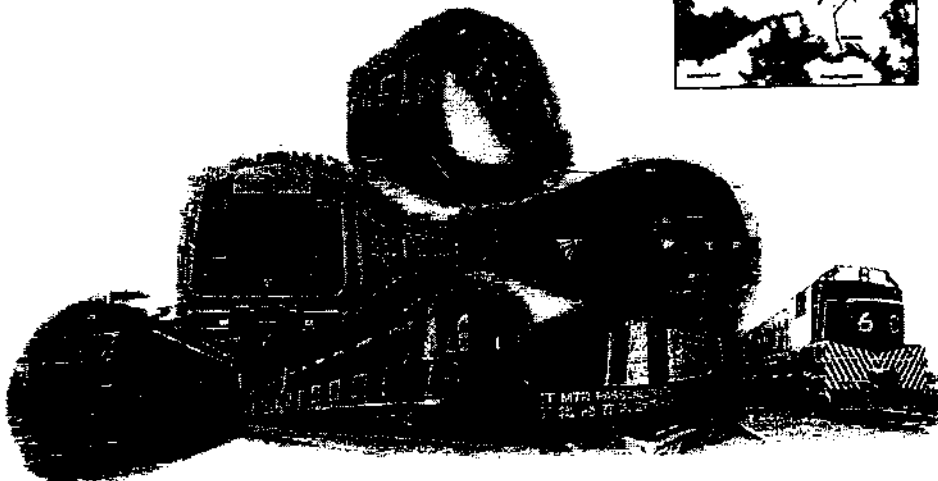
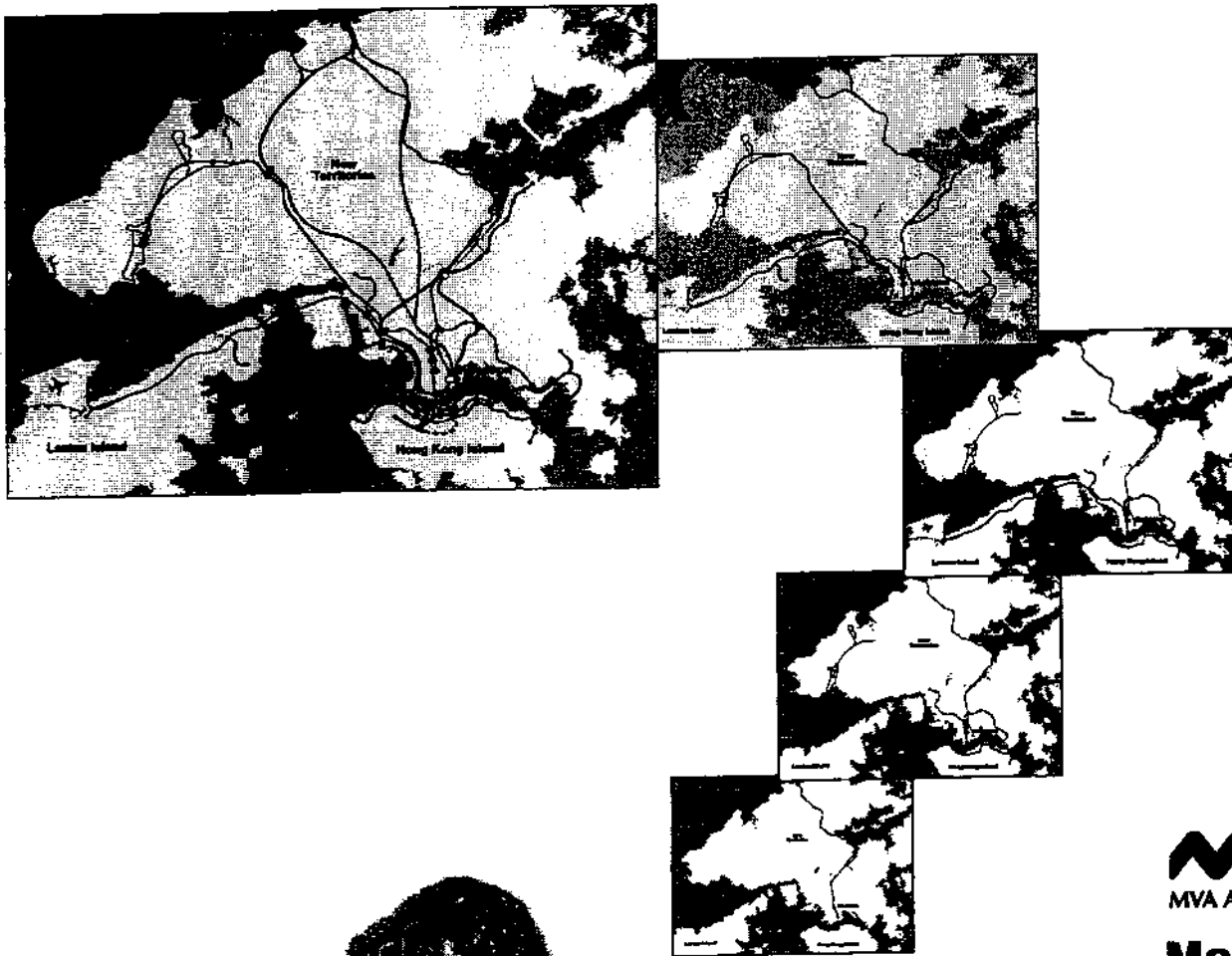


# Annexe **A**

## *Economic Appraisal of the Environmental Costs and Benefits of New Railways*



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**ANNEXE A ECONOMIC APPRAISAL OF THE ENVIRONMENTAL COSTS AND BENEFITS  
OF NEW RAILWAYS****1. INTRODUCTION****1.1 Background**

1.1.1 This Key Issues Paper has been prepared by ERM-Hong Kong and is submitted as part of the Strategic Environmental Assessment (SEA) of the Second Railway Development Study (RDS-2).

