansion under this scheme, but recent experience has also revealed both a severe shortage in the financial resources with many of these projects as well as a failure to keep up with the demand.

2.2.2 Private-Sector Funding

If a project is to be funded completely by the private sector, this implies that no guarantees of any sort, either implicit or explicit, will be available from the public sector. Generally, the public sector will be involved in the process to the following extent: to lay down certain requirements to be met by the concessionaire and to grant permission for the concession to construct and operate the facility. The most difficult element in any private financing structure is likely to be the provision of sufficient equity or guarantees. In the absence of a true owner for the facility, sources may include non-resource bank lending, or loans not backed by another party such as the government. However, in practice, non-resource bank loans for infrastructure projects are rare and difficult.

2.2.3 Public/Private Partnerships (Combined Funding)

Public/private partnerships are characterized by the degree to which the public and private sectors share the risks, obligations, and benefits of a project. The mix of public and private responsibilities and the risk allocation scheme used vary from project to project, and the structure of the partnership depends on the particular mix of responsibilities.

The mix of financing instruments between the public and private sectors can be very diverse, as shown by the experience of certain European countries where private and public sector capitals coexist in varying proportions, according to the rules of private enterprise.(17)

The government involved may be federal, state, or local, while the specific agencies involved are often departments of transportation or independent authorities. The private parties may include firms specializing in public/private infrastructure, construction companies, equipment manufacturers, operations specialists, real estate developers, and various advisors.

2.3 Privatization of Infrastructure Projects

Traditionally, infrastructure was planned, financed, and managed by the public sector, due to the importance of this sector and because infrastructure requires a massive outlay of capital. As noted earlier, governments started finding that privatization was a viable alternative to exclusively public funding, and the private sector has undertaken a greater share of these projects. This private participation in infrastructure (PPI) has arisen as a derivative reform in areas where full privatization seemed less feasible.

According to the World Bank, since 1990, a growing number of low-income developing countries have encouraged the participation of private operators in infrastructure. Between 1990 and 1999, the proportion of low-income countries with at least one private infrastructure project grew from 20% to more than 80%, or 50 countries. Investment in projects with private participation in low-income countries rose almost every year during the 1990s and peaked in 1997 at $35.1 billion. In the transport sector, 20 low-income countries implemented over 190 projects with a total investment of $23 billion between 1990 and 1999.[1] Table 1 shows the growing prevalence of private participation in infrastructure projects in developing countries.

Table 1 Investments in Infrastructure Projects with Private Participation in developing Countries by sector, 1990-1998 in U S $ billions[18]

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Telecommunication	6.6	13.1	7.9	10.9	19.5	20.1	33.4	49.6	53.1
Energy	1.6	1.2	11.1	14.3	17.1	23.9	34.9	46.2	26.8
Transport	7.5	3.1	5.7	7.4	7.6	7.5	13.1	16.3	14
Water & sanitation	0	1	1.8	7.3	0.8	1.4	2	8.4	1.5

2.3.1 Factors Driving Private Participation in Infrastructure

There are many factors increasing the participation of the private sector in the provision of infrastructure projects. According to Sanchez[14], the main factors are as follows:

1. The shortage of public funding. Governments are facing a shortage of public funds to meet infrastructure needs, and experiencing a growing gap between infrastructure needs and the

availability of fiscal funds and aid from external agencies. Symptoms of this problem range from poorly maintained bridges and highways in rural areas to congested cities and airports.

Faced with these problems, governments have found BOT projects to be viable. Governments needed to meet their infrastructure shortfall and have responded by implementing policies that allow and encourage private participation. Deregulation of infrastructure, privatization of state-owned enterprises and concession of public services are some of the policy innovations that have increased the role of the private sector.

2. The notion of efficiency in private enterprises. The private sector has proven to be more efficient and more innovative than the public sector, especially in terms of the design, construction cost, schedule, and operation of customer-oriented services. Able to avoid numerous restrictions and obstacles, private firms realize cost savings by constructing facilities more quickly (e.g., using fast-track or design-build construction schemes) and by bringing the investment into service sooner. In addition, a private firm has profit as a clear incentive to operate the facility efficiently. Private enterprises operate within a restricted budget that is a function of revenues, operating costs and a targeted return on investment, and thus have to control costs closely to achieve desired efficiency and profitability.

3. The expansion of capital markets and innovative infrastructure finance mechanisms. In recent years, the volume of trade and the range of instruments used on the international capital markets have increased substantially, as venture capitalists and institutional investors in developed countries seek to diversify their portfolios and achieve higher returns.

Given the prevalence of these factors, governments have increasingly turned to private financing, which eases the burden on government budgets and encourages better risk sharing, accountability, monitoring, and management in the provision of infrastructure.[18,19]

2.3.2 Structure of Public/Private Partnerships

Public/private partnerships are characterized by the degree to which the public and private sectors share the risks, obligations, and benefits of a given project. The mix of public and private responsibilities and the risk allocation scheme vary from project to project. The structure of a partnership depends on which partner assumes the following responsibilities for the project: (1) initiation and planning; (2) design and engineering; (3) financing; (4) construction; (5) ownership; (6) operation; and (7) revenue collection.

The structural options available to public/private partnerships encompass the full spectrum from fully public to fully private. These options include: Operation and Maintenance Contract (O&M), Super-Turnkey Development, Wraparound Addition, Lease-Develop-Operate (LDO), Temporary Privatization, Buy-Build-Operate (BBO), Build-Transfer-Operate (BTO), Build-Operate-Transfer (BOT), and Build-Own-Operate (BOO). Figure 1 shows the continuum of the P/PP structural options for infrastructure projects.[13]

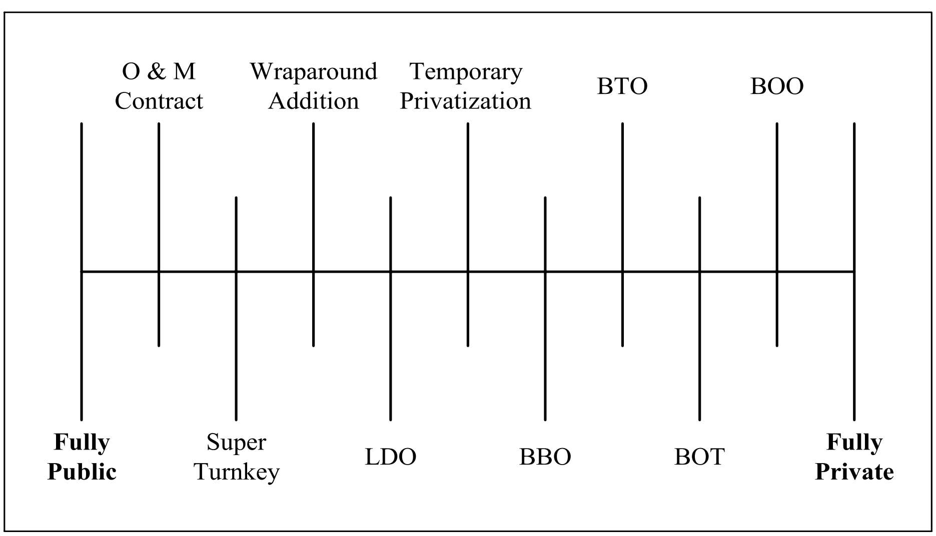


Figure 4 Structural Continuum of Public/Private Partnerships[13]

2.4 Private Toll Roads

Highway infrastructure traditionally has been funded through general government budgets and dedicated taxes and fees rather than tolls. However, the general lack of resources available through traditional government funding sources has led to increasing interest in private toll roads as an alternative way of meeting highway needs. Toll financing is a revenue-generation scheme that provides direct financing for infrastructure projects while shifting the burden of capital, operating, and maintenance costs to specific users. The principal responsibilities for toll road development include design, construction, maintenance, toll collection, arrangement of financing, and legal ownership.(13)

The likelihood of private-sector participation in toll roads can be affected by different factors. For example, the country's political, economic, and legal environment is crucial when determining the potential for effective private participation. Also, compared to investments in other infrastructure sectors (e.g., power or water projects), toll road investments bring a larger number of unfavorable features, such as high initial cost, greater uncertainty regarding costs and revenues, and the need for very extensive rights- of-way with long lead times. All of these factors tend to make BOT toll-road projects more difficult to finance and less attractive to private investors.

However, the BOT scheme is the most common scheme used for private toll roads. We will discuss it in greater detail in Chapter 3.

3.0 BUILD-OPERATE-TRANSFER APPROACH

3.1 Introduction

In recent years, there has been a strong movement toward privatization, and the build-operate-transfer (BOT) concession model has become a major trend in the privatization of public-sector infrastructure projects.

The former Prime Minster of Turkey, Turgut Ozal, first coined the term BOT and used the BOT approach in Turkey in 1984 as part of the Turkish Privatization Program. However, the philosophy and origins of the BOT scheme can be traced back to the privately financed French canals and bridges in the 17th century.[(10)] One of the best known examples of a BOT project is the underwater tunnel connecting England and France.

Since successful implementation of a BOT project is affected by the political and economic environment within the country, it requires great political will and support. A cooperative public/private partnership (P/PP) is a necessary pre-condition for successful BOT project procurement.[(10)] Thus, it is a critical challenge for countries, especially developing countries, to provide necessary support, prepare an adequate legal framework, and identify the major factors that make projects viable and financeable to the private sector.

BOT projects offer a variety of benefits, such as: providing significant potential for technology transfer, increasing local mark capability, and helping development of national capital markets.

BOT projects involve a great deal of uncertainty and risk, including financial, technical, and political.

3.2 Definition of BOT Project

BOT is the term for a model, scheme, or structure that uses private investment to undertake infrastructure development that has historically been the preserve of the public sector.

The BOT approach involves the assembling of private sponsors, usually a consortium of private companies, to finance, design, build, operate, and maintain some type of revenue-producing infrastructure project for a specific period. At the end of this concessionary period, when it has been estimated that all investment costs have been recouped from user fees and a profit has been turned, ownership of the project transfers from the private consortium to the host government.(20)

3.3 Basic Elements of a BOT Concession Project

As stated above, the basic elements of a BOT concession project include a financially feasible project, a receptive host government, a number of private sponsors with local partners, and a group of experienced construction professionals -- all of whom share an interest in a complex web of binding agreements. Figure 5 shows the structure of a typical BOT project.

3.3.1 The Host Government

This is the most important participant in any BOT infrastructure project. The host government remains the final client or purchaser of the project. The BOT approach requires varying degrees of government support depending on the type, size and complexity of project and on the host government's specific economic and regulatory conditions. The host government's direction and support -- legislative, regulatory, administrative and sometime financial -- are essential in most developing countries. The host government must be fully committed to the project, enact legislation that permits the creation and operation of the BOT project, provide the necessary support throughout the period of the concession, and, in case of default, have the required resources to take over the project.

3.3.2 Private Sponsors (Project Company)

The private sponsor of a BOT concession project is generally a complex organization composed of one or several large international construction or engineering firms, equipment suppliers, lending institutions, insurers, equity investors, and a firm with experience in operating and maintaining the particular type of project.

3.3.3 Local Partners

It is normally advisable to include among the sponsors local partners who can help the other sponsors understand the local environment, deal with the host government, and deal with local issues as they arise. The participation of local members, especially if they are politically well connected, is usually a major advantage. In fact, some host governments require the use of local labor, contractors, or the local purchase of project materials.

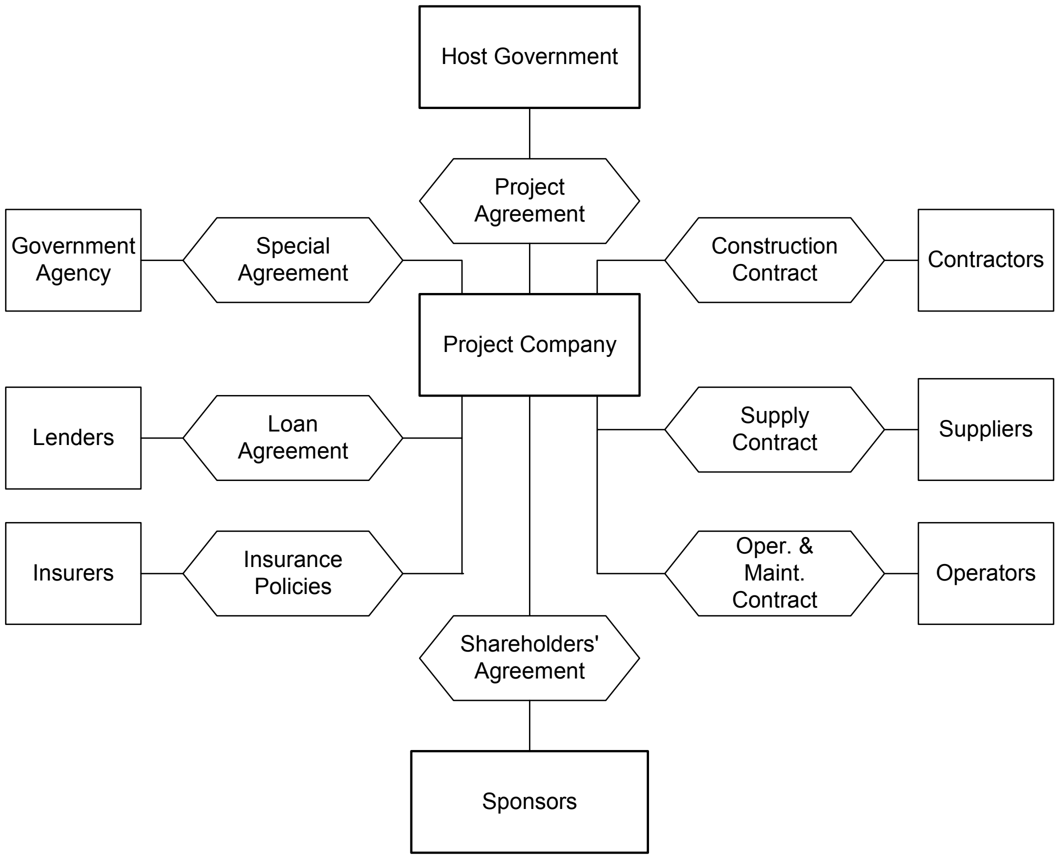


Figure 5 Structure of BOT Project [21]

3.3.4 Construction Consortium

Since a BOT project is generally large and complex, it usually requires the participating construction companies and principal equipment suppliers to assume some degree of the project's risk.[20]

3.4 The Process of a BOT Project

The process of developing a BOT contract is complicated, time consuming, and -- from the sponsors' point of view -- very expensive. The host government must provide timely support required for success of the process by appointing an experienced team for this task and by using practical and efficient methods of evaluation and recruitment.

The BOT process is a highly integrated approach to project development and implementation. The BOT project promotion process begins with having the scope of the project identified either by the public or the private sector, and ends with transferring the project ownership from the private to the public sector.

3.5 Advantages and Challenges of the BOT Approach

In most countries, the BOT approach is preferable to the more traditional approach of using public borrowing or budgetary resources. Unlike in a fully privatized approach, the government retains strategic control over the project, which is transferred back to the public sector at the end of the concession period.

It has been noted in the literature[20,21] that the BOT approach often brings many advantages for the host government, the citizens of the host government, and the BOT consortium.

For the host government:

- BOT allows the government to build much-needed infrastructure projects at little or no cost to taxpayers. It also enables the government to accelerate the development of projects that would otherwise have to wait.
- The government incurs little or no risk as there are generally sufficient bonds in place and sufficient letters of credit in hand to insure completion of the project in the event that the sponsors default prior to completion to the project.
- Because the private sector can usually complete the pre-construction activities more rapidly than government agencies, the project will progress from concept to construction more rapidly.
- Use of private sector capital, initiative and know-how can reduce project construction costs, shorten the construction schedule and improve operating efficiency.
- BOT often provides technology transfer, which increases the training of local personnel, and helps the development of the national capital market.
- Because the sponsors must operate and maintain the facility for periods of time generally exceeding 20 years, chances are good that initial quality of the project will be high.

For the citizens of the host government:

- Taxes in general will not be increased, nor will revenue bonds have to be issued to pay for the project.

- When a project receives income from tolls, only the users of the BOT project facility will be required to pay for it.
- The BOT often provides more jobs, training, and business opportunities for the local citizens.

For the BOT consortium:

- The construction and engineering firms and equipment manufacturers have created a new market for their services and products.
- By purchasing the land adjacent to the project, promoters can benefit from an increase in land value.

Along with all these advantages, there are some disadvantages from which no BOT project is immune. Any number of problems can arise before, during, or after construction of the project. These problems include:

- When a project fails or and defaults occur, the government either will be saddled with the project operation and maintenance costs or will be forced to close the project down; in either case, a drain on public funds will occur.
- Citizens may balk at having to pay for what was once a free service or, because of government subsidies, having to pay more for equivalent services provided by the private developer.

3.6 Financing Technique of BOT Projects

As seen by the lender, a BOT project involves a private-sector borrower who seeks financing on either a limited-resource basis or a non-resource basis. The lenders in a non-resource financing arrangement will look only for the project's assets and revenue stream for repayment, not for additional sources of security, such as the total assets or balance sheets of the project sponsors.

Infrastructure financing is different from other types of commercial financing, such as of an aircraft or shopping center. In equipment or real estate financing, the lender's primary security is the capital value of the asset. Toll roads or power plants, on the other hand, have no guaranteed capital value and very limited potential for resale. The lender's primary security, therefore, is the contracts supporting the project and, most importantly, the certainty of the revenue stream set forth in the project agreement.

Different types of infrastructure have different risk profiles. For example, the revenue from a power plant project is relatively secure and predictable. The host government or public utility may enter a well-defined agreement with the project company to purchase the power output of the plant. However, the source of revenue from a power plant differs from that from a toll road, since the revenue from a toll road depends on the individual traveling decisions of many potential users. The terms of a project agreement for a toll road are based primarily on travel forecasts by experts. Such forecasts are obviously less certain, and thus the agreement is less secure than a well-drafted, long-term power purchase agreement with a creditworthy utility.(21)

Ranasinghe(22) stated common characteristics of most BOT arrangements:

- They are financed on forecasted net-present-value (NPV) and the associated risk.
- They are limited-resource financing arrangements.
- BOT projects have high debt-to-equity ratios.
- The agreement must be fair and reasonable and require the government to guarantee performance.
- The foreign exchange rate must be considered in order to meet the debt payment and return to equity.
- There must be a clear understanding of likely impacts of changes in taxation, resources, and/or legislation.

3.7 Risks with BOT Projects

Identification and management of risks is fundamental to any project. An infrastructure project has fundamental risks associated with it. The participation of the private sector in a BOT project transfers the risk from the public to the private sector. Risks in infrastructure projects are increased by large capital outlays, by the long lead-times typically associated with such projects, and -- for BOT projects -- by lenders and investors having to rely primarily, if not exclusively, on the project cash flow for their returns. Table 2 shows general risks for BOT projects.(21)

BOT projects high-risk and high-return investment. A substantial risk premium, significantly exceeding the normal minimum attractive rate of return, is usually expected by the entrepreneurial promoters.(21) BOT projects involve three different types of risk: technical, financial, and political. Of these three, technical risk is comparatively the easiest to manage;

financial risk, although harder, is still manageable; political risk is by far the most difficult risk element to handle. Thus, the BOT franchisees must properly manage all of these risk elements in order to have a successful project.(11)

Table 2 Risk Identification for BOT Projects (21)

Political Risk	**Construction/Completion Risks**
Political support risk	Delay risk
Taxation risk	Cost overrun risks
Expropriation/nationalization risk	Re-performance risk
Forced buy-out risk	Completion risk
Cancellation of concession	Force majeure risk
Import/export restrictions	Loss or damage to work
Failure to obtain or renew approvals	Liability risk
Country Commercial Risk	**Operation Risks**
Currency inconvertibility risk	Associated infrastructure risks
Foreign exchange risks	Technical risks
Devaluation risks	Demand risk (Volume &Price)
Inflation risk	Supply risk (Volume &Price)
Interest rate risk	Cost escalation risks
Development Risk	Management risks
Bidding risks	Force majeure risk
Planning delay risk	Loss or damage to project facilities
Approval risk	Liability risk
Transnational risk	

The main reasons why a BOT project fails to reach a successful conclusion are: lack of political will or political stability, lack of understanding and support from the host government, unrealistic requirements and expectations from the stockholders, and lack of proper assessment criteria and evaluation practices.(23)

3.8 Factors Increasing the Success of BOT Projects

The success of a BOT project requires a legal, political and commercial environment that is stable, if not fully supportive. In addition, certain kinds of project-specific government guarantees may by necessary. Kumaraswamy and Zhang[10] stated a series of factors that help make a BOT project successful:

1. Win-win principle: the government should attract foreign funds to infrastructure development projects that are particularly needed in their countries. It should also ensure that the projects be developed efficiently to provide an acceptable level of service to the public.

2. Adequate legal and regulatory framework: to attract private sector participation in infrastructure development, the government must develop a legal and regulatory framework for this type of project, as well as ensure a financial environment that is conducive to investment and attractive to foreign investors. However, government over-regulation could burden a BOT project and frustrate investors, and should be avoided.

3. Stable political environment: a central governmental authority is needed to coordinate and reconcile conflicts where necessary and to link foreign investors with government.

4. Good state credibility: the concession periods of BOT projects usually far exceed the term of office of the involved governmental officials. Sponsors and financiers need to have faith in the continuation of the original concession agreement even with any change of government.

5. Developing domestic capital market: strong domestic markets will enable private developers to borrow money for financing non-resource projects from financial institutions, and eventually to float the project off on local stock markets.

6. Competitive bidding: the government should adopt more competitive bidding/ tendering protocols for BOT projects to achieve optimal efficiency and facilitate the selection of the most suitable developers. The evaluation of BOT proposals should also be conducted through a transparent process to ensure fair competition, and to avoid criticism of sponsors' selection or accusations of political favoritism. The government should provide detailed information about a BOT project to facilitate bid preparation, including the government's objectives and the specific procedures for proposal evaluation.

7. Handling land acquisition: assistance from the government is necessary to achieve timely acquisition of land, especially for projects stretching across different provinces, where government coordination is crucial.

8. Option of government guarantees: to further promote private-sector involvement in BOT projects, the government should identify and provide flexible project-specific guarantees against economic risks.

9. Feasible project: it is important that the project be financially and economically sound and be feasible. Also, the fees charged for use must be affordable for the intended users.

10. Strong sponsors: sponsors, especially the construction contractors, must be experienced and reliable and have sufficient financial strength to ensure a successful project.

11. Rational risk allocation: project risks must be allocated rationally among the parties.

4.0 MULTIPLE-CRITERIA DECISION-MAKING

Given the complexity of life today, most of our important decisions require a multiple-criteria decision-making process. Some decisions may be made considering a single criterion, but these are very limited to the simple and relatively unimportant ones. Almost no decisions of significance can be made based on only one criterion. Given these conditions, the two terms "multiple-criteria" and "decision-making" are nearly inseparable, especially when making complex decisions that require consideration of all the different aspects that affect the decision.

Selection of the best proposal for a BOT toll road project is an especially complex and difficult process. The selection process is essentially conflict analysis characterized by reconciliation of technical, socioeconomic, and political value judgments. Therefore, it is very difficult to arrive at a straightforward and unambiguous solution. Rather, the process is necessarily characterized by a search for an acceptable compromise solution, an activity that requires a precise evaluation methodology. Multi-criteria evaluation techniques aim to provide such a set of tools and a flexible approach to dealing with the qualitative multidimensional effects of transport initiatives.(24)

This chapter explores the fundamentals of multiple-criteria decision-making (MCDM) and the different models relevant to solving the problem of evaluating bids or proposals in the transportation sector. A detailed review of the literature on the analytical hierarchy process (AHP), the proposed method of solving the decision problem of this research, is detailed in the next chapter.

