CHAPTER 1

Introduction

1.1 Transportation Problem

Urban transportation is a pressing concern in metropolitan areas of developing world. Rapid population growth has led to a sharp increase in demand for urban transportation facilities and services. The supply of transportation infrastructure is unable to cope with the existing travel demand, as it is being utilized over and above their design capacity. Rapidly increasing motorization has also its own advantages and disadvantages (Ahmed, Lu, & Ye, 2008). An increase of private vehicles improves principally the mobility, but in traffic oversaturated cities causes serious transport related impacts like growing congestion, air and noise pollution, traffic accidents as well as social inequity.

In addition, each metropolitan area in developing countries with highly dense urban structure needs (or perhaps already has) a good prepared transportation master plan including large-scale public transport projects in form of a network. However, investment in roads continues to increase while funding sources in public transport decline due to budget constraints. The implementation of large-scale public transport projects in developing countries depends mainly on public funds availability; i.e. it is generally conducted by governments (Pucher, Korattyswaroopam, & Ittyerah, 2004).

Generally, a good prepared transportation master plan that includes different transportation projects can play an important role in supplying the adequate arrangements needed to fulfill the expected travel demands. These projects are to be evaluated on two levels (Bongardt, Schmid, & Huizenga, 2011):
(1) Corridor level evaluation (called also one project for evaluation), and
(2) Network level evaluation (called also large-scale projects).

Corridor-level evaluation is a bottom-up approach. The aim of a transportation planning is to formulate different options for each project, based on forecasted travel demand, i.e. these project options are the result of a transportation planning. These options are to be evaluated to find the optimum solution. This type of evaluation deals traditionally with technical concerns (e.g., route location, transport mode, etc.).

In the other hand, as transportation master plan contains a lot of projects that form a network, these projects should be subjected to a network evaluation for screening, rating, and setting the priorities for implementation. Obviously, screening and rating these projects should not only based on the financial costs, but also the potential positive and negative impacts on the community, however possible. This means that all the projects embedded in a master plan should be analysed among each other regarding their impacts, and arranged according to their importance to the society and budget availability. Thus, network-level evaluation, on the contrary of corridor evaluation is a top-down approach.

Among the evaluation methodologies for transportation projects, two approaches are used: Economic Feasibility Studies and Sustainability Impact Assessment.

Despite the generalized use of the conventional economic feasibility, its application, by nature, is constrained due to its attitude for translating units of different criteria into monetary or quantitative terms. Otherwise, economic feasibility studies tend to focus largely on economic analysis (benefits and costs) taking into consideration some other measures, such as environmental impacts. Other impacts may receive less consideration or totally overlooked, such as indirect impacts and sustainable indicators that reflect community needs for its long term development. The ignored indirect impacts may include traffic impacts on non-motorized travel, non-users, integration with other transport services, and accessibility to adjusted land uses. Conventional economic feasibility is also characterized by its uncertainty in estimating costs and benefits regarding variations in inflation, foreign exchange, and interest rates over project lifespan (instable economy).

In contrast also, sustainability impact assessment approaches allow simultaneous analysis of several types of criteria, making it a good alternative to address this evaluation problem. The analysis has three general components: (a) an economic analysis in monetary terms, (b) non-monetary but quantitative considerations, and (c) non-quantitative but qualitative considerations. Thus, sustainability impact assessment approaches are more appropriate in case of evaluation of transportation projects which concerns with achieving the community objectives; e.g. Multi-Criteria Decision Analysis (Jones, Tefe, & Appiah-Opoku, 2013). In addition, some modern approaches such as the Analytic Hierarchy Process (AHP) can be applied as a decision making tool with a respectable degree of certainty (Saaty, 2008) and (Islam & Saaty, 2010).

1.2 The Purpose of the Thesis

The purpose of the thesis is to develop a procedure for a comprehensive evaluation of large-scale transportation projects in urban areas, as an attempt to form a framework and methodology for Sustainability Impact Assessments. The evaluation should incorporate sustainability indicators that reflect the technical, economic, social and environmental impacts of each project in the study area. Sustainability indexes should then be identified to reflect the degree of sustainability of each solution among the competing options; i.e. ranking the candidate projects according to their sustainability.

1.3 The Proposed Methodology

The proposed methodology is developed in the following framework: (1) describing the significant sustainable development goals of the study area and the role of the projects in achieving these goals, (2) defining relevant numerous sustainable criteria and local-oriented indicators, (3) investigating the importance of the criteria and the selected indicators in the comprehensive evaluation of the candidate project options, (4) integrating the Multi-Criteria Decision Making Theory with the Analytic Hierarchy Process to construct a composite sustainability index that can be used for screening and prioritizing of project options, (5) determining the percentage of achieved sustainability of option options, and (6) developing an interactive graphical interface to facilitate understanding the inter-relationships in the evaluation process and allow a better visualization of the impact of any change in the input data.

1.4 Thesis Structure

The thesis contains six chapters, which can be summarized as follows:

Chapter 1 contains an introduction to the presented research work, its objectives, methodology and structure.

Chapter 2 reviews the practices of the methods currently applied for the economic feasibility studies of the transportation projects. In addition, the advantages and disadvantages of each method are explained.

Chapter 3 explains the characteristics of a sustainable transport system, its criteria, and indicators. It illustrates also the best practices with an overview of methodologies being applied to identify the top-priority project of a wide range of possible options.

Chapter 4 presents the conventional techniques used for evaluation of transport projects, i.e. Multi-Criteria Decision Analysis and the Analytical Hierarchy Process. It explains in detail their scientific background, application methods and structure with illustration, as well as the sources of strength and weakness.

Chapter 5 proposes a procedure for the comprehensive evaluation of large-scale transportation projects, including the identification of sustainability criteria and indicators which reflect the sustainable development of the study area and its transport system. It includes also the way to analyse, qualify, and quantify the indicators to be employed for the evaluation purpose. The chapter describes the theoretical base of the proposed procedure and its application framework, with an illustrative simple example.

Chapter 6 involves an application of different techniques used for evaluating and rating the transportation projects to both APTA Master Plan 2006 projects and the project "Alexandria Regional Metro: Abou Qir to El Aamiria - Section 1". The techniques applied are Economic Feasibility, Multi-Criteria Decision Analysis (MCDA); i.e. both Weighted Sum Model (WSM) and Multifactor Evaluation Process (MFEP), Analytical Hierarchy Process (AHP), and the Proposed Approach CETP. The application is performed with EXCEL PROGRAMMING, as a tool with wide range capability in a decision making process. The aim of the application is only to investigate the practicality of the various techniques used for the sustainable evaluation of large-scale and long-term public transport projects in metropolitan areas of developing countries, like Alexandria.

Chapter 7 highlights the overall conclusions.