1.1.2 The RDS-2 SEA Study Brief calls for a number of Key Issue Reports to be prepared; the SEA Inception Report suggested topics for these which were accepted by the ESMG. This paper is entitled "*Economic Appraisal of the Environmental Costs and Benefits of New Railways*" was previously published as *Discussion Paper E5*. The paper aims to highlight the manner in which fuller account could be taken of the environmental costs and benefits of railways through the application of cost-benefit analysis techniques.

**1.2 Purpose of the Paper**

1.2.1 There are several objectives of the SEA element of the RDS-2 Study stated in the brief. One of these is to identify the environmental benefits of railway developments. This paper is linked to the attainment of this objective and is a "think-piece" designed to stimulate discussion, within the SEA's Environmental Study Management Group (ESMG), of new ideas and concepts.

1.2.2 Specifically, the paper aims to introduce the concepts of economic as opposed to financial appraisal of railways, and seeks to identify how the environmental costs and benefits of railway development could be quantified in monetary terms. Actual monetary quantification of likely impacts is beyond the scope of this paper and the wider RDS-2 Study, as is coverage of broader questions, such as whether or not the environmental impacts of the transport sector as a whole should be managed through the application of tools such as environmental taxes. The focus of this paper is very much on the environmental costs and benefits of new rail development, although it is noted that other economic benefits (such as time savings, highway decongestion benefits etc.) are likely to be of greater significance in dollar terms within a project appraisal.

1.2.3 The concepts presented in this paper have evolved over recent years and have not previously been applied in Hong Kong. Whilst it is not suggested that the concepts be applied to RDS-2, there may be opportunities to annotate the ongoing assessment with information derived from this type of analysis. A potentially suitable example may be the Greenhouse Gas (GHG) option comparison study or the land cost issues currently being investigated. The opportunity for application of these concepts will be kept under review by the SEA Team and remarked upon at suitable and appropriate junctures.

1.2.4 It is hoped that the information presented in this paper will be a first step toward obtaining broad agreement of the concepts such that the environmental benefits of railways might receive greater prominence in the future appraisal of new railways. It is considered that the fulfilment of this goal could be expected to contribute to a more informed basis on which the potential development of transport infrastructure in the future could be considered.

### 1.3 Structure of the Key Issues Paper

1.3.1 The Key Issues Paper is structured as follows:

- *Section 2* provides a brief introduction the way in which railways have been appraised in the past in Hong Kong and goes on to outline the key concepts underlying economic analysis;
- *Section 3* outlines the ways in which economic analysis can contribute to the assessment of various environmental benefits;
- *Section 4* outlines a range of incentive measures which could be used to enable Government and railway developers to take fuller account of the costs and benefits of new transport links and identifies those which may be applicable to Hong Kong; and
- *Section 5* presents brief conclusions about the potential use of environmental economics in future railway scheme appraisals in the SAR.

## 2. A BRIEF INTRODUCTION TO ECONOMIC ANALYSIS

### 2.1 Introduction

2.1.1 This section of the Key Issues Paper seeks to briefly outline the rationale, methods and application of economic appraisal mechanisms, techniques and procedures<sup>1</sup> as background information to aid the comprehension of the concepts presented in subsequent sections of the document. Firstly though, *Section 2.2* briefly outlines the way in which railways have been appraised in the past in Hong Kong and highlights potential implications of this approach for public policy.

### 2.2 Railway Project Appraisal Techniques

#### *Traditional Project Appraisal Approaches in Hong Kong*

2.2.1 Traditionally, new railway investments in Hong Kong have been conceived on the basis of patronage surety and subsequently appraised in financial terms to determine the priority of the development with environmental considerations, at best, being considered wholly downstream of this process.

2.2.2 In traditional financial appraisals, the capital, maintenance, operational, tax and other *costs* associated with the development of a new railway are compared with *revenues* from sources such as ticket sales, advertising and associated property developments. This is the same appraisal framework as might be employed by any profit making business when considering new investments opportunities.

#### *The Limitations of Traditional Approaches*

2.2.3 The key point about financial appraisals in the context of this key issues paper is that they only consider flows of money to, and from, the *project proponent*. As the project proponent is unable to derive financial reward from any broader environmental, community or societal benefits, which the project may be generating, there is little incentive to pursue any objectives other than those that deliver direct financial benefits and are internal to the organisation such as profit, rate of return, etc. Such benefits are likely to include passenger time savings, highway decongestion benefits and, in a dense urban environment such as Hong Kong's, land take and environmental benefits too. In terms of the environment, the financial incentive faced by the developer is to halt co-operation at the minimum legal requirement. From the perspective of Government, which seeks to maximise the welfare of the community as a whole, a purely financial appraisal may therefore provide insufficient or misleading information on whether a project is desirable.

<sup>1</sup> Many manuals exist detailing the rationale for, and processes of, economic appraisal in great detail. See, for example, *Guide to Cost benefit Analysis of Major Projects*, European Commission, Directorate General for Regional Policy, 1997, or *A Perspective of Welfare Economics*, SK Nath, Macmillan Studies in Economics Series, 1998.