4.1 Definitions

Decision-making is the process of arriving at a determination based on consideration of available alternatives. Multiple-criteria decision-making involves making a decision based on more than one criterion.

Criteria are the rules, measures, and standards that guide decision-makers. Since decision-making is conducted by selecting or considering key attributes, objectives, or variables, all these elements can be referred to here as criteria. That is, criteria are all those attributes, objectives, or variables which have been judged relevant in a given situation by a particular decision-maker.[25] Thus, as the name suggests, multiple-criteria decision-making involves optimizing multiple attributes, objectives, and goals to arrive at an optimal solution.

Criteria can be either well defined and quantitatively measurable (price, size, etc.) or qualitative and difficult to measure (appearance, satisfaction, etc.). Even when criteria can be measured easily, conflicts often arise between decision-makers over the priority and significance of each. Thus, to reach an appropriate decision in the realm of BOT toll road projects, it is important to consider both types of criteria.[26]

4.2 Decision-Making Process

Decision-making has been defined as:

> a dynamic process that involves a complete search of information, full of detours, enriched by feedback, and gathering and discarding information. It is an organic unity of both pre-decision and post-decision stages overlapping over a region of partial decision-making.[25]

Whether simple or complex, all decisions involve the same basic process. The process should be supported by an established model (whether recognized or unrecognized) that guides the decision-maker through all appropriate steps.

A basic process of decision-making, shown in Figure 6, involves the following steps:[26]

1. Decision analysis clarifies the purpose of the decision by identifying the problem and producing a decision statement. This decision statement puts boundaries on the kind of alternatives to be considered. It focuses attention on the level of the decision -- how broad the set of alternatives to be considered is, and how general the decision is. For example, a decision statement "select a contractor for project A" assumes the project can be handled properly and that the only current concern is finding the best contractor. By contrast, the decision statement “select the best way to complete project A" raises the decision level by broadening the scope of the decision to include wider alternatives. Each decision statement assumes prior decisions, and by raising the level of decision, the most accurate statement can be determined.

2. Once a decision statement has been formulated, the set of alternatives or possible courses of action are determined. Resources (time and money) as well as policies and regulations must be evaluated to assess their impact on the decision statement and available alternatives.

3. Once a valid list of alternatives has been established, the criteria for evaluating the alternatives are established. Once again, key resources and regulations are considered. In most cases, all of the criteria are not equally important; thus, they must be ranked and classified according to their significance.

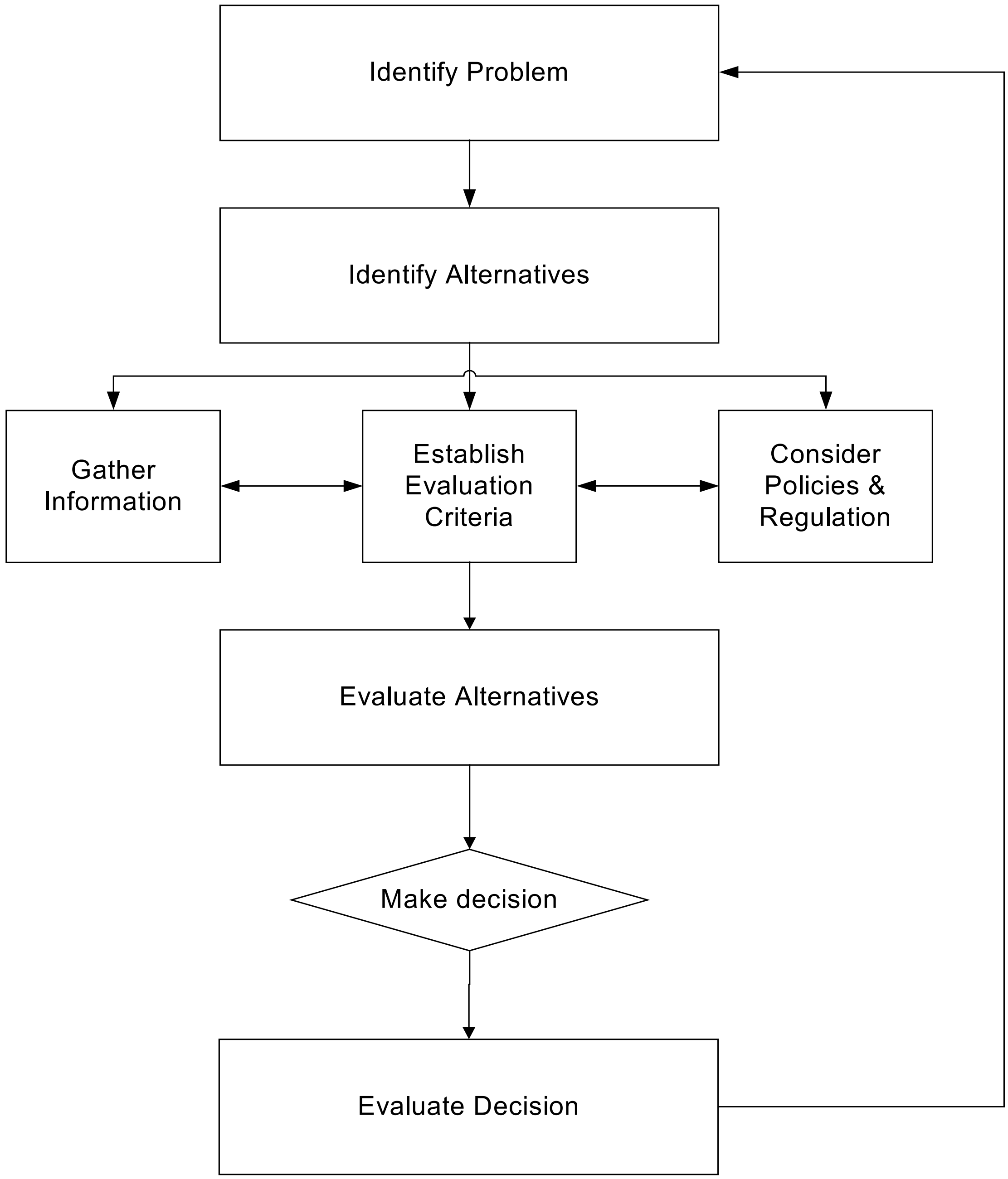


Figure 6 Decision-Making Process [26]

4. The alternatives are then evaluated utilizing key available information and the set of established criteria.

5. Finally, a decision is made regarding the best alternative, and probable consequences of this decision are assessed. It may be necessary to repeat the whole process if it is found that a misjudgment has been made.

A selection of multiple-criteria decision-making models will be described in the following section.

4.3 Multiple-Criteria Decision-Making Models

A model is a simplified representation of a real situation that includes essential features. However, the validity of the conclusion (decision) depends on how accurately the model represents the real situation.

When formulating a model, the requirements for data and possible solutions must be considered. A model is of limited use if the decision-maker is unable to gather data and identify a solution to the problem at hand.(27)

A number of MCDM models are identified in the literature. Munaif(26) explores the four most relevant models for solving the problem of evaluating construction proposals: the merit point system, linear goal programming, multiple attribute utility theory, and the analytical hierarchy process.

4.3.1 Linear Goal Programming

Linear goal programming (LGP) is an extension of the mathematical programming techniques widely used in decision-making. It is based on setting objective functions for each of the selection criteria that emphasize quantitatively what is to be achieved and considering any constraints (economic, social, political) on the project. Linear goal programming is used to find a "satisfying" solution to a decision problem that satisfies a set of aspiration levels rather than maximizing all objectives.(27)

In considering the selection of projects for the public sector, the objective functions (economic growth, wealth distribution, etc.) are derived from financial, economic, political and social considerations. The best bid/proposal is the one that maximizes (or minimizes) the outcome of the objective functions based on the predetermined constraints.

The linear goal programming method, although straightforward, is frequently criticized for increasing the difficulty of formulating important functions and constraints, especially for ordinary decision-makers. Thus, Liberatore(3) indicated that mathematical programming in general is not used at the professional level.

In the same way, quantifying objective functions and constraints poses a problem for decision-makers in the public sector. Many of the objectives and constraints, e.g., social benefits or losses, cannot be quantified in a straightforward manner. Different researchers have suggested that other techniques of decision can be combined with linear goal programming in order to determine the vectors necessary to build the functions and constraints.(28,29,30)

4.3.2 Multiple-Attribute Utility Theory

When the multiple-attribute utility theory (MAUT) is used, the decision-maker first assigns utility values to each multiple-attribute outcome, thereby transforming all attributes into a single composite measure of utility. The proposal that maximizes the expected utility is then selected.

MAUT necessitates the establishment of utility functions representing the decision-maker's value scale for different criteria or goals, and the utility functions are difficult to formulate.(31) MAUT may be troublesome to implement. In addition, it is a highly subjective approach, and it can be time consuming, costly, and frustrating to apply.(27)

4.3.3 Merit Point System

The merit point system (MPS) is the most widely used professional technique for evaluating construction bids. It is reported that the United States Army Corps of Engineers and the World Bank (for construction and development) use the MPS to determine qualified bidders.(26)

The MPS method is based on allocating relevant weights to relevant features or criteria, and then establishing a relationship between the total score of those features and the bid price. The bid that receives the lowest price per merit point is awarded the contract. Table 3 provides a simple example of how the method is used.

The assignment of the merit points for each attribute depends largely on the experience and assessment of the decision-maker conducting the evaluation. The weight given to a certain feature relates to other features and to the total weight (usually 100 points) given to all features.

Table 3 Example of the Application of the Merit Point System [26]

Technical Feature	Total Points	Bid A	Bid B	Bid C
1.Experience on similar projects	30	25	20	30
2. Availability of equipment	10	7	7	5
3. Past performance regarding time	20	15	10	10
4. Experience of staff	10	10	7	5
5. Past performance regarding quality	30	20	15	15
Total Points	100	77	59	65
Bid price		400000	350000	370000
Price per merit points		5194.8	5932.2	5692.3
Rank		1	3	2

The merit point system can be revised by assigning merit points to the bid price along with the other features, with the lowest price receiving the highest number of points. In this case, the bid scoring the highest total number of points wins the project.

This system is easy to use and apply. The disadvantages of this method are evident: they lie in the subjective judgment used in assigning points, and in the lack of established relationships between the different attributes.

4.3.4 Analytical Hierarchy Process (AHP)

The analytical hierarchy process (AHP) is perhaps the most commonly used method for prioritization of decision alternatives. The method is a systematic procedure that organizes the basic rationale of the decision problem by breaking it down into smaller constituent parts and then calling for only one simple pairwise comparison of judgments to develop priorities within each hierarchy.[24] Since this research uses this method, it will be discussed in detail in the next chapter.

4.4 Group Decision-Making

The analytical hierarchy process can be applied successfully by a group. In fact, brainstorming, or sharing ideas and insights, generally leads to more accurate representation and understanding of the issues than would be possible for a single decision-maker.[26,28,30,32] This is because group decision-making reduces all the individual preferences and interests to a single decision reached either by conflict or by compromise.[33]

The different group decision-making techniques cited in the literature include: brainstorming, nominal group technique, surveys, and the Delphi Method.[26]

1. Brainstorming is a group decision-making technique through which a group attempts to find a solution for a specific problem by encouraging its members to spontaneously generate unlimited ideas. Brainstorming is based on the presumption that deferring judgment enables the creative part of the mind to generate ideas and evaluate them later, and that the greater the number of ideas generated, the greater the possibility of reaching an ideal solution.[33]

The creative collaboration and large number of ideas are the major advantages of brainstorming. Its disadvantages are that in such an open atmosphere, some group members may monopolize the session, and that the group may become more concerned with reaching an agreement than with reaching a well-thought-out and useful conclusion.

2. Nominal group technique (NGT): As the term “nominal” (meaning silent and independent) suggests, NGT refers to a process that brings individuals together but does not allow them to communicate verbally. Generating ideas nominally can minimize conforming influences and help maintain social-emotional relationships, both of which can greatly affect the group’s final decision. It also provides for equality of participation and for all members to influence the group decision through voting and ordering of priorities.[33]

NGT's selection process starts with group members silently writing down ideas. One idea at a time is then collected from each member of the group, discussed, defended, and possibly discarded. Ideas are then ranked by vote.

NGT's advantages are that it produces accurate judgments (achieved through rank ordering) and helps eliminate conflict among group members. Its disadvantages are that it requires a highly skilled leader who is knowledgeable about the process, and that it limits creativity and diversity with its one-at-a-time approach.

3. Research surveys are useful when direct interaction among respondents or group members is unnecessary or impossible. With such surveys, the opinions of a chosen group of experts are polled and the results are then analyzed. Surveys can take different forms, including face-to-face interviews, phone interviews, and questionnaires. The advantages of surveys are that they typically cover a large geographic area, poll a large number of respondents, and provide respondents with anonymity. The disadvantage of this technique is that respondents may sometimes misinterpret questions, thereby distorting the results.

4. The Delphi Method: Project Delphi was the name given to an Air Force study developed by the Rand Corporation in the early 1950s to obtain expert opinion on how many Soviet atomic bombs would be required to do specific damage to the U. S. This method has gained wide recognition since then as a powerful technique for group decision-making.

The objective of this method is to obtain the most reliable consensus of a group of experts through the use of intensive questionnaires interspersed with controlled opinion feedback.(33) The special features of the Delphi Method are (1) anonymity, (2) controlled feedback, and (3) statistical group response. Anonymity reduces the effect of dominating individuals. Controlled feedback organizes the exercise into a sequence of rounds and communicates the results to respondents. Statistical group response reduces group pressure for conformity. Another advantage is that the method yields a wide range of opinions from a wide geographic area. Also, the Delphi Method is continuous, offering different iterations and analyses of responses.[26]

However, with this technique, the decision process is tedious and consumes considerable time and effort. Questions are usually sent to respondents again, allowing them to change their answers after hearing feedback on previous answers. A rational final decision is then possible through consensus or vote.

With group decision-making, the group's final decision may be reached through consensus (a solution that satisfies everyone), unanimity (all members of the group agree), majority (the alternative that receives the most votes wins), or a mathematical mean of all judgments.[34] In this research, the group judgment was reached through consensus by agreement/voting.

4.5 Decision Support Systems

Decision support systems (DSS) are developed to provide the information and analysis necessary for the particular decision that must be made. What makes a DSS unique is its interactive access to data and models that deal with a specific decision that requires human intervention and that cannot be solved by the computer alone.[35]

In this research, application of the analytical hierarchy process is supported by a decision support system (DSS), namely the Expert Choice software package (EC).

Decision support systems are computer-based systems that provide interactive support to managers during the decision-making process. DSS allow the decision-maker to retrieve data and test alternative solutions during the process of problem-solving.

4.5.1 DSS Principles

The concept of decision support systems is based on assumptions about the role of computers in effective decision-making:

- The computer must support the manager but not replace his/her judgment. It should therefore neither provide answers nor impose a predefined sequence of analysis.
- The main payoff of computer support is for semi-structured and unstructured problems, where the analysis can be systemized for the computer but the decision-maker's judgments are needed to control the process.
- Effective problem-solving is interactive and is enhanced by dialogue between the user and system.

DSS are characterized by flexibility, user initiation, quick responses, ability to operate with little professional involvement, and decision-making at different managerial levels. DSS are also known for offering analytical power because they are equipped with a variety of models to analyze data.(26)

4.5.2 Expert Choice (EC)

Expert Choice software is a multi-objective decision support system based on the analytical hierarchy process. The Expert Choice software package is intended to make structuring the hierarchy and synthesizing judgments quick and simple, eliminating tedious calculations.[36,37,3]

Developed by Forman, Expert Choice (EC) has been used in various decision problems and based on AHP theory; this software accommodates hierarchy structuring, pairwise comparisons, judgment synthesis, measuring consistency, and sensitivity analysis.

Some of the features of this software are:

- It offers user-friendly displays that make decision model-building straightforward and simple.
- It offers a model view containing either a tree view or cluster view of the decision hierarchy.
- It does not require numerical judgment from the decision-maker; rather, pairwise comparisons may be performed numerically, verbally, or graphically. This is because software converts subjective judgments into the one-to-nine scale prescribed by AHP theory, and then into meaningful priority vectors.

Expert Choice works by examining judgments made by decision-makers, and measures the consistency of those judgments. The software allows for reexamination and revision of judgments for all levels of the hierarchy, and shows where inconsistencies exist and how to minimize them in order to improve the decision.[26]

5.0 ANALYTICAL HIERARCHY PROCESS

The analytical hierarchy process (AHP) was developed by Thomas L. Saaty in the 1970s. AHP provides a flexible and easily understood way to analyze and decompose the decision problem. It is a multi-criteria decision-making methodology that allows subjective as well as objective factors to be considered in the evaluation process. AHP is a method that can be used to establish and connect both physical and social measures, including cost, time, public acceptance, environmental effects, and so on. In its general form, it is a framework for performing both deductive and inductive thinking. AHP was designed as a scaling procedure for measuring priorities in a hierarchal goal structure. It requires pairwise comparison judgments of criteria in terms of relative importance. These judgments can be expressed verbally and enable the decision-maker to incorporate subjectivity, experience and knowledge in an intuitive and natural way.[38]

AHP's power has been validated in empirical use, extended by research, and expanded by new theoretical insights as reported in a series of annual international symposia on AHP.[39] AHP has been widely used as a powerful multiple-criteria decision-making tool. It has been applied to solve highly complex decision problems, in planning and resource allocation as well as conflict resolutions.[40] In later applications, AHP was found to be a powerful tool for selecting projects and proposals, overcoming the limitations of other multiple-criteria decision-making techniques.[3,26,28,29,30,41]

AHP requires the decision-maker to first represent the problem within a hierarchical structure. The purpose of constructing the hierarchy is to evaluate and prioritize the influence of the criteria on the alternatives to attain or satisfy overall objectives. To set the problem in a hierarchical structure, the decision-maker should identify his/her main purpose in solving a problem. In the most elementary form, a hierarchy is structured from the top level (objectives), through intermediate levels (criteria on which subsequent levels depend) to the lowest level (which is usually a list of alternatives). Criteria are then chosen and weighted according to the priority of their importance to the decision-makers. The different alternatives are then evaluated based on those criteria, and the best one is chosen.

5.1 AHP Methodology

AHP is a mathematical algorithm based on priority and simple linear algebra. AHP method involves the following steps:

1. The overall goal (objective) is identified, and the issue is clearly defined.

2. After finding the objective, the criteria used to satisfy the overall goal are identified. Then the sub-criteria under each criterion must be realized so that a suitable solution or alternative may be specified.

3. The hierarchical structure is constructed.

4. Pairwise comparisons are constructed; elements of a problem are paired (with respect to their common relative impact on a property) and then compared.

5. Weights of the decision elements are estimated by using the eigenvalue method.

6. Consistency of the judgments is checked.

The main steps in the process (steps 3 to 6) are detailed in the following sections.

5.2 Constructing the Hierarchy

Constructing the hierarchical structure is the most important step in AHP. There is no specific procedure for constructing a hierarchy, and the approach depends on the kind of decision to be made. The hierarchy should be constructed so that elements at the same level are of the same order of magnitude and must be capable of being related to some or all elements in the next higher level. In atypical hierarchy, the alternatives are at the bottom; the next higher level would consist of the criteria for judging the alternatives. These criteria could be clustered within high-level criteria, where the clusters would be linked to the top single element, which is the objective or the overall goal.[42]

The number of levels in the structure depends upon the complexity of the problem and the degree of detail in the problem. The main objective of the problem is represented at the top level of the hierarchy. Then each level of the hierarchy contains criteria or sub-criteria that influence the decision (See Figure 7). The last level of the structure contains the alternatives.

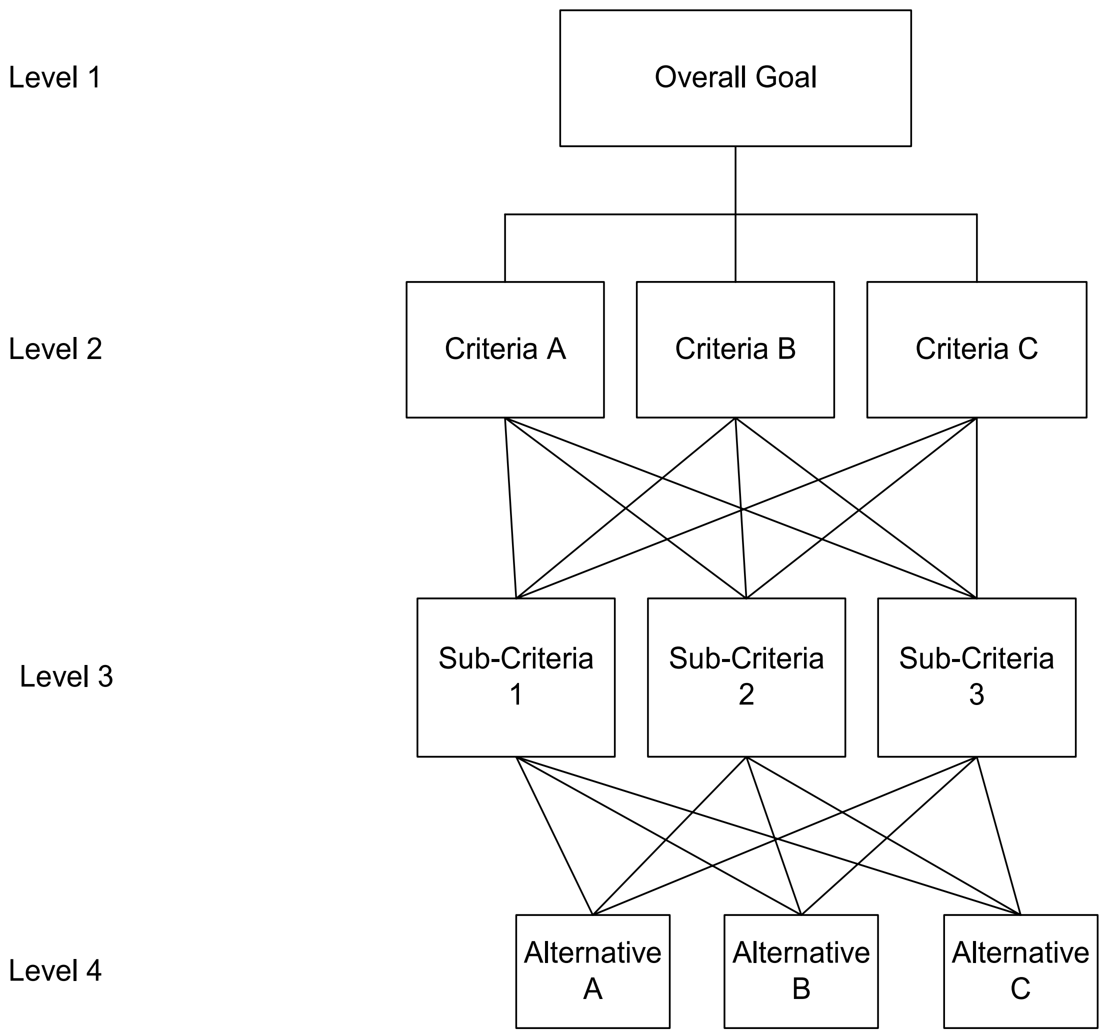


Figure 7 Typical Hierarchy Model

5.3 Pairwise Comparisons

In AHP, once the hierarchy has been constructed, the decision-maker begins the prioritization procedure to determine the relative importance of the elements on each level of the hierarchy. Elements of a problem on each level are paired (with respect to their common relative impacts on a property or criteria) and then compared. The comparison takes this form: How important is element 1 when compared to element 2 with respect to a specific element in the level immediately higher? For each level, starting from the top of the hierarchy and going down, the pairwise comparisons are reduced in the square matrix form, A (5-1). Breaking a complex system into a set of pairwise comparisons is a major feature of AHP. Judgments are often established by an open group process; therefore, dynamic discussion is used for setting priorities by mutual agreement and for revision of views among group members.[43]

$$A = \begin{bmatrix} a_{11} & a_{12} & . & . & . & a_{1n} \\ a_{21} & a_{22} & . & . & . & a_{2n} \\ . & & & & & \\ . & & & & & \\ . & & & & & \\ a_{n1} & a_{n2} & . & . & . & a_{nn} \end{bmatrix} \qquad (5\text{-}1)$$

A is an $n \times n$ matrix in which n is the number of elements being compared. Entries of A, a_{ij} 's are the judgments or the relative scale of alternative i to alternative j. a_{ij} is the entry from the ith row and the jth column of A. It has the following characteristics:

1) $a_{ii} = 1 \Leftrightarrow \mathrm{i} = \mathrm{j}$ (5-2)

2) $a_{ij} = \dfrac{1}{a_{ji}}$ (5-3)

To fill the matrix of A, Saaty[38] proposed the use of a one-to-nine scale to express the decision-maker's preference and intensity of that preference for one element over the other. Table 4 contains the recommended scale from 1-9, which is used to assign a judgment in comparing pairs of like elements on each level of the hierarchy against a criterion in the next highest level. For example, if a_{12}=5, this means that the first alternative is five times more important than the second alternative based on the table. Also, a_{ij} can be written as follows:

$$a_{ij} = \frac{w_i}{w_j} \qquad (5\text{-}4)$$

where w_i is the relative weight of alternative *i*.

