Chapter 7

Conclusions

Developing countries offer a specific unique local context with regards to urban transport. In spite of the deteriorating travel conditions, car ownership continues to rise with increasing population growth and improving living standard. Under these circumstances, infinite transport demands (mainly motorized) continually increase within a finite transport infrastructure. Consequently the quality of urban life is starting to deteriorate and the street has become unpleasant.

Urban Public transport faces significant challenges in developing countries. The government funding is basically directed to construction, expansion and maintenance of roads, while the public transport often does not receive the same care. The implementation of public transport projects may be postponed due to budget constraints, and some existing public transport lines may be canceled, on the assumption that public transport hinders the movement of private cars.

Failure of governments to supply organized public transport and the inadequate public transport capacities compared to the increase in demand have induced the explosion and the intensive use of privately operated minibuses, microbuses, collective taxis, motorcycle taxis, which are often randomly operated under substandard and unsafe conditions.

The travel situation in metropolitan areas of developing counties should be improved, and the traffic conflicts should be released. The only way is to promote safe, attractive and effective public transport. In Alexandria, for example, a lot of public transport projects are already available as results of different transportation studies. However, the decision for implementing one or more of these projects has not been taken so far because of the conflicting opinions and the lack of a mechanism for screening and prioritizing the candidate projects.

The main purpose of this thesis is to review the current techniques used for evaluating and rating transportation projects and to verify their capability and practicality. The thesis also aims to develop a procedure for a comprehensive evaluation of large-scale and long-term public transportation projects, taking into consideration the four essential sustainable criteria (economic, social, environmental, and transport efficiency).

A comprehensive evaluation procedure can provide great advantages by integrating the benefits of the cost-effectiveness with indicators reflecting the community needs and goals; i.e. identify indicators that also support the development in the metropolitan area. In this case, a transportation project option may lead to economic progress, regional expansion, and land use development, as well as creating new jobs and activities within friendly and harmless environment.

The proposed approach should also deal with quantitative criteria and qualitative criteria, and either with “less is better” or “more is better” indicators. It should take also direct and indirect impacts into consideration. Other two facts is also considered by the development of the proposed

procedure: (1) large scale public transport projects in urban areas in developing countries, like Alexandria, are nonprofit and depend mainly on public funds, and (2) the transport tariff is not economic, but social and subsidized.

The current techniques used for evaluation of transport projects can be classified as follows:

- Economic Feasibility
- Multi-Criteria Decision Analysis (MCDA); i.e. both Weighted Sum Model (WSM) and Multifactor Evaluation Process (MFEP)
- Analytical Hierarchy Process (AHP)

Conventional transport feasibility studies often require detailed economic analysis. They tend to focus on a limited set of criteria; such as infrastructure costs, operating costs, travel time saving, and accident damage costs. They overlook many non-monetized impacts, and disregard indirect impacts. Otherwise, the methods are not sufficient for evaluating transportation projects from all viewpoints, and there is no need in an economic analysis to include stakeholders into analysis.

In developing countries, the economic analysis of transportation projects is more complicated due to lack of a consistent database. The economic analysis is by nature complex and strongly interrelated with socio-economic and environmental systems, which cannot be easily monetize. Economic analysis is always associated with risks and uncertainties regarding variations in inflation, foreign exchange, and interest rates (i.e. unstable economy). Furthermore, as the public transport projects are nonprofit and depend mainly on public funds, the application of some economic evaluation tools, such as cost/effectiveness and benefit/cost ratio, may be accompanied by some assumptions and the results will be inaccurate and unreliable.

Multi-Criteria Decision Analysis (MCDA) is one of the established branches of Decision Theory. MCDA techniques are classified into weighted sum model (WSM), the weighted product model (WPM), and the Multifactor Evaluation Process (MFEP). The different MCDA techniques produce a specific single evaluation priority score for each project option, which is used for ranking the various options among each other's. Specifically, MCDA is used for developing guidance to decision makers in dealing with multiple criteria instead of utilizing a common single attribute such as cost-benefit ratio. Additionally, MCDA approaches have been explicitly applied to the problem of incorporating sustainability into transport planning processes. Knowledge generated by MCDA is derived subjectively based on comparative analyses of various elements.

However, MCDA may lead to doubt the results, due to the complexity nature of the methodology and the large amounts of data and information that must be "stored and operated". It can be described as "an exercise in data handling" which may lead to non-transparent results. In addition, charging weights without testing the consistency of allocated weights may lead to subjective results. The stability of the option ranking should then be edited through a sensitivity analysis. A sensitivity analysis is performed in order to see if the result varies, when the weights are changed. Meanwhile, the use of local knowledge in scientific analysis is limited and often ignored in developing countries. The local knowledge is restricted only to setting the criteria weights.

The Analytical Hierarchy Process (AHP) is a decision making tool helping decision-maker facing a complex problem with multiple conflicting and subjective criteria. AHP is used to integrate qualitative and quantitative information into a single output. The main advantages of applying AHP for evaluating alternatives can be summarized as follows: (1) it is carried out in successive steps, so that data management is not complicated as in the MCDA, (2) it is based on pairwise comparison and the participation of stakeholders at each step, (3) it is supported with a mechanism to insure the consistency of the stockholders weights at each step, and (4) the judgment is established on preference relative linear scale that is practically attractive, user-friendly and more common than values.