- 2.2.4 Economic appraisals, on the other hand, seek to extend the financial appraisal framework so that it may capture all costs and benefits to the wider community<sup>2</sup>; within the specific context of this Key Issues Paper, this is taken to relate to the capture of those costs and benefits arising from environmental factors. A simple, hypothetical example is used to demonstrate the difference.
- 2.2.5 When investigating the development of a new recycling facility, a financial appraisal performed by the potential developer might conclude that the value of the revenue from the sale of recycled materials might not be sufficient to cover the expected capital and operating costs of the plant; as a consequence, the traditional project appraisal of the plant would indicate that it will run at a loss and should not, therefore, be commissioned.
- 2.2.6 However, the proposed recycling facility might provide wider benefits and savings<sup>2</sup> of potentially much greater value to the community through savings on valuable and scarce landfill space and waste transport costs.

#### *Implications for Public Policy*

- 2.2.7 These types of savings represent benefits being realised by the wider community, although wholly external to the project proponent. The provision of information regarding the nature and predicted value of the costs and benefits accruing to the community would clearly convey a different message to a third party attempting to assess the desirability of such a facility. If these benefits were large enough or the nature of the project enabled other policy directives to be met (for example air quality enhancements), Government as the agent of the community, might wish to see the project proceed and provide an appropriate form of assistance through available market instruments such as tax measures, even if it was not financially profitable.
- 2.2.8 In the past, however, environmental factors accruing indirectly from projects have traditionally been inherently difficult to identify and monetise in transport project appraisals and the focus of economists has therefore been upon factors such as time savings, vehicle operating costs savings and highway decongestion benefits. However, in the last decade, the work of environmental economists has brought about an improvement in the recording, manipulation and availability of information and has allowed and facilitated the identification and monetisation of such benefits. Whilst it is not expected that such benefits could be included into the decision making framework within the time frame of the current RDS-2 SEA Study, it may be possible to investigate and analyse the methods being used in other countries and adjudge their applicability to the Hong Kong railway development process for potential future use.

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<sup>2</sup> Strictly speaking, economic analysis differs from financial analysis in more than just the extent to which costs and benefits are covered. Economics also values items used at their opportunity cost. Put more simply, this means that factors of production (land, raw materials, capital and labour) are valued at their next best alternative use. For example, if land is given to a project at a concessionary price, a financial appraisal will use the concessionary price to assess viability. An economic appraisal, on the other hand, will use the actual market price rather than the concessionary price, as the next best use would be assumed to pay prevailing market rates.

- 2.2.9 It is fitting therefore, given the objectives of RDS-2 and its SEA component, that this first Key Issues Paper seeks to identify and investigate ways in which the environmental costs and benefits of developing new railways may be captured within existing scheme appraisal frameworks in order to remove one of the foremost obstacles to equal consideration of environmental elements. In preparing this paper, international experience of using environmental economics in railway scheme appraisals has been examined and where appropriate, the relevance to railway development or related contexts to Hong Kong is noted. A framework for possible future application to the Hong Kong context is then suggested for consideration.
- 2.2.10 The remainder of this section presents a brief introduction to the aims of economic analysis and the tools used by economists to place values on environmental goods and services.

### 2.3 Aims of Economic Analysis and the Role of Economists

- 2.3.1 In brief, economics is the study of how society's resources are deployed to meet people's needs. Economics can have a relatively narrow focus, for example, on the individual, the firm, or on particular projects or policies (in which case it is often referred to as "microeconomics"), or it can encompass wider issues such as economic growth, monetary policy or international trade (when it is often called "macroeconomics").
- 2.3.2 Modern economics has a wide range of applications, the discipline having developed numerous specialist branches focusing on different areas of activity. For example, Governments use economic analysis to assist with policy and project formulation on matters such as the national economy, health care provision, industrial development, the environment, transport, social security provisions, etc. However, the goal of the practitioner is almost always to facilitate the most efficient use of resources from the perspective of society as a whole. In this context, success is measured by increases in societal "welfare", which is best described as increases in the standard of living enjoyed by the individuals within a particular economy.
- 2.3.3 It is important to note that economists do not equate the measurement of "welfare" with commonly quoted economic health indicators such as Gross Domestic Product (GDP). GDP is a relatively crude measure of standards of living which captures flows of income in an economy. As such, GDP ignores the state of other important economic resources such as the environment, the stock of economic or social infrastructure and the human capital of a society. GDP also ignores other issues which impact upon the quality of life, such as crime levels or the vibrancy of a country's cultural life. All of these may, however, be included under the umbrella term of "welfare".
- 2.3.4 As would be clear from this explanation, not all the components of welfare are easily defined in monetary terms. *Indeed, much of the effort of professional economists is devoted to assigning monetary values to elements for which there is no clearly defined, direct market price. The role of an economist therefore, is to seek to quantify, in monetary terms, all of the various elements of a policy or project in order to gain a complete perspective on the implications to society and the economy as a whole.*

## 2.4 An Introduction to Environmental Valuation Tools

### *General*

- 2.4.1 As noted previously, the environmental implications of rail developments tend to be experienced by the wider community rather than by the project proponent. This is true whether they are costs, such as increased noise levels, or benefits, such as reduced air pollution, accessibility, etc. Therefore, an economic appraisal is more complex than a financial appraisal because the impacts on a wider range of parties must be identified.
- 2.4.2 A further complication with economic analysis is that, unlike capital or operating costs, many environmental impacts do not have readily available market prices. Therefore, it is much easier to calculate the benefits of increasing industrial output than it is to calculate the benefits of reducing air pollution levels. This is because the value of increased production can be easily referenced to existing market prices, whilst the value of improved air quality can only be quantified with specially developed benefit values.
- 2.4.3 To overcome these difficulties, economists have developed a number of tools for measuring the value that individual persons place upon non-marketed items. Items which have been valued internationally are diverse. For example, in the United Kingdom, manuals have been prepared by Government departments which provide generic values for passenger travel times, accident costs and clean-up expenses after floods. In the context of environmental issues, a range of valuation tools exists which are discussed in the following sections.