For example, w_i=9 implies that alternative *i* is extremely important to the decision-makers as reflected in Table 4.

Table 4 Scale of Relative Importance [38]

Intensity or Relative Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	An activity is strongly favored and its dominance
9	Extremely important	The evidence favor one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgments	When comparison is needed
Reciprocals of above non-zero numbers		If the activity i has one of the above non-zero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared to i

Extracting the judgments enables the construction of the matrix of A, n elements compared to each other with respect to a specific criterion (C). The number of needed entries depends on to the matrix size ($n^2 - n / 2$)[42]. Figure 8 is an example of a typical pairwise comparison matrix.

C	A_1	A_2	A_3	-----	A_n
A_1	1	5	1/4		7
A_2	1/5	1	3		2
A_3	4	1/3	1		1/2
'					'
A_n	1/7	½	2	------	1

Figure 8 Typical Pairwise Comparison Matrix

5.4 Deriving Relative Weight

The next step is to estimate the relative weights of the decision elements by using the eigenvalue method. The mathematical basis for determining the weights has been determined by Saaty[38] based on matrix theory. The procedure is called an eigenvector approach, which takes advantage of characteristics of a special type of matrix called a reciprocal matrix.

The entries a_{ij} are defined by equations 5-2 and 5-3, and according to 5-4 the pairwise comparisons matrix, A in 5-1, can be represented in the form shown in Figure 9:

C	A_1	A_2	A_3	…	A_n
A_1	$\frac{w_1}{w_1}$	$\frac{w_1}{w_2}$	$\frac{w_1}{w_3}$	…	$\frac{w_1}{w_n}$
A_2	$\frac{w_2}{w_1}$	$\frac{w_2}{w_2}$	$\frac{w_2}{w_3}$	…	$\frac{w_2}{w_n}$
A_3	$\frac{w_3}{w_1}$	$\frac{w_3}{w_2}$	$\frac{w_3}{w_3}$	…	$\frac{w_3}{w_n}$
⋮					⋮
A_n	$\frac{w_n}{w_1}$	$\frac{w_n}{w_2}$	$\frac{w_n}{w_3}$	…	$\frac{w_n}{w_n}$

Figure 9 Matrix with Relative Weight

The objective is to find eigenvalues w, for each w_i :

$$w = (w_1, w_2, w_3, ..., w_n) \tag{5-5}$$

where w is eigenvector and a column matrix.

According to Saaty[38] the eigenvector can be generated in different ways, but the geometric means is the best way to used and it is calculated as follows:

1. Multiply out each row in the matrix shown in Figure 9.

2. Since there are n entries in each row, take the nth root of the multiplication.

3. Normalize those roots by deriving the total and dividing them by the total.

$$a = \sqrt[n]{\frac{w_1}{w_1} \times \frac{w_1}{w_2} \times \frac{w_1}{w_3} \times ... \times \frac{w_1}{w_n}} \quad (5\text{-}6)$$

$$b = \sqrt[n]{\frac{w_2}{w_1} \times \frac{w_2}{w_2} \times \frac{w_2}{w_3} \times ... \times \frac{w_2}{w_n}}$$

$$c = \sqrt[n]{\frac{w_3}{w_1} \times \frac{w_3}{w_2} \times \frac{w_3}{w_3} \times ... \times \frac{w_3}{w_n}}$$

.

.

$$n = \sqrt[n]{\frac{w_n}{w_1} \times \frac{w_n}{w_2} \times \frac{w_n}{w_3} \times ... \times \frac{w_n}{w_n}}$$

$Total = a + b + c + ... + n$, then

$$eigenvector = w = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ . \\ . \\ w_n \end{bmatrix} = \begin{pmatrix} a/total \\ b/total \\ c/total \\ . \\ . \\ n/total \end{pmatrix} \quad (5\text{-}7)$$

The reason eigenvalues are computed in this way is explained in Section 5.5. It is stated by Saaty that this result is not usually consistent; therefore, the reliability of the result must be checked. Checking the consistency is the final step.

5.5 Checking Consistency of the Results

In decision-making, it is important to know how good the consistency is. Consistency in this case means that the decision procedure is producing coherent judgments in specifying the pairwise comparison of the criteria or alternatives.

Matrix A satisfies the cardinal consistency rule. The cardinal consistency rule is:

$$a_{ij} a_{jk} = a_{ik} \text{ for } i, j, k = 1, \ldots n. \tag{5-8}$$

When A is consistent, and

$$a_{ij} = \frac{w_i}{w_j} \Rightarrow \mathrm{w}_\mathrm{i} = a_{ij} \mathrm{w}_\mathrm{j} \text{ for } i, j = 1, \ldots n. \tag{5-9}$$

Therein lies the following matrix equation:

$$Aw = \begin{bmatrix} a_{11} & a_{12} & . & . & . & a_{1n} \\ a_{21} & a_{22} & . & . & . & a_{2n} \\ . & & & & & . \\ . & & & & & . \\ . & & & & & . \\ a_{n1} & a_{n2} & . & . & . & a_{nn} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ . \\ . \\ . \\ w_n \end{bmatrix} = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & . & . & . & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & . & . & . & \frac{w_2}{w_n} \\ . & & & & & . \\ . & & & & & . \\ . & & & & & . \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & . & . & . & \frac{w_n}{w_n} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ . \\ . \\ . \\ w_n \end{bmatrix}$$

$$Aw = \begin{bmatrix} \frac{w_1}{w_1} w_1 + & \frac{w_1}{w_2} w_2 + & . & . & . & + \frac{w_1}{w_n} w_n \\ \frac{w_2}{w_1} w_1 + & \frac{w_2}{w_2} w_2 + & . & . & . & + \frac{w_2}{w_n} w_n \\ . & & & & & . \\ . & & & & & . \\ . & & & & & . \\ \frac{w_n}{w_1} w_1 + & \frac{w_n}{w_2} w_2 + & . & . & . & + \frac{w_n}{w_n} w_n \end{bmatrix} = \begin{bmatrix} w_1 + w_1 + ... + w_1 \\ w_2 + w_2 + ... + w_2 \\ . \\ . \\ . \\ w_n + w_n + ... + w_n \end{bmatrix}$$

$$Aw = \begin{bmatrix} nw_1 \\ nw_2 \\ . \\ . \\ . \\ nw_n \end{bmatrix} = n \begin{bmatrix} w_1 \\ w_2 \\ . \\ . \\ . \\ w_n \end{bmatrix} = nw$$

$$Aw = nw \qquad (5\text{-}10)$$

In matrix theory, this equation, 5-10, is satisfied only if w is an eigenvector of A with eignvalue n. (That is the reason that the eigenvector is computed as in the previous section).

Hence, all the rows in the represented matrix are constant multiples of the first row. From linear algebra, all the eigenvalues $\lambda_i, i = 1,...n$ are zero except one. Let that one be called $\lambda_{\max}$. Since A is a reciprocal matrix and all the entries are positive, all the eigenvalues of A are positive and unique.

$$\sum_{i=1}^{n} \lambda_i = Trace(A) = n \tag{5-11}$$

The trace of a matrix is summation of the diagonal entries. Since the diagonal entries of A are one, then the trace of A is *n*.

Since all the eigenvalues λ_i are zero except $\lambda_{\max}$, then

$$\sum_{i=1}^{n} \lambda_i = \lambda_{\max} . \tag{5-12}$$

This implies that $\lambda_{\max} = n$ and $\lambda_{\max}$ can be used as an approximation for n.

After getting w, $\lambda_{\max}$ can be computed as follows:

$$Aw = \lambda w \quad \text{,where } \lambda = \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ . \\ . \\ . \\ \lambda_n \end{bmatrix} \text{ and } \lambda w = \begin{bmatrix} \lambda_1 w_1 \\ \lambda_2 w_2 \\ . \\ . \\ . \\ \lambda_n w_n \end{bmatrix} \tag{5-13}$$

Also,

$$Aw = \begin{bmatrix} a_{11} & a_{12} & . & . & . & a_{1n} \\ a_{21} & a_{22} & . & . & . & a_{2n} \\ . & & & & & . \\ . & & & & & . \\ . & & & & & . \\ a_{n1} & a_{n2} & . & . & . & a_{nn} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ . \\ . \\ . \\ w_n \end{bmatrix} =$$

$$\begin{bmatrix} a_{11}w_1 + & a_{12}w_2 + & . & . & . & +a_{1n}w_n \\ a_{21}w_1 + & a_{22}w_2 + & . & . & . & +a_{2n}w_n \\ . & & & & & . \\ . & & & & & . \\ . & & & & & . \\ a_{n1}w_1 + & a_{n2}w_2 + & . & . & . & +a_{nn}w_n \end{bmatrix} = \begin{bmatrix} \lambda_1 w_1 \\ \lambda_2 w_2 \\ . \\ . \\ . \\ \lambda_n w_n \end{bmatrix} \tag{5-14}$$

Then,

$$\begin{bmatrix} \lambda_1 \\ \lambda_2 \\ . \\ . \\ . \\ \lambda_n \end{bmatrix} = \begin{bmatrix} a_{11}\frac{w_1}{w_1} + & a_{12}\frac{w_2}{w_1} + & . & . & . & +a_{1n}\frac{w_n}{w_1} \\ a_{21}\frac{w_1}{w_2} + & a_{22}\frac{w_2}{w_2} + & . & . & . & +a_{2n}\frac{w_n}{w_2} \\ . & & & & & . \\ . & & & & & . \\ . & & & & & . \\ a_{n1}\frac{w_1}{w_n} + & a_{n2}\frac{w_2}{w_n} + & . & . & . & +a_{nn}\frac{w_n}{w_n} \end{bmatrix} = \begin{bmatrix} \sum_{j=1}^{n} a_{ij}\frac{w_j}{w_1} \\ \sum_{j=1}^{n} a_{ij}\frac{w_j}{w_2} \\ . \\ . \\ . \\ \sum_{j=1}^{n} a_{ij}\frac{w_j}{w_n} \end{bmatrix} \tag{5-15}$$

Therefore,

$$\begin{bmatrix} \lambda_1 \\ \lambda_2 \\ . \\ . \\ . \\ \lambda_n \end{bmatrix} = \begin{bmatrix} \sum_{j=1}^{n} a_{ij}\frac{w_j}{w_1} \\ \sum_{j=1}^{n} a_{ij}\frac{w_j}{w_2} \\ . \\ . \\ . \\ \sum_{j=1}^{n} a_{ij}\frac{w_j}{w_n} \end{bmatrix} \tag{5-16}$$

Hence,

$$\lambda_{\max} = \max(\lambda_1, \lambda_2, ..., \lambda_n). \tag{5-17}$$

$$\lambda_i = \sum_{j=1}^{n} a_{ij} \frac{w_j}{w_i} \text{ then } \lambda_{\max} = \max(\lambda_i) \tag{5-18}$$

If $\lambda_{\max}$ is close to n, it implies that w is consistent. If $\lambda_{\max}$ is not close to n, it implies that w is not consistent. An index is needed to measure the consistency of weights. The following index, the consistency index, was suggested by Saaty:

$$\text{Consistency index}, C.I = \frac{\lambda_{\max} - n}{n-1} \tag{5-19}$$

This is an index to assess how much the consistency of pairwise comparisons differs from perfect consistency. The numerator signifies the deviation of the maximum eigenvalue ($\lambda_{\max}$) from perfect consistency, which is n. The denominator is needed to compute an average deviation of each pairwise comparison from perfectly consistent judgment. A value of one was subtracted from the order of matrix n, because one of the pairwise comparisons is a self-comparison, and there should be no inconsistency involved in self-comparison.

The consistency check of pairwise comparison is done by comparing the computed consistency index with the average consistency index of randomly generated reciprocal matrices using the one-to-nine scale. The consistency index computed this way is called the random index (RI). Table 5 shows the random indices for matrices of order 1 through 10.

Table 5 Random Indices (RI) [40]

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.4	1.45	1.49

AHP measures the overall consistency of judgments by means of a consistency ratio (CR). The consistency ratio is obtained by dividing the computed consistency index by the random index:

$$CR = \frac{C.I}{RI} \tag{5-18}$$

Saaty[38] stated that a consistency ratio of 0.10 or less can be considered acceptable; otherwise, the judgments should be improved. This improvement would be done by double-checking the data entry and by omitting bad judgments that have high inconsistency ratios.

5.6 AHP Advantages

A great advantage of the AHP method is that by structuring the function of a system hierarchically in multiple objective frameworks, the fuzziness of imprecise phenomena can be measured in a meaningful way. The AHP method's comparative advantage lies in dealing with areas too fuzzy, too unstructured, or too political for traditional techniques which require that the measurement scale be made explicit.[43] Other advantages of the AHP are:

- It provides a single, easily understood model for unstructured problems.
- It enables decision-makers to refine their definition of a problem and improve judgment and understanding by repeating the process.
- It agrees well with the behavior of decision-makers, since decision-makers base judgments on knowledge and experience and then make decisions accordingly.[31]

- It helps the decision-makers not only to set the relative order of importance of different criteria or projects, but also to indicate how much importance one may have over the other.
- It does not require consensus, but rather produces a representative outcome based on diverse judgments.
- It leads to an overall estimate of the desirability of each alternative.
- It can deal with the interdependence of elements in a system.
- It reflects the natural tendency of the human mind to sort elements of a system into different levels and to group like elements within each level.
- It tracks the logical consistency of judgments used in determining priorities.

6.0 RESEARCH METHODOLGY

This research developed a multi-criteria decision-making model for the selection of BOT proposals by the public sector. The methodology, as presented in Figure 10, consists of six steps:

- Step one: a literature review that is both intensive and comprehensive for the following: (1) trends of privatization regarding public/private partnership for toll roads; (2) review of BOT projects, including concept, structure and process, and applications; and (3) review of multi-criteria decision-making processes,
- Step two: identification of (1) the problem, (2) the decision process for selecting the best BOT proposals, and (3) selection criteria and sub-criteria.
- Step three: structuring the decision process as a hierarchy.
- Step four: developing the preliminary model and refining the decision-making procedure.
- Step five: validation of the model using a case study.
- Step six: discussion and conclusions.

6.1 Research Approach and Problem Area

BOT toll road projects are large investments with complex and multidimensional characteristics. Selecting the best proposals is a crucial part of a government's BOT policy.

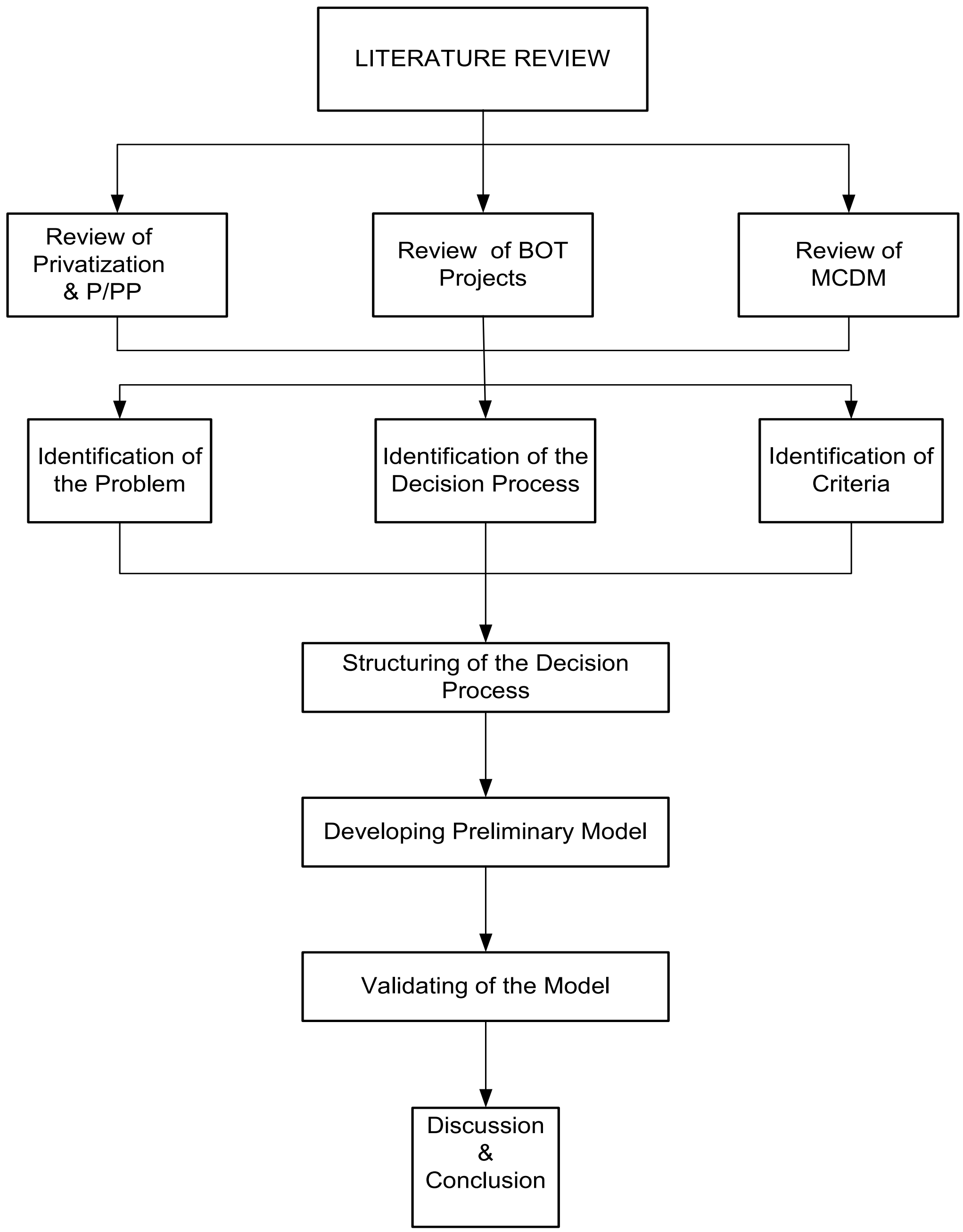


Figure 10 Research Methodology

Given that, governments should adopt more competitive bidding/tendering protocols for BOT projects in order to achieve an optimal and efficient selection process and to develop a trustworthy and attractive field of BOT projects. Private sponsors cannot be expected to invest time and resources developing bids if the process for awarding BOT projects is not orderly, fair, and transparent so that a promoter's chances for success are predictable. The bid evaluation criteria must be clearly defined and the bids must be evaluated in a public and objective manner.(21)

One of the main factors behind successful BOT projects is a complete and reliable selection process. Tiong(8) indicates that choosing the best proposals depends on three elements: clear and specific criteria, the quality of the evaluation process, and selection of the best proposal. The competitive method is the most common technique used in the selection process.

Currently, there is no systematic process or selection criteria to guide decision-makers within the public sector to make quality selections. Rather, the criteria and the decision procedure are often unclear. In addition, previous research has rarely considered the specific needs of the public sector.

To identify our specific research problem, we will first explain the selection process and existing evaluation techniques and then identify the research problem considered in this thesis.

6.2 Selection Process

The commonly used selection process consists of five stages, as presented in Figure 11. First, a government issues requests for qualification (RFQ) and selects the qualified development companies or consortia. Second, the government issues the requests for a specific project proposal (RFP) to the qualified consortia. Third, the government evaluates the proposals and selects the best ones for the project. This stage -- evaluation and selection of the proposals -- is the focus of our research. In this stage, the government "short lists" or selects the best proposals to be promoted to the next stage -- the negotiation stage. Fourth, the government negotiates with the selected promoters regarding points that had not been settled in the previous stage. Finally, the government selects the winner of the project.

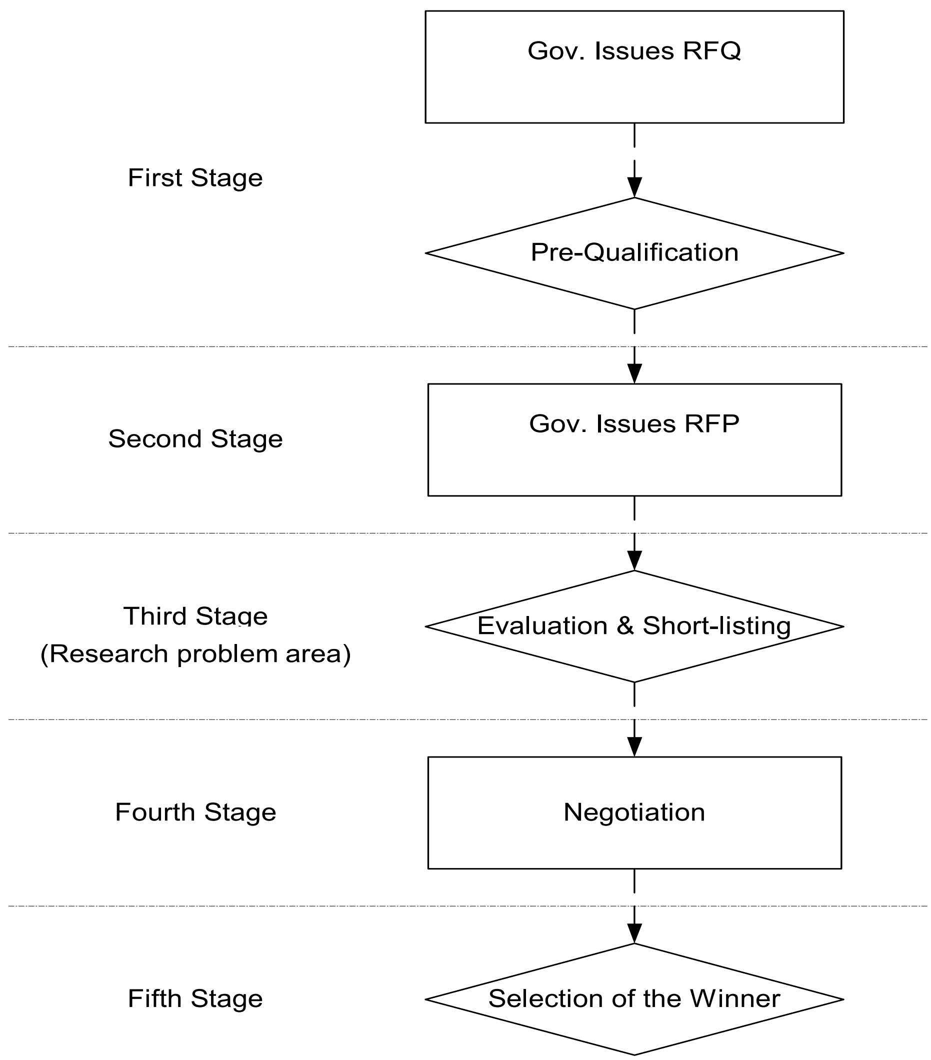


Figure 11 BOT Selection Process

6.2.1 RFQ and Pre-qualification

BOT infrastructure projects are large projects requiring a great deal of investment, commitment, and related experience. Therefore, a government usually uses the request for qualification (RFQ) to make sure that RFPs are issued to only reputable and experienced parties. Though this is the common procedure, some governments do not request qualification but instead follow the convention of simply advertising the project and accepting the proposals. Governments do this because they think that BOT infrastructure projects are large enough to eliminate small contractors from bidding.