If a large number of evaluation criteria and project options exist in an evaluation process, AHP will suffer hard debates during allocation of weights for pairwise comparison. The pairwise comparison should be conducted for the different options regarding all criteria. Thus, the proposed procedure described later (CETP) overcomes this problem by decision making on sequential stages, in the context of a hierarchical structure, with visual presentation of results at every stage.

The main objective of the proposed approach (CETP) is the comprehensive analysis of candidate transportation project options and arranging them regarding their importance to the target sustainability of the community. It is based on integration between Multi-Criteria Decision Analysis (MCDA) and the Analytical Hierarchy Process (AHP). Thus, it can combine benefits of both techniques. These two techniques are chosen because of their capability to deal with preference-based decisions over a lot of alternative options based on criteria that are characterized by multiple, usually conflicting, attributes. In the proposed approach, the MCDA is used for analyzing the quantitative criteria and the AHP for the qualitative criteria.

CEPT organizes the decision-making problem into a relative hierarchy structure of four levels. This structure allows criteria comparisons related to their importance from the viewpoint of multiple stockholders with different interests step-by-step, through a logical systematic manner. Thus, it helps decision-makers facing a complex problem with multiple conflicting and subjective criteria, and understanding the internal complications in the process. The consequence of applying this approach can be summarized as follows:

- Defining the relative importance of the four sustainable criteria (economic, social, environmental, and transportation efficiency)
- Identifying the indicators of the sustainable criteria and indicate their relative importance
- Prioritizing projects options regarding the indicators (Global Priority)
- Rating projects options according to their composite sustainability indexes (Priorities Aggregation)
- Determining a visual composite sustainability level for each Option.

These different above stated techniques are applied for Evaluation and rating of APTA Master Plan projects (2006) and Section 1 of the project "Alexandria Regional Metro: Abou Qir to El Aamiria" (1998). 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. The application is performed with EXCEL programming to utilize its wide range capability in a decision making

process, such as formatting, formulating, and analyzing of large amount of data and information in spreadsheets, creating graphical and visual representations, and capability for what if analysis for supporting decision making.

For the feasibility analysis, four programs are developed in the framework of the thesis. Three programs are shaped for analyzing LRT, BRT, and RRT, individually, based on life cycle cost analysis. Each of which includes 4 spreadsheets; Introduction, Input/output, Investments, and graphical representation. The programs enable the calculations for projects with one, two, or three construction periods. The last program is designed to compare the options. It includes ten spreadsheets; from which seven include the inputs/outputs of the feasibility analysis of the projects options, an options comparison, input, and graphical representation spreadsheets. All the spreadsheets are integrated with each other's. They transfer automatically the inputs and outputs between them.

A program (MCDA) is developed for the application of the Multi-Criteria Decision Analysis. It includes four spreadsheets, "Introduction" that contains the application theory, "WSM" for performing the Weighted Sum Model, "MFEP" for applying the Multifactor Evaluation Process, and Graphics for visual presentation of results.

The program (AHP) is developed for the application of the Analytical Hierarchy Process. It includes three spreadsheets, "Introduction" that contains the application theory, "Calculations", and Graphics for visual presentation of results.

The program (CETP) is developed for the comprehensive analysis of transportation project options and arranging them regarding their importance to sustainable criteria. It is an interactive program that includes eight spreadsheets, Introduction, Criteria, Indicators, Economic, Social, Environment, Transport, and Graphics.

For testing the capabilities of the programs, a limited sensitivity analysis is carried out to identify the variation of the results by changing the weights

As expected, there are major variations in the ranking of the projects by the application of the different techniques. The Reasons can be resumed as follows:

- The theoretical nature of each technique.
- The feasibility analysis is essential for highlighting the differences between alternatives, but is in insufficient for a comprehensive evaluation.
- MCDA is not used qualitative criteria, while the application AHP and CEPT are used for both quantitative and qualitative Criteria.
- MCDA utilizes scientific analysis of data and the professional judgment for weighting criteria.
- AHP depends mainly in the pairwise comparison on allocating criteria weights
- CEPT integrates scientific analysis with local knowledge by setting weights at the different steps of the process.

The application confirms the practicality and capability of the proposed procedure and program CETP for comprehensive evaluation of large-scale and long-term transport projects. It uses

Multi-Criteria Decision Analysis (MCDA), in a combination with the Analytical Hierarchy Process (AHP) to investigate precisely a large number of project options and a wide range of indicators to identify clearly superior options. CEPT produces a global priority index which is used for rating the project options, and a composite sustainability level, which presents the percentage of the achieved sustainability of each option to the maximum achievable sustainability. CETP can also support the decision making through a visual presentation of the interrelationships between indicators and results, and preforming a sensitivity test in situations where uncertainties exist in the definition of criteria weights. In case of non-identical, but comparable options, the visualizing tool enables assessing a trade-offs to identify dominant options.

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