### *Market Price Approaches*

- 2.4.4 In some instances, environmental factors can be measured through linkage to readily available information on market prices. There are two valuation approaches that use market prices in this way:
- *The Dose-Response Approach.* This approach can be used when the environmental effect might lead to a change in the productivity of some process or asset. For example, if water quality was improved by the implementation of a sewage treatment project and this in turn led to higher yields in local mariculture, one of the benefits of the project would be greater output from the fish farms. This benefit would be monetised by estimating the increase in fish production and then using current market prices to value the increase.
  - *The Replacement Costs Approach.* This method is often employed to assess the value of damages to an asset which needs replacing after the implementation of a project. In the context of railway development, the approach might be useful when comparing the costs of reprovisioning environmental resources, such as the provision of compensatory ecological habitats or the relocation of amenity facilities. An important underlying assumption of the replacement costs approach is that the affected asset needs to be replaced, or that there is little doubt that the community would be willing to pay to have it replaced.

### *Household Production Function Approaches*

- 2.4.5 Household production function approaches examine existing household expenditure in order to value the impacts of a project or policy in monetary terms. The most relevant of these to transport developments is the *Travel Cost Method*.
- 2.4.6 The travel cost method is used to value environmental resources or assets which are visited for leisure travel. The rationale is that if persons are prepared to pay the entrance fees (if any) and travel costs (including value of time as well as fares of vehicle operating costs) of accessing a particular site, their enjoyment of that site must be at least equal to the travel costs of getting there. The method can therefore be useful for placing a value on assets such as nature reserves or scenic locations.
- 2.4.7 The method does have acknowledged weaknesses though. In particular, it is less useful when:
- the attraction in question is linear in nature (i.e. an attraction such as a river that offers recreation opportunities along a long distance) as this makes it difficult to estimate travel costs; and
  - a site is only partially damaged as it can only provide estimates for the total value of a site.
- 2.4.8 Also, the valuation method is not theoretically valid if the journey to the site is part of the attraction as is the case in Hong Kong, for example, with boat trips to the outlying islands or the bus journey to Wong Shek in the Sai Kung Country Park.

### *Hedonic Pricing*

- 2.4.9 Hedonic pricing is principally used to analyse the impacts of projects on property or land prices. The concept behind hedonic pricing is that the price paid for a property is a reflection of the many attributes it offers. For example, property prices in Hong Kong are affected by numerous factors such as location, height, size, aspect and proximity to facilities such as transport, cinemas, shops, schools, etc.
- 2.4.10 A portion of the property value is also accounted for by the quality of the local environment. It follows therefore, that changes to this environment may lead to changes in property values, which, when summed together may represent a considerable monetary sum.
- 2.4.11 The calculation of property price implications due to certain environmental changes is a complex task, not least when there are many confounding variables (such as cyclical fluctuations in property prices). However, hedonic pricing studies have been successfully undertaken in other countries to estimate the value (costs or benefits) to a community from changes in the level of aircraft and traffic noise, and the positive contributions provided by the proximity of amenity areas such as rivers, canals and parks. In the context of environmental changes brought about by new railway development, be they positive (e.g. less pollution from road traffic) or negative (e.g. noise or visual intrusion), the impacts on prices of certain environmental variables would need to be isolated from other price influencing factors (e.g. proximity to good schools, rail stations, etc.). It should be possible to calculate this in Hong Kong, for situations



where there have been significant changes to the local environment and where a reliable time-series of property data is available.

### *Contingent Valuation*

- 2.4.12 Contingent valuation methods (CVM) use structured surveys to identify what individuals would be willing to pay contingent upon a specified event or change happening. Contingent valuation surveys can either be based on a willingness to pay (WTP) by the interviewee or on a willingness to accept (WTA) compensation in the light of damages, although WTP surveys are by far the most common in practice.
- 2.4.13 Contingent valuation can be a very useful tool when there is no market price which can be used to estimate the value of damages and the approach is used successfully in many contexts. However, as with all valuation tools, care needs to be taken to avoid misleading results:
- The survey design needs to be undertaken with great care. In particular, the questions must be not be phrased in a way that alters individuals' actual beliefs, and a representative sample of the population must be interviewed (as with, for example, political opinion polls).
  - The environmental impact in question must be experienced by people in some way and must be fully comprehended by them. For example, impacts on ground water conditions that did not affect humans would be difficult to assess through WTP as interviewees would experience no welfare change from the impact in question.
  - As the environment is often an emotive issue, it is very often the case that even those that consider themselves environmentally literate have misunderstandings about the causes and effects of environmental problems. Therefore, there is often a need to provide a clear explanation of the proposed scenario to survey participants.
- 2.4.14 Although there are known difficulties, contingent valuation methods are frequently undertaken successfully, and they represent one of the principal means of valuing benefits and dis-benefits associated with changes in environmental conditions.