Due to the burdensome nature of the technical, financial, and/or political constraints imposed upon the promoters, the number of promoters bidding on a BOT contract is generally limited.[8]

6.2.2 RFP and Tendering

In an RFP, the government states the broad requirements which have to be satisfied in the proposals. These requirements must include maximizing the economic, social, political, and environmental benefits to the public as well as solving the identified needs of the project.[8]

6.2.3 Evaluation Techniques

A government evaluates and ranks the proposals in order to select the best ones for the next stage of the tendering process, and this important stage greatly affects the final selection and the winner of the project.

The government usually forms an assessment panel to evaluate the proposals submitted by the pre-qualified promoters. Usually, the chairperson and some members of the group come from the transportation authority, and other members come from other related areas of the government such as financial, legal, and environmental. This group of decision-makers evaluates all aspects of the proposals.

The net present value (NPV) and score system are the most common evaluation techniques used by governments. Some governments also use different techniques like the Kepno-Trego technique or the single-criterion evaluation technique, based on their specific needs or priorities.

6.2.3.1 The NPV method. NPV, or a similar evaluation technique, the internal rate of return (IRR), is based on the discounted cash flow model. This model combines all the cash flow profiles of a project for the project period adjusted for time value of money and represents them as a measure of profitability, such as NPV or IRR. The NPV method shows the difference between the present value of the revenues and the present value of the expenditures of a project.

Some governments evaluate a proposal's commercial and financial package by performing an NPV; the lower the NPV, the cheaper the offer. For utilities projects, the comparison is straightforward as it is generally based on the government's offtake agreement. For a toll road, it is more complicated as traffic is not normally guaranteed. Nevertheless, as long as there are adequate traffic studies and conservative traffic forecasts, the government will compare the NPV of the cash flow based on the toll revenues, operation and maintenance costs, financing charges, and loan repayments.

The advantage of using the NPV method is that the proposals can be compared based on numbers. The disadvantage of this method is that it does not consider or evaluate the technical aspects of the proposals.(8)

6.2.3.2 <u>Score system</u>. In this evaluation system, the government sets up selection criteria and weighs financial, technical, and other aspects of the proposals. Points are given to each selection criterion, and the proposal with the highest overall score is considered to be the best one. The advantage of this method is that several criteria are used in comparing the proposals. The disadvantage is that it assumes that all criteria are of equal importance.(8)

6.2.3.3 <u>The Kepno-Trego Technique.</u> This technique first separates the "must" or essential criteria from the "want" criteria, and any tender that fails to meet any "must" is rejected at the outset. Next, the degree to which the "wants" are satisfied is evaluated, with overall scores being derived for each tender.(10)

The Kepno-Trego technique is preferable to the NPV because it includes criteria other than financial ones, and it is better than the score system because it segregates the essential criteria from other criteria. However, the Kepno-Trego technique does not indicate the relative weight for each criterion or consider how criteria are interrelated and affect each other, but rather simply weighs the effect of each criterion separately.

The result of this evaluation stage is the selection of a few proposals for the short list, which are then considered in the next stage of the process.

6.2.4 Negotiation Stage

In the negotiation stage, the government seeks further clarification of the proposals and negotiates with the promoters. The government may request more details about the design, do risk analyses and risk sharing negotiations, complete detailed financial evaluations, etc.

6.3 Identification of the Research Problem

The stages and procedure included in the evaluation process described above are adequate, but a problem is apparent with the evaluation criteria and techniques, or the third stage of the process. The evaluation procedure described above has the following main problems:

- The procedure does not consider and include the effect of all criteria and variables affecting the BOT project. For example, some governments do not include important criteria such as technical criteria in their evaluation. This may eliminate one of the advantages of having a BOT project, which is that the private sector is more efficient and can often provide innovative technical solutions.
- The evaluation technique is not a clear procedure with criteria known in advance, and this reduces the transparency of the evaluation. Governments, especially in developing countries or in countries new to BOT projects, should attract the private sector to this field by increasing the transparency of the process.
- Currently, in order to overcome the evaluation problem, the private promoters either raise the cost of their proposal during tendering in order to be able to meet possible unknown

evaluation criteria, or they lower their cost to make sure they will be selected for short-listing but then raise their cost during the negotiation stage. In both cases, the public sector ends up with a project with greater cost or fewer benefits.

- BOT projects are a new field for the public sector in most countries. Decision-makers lack knowledge and experience in evaluating them, especially in developing countries.

An improved evaluation model for selection of the best proposals for BOT toll road projects should include the following essential characteristics: transparency, simplicity, robustness, and accountability.(24) An effective model, such as the one developed in this research, should:

- Be based on a simple data acquisition system and an appropriate analytical tool.
- Be able to be clearly interpreted by decision-makers.
- Include and weigh all the criteria affecting the project, both tangible and intangible.
- Be capable of making clearly derived decisions that can be traced back through the different stages of the process.
- Be able to accommodate any number of criteria and any number of proposals.

7.0 MODEL FORMULATION

7.1 Identifying a Model of Solution

As we have seen, the problem addressed in this research involves multiple criteria, and the decision process is carried out by a group of decision-makers. Thus, this research has developed a multi-criteria decision-making model to address this problem.

In Chapter 4, we explored various models, and we concluded that AHP is the most suitable model for this research problem, thereby determining the selection criteria and their relative weights. This is because other multiple-criteria decision-making techniques lack AHP's capability to elicit expert judgment and provide consistent feedback to decision-makers.(28)

As described in the following sections, and shown in Figure 12, the model of this research consists of the following steps:

- Gathering project data;
- Identifying project evaluation criteria and sub-criteria;
- Structuring the hierarchy;
- Enabling the group's decision-making process by:
  - developing pairwise comparison using EC software,
  - facilitating consensual agreement through voting,
  - checking the consistency ratio,
  - revising the judgment if needed,
  - ranking the proposals and having the group agree on the ranking
- Selection of the best alternative from the top-ranked proposals.

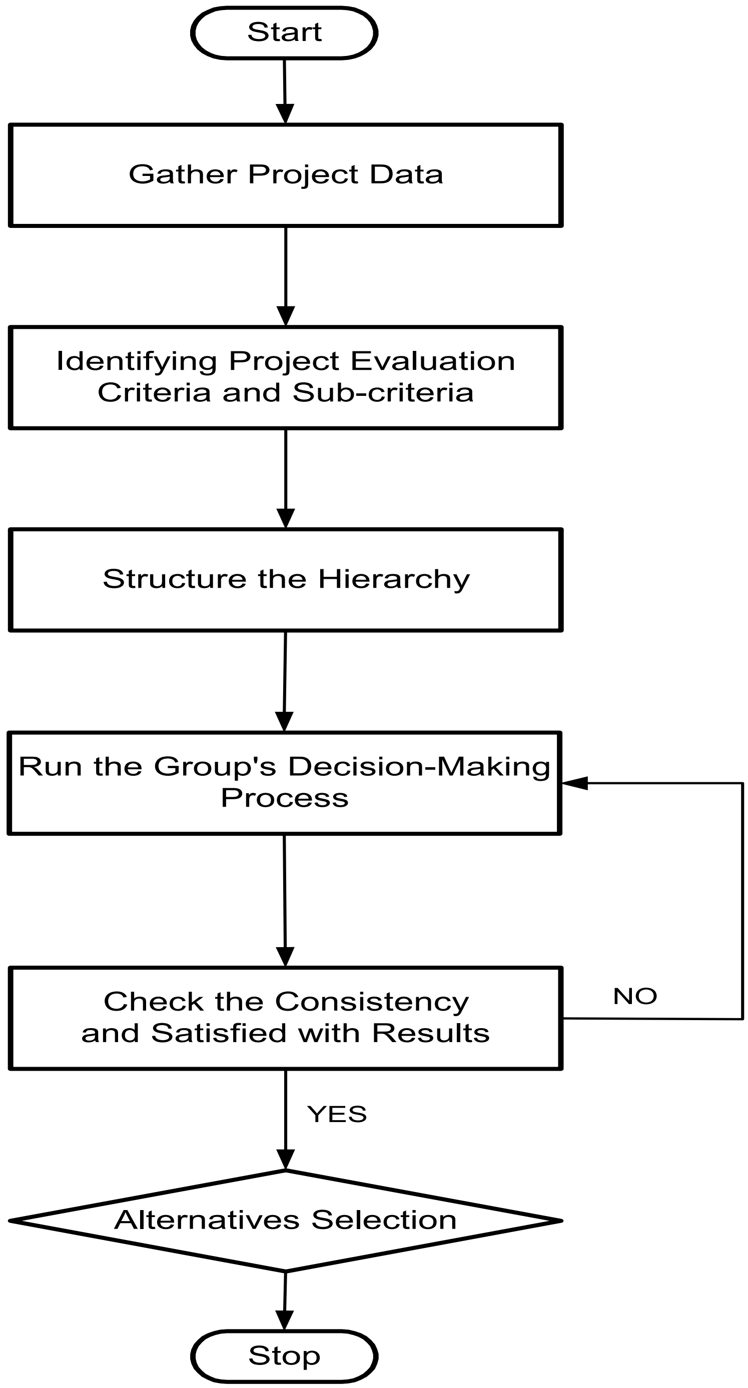


Figure 12 Research Model

7.2 Gathering Project Data

Usually, when a government prepares the request for proposal, it indicates its specific needs as well as the evaluation process and criteria to be used. The particular needs and requirements differ from country to country and from project to project. Given the complexity of road infrastructure projects and the diversity of objectives that road agencies often have for their projects, it is often difficult for a government to come up with an ideal bidding rule. Although it is relatively easy for a government to identify its particular needs, the evaluation process and evaluation criteria require great knowledge and previous experience of BOT toll road projects.

Currently there is no standard that can help a government in preparing and choosing selection criteria. However, this research has developed a general evaluation process and criteria that could be used as guidelines for governments and that can enable each government to determine the appropriate weight or importance of each criterion based on the project situation.

7.3 Identifying Project Selection Criteria

In developing a competitive procedure, the most crucial aspect is the evaluation criteria used to select the winning sponsors. It is highly recommended to develop a standard bidding process with known criteria as well as a transparent procedure for requesting and evaluating proposals.[44]

As maintained earlier, the selection/evaluation process is one of the crucial parts of a BOT project. This process should have precise criteria that cover all aspects of the process (financial, technical, social, environmental, etc.).

This research has developed a model which includes all of the common criteria that usually affect the selection process of BOT toll road projects. In reviewing previous projects, we noticed that the selection process often limited the selection criteria, in some cases to only a single criterion, as occurred in Chile and Hungary.[8,44]

This research, by contrast, aimed to establish general criteria which could meet the different needs of each project and/or country. And given the capability of the EC software, the decision-makers can suspend any criteria which do not comply with their needs and can select the most suitable weight for each criterion. The criteria developed by this research should help to enable clear and fair evaluation, which will help achieve a win-win outcome for both private and public interests. Although previous research has briefly stated limited selection criteria[8,13,14], this research derived a comprehensive list of criteria covering all aspects of a BOT toll road project. This list includes the following five main criteria:

- promoters' qualifications,
- project evaluations,
- financial feasibility,
- implementation requirements, and
- socio-economic effects.

Table 6 shows the list of the main criteria and sub-criteria.

Table 6 Selection Criteria and Sub-criteria

Promoters' Qualifications
Experience of the principal firms
Financial capacity and strength
Parent company support
Project Evaluations
Compliance with tender, and local guidelines and plans
Degree of project definition and scope
Enhancement of existing transportation system
Compatibility with existing transportation system
Technical innovation
Realistic construction schedule
Maintainability and durability of the project
Project necessity
Financial Feasibility
Compliance with requirements for the financial package
Appropriateness of financial plan
Level of public resource required
Financial return to the government
Reasonable toll rate and toll adjustment method
Non-toll revenue support
Implementation Requirements
Compliance with environmental requirements
Degree of local opposition/support
Handling right-of-way acquisition
Ease of implementation
Socio-Economic effects
Contribution to economy
Benefit to community
Local participation and involvement
Local procurement of materials

7.3.1 Promoters' Qualifications

The main factors considered in evaluating promoters include: accomplishments in past and current business, track record in managing large and complex civil works contracts, financial strength, experience in operating toll roads, and capability relative to the number and size of current projects.

The sub-criteria for this criterion include:

1. **Experience of principle firms**: the principle members of the consortium should be evaluated for: (1) technical experience, especially with similar projects; (2) managerial and leadership structure; (3) project managers' experience; (4) ability to deal with the public sector; and (5) size and type of ongoing projects. The greater the experience of principle firms, the higher the ranking.
2. **Financial capacity and strength**: the evaluators should assess the financial ability of the consortium, its capability to commit, and its ability to obtain its own financial resources for the proposed project. As we maintained earlier, the size and scale of a BOT project requires a strong financial capability of the consortium. The greater the financial capacity, the higher the ranking.
3. **Parent company support**: since the consortium will obtain its technical and financial strength from the parent company, the evaluators should check the size and the type of support the consortium will receive from the parent company. Adequate support will also ensure the quality of building and operating the project. Usually, it is better to include in the consortium an international firm, which could improve the technical solution and strengthen the possibility of financing for the project. But this should not to reduce the

chances for capable local participation. The greater the availability of support from the parent company, the higher the ranking.

7.3.2 Project Evaluations

Each project has its unique conditions, priorities, and nature. It is important to check the effect of these factors on the project criterion and to make sure that the proposal meets this criterion. This category evaluates the technical characteristics of the project, whereas the next one evaluates the financial characteristics. The sub-criteria for project qualification are:

1. **Compliance with tender and local guidelines and plans**: evaluators should insure that the project will satisfy the objectives and guidelines given in the request for proposals, and that the project is consistent with the country's transportation plan as well as local rules and regulations. The better the compliance, the higher the ranking.
2. **Degree of project definition and scope**: the promoter should clarify the scope of the project considering characteristics such as size, estimated cost, assumptions, and duration of the project. The clearer the scope and definition of the proposal, the higher the ranking.
3. **Enhancement of existing transportation system**: this sub-criterion measures the degree that the project will improve or solve existing problems in the transportation system, as well as how the system will benefit from the project. The greater the enhancement, the higher the ranking.
4. **Compatibility with existing transportation system**: evaluators should ensure the compatibility of the proposal with the existing network. The project should comply with local transportation plans, and the design should meet the standards and specifications

used within the country. The greater the compliance with the existing system and the less the required work to connect the project to the existing system, the higher the ranking.

5. **Technical innovation**: evaluators should measure how much the project can contribute to the system and country by the transfer of technology from the contractor, equipment suppliers, and operator to the project company, and hence to the local government. Such technology transfer could come through a training program for the local staff who will operate the project at the end of the concession period, and will be increased by the use of advanced and cost-effective equipment such as electronic toll collection. Innovative techniques will increase the project's durability and efficiency. The greater the technical innovation, the higher the ranking.
6. **Realistic construction schedule**: toll road projects are usually schedule-driven. The earlier the project enters into operation, (1) the sooner the local government can solve or improve the transportation system, and (2) the earlier the revenue stream starts, thus saving financial costs and increasing rate of return on the project.(14) The shorter and more realistic the schedule, the higher the ranking.
7. **Maintainability and durability of the project**: the evaluators should measure the ability of the project promoters to develop a quality design that uses durable equipment and material. The greater the maintainability and durability, the higher the ranking.
8. **Project necessity**: decision-makers should assess the project necessity by checking the need for the project, the seriousness of the problem that this project will solve, and the project's contribution to the transportation system. The greater the necessity, the higher the ranking.

7.3.3 Financial Feasibility

A BOT proposal should be evaluated clearly and carefully to insure that the BOT project is financially viable and that there are sufficient funds to cover the cost of implementing the project according to the planned objectives and schedule. The sub-criteria for financial feasibility are:

1. **Compliance with requirements for the financial package**: evaluators should ensure that the proposal complies with the financial requirements of the government. The greater the compliance, the higher the ranking.
2. **Appropriateness of financial plan:** in BOT projects, it is essential to structure a financial package or plan which matches the anticipated cash flow generated by the project. The evaluators should ensure that the plan includes a feasibility study, an investment proposal, and a pricing proposal. The plan should be efficient and involve minimum financial risk to the government. The plan should also show the source of financing for the project, whether equity or bonds. The proposal with stronger and more sound financial plans will be given more weight. The greater the appropriateness of the financial plan, the higher the ranking.
3. **Level of public resources required:** the government should seek to minimize the need for public financial support for the project in order to maximize the benefit of the project. In some cases, government financial support and risk assumption may be necessary to support a project that would otherwise be unable to close financing because of weak project economics or an unfavorable country and concession environment.(19) This sub-criterion will indicate the level of the support required by the government. This support

could be in the form of minimum revenue guarantees, cash grants, loans, or any other form of financial support. The less the required public support, the higher the ranking.

4. **Financial return to the government:** the evaluators should check whether the government will receive revenue that exceeds the return-on-investment ceiling. From the government's point of view, this measure can make the proposal more attractive; however, it is recommended that some minimal share of this revenue on the investment ceiling be given to the concessionaire as an incentive to continue operating efficiently after it has reached the return-on-investment ceiling. The higher the financial return to the government, the higher the ranking.
5. **Reasonable toll rate and toll adjustment method:** the rationale for the toll adjustment mechanism is to both maintain a low and stable rate as the government aims, and to allow the franchise option to increase tolls under certain conditions at specified dates, in the hope of achieving a reasonable but not excessive level of return.(13) The base toll rate and the subsequent adjustments which compensate for an increase in operational cost during the concession period should keep the project financially viable for the sponsors and fair for the public. The lower the toll rate, the higher the ranking.
6. **Non-toll revenue support:** this variable considers the resources other than toll which could be generated from services along the road, such as service areas, and right-of-way access for utilities like telephone, cable, or fiber optics. Even though the toll revenue is the main source of income, the evaluators should not ignore these additional sources. The greater the non-toll revenue generated, the higher the ranking.

7.3.4 Implementation Requirements

This criterion relates to the condition of some requirements that are essential for the implementation of the project. The sub-criteria are:

1. **Compliance with environmental requirements:** it is very important for the evaluators to assess the environmental impact of the project seriously and to provide the required environmental assessment plan. The environmental impact includes the effects of vehicle emissions on air quality, noise and vibration, the greenhouse effect, and the impact on historic value of buildings. The less the environmental impact, the higher the ranking.
2. **Degree of local opposition/support:** one of the greatest impediments to toll roads is the public's resistance to paying tolls, especially on existing roads that the public often perceives as already paid for through tax revenues. On the other hand, sometimes the public prefers paying tolls rather than waiting for public funding, especially if the project may contribute to the local economy. Thus, it is important for evaluators assess the local support. The greater the local support, the higher the ranking.
3. **Handling right-of-way acquisition:** land acquisition is a complicated issue in many BOT projects. In order to have a financially viable project, it is important to decide how much the sponsor will pay for the land right-of-way as well as how much the government should bear of that cost. The lower the government's contribution to the cost of right-of-way acquisition, the higher the ranking.
4. **Ease of implementation:** evaluators should assess the practicality of the project design and how easily it can be implemented. This is determined by evaluating the design, the type of materials and equipment, and the project location. The easier the implementation, the higher the ranking.

7.3.5 Socio-Economic Effects

This criterion considers the proposal's socio-economic impact and effect. It is very important to measure the cost and benefits to the local public and to make sure that they will not end up with a greater cost than benefit. The sub-criteria are:

1. **Contribution to economy:** evaluators should assess the project's likely enhancement of the local economy through growth and employment in other industries, technology transfer, improving labor force skills, etc..(21) The greater the contribution, the higher the ranking.
2. **Benefit to community:** a local community can gain benefits from a project other than the transportation gain; these include an increase in the land value, an increase in the job market, etc. The greater the benefit, the higher the ranking.
3. **Local participation and involvement:** evaluators should assess the possibility of local participation. This could come in different forms: subcontracting, local financing, local recruitment of labor, involvement of minority businesses and/or labor. The greater the local participation, the higher the ranking.
4. **Local procurement of materials:** evaluators should ensure that promoters use local materials and services as long as they are competitive with regard to quality, price, service, and schedule of delivery. The greater the local procurement, the higher the ranking.

7.4 Structuring the Hierarchy

As we explained in Chapter 5, once the problem is identified and the decision's goal and evaluation criteria recognized, the decision can be structured as a hierarchy. The structure of this research model consists of a four-level hierarchy:

- The top level, the goal, is to select the best BOT toll road proposal.
- The second level, or the criteria, includes the main five criteria: promoters' qualifications, project qualifications, financial feasibility, implementation requirements, and socio-economic effects.
- The third level, or the sub-criteria level, includes the 25 sub-criteria discussed in the section above.
- The fourth level, or the alternatives, includes all of the proposals.

Figure 13 shows this hierarchy structure, and Figure 14 shows the same hierarchy in the EC software view.