## **2.5 Project and Policy Appraisal Tools**

### *Introduction*

- 2.5.1 Once economic values have been developed for impacts, they need to be analysed through the application of project or policy appraisal techniques in order to address the total benefit (or dis-benefit) to the community arising from a particular project. This is conceptually the same as financial analyses of costs and revenues associated with a particular proposal, although it is of course broader in scope (see *Section 2.2*). Two tools are of particular use from the perspective of the public policy maker:
- cost-benefit analysis; and
  - costs effectiveness analysis.

Each of these tools is examined below.

### *Cost-benefit Analysis*

- 2.5.2 The purpose of Cost-benefit Analysis (CBA) is to identify the full range of costs and benefits associated with a particular project or policy and present the findings in a common unit of value, namely money. The purpose of using money is principally that presentation in a common unit of value allows for easy comparison, and for calculation of financial ratios such as net present value, internal rate of return, payback period and cost/benefit ratio. It is therefore worth stressing that the use of money does not imply that economists believe that something has no value unless it can be expressed in money terms.
- 2.5.3 As economic analysis seeks to encompass all relevant effects caused by the project, a comprehensive approach needs to be adopted to ensure that impacts on all affected parties are considered. It is also important to note that other, more common economic benefits can also be captured within a CBA of public transport projects, including:
- passenger time savings arising from improved routing options;
  - time saving for existing road users, arising from the decongestion effects of road users diverting to rail;
  - savings in vehicle operating costs, representing the lower running costs per passenger km of rail; and
  - accident benefits, reflecting the fact that rail is typically a much safer mode of transport than road.
- 2.5.4 Ultimately, every CBA is seeking to identify whether the total benefits of a particular project, policy or regulation exceed the costs. Where this is not the case, persuasive arguments typically need to be advanced for continuing with the proposal. Such reasons might include overall social concerns, or the inability to capture some other important impact of the proposal in money terms. CBA can therefore be a powerful aid to resource allocation in the following ways:
- the fundamental desirability of the proposal under consideration can be assessed;
  - different options for meeting the same objectives can be reviewed to see what type and scale of investment is justified; and
  - scarce resources can be prioritised between desirable projects by proceeding with those which have the greatest benefits first.
- 2.5.5 There exists a substantial literature on the development and application of the CBA process; however, to provide an overview of the key steps, *Figure 2.5* presents a brief summary of the process.

### *Cost-effectiveness Analysis*

- 2.5.6 Cost-effectiveness analysis (CEA) follows the same basic approach as CBA and utilises the same valuation tools. However, where CBA seeks to identify the full range of costs and benefits of implementing a proposed project, CEA seeks to identify the least-cost approach to achieving an already agreed objective.

2.5.7 It is important to note that the two approaches are not mutually exclusive. For example, whilst one might use CBA to set an air pollution control standard, once the standard is agreed and fixed as the objective of air quality policy, CEA could be used to assess the various ways of meeting the required quality objective. More often though, CEA is used to help identify least cost solutions to meeting standards which have been developed through technical analyses rather than economic ones.

## 2.6 Summary

2.6.1 From the valuation approaches and economic tools described above, it can be seen that there is a variety of methods which can be used to value positive and negative environmental effects. Many of these could be used in the context of the appraisal of new railway development.

2.6.2 In *Section 3*, a range of environmental effects typically resulting from development of rail schemes is discussed and potentially relevant valuation approaches are identified.

### 3. ENVIRONMENTAL ECONOMICS AND RAILWAY DEVELOPMENT

#### 3.1 Introduction

3.1.1 This section examines a range of environmental issues which might typically be influenced by decisions on the development of new railway developments and briefly discusses how the application of economic analysis through the monetisation of environmental benefits could contribute to decision making.

3.1.2 The range of environmental issues discussed comprises:

- Air Pollution;
- Noise;
- Landscape & Visual Impacts;
- Ecology; and
- Energy Consumption and its implications for Greenhouse Gas emissions.

3.1.3 The relevance and nature of the economic tools available for application to specific environmental issues is presented in summary form and examples of the international application of a number of these tools is provided for illustrative purposes.

#### *Air Pollution*

3.1.4 Air pollution control strategies are now commonly subjected to economic analysis in North America and the European Union. International donor agencies, such as the World Bank and the Asian Development Bank, also frequently require economic assessments of air pollution control strategies<sup>3</sup>.

3.1.5 Locally, railway developers are requesting monetised economic analyses of the benefits of reduced air pollution as a part of the feasibility studies for new railway extensions, partly in response to growing public concerns about air quality problems but also to demonstrate the environmental benefits attributable from such development proposals.

3.1.6 The approach to calculating the economic benefits of reduced air pollution has been facilitated by recent research which has identified dose-response functions which can now predict the likely health impacts of changes to ambient air pollution levels. The process can be summarised as follows:

- calculate differences in emissions for the "with" and "without" project scenarios to identify the emissions benefit of the project;
- estimate the subsequent reduction in ambient air pollution concentrations;
- apply dose response functions to identify the impact of changes in concentrations on human health and other affected receptors, such as buildings and crops;
- identify the exposed population and calculate the health outcome; and
- apply established economic valuation techniques to quantify the benefits accruing from reduced morbidity and mortality.

<sup>3</sup> For example see "An Air pollution Control Strategy for Chongqing" presented to POLMET '97 by Roger Barrowcliffe of ERM. The study was funded by the World Bank.

3.1.7 The valuation of morbidity and mortality used in economic analyses is calculated in the following ways:

- *Morbidity.* Morbidity impacts are valued principally through analyses of medical costs and reduced productivity (arising from days lost to sick leave and reduced efficiency whilst at work).
- *Mortality.* Values for reduced loss of life centre on three main groups of costs. The first addresses hospital treatment costs, the second considers lost productivity, whilst the third incorporates WTP estimates for reduced risks of dying. Sometimes these WTP estimates are derived from observed behaviour in situations where individuals cut costs whilst having knowledge of the increased risks they are facing or accept hazardous jobs in return for wage risk premiums. Alternatively, they can be produced using carefully structured surveys which ask respondents to trade-off small changes in risk with varying levels of cost for specified activities.

#### *Noise Pollution*

3.1.8 Economic studies of noise pollution have been undertaken in a number of countries around the world, focusing on the effects of aircraft and traffic noise on property prices and rental levels. The first studies were undertaken in the USA in the early 1960s as passenger airlines began to introduce jet aircraft. Compared to their propeller driven predecessors, jet aircraft were much noisier, stimulating many complaints from nearby residents regarding the possible effects on property prices.

3.1.9 Subsequent studies found that property values had been affected and similar analyses were subsequently undertaken for other airports and for road traffic noise.

3.1.10 Generally, two types of economic analyses have been undertaken in order to identify the costs resulting from noise pollution:

- hedonic pricing studies, which examine changes in property prices over time and adjust for other confounding variables (such as general movements in prices); and
- willingness-to-pay (WTP) studies, which enquire about the value residents would place on reductions in the level of traffic noise.

3.1.11 As hedonic pricing studies are based on actual market data, they are more accurate than WTP based studies. However, data do need to be available which permit an analysis of the impacts of changes in noise levels on rental or purchase prices. Hong Kong has comparatively sophisticated historical data on property prices, and it is therefore likely that economic studies of this sort could be undertaken in Hong Kong.

- 3.1.12 An alternative and perhaps more expedient approach would be to use existing international estimates as the basis of monetisation. For example, studies of the impact of traffic noise on rental levels in Switzerland found that a 1 dB(A) decrease in road traffic noise would raise rental levels by between 0.9 and 1.25 percent. However, there are particular problems with transferring benefit values generated for one location to another. Box 3.3a below summarises some key issues concerning the "transferability" of benefits.
- 3.1.13 In Hong Kong, there may be a further means of costing noise impacts. This occurs when new road or rail developments "sterilise" corridors of land due to the potential for excessive noise to prohibit residential or commercial development within close proximity to the transport corridor. Given the high cost of development land in Hong Kong, the potential cost could be very high.

**Box 3.3a Benefit Transferability**

In order to determine monetary values associated with benefits (or damages) resulting from particular events, a number of steps are required:

- understanding of the sources of the benefit/dis-benefit and the mechanism by which they impose damage (e.g. time delays through road blockages or diversions to other modes);
- identification of affected *receptors* (e.g. people, property, vehicles);
- identification of the relationship between the event and the damage/benefit to the receptor;
- estimation of the size of population or area of land at risk, and the scale of potential impacts; and
- assessment of the value to society of reducing these impacts.

Where these factors vary significantly between locations, or between beneficiary groups, transfers of benefit/dis-benefit values between cases may not be robust.

- 3.1.14 The discussion above indicates that many of the conditions which would allow for the transfer of benefit estimates from the Swiss example to the Hong Kong context cannot be said to exist. Therefore, close attention would have to be paid to the benefit estimates cited, and to the results of similar studies, before they could be applied in the SAR. In particular, fresh research or validation studies might need to be carried out.
- 3.1.15 However, if benefit estimates were available, for example, from hedonic pricing techniques, it would be relatively straightforward to translate noise impacts into economic terms. The process would be as follows:
- through noise modelling, identify the number of households experiencing changing levels of noise as a result of the proposal and quantify the change in noise level;
  - compile data on the values of the properties from sources such as the Hong Kong Government's Ratings and Valuations Department;
  - apply the selected value for changes in noise to all affected properties.

3.1.16 In terms of its applicability to railway developments in Hong Kong, the technique could be used in three ways:

- the economic dis-benefits of road and rail options serving the same corridor could be compared;
- if a new rail line is being considered to relieve an existing road corridor, a part of the benefit might be noise reduction and the technique could therefore be used to capture these benefits; or
- for a planned or existing rail line, the value for money of proposed noise mitigation measures could be assessed by comparing engineering and operating costs with benefits.

#### *Landscape & Visual Impact*

3.1.17 Economic assessments of the impacts of visual intrusion are considered to be best tackled using CVM surveys as in each instance, the impacts are likely to be unique. Therefore, studies which are based on data derived from observed impacts of previous studies (for example hedonic pricing studies) are unlikely to cover a comparable situation.

3.1.18 A number of studies have been carried out which seek to place a value on a particular landscape. Such studies have been used in Europe to determine the fate of development options which might affect scenic areas<sup>4</sup>. CVM studies can be structured so as to identify the value placed on a particular scenic area by users, and how much they would be willing to pay to have it preserved. The approach might therefore be of relevance when considering the relative impacts of new rail developments which impact upon areas of sensitive landscape.