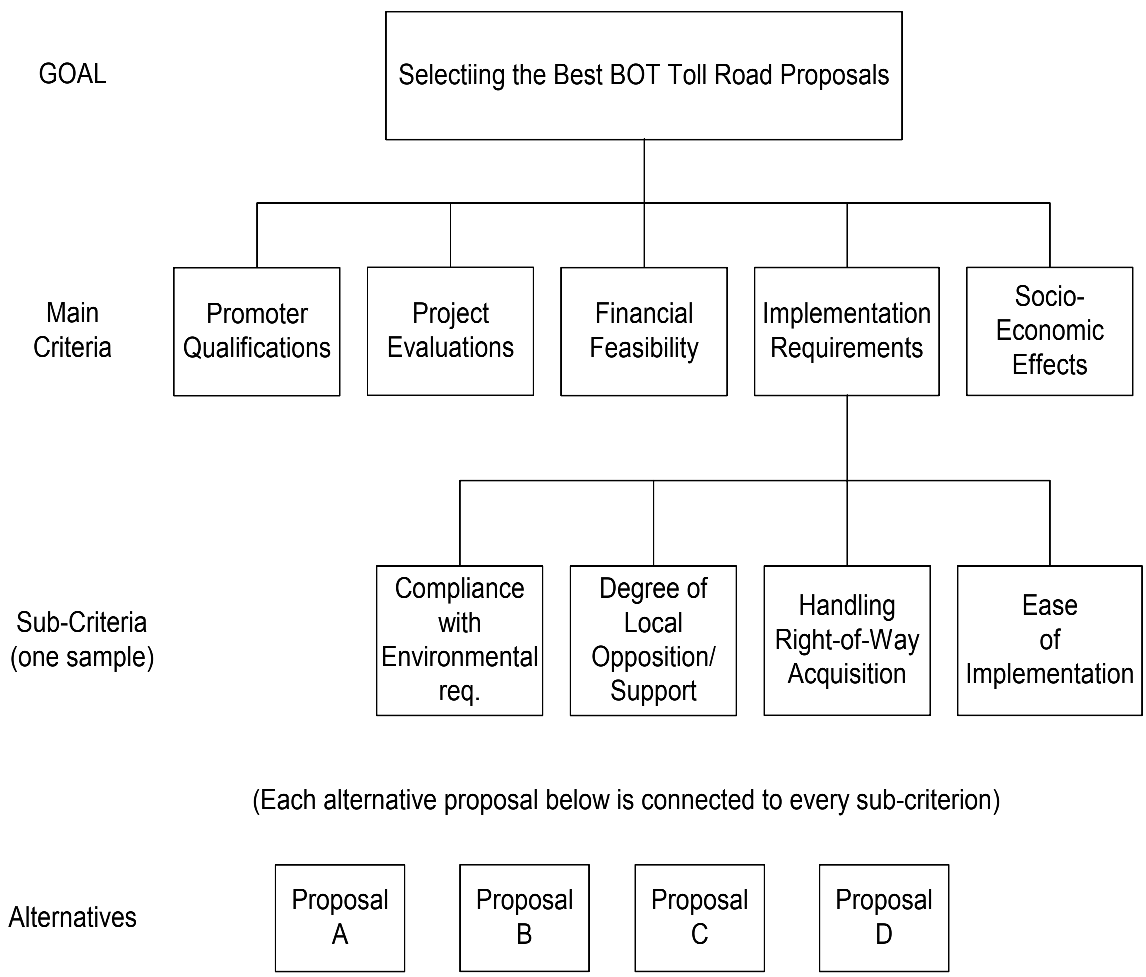


Figure 13 Hierarchy Structure of Selection Process for BOT Toll Road Proposals

Model Name: Selection of BOT toll road proposals

Treeview

- **Goal: Select the Best BOT Toll Road Proposals**
  - **Promoters qualifications**
    - **Experience of the principal firms**
    - **Financial capacity and strength**
    - **Parent company support**
  - **Project qualifications**
    - **Compliance with tender and local guidelines**
    - **Degree of project definition and scope**
    - **Enhancement of existing syatem**
    - **Compatibility with existing transportation system**
    - **Technical innovation**
    - **Realistic construction schedule**
    - **Maintainability and durability of the project**
    - **Project necessity**
  - **Financial feasibility**
    - **Compliance with requirements for the financial package**
    - **Appropriate financial plan**
    - **Level of public resource required**
    - **Financial return to government**
    - **Reasonable toll rate and toll adjustment method**
    - **Non-toll revenue support**
  - **Implementation requirements**
    - **Comply with environmental requirements**
    - **Degree of local opposition/support**
    - **Handling right-of-way acquisition**
    - **Ease of implementation**
  - **Socio-economic effects**
    - **Contribution to economy**
    - **Benefit to community**
    - **Local participants and involvement**
    - **Local procurement of materials**

* *Ideal mode*

Figure 14 The Model Hierarchy in the EC Software View

7.5 Enabling the Group's Decision-Making Process

After identifying the criteria and structuring the hierarchy, the group of decision-makers starts the selection process utilizing this research model, which is based on AHP. Usually a group decision is better than individual one. However, this often requires the following two factors:

- the availability of clear evaluation criteria and sufficient data on all criteria and alternatives;
- the availability of a group of decision-makers who can work as a team, who clearly understand the goal of the process, and who have the same interest and priorities as the organization.

Saaty(38) stated that group decision-making moves faster when the participants have common goals, have a closed long-term contract, work in a climate of social acceptance, and have equal status when participating.

Al-Araimi(28) maintained that the most important issue for making group judgments is the selection of the right mechanism for AHP pairwise comparison judgments. Regarding strategies for conducting group decision-making sessions in which AHP is used, Saaty(45) noted two ways to generate entries for the pairwise comparison matrices at each level: consensus vote and individual judgments. Diao and Zhou have pointed out that having group consensus helps to generate decision alternatives quickly and efficiently. (28) Thus, this research model presumes the use of consensus through voting by the decision-making group.

Utilizing the EC software, the group starts the comparison by evaluating and ranking the five criteria. Then, within each criterion, they evaluate the sub-criteria. Next, they evaluate the alternative proposals against each sub-criterion. As discussed earlier in Chapter 5, the quality of the judgments is validated by checking the degree of consistency. After the group finishes with the judgments, they should check the consistency ratio, and if they find it greater than 0.1, they should review their judgments.

Once the group has reviewed all the judgments and generated the ranking, the top- ranked proposals will be selected.

8.0 VALIDATING THE MODEL WITH A CASE STUDY

8.1 Introduction

After the model was formulated through identification of the criteria and sub-criteria and by developing a framework for the selection process, it was validated. Available strategies for validation of any research project include: case studies, field studies, observation, and experimentation.[46] Observation, a field study, or experimental methods are not appropriate in this research for the following reasons:

- The decision process is a mental process which cannot be easily observed.
- Decisions made throughout the evaluation of BOT projects are usually made without any formal process.
- The data related to the topic of this research is sensitive and confidential to the public sector, and the researcher is not allowed to participate as a facilitator in the real decision process.
- It is hard to set up the decision-making group in an environment that enables observation of the decision process.

However, case study research is very useful in research areas where there is little control of the event[46], such as occurs with the evaluation of BOT projects. This research used a California Department of Transportation (Caltrans) case study for the validation and verification of the model. Due to the sensitivity and confidentiality of this type of data within the government in many countries, the researcher encountered difficulty in obtaining data about additional cases. The Caltrans case, which proved useful, was selected for the following reasons:

- Caltrans data included information about the evaluation criteria, the relative scores of the criteria, and the assigned scores and ranking of the proposals submitted.
- A few other cases were found that included just one criterion and/or one alternative. However, use of this research model requires multiple criteria and more than one alternative; the Caltrans case offered nine criteria and eight alternatives.

The objectives of this validation were: to validate the model in terms of its objective, to identify the Caltrans case study decision output when all the criteria had been used, and to define how to limit the criteria.

8.2 Case Study Background

The report of Gomez-Ibanez et al.[47] is the best source of information about Caltrans's experience with private toll roads. The information in this section and the data of the case study are taken from that report.

In California in the 1970s, highway construction slowed due to a combination of community and environmental opposition and limits on highway funding. By the late 1970s, California could no longer afford to complete its original freeway plan. Thus, Caltrans originated the privatization program in the 1980s to solve the state's growing transportation problem.

The option of privatization was developed by Caltrans with the help of Parsons Municipal Services. Assembly Bill 680 (AB 680) authorized Caltrans to facilitate the development and construction of privately constructed projects.

8.3 Caltrans Evaluation Process and Criteria

Caltrans developed an evaluation process similar to the one described earlier in Chapter 6. After the RFQ were issued, Caltrans received 13 responses from groups representing most of the major U.S. transportation construction and design firms. Caltrans used the scoring system for the evaluation process and used nine criteria with a maximum of 110 points. Table 7 shows Caltrans' evaluation criteria.

Table 7 Caltrans Evaluation Criteria[47]

Criteria		Max. Points
A	Transportation service provided	20
B	Encourages economic prosperity and makes business sense	10
C	Degree of local support	15
D	Ease of implementation	15
E	Experience and expertise of the proposers	15
F	Environmental quality and energy conservation	10
G	Non-toll revenue support	5
H	Degree of technical innovation	10
I	Civil right objectives	10
	Total	**110**

Caltrans then reviewed and evaluated the proposals. Since the selected proposal was required to have at least one project each in northern and southern California, the final selection for the demonstration projects included the following: SR-57; SR-125 (Parsons Brinckerhoff); SR-91 median lanes; and the Midstate tollway. Table 8 shows Caltrans' project ranking and the relative weight of each criterion.

Table 8 Caltrans Project Ranking[47]

Rank	Project	A	B	C	D	E	F	G	H	I	Total
1	SR -57	18.3	8.4	13.1	11.3	11.4	9.4	1.6	9.0	10.0	92.5
2	SR-125 (Parsons)	17.0	8.9	11.4	12.0	13.0	8.3	4.3	9.1	7.7	91.7
3	SR - 91	17.3	7.7	11.0	14.4	12.9	8.1	0.6	9.1	10.0	91.1
4	SR -125 (Bechtel)	18.0	8.7	11.4	11.7	12.0	7.9	3.4	8.4	7.3	88.8
5	LA - Palmdale	13.3	4.1	10.5	7.3	12.7	9.6	4.3	9.3	8.6	79.7
6	Midstate	13.3	7.6	10.9	7.6	13.4	6.6	3.4	8.6	8.0	79.4
7	SR-118/ SR-126	9.6	7.1	9.6	9.1	12.1	5.6	3.9	6.4	9.3	72.7
8	Embarcadero	4.3	3.4	4.4	5.6	10.3	4.6	4.7	3.0	6.7	47.0

8.4 Results and Analysis

In order to run this research model, first the Caltrans criteria were matched against the model's criteria as shown in Table 8; Figure 13 shows the hierarchy of the matched criteria. Second, in order to use the one-to-nine scale of relative importance, Caltrans' criteria scores (shown in Table 7) and the scores given to each project (shown in Table 8), were converted, as shown in Table 9. Third, the pairwise comparison judgments were entered. Then the model was run and the alternatives were ranked.

8.4.1 Model Validation

This research model used Caltrans' criteria and generated exactly the same ranking as Caltrans. Figure 15 shows that ranking. Reaching the same result with independent methodology is validation of the objective of the model.

Table 9 Caltrans Criteria Matched against the Model Criteria

Research Model			Caltrans
Criteria	1-to-9 scale	Score	Criteria
Promoters' Qualifications	**3.375**	**15**	
Experience of the principal firms	3.375	15	**E**. Experience & expertise of proposer
Financial capacity and strength			
Parent company support			
Project Evaluations	**6.75**	**30**	
Compliance with tender guidelines			
Degree of project definition & scope			
Enhancement of trans. system	4.5	20	**A.** Transportation Services Provided
Compatibility with trans. system			
Technical innovation	2.25	10	**H**. Degree of technical innovation
Realistic construction schedule			
Maintainability and durability			
Project necessity			
Financial Feasibility	**1.125**	**5**	
Compliance with financial req.			
Appropriateness of financial plan			
Level of public resource required			
Financial return to the government			
Reasonable toll rate and adjustment			
Non-toll revenue support	1.125	5	**G**. Non-toll revenue support
Implementation Requirements	**9**	**40**	
Compliance with environmental req.	2.25	10	**F**. Environmental quality & energy cons.
Degree of local opposition/support	3.375	15	**C.** Degree of local support
Handling right-of-way acquisition			
Ease of implementation	3.375	15	**D.** Ease of implementation
Socio-Economic effects	**4.5**	**20**	
Contribution to economy	2.25	10	**B.** Encouraging economic prosperity
Benefit to community			
Local participation and involvement	2.25	10	**I**. Civil right objectives
Local procurement of materials			

Model Name: Case study-Caltrans

Treeview

- Goal: Select the Best BOT Toll Road Proposals
  - Promoters qualifications (E) (G: .136)
  - Project evaluations (G: .273)
    - Enhancement of transportation system (A) (G: .182)
    - Technical innovation (H) (G: .091)
  - Financial feasibility (G) (G: .045)
  - Implementation requirements (G: .364)
    - Compliance with environmental requirements (F) (G: .091)
    - Degree of local opposition/support (C) (G: .136)
    - Ease of implementation (D) (G: .136)
  - Socio-economic effects (G: .182)
    - Contribution to economy (B) (G: .091)
    - Local participation and involvement (I) (G: .091)

Alternatives

SR 57	.144
SR 125 (Parsons)	.142
SR-91	.141
SR 125 (Bechtel)	.138
LA -Palmdale	.124
Midstate	.124
SR 118/ 126	.113
Ebarcadero	.073

* *Ideal mode*

Figure 15 Ranking in Caltrans Case Study

8.4.2 The Analysis

The outcome of the results presented above is highly dependent on the hierarchy structured by the decision-makers and on the relative judgments made about the various elements of the problem. Changes in the hierarchy or the judgments may lead to changes in the outcome.[37] For example, Figure 16 shows the sensitivity of the outcome to change in the relative importance of the implementation requirements criteria. With its current weight of 0.364, the top-ranked project is SR-57. If the relative importance of this criterion was judged differently and its weight decreased to 0.15, the top-ranked project would then be SR-125 (Parsons).

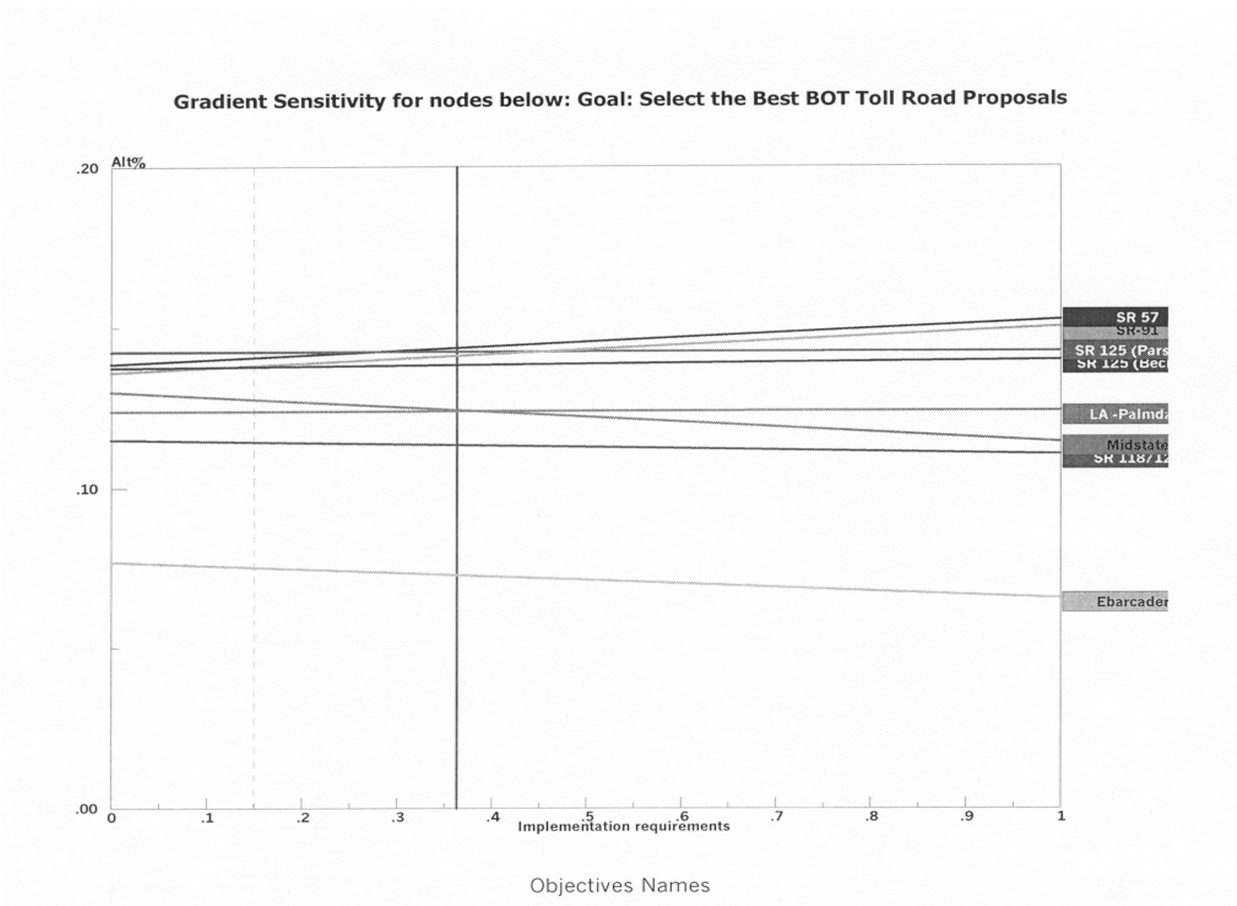


Figure 16 Sensitivity of the Outcome to Change in Criteria Weight

The results of this case study were also tested by examining the performance sensitivity shown in Figure 17, which is also part of the model output. The overall ranking of alternatives is presented at the right side of this figure. The curves in Figure 17 indicate the ranking of the alternatives for each of the main criteria. The curve for SR-57, for example, shows it is ranked first on all criteria except for promoters' qualifications and financial feasibility.

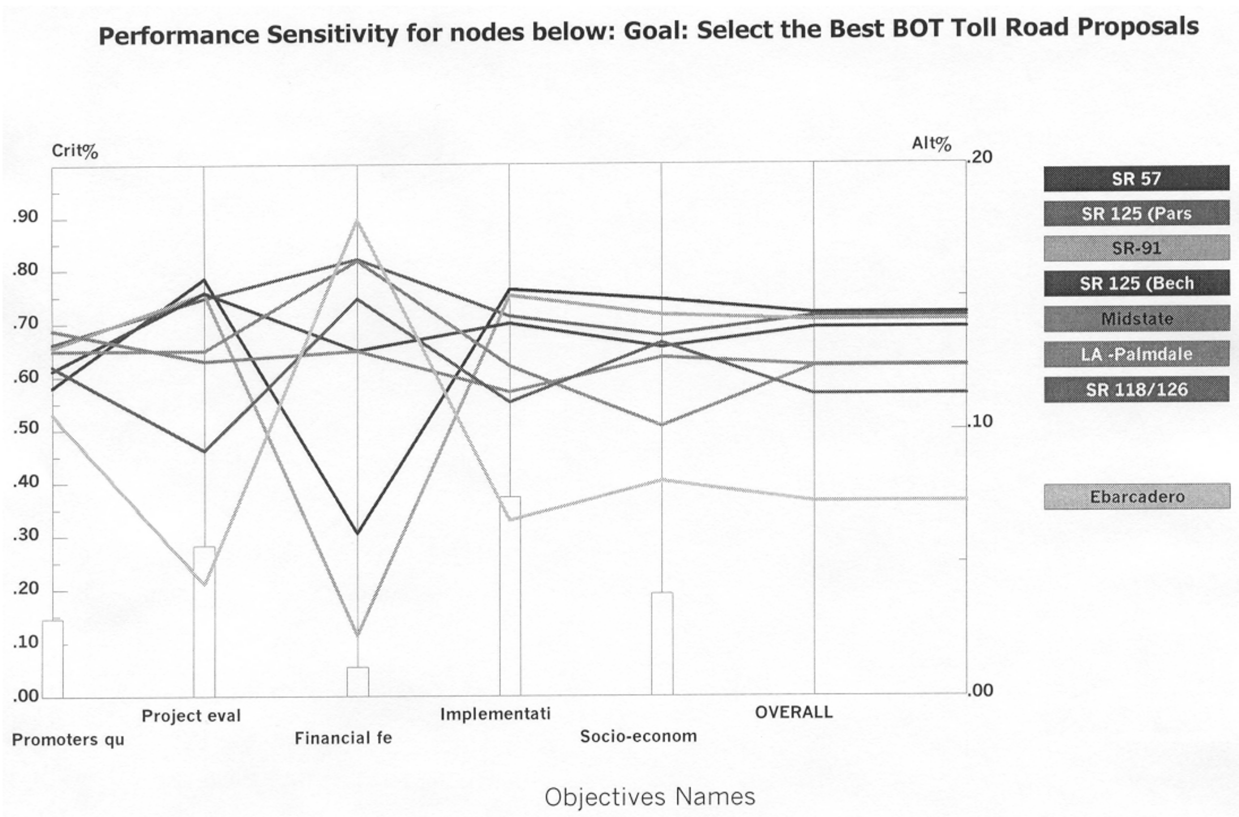


Figure 17 The Performance Sensitivity of Alternatives

The effect of potential changes in the relative importance of the criteria on the resulted ranking of the alternatives was investigated. As shown in Figure 18, increasing or decreasing the assigned weight of a criterion (represented by the length of the bar) would accordingly affect the priority of the alternative most affected by that criterion. Figure 19 shows how the top-ranked alternative changed from SR-57 (as seen in Figure 18) to SR-125 (Parsons) (as seen in Figure 19) when the weight of the financial feasibility criterion was changed to 10.1%.

Appendix A shows the detailed pairwise comparison and priorities of this validation in EC printout.