3.1.19 CVM studies could therefore be used in two contexts:

- to determine the relative costs of rail options in terms of damage to landscapes; and
- public attitudes to proposals for avoiding scenic areas (for example through tunnelling) could be studied to see if the public's willingness to pay for preserving the landscape was greater than the cost of alternatives. Where WTP exceeded the costs of alternatives, there would appear to be a case for adopting the alternatives from the perspective of the community.

3.1.20 In specific circumstances, the travel cost method can also be employed to produce a value for certain attractions. However, as noted in *Section 2.4.3* this approach needs to be used with care.

<sup>4</sup> See, for example, Willis and Garrod, *Valuing Landscapes: A Contingent Valuation Approach*, *Journal of Environmental Management*, vol 37.

*Ecology*

- 3.1.21 As with visual intrusion, impacts on the ecology of an area and on biodiversity can be assessed using WTP techniques. Alternatively, the travel cost method can be employed to produce estimates.
- 3.1.22 One philosophical problem with the use of these approaches to valuing biodiversity and ecology is that they only assess the value to humans. Unlike the other impacts identified above, where the impacts on humans are the main concern, many conservation advocates argue that the reasons for preserving habitats and the associated flora and fauna do not derive from human values of specific locations, but rather, are motivated more by moral and ethical arguments. Therefore, to value sites according to their value to humans may be inappropriate.
- 3.1.23 One possible way of avoiding such dilemmas is the replacement costs approach. Where successful re-provision of a habitat is possible, a cost can be placed on rectifying the damage caused by a particular scheme. In Hong Kong, where ecological resource loss compensation schemes are being advanced, this latter approach is of particular relevance.
- 3.1.24 However, the "re-creatability" of some complex habitats to fully compensate for the ecological value lost to a new development may be constrained and the time frame for establishing mature and ecological stable habitats may involve many years, in some cases extending to decades. These factors would need to be accommodated in the replacement cost analyses.

*Greenhouse Gas and Energy Use*

- 3.1.25 At a macro level, the provision of public transport (rather than a reliance upon private vehicle ownership) can have significant impacts on energy and, therefore, on the level of Greenhouse Gas (GHG) emissions. The emissions of an area as small as Hong Kong will make little discernible difference to overall global climate change and the greenhouse gas emissions will take long time and have excessive long atmospheric lifetime, and hence the SAR itself will be unable to distinguish in experiencing any tangible benefits of climate change arising out of its own actions. This is unlike many other environmental issues, such as particulate pollution. With particulates, local actions lead to benefits which are realised, in the main, within Hong Kong.
- 3.1.26 There will of course be benefits from the SAR curbing GHG emissions, but these will be experienced by the international community at large (and in particular those countries most at risk from GHG related phenomena such as sea level rise). Therefore, unlike with local pollution issues (such as particulates), Hong Kong will only get a very small proportion of the benefits of its actions as the benefits are global and not local (conversely, Hong Kong will benefit from the actions of others to which it does not itself contribute). Although most benefits from reduced GHG emission would accrue to parties outside Hong Kong, the SAR Government has committed itself to developing GHG control policies in response to the Kyoto Protocol and has recently commissioned a study to identify and examine the cost effectiveness of GHG mitigation measures.



3.1.27 The promotion of public transport (particularly rail-based public transport) is one possible means of responding to increasing GHG emissions; indeed, such a strategy may prove to be one of the more cost-effective methods of reducing energy consumption and associated greenhouse gas emissions. If this proves to be the case, there would be economic benefits associated with promoting rail and the extent of these benefits could be calculated by identifying how much cheaper it would be to develop railways as a mitigation measure than it would be to use the next least expensive control option. Alternatively, costs per tonne of CO<sub>2</sub> abated could also be applied using values produced by the Inter-governmental Panel on Climate Change, which estimated that the damage costs of CO<sub>2</sub> per tonne were between US\$ 0-22.

### 3.2 The Application of Environmental Economics to the Transport Sector

#### *Introduction*

3.2.1 Although transport projects have not typically been appraised using environmental economics, recent developments in the valuation of environmental damages have enabled the wider application of analyses.

3.2.2 The focus for such applications has been the countries of Western Europe, where policy development in the past 5-10 years has shifted in favour of giving greater emphasis to public transport. In particular, the European Commission's ExternE<sup>5</sup> project has presented case studies which illustrate the costs of transport sourced air pollution.

#### *Case Study 1: The Netherlands*

3.2.3 Using the methodologies developed by ExternE, an analysis was undertaken of the 'per kilometre' costs associated with air pollution in the Netherlands.

3.2.4 The external costs of air pollution for a number of routes were examined. One of the routes selected was the journey from Schipol Airport to Rotterdam Central Station, a journey of 60.1 km by road or 66.5 km by rail. The journey is through an area with population densities ranging from 500 to 3000 people per km<sup>2</sup>. Table 3.1 presents the major findings of the analysis.

**Table 3.1 Air Pollution Damage Costs for Road and Rail Traffic, Schipol Airport to Rotterdam Central Station, the Netherlands (1995 prices)**

Vehicle type (1990 average for each)	Damage in ECU <sup>(1)</sup> per 1000 vehicle km <sup>(2)</sup>	Damage in ECU per 1000 passenger km
Petrol car	12.4	8.7
Diesel car	69.9	48.9
LPG car	9.4	6.6
Bus	401	33.4
Train (stopping service)	152	2.4

Source: ExternE study, European Commission.