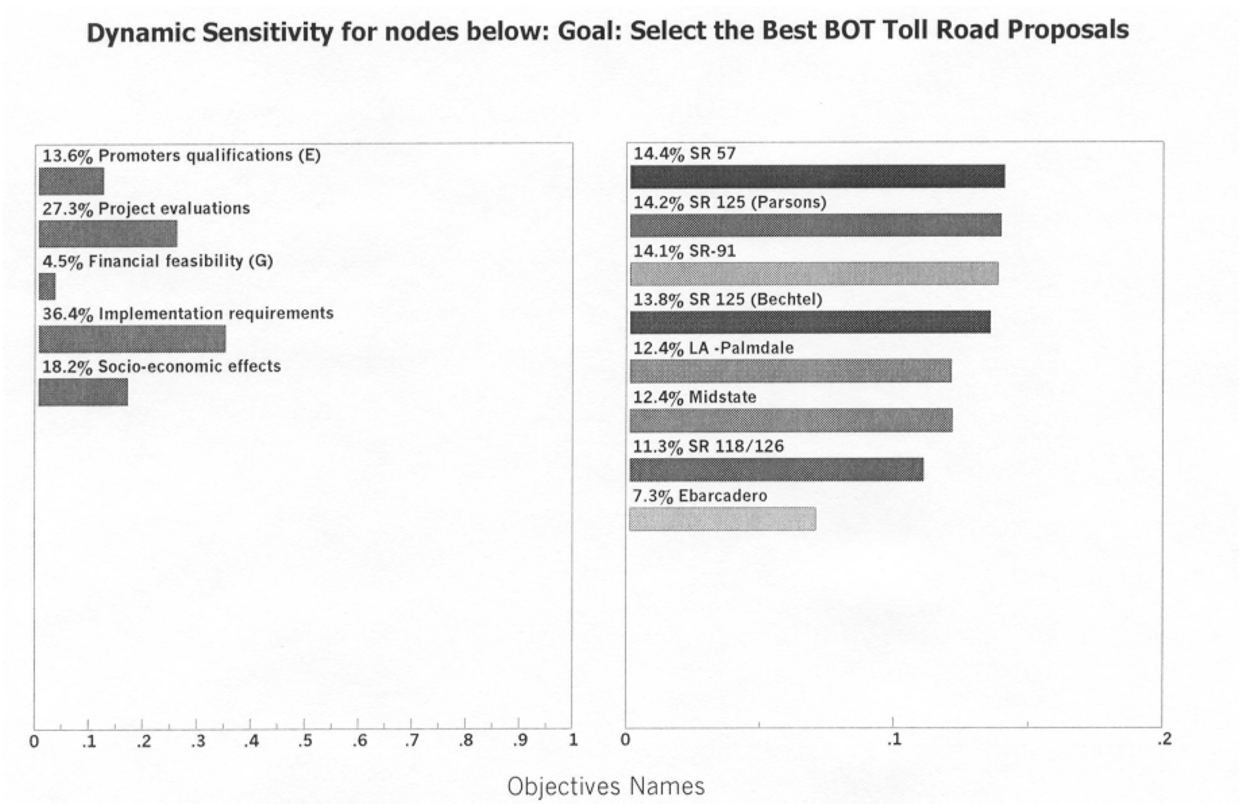


Figure 18 The Dynamic Sensitivity of Alternatives

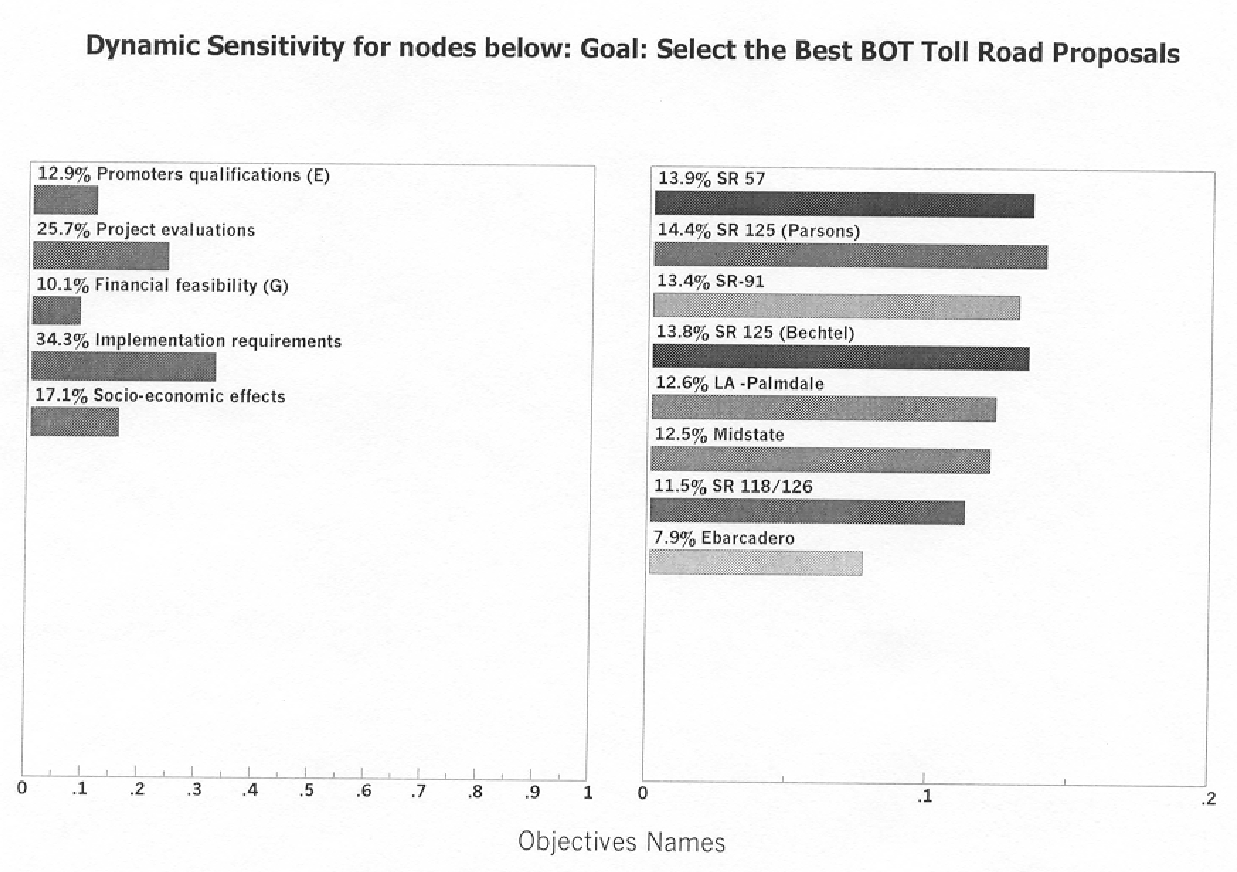


Figure 19 The Dynamic Sensitivity of Alternatives with Changed Priorities

8.4.3 Decision Output with All Criteria

After the model was tested with only the nine criteria of Caltrans, the model was tested with values for all criteria to see how this would affect the selection decision. First, we labeled the non-Caltrans criteria with the letters J to Y. Since no reference numbers could be used to assign values to these criteria, this research assumed a reasonable value (relative to the values of the nine criteria used by Caltrans) for each criterion, as shown in Table 10. It is important to note that these values are not assumed to be reflect real values; they are only used to run the model

Table 10 Assumed Values for the Additional Criteria of the Model

Research Model			Caltrans
Criteria	1-to-9 scale	Max. Score	Criteria
Promoters' Qualifications	**4.0**	**40**	
Experience of the principal firms	3.375	15	**E**. Experience & expertise of proposer
Financial capacity and strength	3.375	15	**J**
Parent company support	2.25	10	**K**
Project Evaluations	**9.0**	**90**	
Compliance with tender guidelines	1.125	5	**L**
Degree of project definition & scope	1.125	5	**M**
Enhancement of trans. system	4.5	20	**A.** Transportation Services Provided
Compatibility with trans. system	4.5	20	**N**
Technical innovation	2.25	10	**H**. Degree of technical innovation
Realistic construction schedule	2.25	10	**O**
Maintainability and durability	2.25	10	**P**
Project necessity	2.25	10	**Q**
Financial Feasibility	**6.0**	**60**	
Compliance with financial req.	1.125	5	**R**
Appropriateness of financial plan	3.375	15	**S**
Level of public resource required	1.125	5	**T**
Financial return to the government	2.25	10	**U**
Reasonable toll rate and adjustment	4.5	20	**V**
Non-toll revenue support	1.125	5	**G**. Non-toll revenue support
Implementation Requirements	**5.0**	**50**	
Compliance with environmental req.	2.25	10	**F**. Environmental quality & energy cons.
Degree of local opposition/support	3.375	15	**C.** Degree of local support
Handling right-of-way acquisition	2.25	10	**W**
Ease of implementation	3.375	15	**D.** Ease of implementation
Socio-Economic effects	**4.5**	**45**	
Contribution to economy	2.25	10	**B.** Encouraging economic prosperity
Benefit to community	3.375	15	**X**
Local participation and involvement	2.25	10	**I**. Civil right objectives
Local procurement of materials	2.25	10	**Y**

- Note for Table 9: to convert to 1-to-9 scale: the max. score for the main criteria, 90, is assumed =9; and the max. score for the sub-criteria, 20, is assumed = 9.

with all criteria to observe the effect on the selection decision. The score for each project relative to the additional criteria was assumed as shown in Table 11.

Table 11 Values Assumed for Projects Relative to The Additional Criteria

Project	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
SR -57	11.0	7.0	5.0	4.0	17.0	8.5	9.0	8.0	2.0	6.0	1.5	2.0	4.0	9.0	11.5	8.0
125(Parsons)	13.0	8.5	3.0	2.5	16.5	8.0	8.5	7.5	3.0	13.0	2.5	8.0	17.0	8.5	11.0	7.5
SR - 91	14.0	9.0	3.0	4.0	17.0	9.0	8.5	8.0	1.0	3.5	1.5	1.5	2.0	8.0	10.5	7.5
125 (Bechtel)	13.5	8.0	4.0	4.0	16.0	7.5	8.0	8.5	3.0	9.5	3.5	7.5	15.0	7.0	9.5	8.5
LA - Palmdale	14.0	8.5	2.5	2.0	12.5	9.0	7.7	8.0	3.0	13.0	2.5	8.5	17.0	9.5	8.5	4.5
Midstate	10.5	7.0	3.0	3.5	13.0	8.5	8.0	8.5	3.0	9.5	3.5	7.5	15.0	9.5	11.0	7.0
SR-118/126	12.5	8.0	2.5	2.5	10.0	6.0	5.0	4.5	4.0	12.0	3.0	7.5	16.0	6.0	10.0	9.0
Embarcadero	9.5	8.0	2.0	2.0	6.0	5.5	5.0	4.0	4.5	14.0	4.5	9.5	18.5	5.0	6.0	4.0

The results of the model when all the criteria were used show that the final selection differs from the Caltrans selection. Figure 20 shows the hierarchy and weight of all criteria, and Figure 21 shows the ranking and the priorities of the alternatives. Note that the top-ranked project selected by Caltrans, SR-57, was ranked fourth.

This result indicates that the use of this model may lead Caltrans to better decisions or to selecting better projects. Table 12 compares Caltrans' ranking results to those of the model.

Another finding is that the Caltrans results show that the projects ranked 5 and 6 were very close, with total scores of 79.7 and 79.4, respectively. Our model, using all the criteria, ranked these same projects as 3 and 5, respectively, indicating that the use of the model may help the decision-makers make clearer and better decisions.

Appendix B shows the EC print out with the data of the decision output with all criteria.

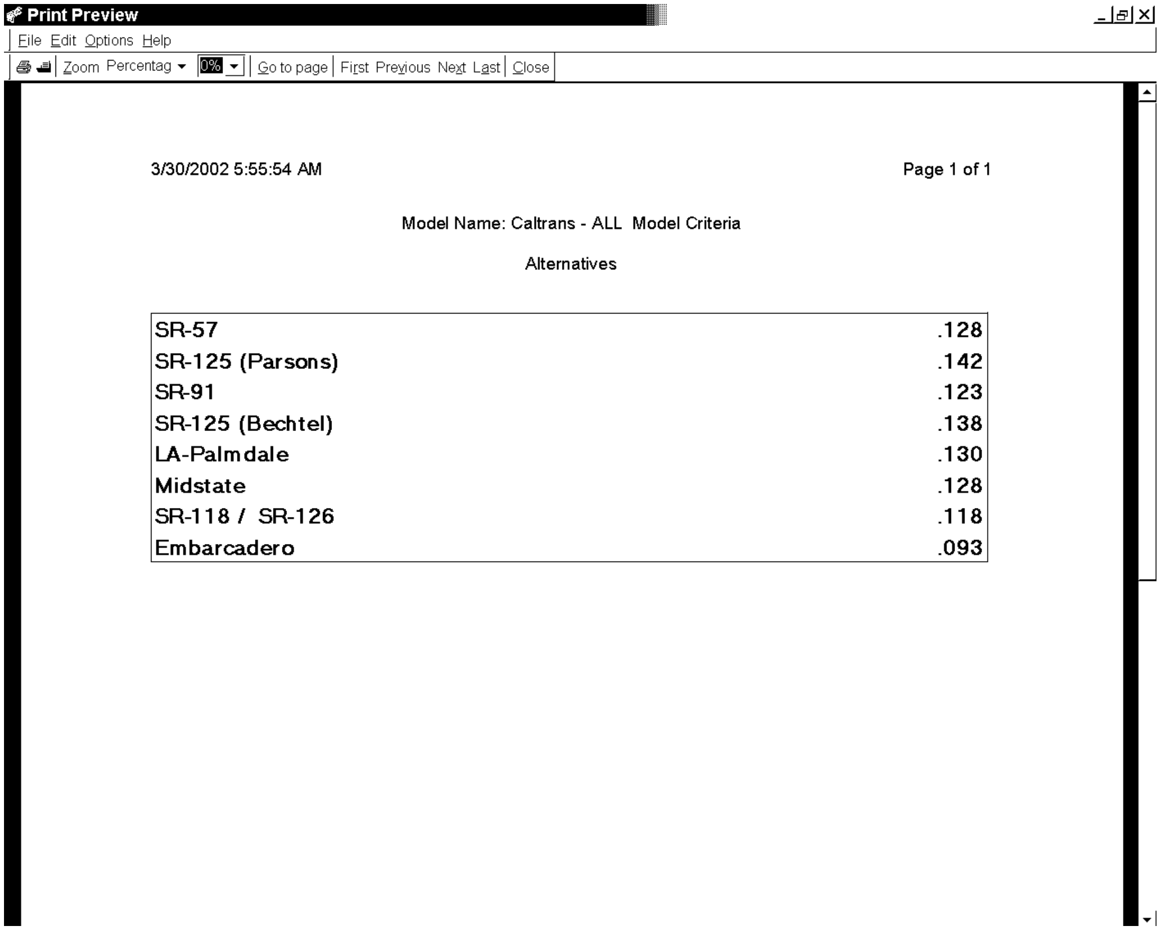
Model Name: Caltrans - ALL Model Criteria

Treeview

- **Goal: Select the Best BOT Toll Road Proposals**
  - **Promoters qualifications (G: .140)**
    - **Experience of the principal firms (G: .053)**
    - **Financial capacity and strength (G: .053)**
    - **Parent company support (G: .035)**
  - **Project evaluations (G: .316)**
    - **Compliance with tender and local guidelines (G: .018)**
    - **Degree of project definition and scope (G: .018)**
    - **Enhancement of existing syatem (G: .070)**
    - **Compatibility with existing transportation system (G: .070)**
    - **Technical innovation (G: .035)**
    - **Realistic construction schedule (G: .035)**
    - **Maintainability and durability of the project (G: .035)**
    - **Project necessity (G: .035)**
  - **Financial feasibility (G: .212)**
    - **Compliance with requirements for the financial package (G: .018)**
    - **Appropriate financial plan (G: .053)**
    - **Level of public resource required (G: .018)**
    - **Financial return to government (G: .035)**
    - **Reasonable toll rate and toll adjustment method (G: .071)**
    - **Non-toll revenue support (G: .018)**
  - **Implementation requirements (G: .174)**
    - **Comply with environmental requirements (G: .035)**
    - **Degree of local opposition/support (G: .052)**
    - **Handling right-of-way acquisition (G: .035)**
    - **Ease of implementation (G: .052)**
  - **Socio-economic effect (G: .158)**
    - **Contribution to economy (G: .035)**
    - **Benefit to community (G: .053)**
    - **Local participants and involvement (G: .035)**
    - **Local procurement of materials (G: .035)**

* *Ideal mode*

Figure 20 The Hierarchy and Weight of All Criteria



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Model Name: Caltrans - ALL Model Criteria

Alternatives

SR-57	.128
SR-125 (Parsons)	.142
SR-91	.123
SR-125 (Bechtel)	.138
LA-Palmdale	.130
Midstate	.128
SR-118 / SR-126	.118
Embarcadero	.093

Figure 21 Ranking and Priorities of Alternatives

Table 12 Comparison of Caltrans' Ranking with the Model Results

Caltrans Ranking	**Project**	Model Ranking
1	SR -57	4
2	SR-125(Parsons)	1
3	SR - 91	6
4	SR-125 (Bechtel)	2
5	LA-Palmdale	3
6	Midstate	5
7	SR-118/SR-126	7
8	Embarcadero	8

8.4.4 Criteria Limits

It is very important for each alternative to conform to the limits of the criteria and variables. This model, using the EC software, can define these limits as upper and lower bounds that an alternative must meet. If one of the alternatives does not satisfy one of these limits, the alternative is displayed in red with strikethrough and can easily be removed from the selection. For example, in the previous test of the model with all criteria, it was assumed that the estimated time to construct the proposed road is one year; the criteria of realistic construction schedule was limited to a minimum of 10 months and a maximum of 18 months. The data assumed for the project is shown in Table 13.

Table 13 The Assumed Value for Construction Schedule

Project	Construction Schedule (Months)
SR -57	14
SR-125(Parsons)	8
SR - 91	16
SR-125 (Bechtel)	20
LA-Palmdale	12
Midstate	14
SR-118/SR-126	18
Embarcadero	22

After the data for the construction schedule were entered and the limits for the realistic construction schedule were set, the output of the model shows that projects SR-125 (Parsons), SR-125 (Bechtel), and Embarcadero did not satisfy the limits. It is of value to make sure that even if one alternative receives a high evaluation, like the top- ranked project SR-125 (Parsons), but does not meet important limits of the criteria, it should not be selected. Figure 22 shows the output of the model with those limits.

Appendix C shows the EC printout of the model with limits for criteria.

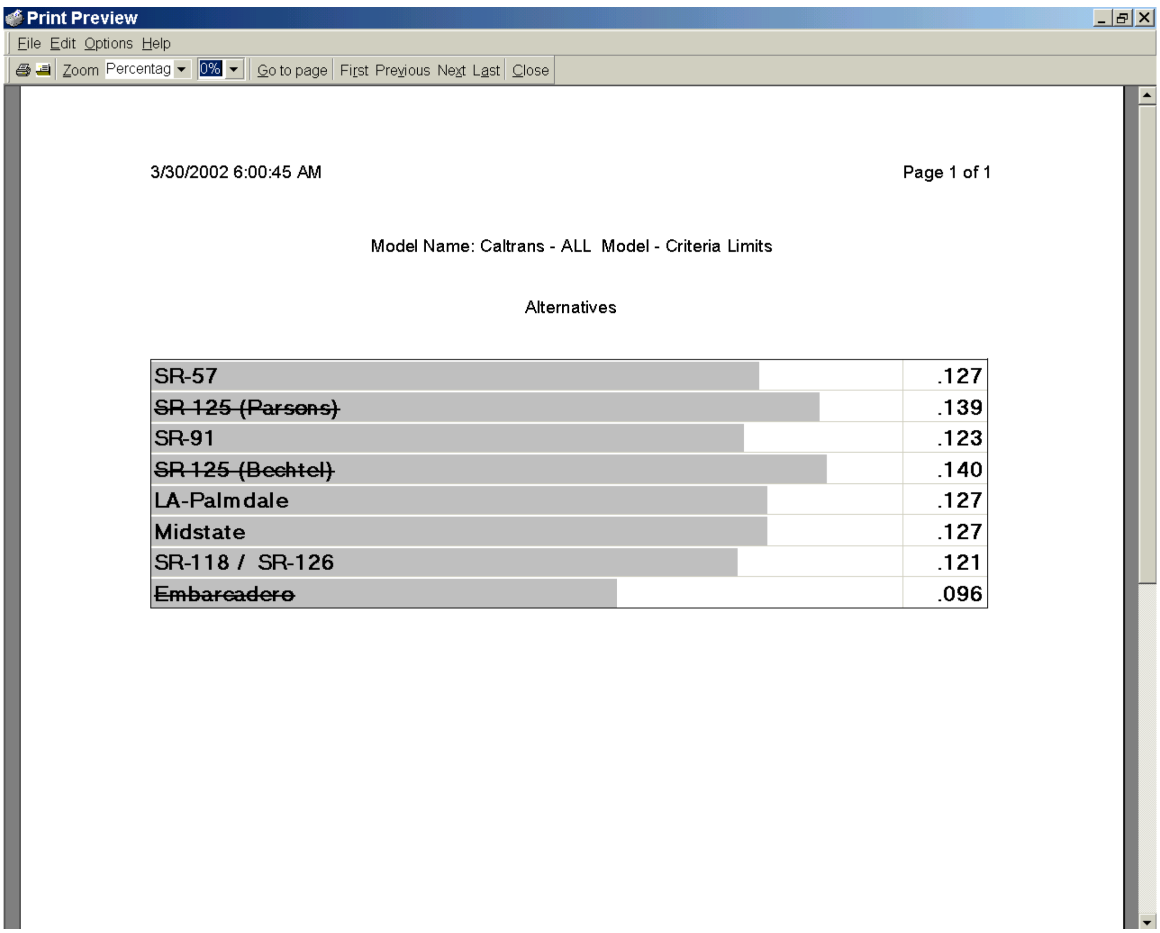

Figure 22 Model Output with Limits for Criteria

9.0 CONCLUSIONS AND FUTURE STUDY

9.1 Summary

The main objectives of this research have been to understand the details of toll road projects in order to (1) identify the criteria and variables related to toll roads, and (2) develop an integrated decision-making process model as a framework to help the public sector make quality decisions in selecting the best BOT toll road proposals.

The work of this research included identifying five main criteria with 25 sub-criteria that affect BOT toll projects. These main criteria were: promoters' qualifications, project evaluations, financial feasibility, implementation requirements, and socio-economic effects. Next, the decision problem was structured as a hierarchy that included, at the top level, the goal of selecting the best proposals; on the second and third levels, respectively, the criteria and sub-criteria; and finally, on the bottom level, all of the proposals. This research defined the framework for the decision process and highlighted the process completed by a group of decision-makers who reach decisions by consensus voting/agreement. The model was validated by the Caltrans case study and the analysis and limits of the model were discussed.

This research developed a framework that will enable the public sector to make better decisions when selecting BOT toll road proposals and will save decision-makers time and effort. Since the model made the selection process clear and able to be traced back by all parties, these changes will likely encourage the private sector to bid on BOT projects.

9.2 Conclusions

The model developed by this research studied BOT toll projects and focused on the third step of their selection process. The research reached important conclusions, which include the following:

- The field of BOT toll road projects is growing all around the world, and there is currently a lack of evaluative criteria and decision-making tools to help the public sector select the best proposals.
- There are many criteria and variables that affect BOT toll road projects, and these should be considered in the evaluation process. This research shows that the consideration of all these criteria could help produce better decisions.
- Decision-makers within the public sector need a practical and simple tool that can be implemented easily. This research developed a systematic approach that includes all the criteria and can accommodate subjective judgments.
- The decision process in this model involves group decision-making, and since the model is based on AHP, it helps the decision-makers to accommodate diverse judgments. It also permits the decision-makers to check their judgments through consistency ratios.
- This model is based on a simple yet powerful tool, AHP. AHP is the most suitable technique for public-sector use because it is easy to use, it helps decision-makers to understand the problem by structuring the hierarchy, and it transfers their subjective judgments into meaningful weights and ratios that represent their priorities.

9.3 Contribution of the Research

It has been clear that the demand for infrastructure is growing, and governments have found privatization in general and the BOT approach in particular to be viable solutions to this problem. The private sector is interested in this field because it opens up tremendous opportunities for them. Both the public and private sectors recognize that the evaluation process is a crucial part of the implementation of this approach. The strong movement toward the expanded use of BOT toll projects requires governments to have a rational and comprehensive selection process that addresses all of the issues affecting the selection of proposals.

The model developed by this research is expected to provide the following important contributions:

- It acts as a proposal-selection guide that helps the public sector select various criteria that should be considered in evaluating and selecting the best proposals.
- It is a decision-making tool that provides the decision-makers with steps to help them structure the decision problem and drive their judgments in a systematic way.
- The uses of this model will save decision-makers within the public sector a great deal of time and effort.
- This model will likely encourage the private sector to bid on projects by providing a clear and fair selection process.
- This research introduces to decision-makers in this field a powerful yet simple tool, AHP, which has not been used widely in the transportation field before.

9.4 Limitations of the Research

This research has made significant contributions, but there are several limitations as well. The major limitations are:

- The test data are relatively limited, and even though the Caltrans case study provided a good validation test, more cases would enable a comprehensive analysis. This limitation resulted from two main factors: (1) the field of BOT toll-road projects is relatively new in many countries, so there are limited implemented cases; and (2) within this field, data from the public sector is considered sensitive and confidential.
- This research focused on the third stage of the selection process and considered all of the steps of the process. However, it did not integrate the entire process into the model, especially the stage following the evaluation stage -- the negotiation stage.
- This research defined and explained all evaluation criteria but did not include exact values or limits for each one. This is because of the following factors: (1) due to the nature of BOT toll road projects, the values or weights for these criteria differ from country to country and from one project to another; (2) there is a lack of data and information about previous cases; and (3) this field is relatively new, so there are few existing BOT toll roads available to study.

9.5 Recommendations for Future Study

The above limitations provide an opportunity for future study, especially in the following areas:

- This research developed a model for the third stage of the evaluation process. It will be good for future researchers to develop other models to integrate this model with the next stage -- the negotiation stage. Furthermore, since BOT projects involve high risk, it will be of value if these future models include risk analysis.
- It is hoped that, in the future, with increased implantation of BOT toll road projects, there will be more information and data available, and additional work will then be done to provide reference values for the evaluation criteria

APPENDICES

Appendix A
EC Printout of Model Validation with Caltrans

Model Name: Case study-Caltrans

Treeview

- **Goal: Select the Best BOT Toll Road Proposals**
  - **Promoters qualifications (E) (L: .136)**
  - **Project evaluations (L: .273)**
    - **Enhancement of transportation system (A) (L: .667)**
    - **Technical innovation (H) (L: .333)**
  - **Financial feasibility (G) (L: .045)**
  - **Implementation requirements (L: .364)**
    - **Compliance with environmental requirements (F) (L: .250)**
    - **Degree of local opposition/support (C) (L: .375)**
    - **Ease of implementation (D) (L: .375)**
  - **Socio-economic effects (L: .182)**
    - **Contribution to economy (B) (L: .500)**
    - **Local participation and involvement (I) (L: .500)**

Alternatives

SR 57	**.144**
SR 125 (Parsons)	**.143**
SR-91	**.141**
SR 125 (Bechtel)	**.139**
LA -Palmdale	**.123**
Midstate	**.123**
SR 118/126	**.113**
Ebarcadero	**.073**

Data Grid

* *Distributive mode*

Distributive mode Alternative	Total	Pairwise Promoters qualifications (E) (L: .136)
✓SR 57	.144	.844
✓SR 125	.143	.962
✓SR-91	.141	.953
✓SR 125 (Bechtel)	.139	.890
✓LA -Palmdale	.123	.944
✓Midstate	.123	1.000
✓SR 118/126	.113	.901
✓Ebarcadero	.073	.770

Distributive mode Alternative	Pairwise Project evaluations Enhancement of transportation system (A) (L: .667)	Pairwise Project evaluations Technical innovation (H) (L: .333)
✓SR 57	1.000	.964
✓SR 125	.926	.973
✓SR-91	.944	.973
✓SR 125 (Bechtel)	.982	.901
✓LA -Palmdale	.727	1.000
✓Midstate	.727	.926
✓SR 118/126	.527	.691
✓Ebarcadero	.236	.324

Distributive mode Alternative	Pairwise Financial feasibility (G) (L: .045)
✓SR 57	.341
✓SR 125	.917
✓SR-91	.128
✓SR 125 (Bechtel)	.725
✓LA -Palmdale	.913
✓Midstate	.725
✓SR 118/126	.833
✓Ebarcadero	1.000

Distributive mode Alternative	Pairwise Implementation requirements (L Compliance with environmental requirements (F) (L: .250)
SR 57	.972
SR 125	.860
SR-91	.843
SR 125 (Bechtel)	.827
LA -Palmdale	1.000
Midstate	.690
SR 118/126	.584
Ebarcadero	.479

Distributive mode Alternative	Pairwise Implementation requirements (L Degree of local opposition/support (C) (L: .375)	Pairwise Implementation requirements (L Ease of implementation (D) (L: .375)
SR 57	1.000	.786
SR 125	.870	.833
SR-91	.836	1.000
SR 125 (Bechtel)	.869	.813
LA -Palmdale	.805	.508
Midstate	.837	.528
SR 118/126	.741	.634
Ebarcadero	.340	.391

Distributive mode Alternative	Pairwise Socio-economic effects Contribution to economy (B) (L: .500)	Pairwise Socio-economic effects Local participation and involvement (I) (L: .500)
SR 57	.943	1.000
SR 125	1.000	.769
SR-91	.869	1.000
SR 125 (Bechtel)	.982	.730
LA -Palmdale	.463	.861
Midstate	.857	.805
SR 118/126	.801	.933
Ebarcadero	.383	.671

Synthesis: Details

Alts	Level 1	Level 2	Prty
Percent ...			**7.2**
	Percent Financial feasibility (G) (L: .045)		**0.8**
	Financial feasibility (G) (L: .045)		.008
	Percent Implementation requirements (L: .364)		**2.4**
		Complianc...	.007
	Implementation requirements (L: .364)	Degree of I...	.007
		Ease of im...	.010
Ebarcadero	**Percent Project evaluations (L: .273)**		**1.1**
	Project evaluations (L: .273)	Enhancem...	.007
		Technical i...	.004
	Percent Promoters qualifications (E) (L: .136)		**1.4**
	Promoters qualifications (E) (L: .136)		.014
	Percent Socio-economic effects (L: .182)		**1.5**
	Socio-economic effects (L: .182)	Contributio...	.006
		Local parti...	.009
Percent ...			**12.4**
	Percent Financial feasibility (G) (L: .045)		**0.7**
	Financial feasibility (G) (L: .045)		.007
	Percent Implementation requirements (L: .364)		**4.5**
		Complianc...	.015
	Implementation requirements (L: .364)	Degree of I...	.017
		Ease of im...	.013
LA-Palm...	**Percent Project evaluations (L: .273)**		**3.5**
	Project evaluations (L: .273)	Enhancem...	.022
		Technical i...	.013
	Percent Promoters qualifications (E) (L: .136)		**1.8**
	Promoters qualifications (E) (L: .136)		.018
	Percent Socio-economic effects (L: .182)		**1.9**
	Socio-economic effects (L: .182)	Contributio...	.007
		Local parti...	.012
Percent ...			**12.3**
	Percent Financial feasibility (G) (L: .045)		**0.6**
	Financial feasibility (G) (L: .045)		.006
	Percent Implementation requirements (L: .364)		**4.1**
		Complianc...	.010
	Implementation requirements (L: .364)	Degree of I...	.018
		Ease of im...	.013
Midstate	**Percent Project evaluations (L: .273)**		**3.4**
	Project evaluations (L: .273)	Enhancem...	.022
		Technical i...	.012
	Percent Promoters qualifications (E) (L: .136)		**1.9**
	Promoters qualifications (E) (L: .136)		.019
	Percent Socio-economic effects (L: .182)		**2.3**
	Socio-economic effects (L: .182)	Contributio...	.012
		Local parti...	.011
Percent ...			**14.1**

Alts	Level 1	Level 2	Prty
	Percent Financial feasibility (G) (L: .045)		**0.1**
	Financial feasibility (G) (L: .045)		.001
	Percent Implementation requirements (L: .364)		**5.5**
		Complianc...	.012
	Implementation requirements (L: .364)	Degree of l...	.018
		Ease of im...	.025
SR-91	**Percent Project evaluations (L: .273)**		**4.1**
	Project evaluations (L: .273)	Enhancem...	.028
		Technical i...	.013
	Percent Promoters qualifications (E) (L: .136)		**1.8**
	Promoters qualifications (E) (L: .136)		.018
	Percent Socio-economic effects (L: .182)		**2.6**
	Socio-economic effects (L: .182)	Contributio...	.013
		Local parti...	.013
Percent ...			**11.4**
	Percent Financial feasibility (G) (L: .045)		**0.7**
	Financial feasibility (G) (L: .045)		.007
	Percent Implementation requirements (L: .364)		**4.0**
		Complianc...	.008
	Implementation requirements (L: .364)	Degree of l...	.016
		Ease of im...	.016
SR 118/1...	**Percent Project evaluations (L: .273)**		**2.5**
	Project evaluations (L: .273)	Enhancem...	.016
		Technical i...	.009
	Percent Promoters qualifications (E) (L: .136)		**1.7**
	Promoters qualifications (E) (L: .136)		.017
	Percent Socio-economic effects (L: .182)		**2.5**
	Socio-economic effects (L: .182)	Contributio...	.012
		Local parti...	.013
Percent ...			**13.9**
	Percent Financial feasibility (G) (L: .045)		**0.6**
	Financial feasibility (G) (L: .045)		.006
	Percent Implementation requirements (L: .364)		**5.1**
		Complianc...	.012
	Implementation requirements (L: .364)	Degree of l...	.019
		Ease of im...	.020
SR 125 (...	**Percent Project evaluations (L: .273)**		**4.1**
	Project evaluations (L: .273)	Enhancem...	.029
		Technical i...	.012
	Percent Promoters qualifications (E) (L: .136)		**1.7**
	Promoters qualifications (E) (L: .136)		.017
	Percent Socio-economic effects (L: .182)		**2.4**
	Socio-economic effects (L: .182)	Contributio...	.014
		Local parti...	.010
Percent ...			**14.2**
	Percent Financial feasibility (G) (L: .045)		**0.7**
SR 125 (...	Financial feasibility (G) (L: .045)		.007
	Percent Implementation requirements (L: .364)		**5.2**
	Implementation requirements (L: .364)	Complianc...	.012

Alts	Level 1	Level 2	Prty
	Implementation requirements (L: .364)	Degree of I...	.019
		Ease of im...	.021
	Percent Project evaluations (L: .273)		**4.1**
	Project evaluations (L: .273)	Enhancem...	.028
		Technical i...	.013
SR 125 (...	**Percent Promoters qualifications (E) (L: .136)**		**1.8**
	Promoters qualifications (E) (L: .136)		.018
	Percent Socio-economic effects (L: .182)		**2.4**
	Socio-economic effects (L: .182)	Contributio...	.014
		Local parti...	.010
Percent ...			**14.5**
	Percent Financial feasibility (G) (L: .045)		**0.3**
	Financial feasibility (G) (L: .045)		.003
	Percent Implementation requirements (L: .364)		**5.6**
		Complianc...	.014
	Implementation requirements (L: .364)	Degree of I...	.022
		Ease of im...	.020
SR 57	**Percent Project evaluations (L: .273)**		**4.3**
	Project evaluations (L: .273)	Enhancem...	.030
		Technical i...	.013
	Percent Promoters qualifications (E) (L: .136)		**1.6**
	Promoters qualifications (E) (L: .136)		.016
	Percent Socio-economic effects (L: .182)		**2.7**
	Socio-economic effects (L: .182)	Contributio...	.014
		Local parti...	.013

Appendix B
EC Printout of the Decision Output with All Criteria

Model Name: Caltrans - ALL Model Criteria

Treeview

- **Goal: Select the Best BOT Toll Road Proposals**
  - **Promoters qualifications (L: .140)**
    - **Experience of the principal firms (L: .375)**
    - **Financial capacity and strength (L: .375)**
    - **Parent company support (L: .250)**
  - **Project evaluations (L: .316)**
    - **Compliance with tender and local guidelines (L: .056)**
    - **Degree of project definition and scope (L: .056)**
    - **Enhancement of existing syatem (L: .222)**
    - **Compatibility with existing transportation system (L: .222)**
    - **Technical innovation (L: .111)**
    - **Realistic construction schedule (L: .111)**
    - **Maintainability and durability of the project (L: .111)**
    - **Project necessity (L: .111)**
  - **Financial feasibility (L: .212)**
    - **Compliance with requirements for the financial package (L: .083)**
    - **Appropriate financial plan (L: .250)**
    - **Level of public resource required (L: .083)**
    - **Financial return to government (L: .167)**
    - **Reasonable toll rate and toll adjustment method (L: .333)**
    - **Non-toll revenue support (L: .083)**
  - **Implementation requirements (L: .174)**
    - **Comply with environmental requirements (L: .200)**
    - **Degree of local opposition/support (L: .300)**
    - **Handling right-of-way acquisition (L: .200)**
    - **Ease of implementation (L: .300)**
  - **Socio-economic effect (L: .158)**
    - **Contribution to economy (L: .222)**
    - **Benefit to community (L: .333)**
    - **Local participants and involvement (L: .222)**
    - **Local procurement of materials (L: .222)**

Alternatives

SR-57	**.128**
SR-125 (Parsons)	**.142**
SR-91	**.123**
SR-125 (Bechtel)	**.138**
LA-Palmdale	**.130**
Midstate	**.128**
SR-118 / SR-126	**.118**
Embarcadero	**.093**

* *Ideal mode*

Data Grid

Alternative	Tota	Pairwise Promoters qualifications Experience of the principal firms (L: .375)	Pairwise Promoters qualifications Financial capacity and strength (L: .375)
SR-57	.803	.851	.786
SR-125	.895	.970	.929
SR-91	.775	.964	1.000
SR-125	.864	.896	.964
LA-Palmdale	.815	.948	1.000
Midstate	.807	1.000	.750
SR-118 /	.741	.903	.892
Embarcadero	.586	.769	.678

Alternative	Pairwise Promoters qualifications Parent company support (L: .250)	Pairwise Project evaluations Compliance with tender and local guidelines (L: .056)
SR-57	.778	1.000
SR-125	.944	.600
SR-91	1.000	.600
SR-125	.889	.799
LA-Palmdale	.944	.500
Midstate	.777	.599
SR-118 /	.888	.499
Embarcadero	.888	.400

Alternative	Pairwise Project evaluations Degree of project definition and scope (L: .056)	Pairwise Project evaluations Enhancement of existing syatem (L: .222)
SR-57	1.000	1.000
SR-125	.625	.929
SR-91	1.000	.946
SR-125	1.000	.984
LA-Palmdale	.500	.727
Midstate	.875	.727
SR-118 /	.625	.525
Embarcadero	.500	.235

Alternative	Pairwise Project evaluations Compatibility with existing transportation system (L: .222)	Pairwise Project evaluations Technical innovation (L: .111)
SR-57	1.000	.968
SR-125	.971	.979
SR-91	1.000	.979
SR-125	.941	.903
LA-Palmdale	.735	1.000
Midstate	.765	.925
SR-118 /	.588	.688
Embarcadero	.353	.323

Alternative	Pairwise Project evaluations Realistic construction schedule (L: .111)
SR-57	.944
SR-125	.889
SR-91	1.000
SR-125	.833
LA-Palmdale	1.000
Midstate	.944
SR-118 /	.666
Embarcadero	.610

Alternative	Pairwise Project evaluations Maintainability and durability of the project (L: .111)	Pairwise Project evaluations Project necessity (L: .111)
SR-57	1.000	.942
SR-125	.944	.883
SR-91	.944	.942
SR-125	.889	1.000
LA-Palmdale	.855	.941
Midstate	.889	1.000
SR-118 /	.555	.529
Embarcadero	.555	.470

Alternative	Pairwise Financial feasibility Compliance with requirements for the financial package (L: .083)
SR-57	.445
SR-125	.667
SR-91	.222
SR-125	.667
LA-Palmdale	.667
Midstate	.667
SR-118 /	.889
Embarcadero	1.000

Alternative	Pairwise Financial feasibility Appropriate financial plan (L: .250)	Pairwise Financial feasibility Level of public resource required (L: .083)
SR-57	.429	.334
SR-125	.929	.556
SR-91	.250	.334
SR-125	.679	.778
LA-Palmdale	.928	.556
Midstate	.679	.778
SR-118 /	.857	.667
Embarcadero	1.000	1.000

Alternative	Pairwise Financial feasibility Financial return to government (L: .167)
✓SR-57	.235
✓SR-125	.942
✓SR-91	.177
✓SR-125	.883
✓LA-Palmdale	1.000
✓Midstate	.883
✓SR-118 /	.882
✓Embarcadero	.696

Alternative	Pairwise Financial feasibility Reasonable toll rate and toll adjustment method (L: .333)
✓SR-57	.216
✓SR-125	.919
✓SR-91	.108
✓SR-125	.811
✓LA-Palmdale	.919
✓Midstate	.811
✓SR-118 /	.865
✓Embarcadero	1.000

Alternative	Pairwise Financial feasibility Non-toll revenue support (L: .083)	Pairwise Implementation requirements (L Comply with environmental requirements (L: .200)
SR-57	.341	.979
SR-125	.916	.865
SR-91	.128	.844
SR-125	.724	.823
LA-Palmdale	.915	1.000
Midstate	.724	.688
SR-118 /	.830	.584
Embarcadero	1.000	.480

Alternative	Pairwise Implementation requirements (L Degree of local opposition/support (L: .300)	Pairwise Implementation requirements (L Handling right-of-way acquisition (L: .200)
SR-57	1.000	.948
SR-125	.870	.895
SR-91	.840	.843
SR-125	.870	.737
LA-Palmdale	.801	1.000
Midstate	.831	1.000
SR-118 /	.732	.632
Embarcadero	.336	.526

Alternative	Pairwise Implementation requirements (L Ease of implementation (L: .300)	Pairwise Socio-economic effect Contribution to economy (L: .222)
SR-57	.786	.944
SR-125	.833	1.000
SR-91	1.000	.865
SR-125	.812	.977
LA-Palmdale	.507	.460
Midstate	.527	.854
SR-118 /	.631	.798
Embarcadero	.388	.382

Alternative	Pairwise Socio-economic effect Benefit to community (L: .333)	Pairwise Socio-economic effect Local participants and involvement (L: .222)
SR-57	1.000	1.000
SR-125	.957	.770
SR-91	.913	1.000
SR-125	.826	.730
LA-Palmdale	.700	.859
Midstate	.906	.799
SR-118 /	.823	.929
Embarcadero	.494	.669

Alternative	Pairwise Socio-economic effect Local procurement of materials (L: .222)
SR-57	.890
SR-125	.834
SR-91	.834
SR-125	.945
LA-Palmdale	.500
Midstate	.778
SR-118 /	1.000
Embarcadero	.444

Synthesis: Details

Alts	Level 1	Level 2	Prty
Percent ...			**9.3**
	Percent Financial feasibility (L: .212)		**3.2**
	Financial feasibility (L: .212)	Complianc...	.003
		Appropriat...	.008
		Level of pu...	.003
		Financial r...	.004
		Reasonabl...	.011
		Non-toll re...	.003
	Percent Implementation requirements (L: .174)		**1.2**
	Implementation requirements (L: .174)	Comply wit...	.003
		Degree of I...	.003
		Handling ri...	.003
		Ease of im...	.003
Embarca...	**Percent Project evaluations (L: .316)**		**2.0**
	Project evaluations (L: .316)	Complianc...	.001
		Degree of ...	.001
		Enhancem...	.003
		Compatibili...	.004
		Technical i...	.002
		Realistic c...	.003
		Maintainab...	.003
		Project nec...	.003
	Percent Promoters qualifications (L: .140)		**1.7**
	Promoters qualifications (L: .140)	Experience...	.006
		Financial c...	.006
		Parent co...	.005
	Percent Socio-economic effect (L: .158)		**1.2**

Alts	Level 1	Level 2	Prty
		Contributio...	.002
Embarca...	Socio-economic effect (L: .158)	Benefit to c...	.004
		Local parti...	.004
		Local proc...	.002
Per cent ...			**13.2**
	Per cent Financial feasibility (L: .212)		**3.1**
		Complianc...	.002
		Appropriat...	.008
	Financial feasibility (L: .212)	Level of pu...	.002
		Financial r...	.006
		Reasonabl...	.010
		Non-toll re...	.003
	Per cent Implementation requirements (L: .174)		**2.3**
		Comply wit...	.006
	Implementation requirements (L: .174)	Degree of l...	.007
		Handling ri...	.006
		Ease of im...	.004
	Per cent Project evaluations (L: .316)		**4.0**
		Complianc...	.001
LA-Palm...		Degree of ...	.001
		Enhancem...	.008
	Project evaluations (L: .316)	Compatibili...	.008
		Technical i...	.006
		Realistic c...	.006
		Maintainab...	.005
		Project nec...	.005
	Per cent Promoters qualifications (L: .140)		**2.1**
		Experience...	.008
	Promoters qualifications (L: .140)	Financial c...	.008
		Parent co...	.005
	Per cent Socio-economic effect (L: .158)		**1.7**
		Contributio...	.003
	Socio-economic effect (L: .158)	Benefit to c...	.006
		Local parti...	.005
		Local proc...	.003
Per cent ...			**12.8**
	Per cent Financial feasibility (L: .212)		**2.6**
		Complianc...	.002
		Appropriat...	.006
	Financial feasibility (L: .212)	Level of pu...	.002
		Financial r...	.005
		Reasonabl...	.009
Midstate		Non-toll re...	.002
	Per cent Implementation requirements (L: .174)		**2.1**
		Comply wit...	.004
	Implementation requirements (L: .174)	Degree of l...	.007
		Handling ri...	.006
		Ease of im...	.004
	Per cent Project evaluations (L: .316)		**4.2**

Alts	Level 1	Level 2	Prty
		Complianc...	.002
		Degree of ...	.002
		Enhancem...	.008
		Compatibili...	.009
	Project evaluations (L: .316)	Technical i...	.005
		Realistic c...	.005
		Maintainab...	.005
		Project nec...	.006
Midstate	**Percent Promoters qualifications (L: .140)**		**1.8**
		Experience...	.008
	Promoters qualifications (L: .140)	Financial c...	.006
		Parent co...	.004
	Percent Socio-economic effect (L: .158)		**2.1**
		Contributio...	.005
	Socio-economic effect (L: .158)	Benefit to c...	.008
		Local parti...	.004
		Local proc...	.004
Percent ...			**11.7**
	Percent Financial feasibility (L: .212)		**2.8**
		Complianc...	.002
		Appropriat...	.007
	Financial feasibility (L: .212)	Level of pu...	.002
		Financial r...	.005
		Reasonabl...	.010
		Non-toll re...	.002
	Percent Implementation requirements (L: .174)		**1.7**
		Comply wit...	.003
	Implementation requirements (L: .174)	Degree of l...	.006
		Handling ri...	.003
		Ease of im...	.005
	Percent Project evaluations (L: .316)		**3.0**
		Complianc...	.001
SR-118 /...		Degree of ...	.002
		Enhancem...	.006
	Project evaluations (L: .316)	Compatibili...	.007
		Technical i...	.004
		Realistic c...	.004
		Maintainab...	.003
		Project nec...	.003
	Percent Promoters qualifications (L: .140)		**2.0**
		Experience...	.008
	Promoters qualifications (L: .140)	Financial c...	.007
		Parent co...	.005
	Percent Socio-economic effect (L: .158)		**2.2**
		Contributio...	.004
	Socio-economic effect (L: .158)	Benefit to c...	.007
		Local parti...	.005
		Local proc...	.006
Percent ...			**13.9**

Alts	Level 1	Level 2	Prty
	Percent Financial feasibility (L: .212)		**2.6**
		Complianc...	.002
		Appropriat...	.006
	Financial feasibility (L: .212)	Level of pu...	.002
		Financial r...	.005
		Reasonabl...	.009
		Non-toll re...	.002
	Percent Implementation requirements (L: .174)		**2.3**
		Comply wit...	.005
	Implementation requirements (L: .174)	Degree of l...	.007
		Handling ri...	.004
		Ease of im...	.007
	Percent Project evaluations (L: .316)		**4.8**
		Complianc...	.002
SR-125 (...		Degree of ...	.003
		Enhancem...	.011
	Project evaluations (L: .316)	Compatibili...	.011
		Technical i...	.005
		Realistic c...	.005
		Maintainab...	.005
		Project nec...	.006
	Percent Promoters qualifications (L: .140)		**2.1**
		Experience...	.008
	Promoters qualifications (L: .140)	Financial c...	.008
		Parent co...	.005
	Percent Socio-economic effect (L: .158)		**2.1**
		Contributio...	.005
	Socio-economic effect (L: .158)	Benefit to c...	.007
		Local parti...	.004
		Local proc...	.005
Percent ...			**14.3**
	Percent Financial feasibility (L: .212)		**3.0**
		Complianc...	.002
		Appropriat...	.008
	Financial feasibility (L: .212)	Level of pu...	.002
		Financial r...	.005
		Reasonabl...	.010
		Non-toll re...	.003
	Percent Implementation requirements (L: .174)		**2.4**
		Comply wit...	.005
SR-125 (...	Implementation requirements (L: .174)	Degree of l...	.007
		Handling ri...	.005
		Ease of im...	.007
	Percent Project evaluations (L: .316)		**4.5**
		Complianc...	.002
		Degree of ...	.002
	Project evaluations (L: .316)	Enhancem...	.010
		Compatibili...	.011
		Technical i...	.005

.

Alts	Level 1	Level 2	Prty
		Realistic c...	.005
	Project evaluations (L: .316)	Maintainab...	.005
		Project nec...	.005
	Percent Promoters qualifications (L: .140)		**2.1**
		Experience...	.008
SR-125 (...	Promoters qualifications (L: .140)	Financial c...	.008
		Parent co...	.005
	Percent Socio-economic effect (L: .158)		**2.3**
		Contributio...	.006
	Socio-economic effect (L: .158)	Benefit to c...	.008
		Local parti...	.004
		Local proc...	.005
Percent ...			**12.6**
	Percent Financial feasibility (L: .212)		**1.0**
		Complianc...	.001
		Appropriat...	.004
	Financial feasibility (L: .212)	Level of pu...	.001
		Financial r...	.001
		Reasonabl...	.002
		Non-toll re...	.001
	Percent Implementation requirements (L: .174)		**2.5**
		Comply wit...	.005
	Implementation requirements (L: .174)	Degree of l...	.008
		Handling ri...	.005
		Ease of im...	.007
	Percent Project evaluations (L: .316)		**4.9**
		Complianc...	.003
SR-57		Degree of ...	.003
		Enhancem...	.011
	Project evaluations (L: .316)	Compatibili...	.011
		Technical i...	.005
		Realistic c...	.005
		Maintainab...	.006
		Project nec...	.005
	Percent Promoters qualifications (L: .140)		**1.8**
		Experience...	.007
	Promoters qualifications (L: .140)	Financial c...	.007
		Parent co...	.004
	Percent Socio-economic effect (L: .158)		**2.4**
		Contributio...	.005
	Socio-economic effect (L: .158)	Benefit to c...	.008
		Local parti...	.006
		Local proc...	.005
Percent ...			**12.5**
	Percent Financial feasibility (L: .212)		**0.6**
		Complianc...	.001
SR-91	Financial feasibility (L: .212)	Appropriat...	.002
		Level of pu...	.001
		Financial r...	.001

Alts	Level 1	Level 2	Prty
	Financial feasibility (L: .212)	Reasonabl...	.001
		Non-toll re...	.000
	Per cent Implementation requirements (L: .174)		**2.5**
	Implementation requirements (L: .174)	Comply wit...	.005
		Degree of I...	.007
		Handling ri...	.005
		Ease of im...	.008
	Per cent Project evaluations (L: .316)		**4.8**
	Project evaluations (L: .316)	Complianc...	.002
		Degree of ...	.003
		Enhancem...	.011
		Compatibili...	.011
SR-91		Technical i...	.005
		Realistic c...	.006
		Maintainab...	.005
		Project nec...	.005
	Per cent Promoters qualifications (L: .140)		**2.2**
	Promoters qualifications (L: .140)	Experience...	.008
		Financial c...	.008
		Parent co...	.006
	Per cent Socio-economic effect (L: .158)		**2.4**
	Socio-economic effect (L: .158)	Contributio...	.005
		Benefit to c...	.008
		Local parti...	.006
		Local proc...	.005

Appendix C
EC Printout of the Model with Criteria Limits

Model Name: Caltrans - ALL Model - Criteria Limits

Treeview

- **Goal: Select the Best BOT Toll Road Proposals**
  - **Promoters qualifications (L: .140)**
    - **Experience of the principal firms (L: .375)**
    - **Financial capacity and strength (L: .375)**
    - **Parent company support (L: .250)**
  - **Project evaluations (L: .316)**
    - **Compliance with tender and local guidelines (L: .056)**
    - **Degree of project definition and scope (L: .056)**
    - **Enhancement of existing syatem (L: .222)**
    - **Compatibility with existing transportation system (L: .222)**
    - **Technical innovation (L: .111)**
    - **Realistic construction schedule (L: .111)**
    - **Maintainability and durability of the project (L: .111)**
    - **Project necessity (L: .111)**
  - **Financial feasibility (L: .212)**
    - **Comliance with requirements for the financial package (L: .083)**
    - **Appropriate financial plan (L: .250)**
    - **Level of public resource required (L: .083)**
    - **Financial return to government (L: .167)**
    - **Reasonable toll rate and toll adjustment method (L: .333)**
    - **Non-toll revenue support (L: .083)**
  - **Implementation requirements (L: .174)**
    - **Comply with environmental requirements (L: .200)**
    - **Degree of local opposition/support (L: .300)**
    - **Handling right-of-way acquisition (L: .200)**
    - **Ease of implementation (L: .300)**
  - **Socio-Economic effect (L: .158)**
    - **Contribution to economy (L: .222)**
    - **Benefit to community (L: .333)**
    - **Local participant and involvement (L: .222)**
    - **Local procurement of materials (L: .222)**

Alternatives

SR-57	**.127**
~~SR-125 (Parsons)~~	**.139**
SR-91	**.123**
~~SR-125 (Bechtel)~~	**.140**
LA-Palmdale	**.127**
Midstate	**.127**
SR-118 / SR-126	**.121**
~~Embarcadero~~	**.096**

* *Ideal mode*

Data Grid

Alternative	Tota	Pairwise Promoters qualifications Experience of the principal firms (L: .375)	Pairwise Promoters qualifications Financial capacity and strength (L: .375)
✓SR-57	.787	.851	.786
✓~~SR-125~~	.864	.970	.929
✓SR-91	.766	.964	1.000
✓~~SR-125~~	.870	.896	.964
✓LA-Palmdale	.788	.948	1.000
✓Midstate	.791	1.000	.750
✓SR-118 /	.753	.903	.892
✓~~Embarcadero~~	.599	.769	.678

Alternative	Tota	Pairwise Promoters qualifications Parent company support (L: .250)
✓SR-57	.787	.778
✓~~SR-125~~	.864	.944
✓SR-91	.766	1.000
✓~~SR-125~~	.870	.889
✓LA-Palmdale	.788	.944
✓Midstate	.791	.777
✓SR-118 /	.753	.888
✓~~Embarcadero~~	.599	.888

Alternative	Tota	Pairwise Project evaluations Compliance with tender and local guidelines (L: .056)
✓SR-57	.787	1.000
✓~~SR-125~~	.864	.600
✓SR-91	.766	.600
✓~~SR-125~~	.870	.799
✓LA-Palmdale	.788	.500
✓Midstate	.791	.599
✓SR-118 /	.753	.499
✓~~Embarcadero~~	.599	.400

Alternative	Tota	Pairwise Project evaluations Degree of project definition and scope (L: .056)
SR-57	.787	1.000
~~SR-125~~	.864	.625
SR-91	.766	1.000
~~SR-125~~	.870	1.000
LA-Palmdale	.788	.500
Midstate	.791	.875
SR-118 /	.753	.625
~~Embarcadero~~	.599	.500

Alternative	Tota	Pairwise Project evaluations Enhancement of existing syatem (L: .222)
✓SR-57	.787	1.000
✓~~SR-125~~	.864	.929
✓SR-91	.766	.946
✓~~SR-125~~	.870	.984
✓LA-Palmdale	.788	.727
✓Midstate	.791	.727
✓SR-118 /	.753	.525
✓~~Embarcadero~~	.599	.235

Alternative	Tota	Pairwise Project evaluations Compatibility with existing transportation system (L: .222)
✓SR-57	.787	1.000
✓~~SR-125~~	.864	.971
✓SR-91	.766	1.000
✓~~SR-125~~	.870	.941
✓LA-Palmdale	.788	.735
✓Midstate	.791	.765
✓SR-118 /	.753	.588
✓~~Embarcadero~~	.599	.353

Alternative	Tota	Pairwise Project evaluations Technical innovation (L: .111)
SR-57	.787	.968
~~SR-125~~	.864	.979
SR-91	.766	.979
~~SR-125~~	.870	.903
LA-Palmdale	.788	1.000
Midstate	.791	.925
SR-118 /	.753	.688
~~Embarcadero~~	.599	.323

Alternative	Tota	INCR Project evaluations Realistic construction schedule (L: .111)
SR-57	.787	14
~~SR-125~~	.864	8
SR-91	.766	16
~~SR-125~~	.870	20
LA-Palmdale	.788	12
Midstate	.791	14
SR-118 /	.753	18
~~Embarcadero~~	.599	22

Alternative	Tota	Pairwise Project evaluations Maintainability and durability of the project (L: .111)	Pairwise Project evaluations Project necessity (L: .111)
SR-57	.787	1.000	.942
~~SR-125~~	.864	.944	.883
SR-91	.766	.944	.942
~~SR-125~~	.870	.889	1.000
LA-Palmdale	.788	.855	.941
Midstate	.791	.889	1.000
SR-118 /	.753	.555	.529
~~Embarcadero~~	.599	.555	.470

Alternative	Tota	Pairwise Financial feasibility Comliance with requirements for the financial package (L: .083)
SR-57	.787	.445
~~SR-125~~	.864	.667
SR-91	.766	.222
~~SR-125~~	.870	.667
LA-Palmdale	.788	.667
Midstate	.791	.667
SR-118 /	.753	.889
~~Embarcadero~~	.599	1.000

Alternative	Tota	Pairwise Financial feasibility Appropriate financial plan (L: .250)	Pairwise Financial feasibility Level of public resource required (L: .083)
SR-57	.787	.429	.334
~~SR-125~~	.864	.929	.556
SR-91	.766	.250	.334
~~SR-125~~	.870	.679	.778
LA-Palmdale	.788	.928	.556
Midstate	.791	.679	.778
SR-118 /	.753	.857	.667
~~Embarcadero~~	.599	1.000	1.000

Alternative	Tota	Pairwise Financial feasibility Financial return to government (L: .167)
SR-57	.787	.235
~~SR-125~~	.864	.942
SR-91	.766	.177
~~SR-125~~	.870	.883
LA-Palmdale	.788	1.000
Midstate	.791	.883
SR-118 /	.753	.882
~~Embarcadero~~	.599	.696

Alternative	Tota	Pairwise Financial feasibility Reasonable toll rate and toll adjustment method (L: .333)
SR-57	.787	.216
~~SR-125~~	.864	.919
SR-91	.766	.108
~~SR-125~~	.870	.811
LA-Palmdale	.788	.919
Midstate	.791	.811
SR-118 /	.753	.865
~~Embarcadero~~	.599	1.000

		Pairwise Financial feasibility
Alternative	Tota	Non-toll revenue support (L: .083)
✓SR-57	.787	.341
✓~~SR-125~~	.864	.916
✓SR-91	.766	.128
✓~~SR-125~~	.870	.724
✓LA-Palmdale	.788	.915
✓Midstate	.791	.724
✓SR-118 /	.753	.830
✓~~Embarcadero~~	.599	1.000

Alternative	Tota	Pairwise Implementation requirements (L Comply with environmental requirements (L: .200)
✓SR-57	.787	.979
✓~~SR-125~~	.864	.865
✓SR-91	.766	.844
✓~~SR-125~~	.870	.823
✓LA-Palmdale	.788	1.000
✓Midstate	.791	.688
✓SR-118 /	.753	.584
✓~~Embarcadero~~	.599	.480

Alternative	Tota	Pairwise Implementation requirements (L Degree of local opposition/support (L: .300)
✓SR-57	.787	1.000
✓~~SR-125~~	.864	.870
✓SR-91	.766	.840
✓~~SR-125~~	.870	.870
✓LA-Palmdale	.788	.801
✓Midstate	.791	.831
✓SR-118 /	.753	.732
✓~~Embarcadero~~	.599	.336

Alternative	Tota	Pairwise Implementation requirements (L Handling right-of-way acquisition (L: .200)
✓SR-57	.787	.948
✓~~SR-125~~	.864	.895
✓SR-91	.766	.843
✓~~SR-125~~	.870	.737
✓LA-Palmdale	.788	1.000
✓Midstate	.791	1.000
✓SR-118 /	.753	.632
✓~~Embarcadero~~	.599	.526

Alternative	Tota	Pairwise Implementation requirements (L Ease of implementation (L: .300)	Pairwise Socio-Economic effect Contribution to economy (L: .222)
✓SR-57	.787	.786	.944
✓~~SR-125~~	.864	.833	1.000
✓SR-91	.766	1.000	.865
✓~~SR-125~~	.870	.812	.977
✓LA-Palmdale	.788	.507	.460
✓Midstate	.791	.527	.854
✓SR-118 /	.753	.631	.798
✓~~Embarcadero~~	.599	.388	.382

Alternative	Tota	Pairwise Socio-Economic effect Benefit to community (L: .333)	Pairwise Socio-Economic effect Local participant and involvement (L: .222)
✓SR-57	.787	1.000	1.000
✓~~SR-125~~	.864	.957	.770
✓SR-91	.766	.913	1.000
✓~~SR-125~~	.870	.826	.730
✓LA-Palmdale	.788	.700	.859
✓Midstate	.791	.906	.799
✓SR-118 /	.753	.823	.929
✓~~Embarcadero~~	.599	.494	.669

Alternative	Tota	Pairwise Socio-Economic effect Local procurement of materials (L: .222)
SR-57	.787	.890
~~SR-125~~	.864	.834
SR-91	.766	.834
~~SR-125~~	.870	.945
LA-Palmdale	.788	.500
Midstate	.791	.778
SR-118 /	.753	1.000
~~Embarcadero~~	.599	.444

'Musts' Values for Covering Objectives

Covering Objective	Data must be >=	Data must be <=
Realistic construction schedule (L: .111)	10	18

Synthesis: Details

Alts	Level 1	Level 2	Prty
Per cent ...			**9.9**
	Per cent Financial feasibility (L: .212)		**3.3**
		Comliance ...	.003
		Appropriat...	.009
	Financial feasibility (L: .212)	Level of pu...	.003
		Financial r...	.004
		Reasonabl...	.011
		Non-toll re...	.003
	Per cent Implementation requirements (L: .174)		**1.2**
		Comply wit...	.003
	Implementation requirements (L: .174)	Degree of l...	.003
		Handling ri...	.003
		Ease of im...	.003
	Per cent Project evaluations (L: .316)		**2.3**
		Complianc...	.001
Embarca...		Degree of ...	.001
		Enhancem...	.003
	Project evaluations (L: .316)	Compatibili...	.004
		Technical i...	.002
		Realistic c...	.006
		Maintainab...	.003
		Project nec...	.003
	Per cent Promoters qualifications (L: .140)		**1.8**
		Experience...	.007
	Promoters qualifications (L: .140)	Financial c...	.006
		Parent co...	.005
	Per cent Socio-Economic effect (L: .158)		**1.3**
		Contributio...	.002
	Socio-Economic effect (L: .158)	Benefit to c...	.004
		Local parti...	.004
		Local proc...	.003
Per cent ...			**12.6**
	Per cent Financial feasibility (L: .212)		**3.1**
		Comliance ...	.002
		Appropriat...	.008
	Financial feasibility (L: .212)	Level of pu...	.002
		Financial r...	.006
		Reasonabl...	.010
		Non-toll re...	.003
LA-Palm...	**Per cent Implementation requirements (L: .174)**		**2.3**
		Comply wit...	.006
	Implementation requirements (L: .174)	Degree of l...	.007
		Handling ri...	.006
		Ease of im...	.004
	Per cent Project evaluations (L: .316)		**3.5**
	Project evaluations (L: .316)	Complianc...	.001

Alts	Level 1	Level 2	Prty
		Degree of ...	.001
		Enhancem...	.008
		Compatibili...	.008
	Project evaluations (L: .316)	Technical i...	.006
		Realistic c...	.001
		Maintainab...	.005
		Project nec...	.005
LA-Palm...	**Percent Promoters qualifications (L: .140)**		**2.1**
		Experience...	.008
	Promoters qualifications (L: .140)	Financial c...	.008
		Parent co...	.005
	Percent Socio-Economic effect (L: .158)		**1.7**
		Contributio...	.003
	Socio-Economic effect (L: .158)	Benefit to c...	.006
		Local parti...	.005
		Local proc...	.003
Percent ...			**12.6**
	Percent Financial feasibility (L: .212)		**2.6**
		Comliance ...	.002
		Appropriat...	.006
	Financial feasibility (L: .212)	Level of pu...	.002
		Financial r...	.005
		Reasonabl...	.009
		Non-toll re...	.002
	Percent Implementation requirements (L: .174)		**2.1**
		Comply wit...	.004
	Implementation requirements (L: .174)	Degree of I...	.007
		Handling ri...	.006
		Ease of im...	.004
	Percent Project evaluations (L: .316)		**4.0**
		Complianc...	.002
Midstate		Degree of ...	.002
		Enhancem...	.008
	Project evaluations (L: .316)	Compatibili...	.009
		Technical i...	.005
		Realistic c...	.003
		Maintainab...	.005
		Project nec...	.006
	Percent Promoters qualifications (L: .140)		**1.8**
		Experience...	.008
	Promoters qualifications (L: .140)	Financial c...	.006
		Parent co...	.004
	Percent Socio-Economic effect (L: .158)		**2.2**
		Contributio...	.005
	Socio-Economic effect (L: .158)	Benefit to c...	.008
		Local parti...	.005
		Local proc...	.004
Percent ...			**12.3**
SR-118 /...	**Percent Financial feasibility (L: .212)**		**2.9**

Alts	Level 1	Level 2	Prty
	Financial feasibility (L: .212)	Comliance ...	.003
		Appropriat...	.007
		Level of pu...	.002
		Financial r...	.005
		Reasonabl...	.010
		Non-toll re...	.002
	Percent Implementation requirements (L: .174)		**1.8**
	Implementation requirements (L: .174)	Comply wit...	.003
		Degree of l...	.006
		Handling ri...	.004
		Ease of im...	.005
	Percent Project evaluations (L: .316)		**3.2**
	Project evaluations (L: .316)	Complianc...	.001
		Degree of ...	.002
SR-118 /...		Enhancem...	.006
		Compatibili...	.007
		Technical i...	.004
		Realistic c...	.006
		Maintainab...	.003
		Project nec...	.003
	Percent Promoters qualifications (L: .140)		**2.1**
	Promoters qualifications (L: .140)	Experience...	.008
		Financial c...	.008
		Parent co...	.005
	Percent Socio-Economic effect (L: .158)		**2.3**
	Socio-Economic effect (L: .158)	Contributio...	.005
		Benefit to c...	.007
		Local parti...	.005
		Local proc...	.006
Percent ...			**14.0**
	Percent Financial feasibility (L: .212)		**2.6**
	Financial feasibility (L: .212)	Comliance ...	.002
		Appropriat...	.006
		Level of pu...	.002
		Financial r...	.005
		Reasonabl...	.009
		Non-toll re...	.002
	Percent Implementation requirements (L: .174)		**2.3**
	Implementation requirements (L: .174)	Comply wit...	.005
SR-125 (...		Degree of l...	.007
		Handling ri...	.004
		Ease of im...	.007
	Percent Project evaluations (L: .316)		**4.9**
	Project evaluations (L: .316)	Complianc...	.002
		Degree of ...	.003
		Enhancem...	.011
		Compatibili...	.011
		Technical i...	.005
		Realistic c...	.006

Alts	Level 1	Level 2	Prty
	Project evaluations (L: .316)	Maintainab...	.005
		Project nec...	.006
	Percent Promoters qualifications (L: .140)		**2.1**
	Promoters qualifications (L: .140)	Experience...	.008
		Financial c...	.008
SR-125 (...		Parent co...	.005
	Percent Socio-Economic effect (L: .158)		**2.2**
	Socio-Economic effect (L: .158)	Contributio...	.006
		Benefit to c...	.007
		Local parti...	.004
		Local proc...	.005
Percent ...			**13.8**
	Percent Financial feasibility (L: .212)		**3.0**
	Financial feasibility (L: .212)	Comliance ...	.002
		Appropriat...	.008
		Level of pu...	.002
		Financial r...	.005
		Reasonabl...	.010
		Non-toll re...	.003
	Percent Implementation requirements (L: .174)		**2.4**
	Implementation requirements (L: .174)	Comply wit...	.005
		Degree of I...	.007
		Handling ri...	.005
		Ease of im...	.007
	Percent Project evaluations (L: .316)		**4.1**
	Project evaluations (L: .316)	Complianc...	.002
		Degree of ...	.002
SR-125 (...		Enhancem...	.010
		Compatibili...	.011
		Technical i...	.006
		Realistic c...	.000
		Maintainab...	.005
		Project nec...	.005
	Percent Promoters qualifications (L: .140)		**2.1**
	Promoters qualifications (L: .140)	Experience...	.008
		Financial c...	.008
		Parent co...	.005
	Percent Socio-Economic effect (L: .158)		**2.3**
	Socio-Economic effect (L: .158)	Contributio...	.006
		Benefit to c...	.008
		Local parti...	.004
		Local proc...	.005
Percent ...			**12.4**
	Percent Financial feasibility (L: .212)		**1.0**
	Financial feasibility (L: .212)	Comliance ...	.001
		Appropriat...	.004
SR-57		Level of pu...	.001
		Financial r...	.001
		Reasonabl...	.002

Alts	Level 1	Level 2	Prty
	Financial feasibility (L: .212)	Non-toll re...	.001
	Percent Implementation requirements (L: .174)		**2.5**
	Implementation requirements (L: .174)	Comply wit...	.005
		Degree of l...	.008
		Handling ri...	.005
		Ease of im...	.007
	Percent Project evaluations (L: .316)		**4.7**
SR-57	Project evaluations (L: .316)	Complianc...	.003
		Degree of ...	.003
		Enhancem...	.011
		Compatibili...	.011
		Technical i...	.005
		Realistic c...	.003
		Maintainab...	.006
		Project nec...	.005
	Percent Promoters qualifications (L: .140)		**1.8**
	Promoters qualifications (L: .140)	Experience...	.007
		Financial c...	.007
		Parent co...	.004
	Percent Socio-Economic effect (L: .158)		**2.4**
	Socio-Economic effect (L: .158)	Contributio...	.005
		Benefit to c...	.008
		Local parti...	.006
		Local proc...	.005
Percent ...			**12.4**
	Percent Financial feasibility (L: .212)		**0.6**
	Financial feasibility (L: .212)	Comliance ...	.001
		Appropriat...	.002
		Level of pu...	.001
		Financial r...	.001
		Reasonabl...	.001
		Non-toll re...	.000
	Percent Implementation requirements (L: .174)		**2.5**
	Implementation requirements (L: .174)	Comply wit...	.005
		Degree of l...	.007
		Handling ri...	.005
SR-91		Ease of im...	.008
	Percent Project evaluations (L: .316)		**4.7**
	Project evaluations (L: .316)	Complianc...	.002
		Degree of ...	.003
		Enhancem...	.011
		Compatibili...	.011
		Technical i...	.006
		Realistic c...	.004
		Maintainab...	.005
		Project nec...	.005
	Percent Promoters qualifications (L: .140)		**2.2**
	Promoters qualifications (L: .140)	Experience...	.008
		Financial c...	.008

Alts	Level 1	Level 2	Prty
	Promoters qualifications (L: .140)	Parent co...	.006
	Per cent Socio-Economic effect (L: .158)		**2.4**
SR-91	Socio-Economic effect (L: .158)	Contributio...	.005
		Benefit to c...	.008
		Local parti...	.006
		Local proc...	.005

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