Notes: (1) One ECU equals one Euro, which is approximately HK\$8.40.

(2) These figures make no allowance for the number of passengers travelling.

<sup>5</sup> European Commission (forthcoming), *Analysis of the External Costs of Transport and Extension of the ExternE Methodology*.

- 3.2.5 As can be seen from the table, diesel cars and buses perform the worst in terms of external costs per passenger kilometre travelled. This is because of the importance of particulates from diesel in the calculation of total damage costs. As can be seen, with the prevailing technologies, railways were by far the most efficient in terms of external costs per passenger kilometre travelled.
- 3.2.6 The ExternE study considered that although such figures should be treated with caution, they indicated the rough order of damage costs associated with passenger transport, and that taxes on fuels in no way internalise the damage costs imposed by motorists (that is, damage to the community was more than the community received in tax revenues).
- 3.2.7 Although the same or a similar methodology could be applied to Hong Kong, the values could not be readily transferred because many of the damage costs are determined by factors such as proximity of emissions to receptors (principally humans, buildings and agriculture). In general, given the density of population in Hong Kong and the form of the urban landscape, it could be expected that the damage costs would be greater in the SAR than in Holland.

*Case Study 2: London*

- 3.2.8 The ExternE methodology has also been applied in the estimation of the external environmental costs of different transportation modes in London. This case study was based on an 11 km stretch of road called Edgware Road, which starts in central London and extends northward to the outer suburbs. Table 3.2 summarises the results of the analysis. It should be noted that the costs given should not necessarily be similar to the costs given above for the Netherlands. This is due to changes in vehicle mix and the nature of the journeys in question (the London case study being principally urban and the Dutch one being inter-urban).

**Table 3.2 External Environmental Costs from Transport Modes in London (1995 prices)**

Category	Local Impacts ECU <sup>(1)</sup> /1000 km <sup>(2)</sup>	Regional Impacts ECU <sup>(1)</sup> /1000 km <sup>(2)</sup>	Global Warming ECU <sup>(1)</sup> /1000 km <sup>(2)</sup>	Total ECU <sup>(1)</sup> /1000 km <sup>(2)</sup>	Total ECU <sup>(1)</sup> /1000 passenger km
Average car	43.3	11.61	2.31	57.22	47.68
Average bus	553.2	127.4	14.54	695.14	57.93
Modern bus	208.6	155.2	21.50	285.30	32.11
Electric bus	-	41.6	8.35	49.95	4.16
Light rail	-	164.3	33.10	197.40	4.94

Source: ExternE, European Commission

Notes: (1) One ECU equals one Euro, which is approximately HK\$8.40.

(2) These figures make no allowance for the number of passengers travelling.

- 3.2.9 Again, average bus, with its reliance on relatively dirty diesel engines performs poorly in terms of external costs per passenger km, although modern engines improve this markedly. For electrically powered equipment, it was assumed that the existing UK fuel mix was used to generate power. A sub-option was run with generation only from combined cycle gas turbines, which resulted in much lower damage costs due to the environmental benefits of burning gas over coal or oil.
- 3.2.10 As an additional analysis, the net benefits of introducing light rail and electric buses were assessed, using assumptions about modal shift from private cars to public transport in the corridor. The "air pollution" benefits for the potential projects were estimated to be of the order of ECU 270,000 to 430,000 per year for light rail and electric bus systems respectively (approximately HK\$ 2,268,000 to HK\$ 3,612,000 at current exchange rates). In net present value terms this relates to benefits of about \$32 million and \$51 million respectively when discounted at a four percent test discount rate over 20 years.
- 3.3 Summary**
- 3.3.1 Table 3.3 presents a summary of the possible application of economic valuation techniques to a range of environmental issues; the range of issues is derived from the environmental issues outlined in the Technical Memorandum to the EIA Ordinance. An indication is also provided as to which economic valuation techniques could be employed to monetise each of the environmental issues and the ease with which these approaches could be applied based on international experience.

Table 3.3 Economic Valuation Techniques which may be Appropriate to Various Environmental Issues\*

Environmental Issue	Applicable Economic Evaluation Techniques	Previous Applications	Likely Applicability to HK	Ease of Applicability	Other Comments
Air Pollution	Dose response (human health)	Yes - numerous	High	Techniques established but data hungry	Key issue in HK
Fish Culture	Market prices (dose response)	Yes - numerous	Moderate in context of rail development	Relatively straightforward	Needs good data on fish output
Ecology	Market prices (replacement costs) or WTP	Yes - numerous	High with some route options	Market prices straightforward, WTP method well known and practised	Human-centred so may not be appropriate
Waste	EIAO focus is on waste issues during construction	Various studies have looked at benefits of waste avoidance	Moderate in context of rail development	Easy to cost waste generation costs (based on landfill costs)	Not of great relevance to rail development
Noise Pollution	Hedonic pricing (property prices)	Yes - small number of empirical studies	High	Techniques established but data hungry	Could be important given urban form
Hazard	Dependent upon subject at risk	Cost benefit analysis is routinely used to appraise risk mitigation measures	High with some route options	Variety of techniques established	Nature of risk needs specifying
Heritage and Cultural	Market prices (replacement costs) or WTP	Yes - small number of empirical studies	High with some route options	Market prices straightforward, WTP method well known and practised	Assets out of context may be of limited worth
Greenhouse Gas (incl Energy)	Varies - based on saving per tonne over next most expensive option	Yes - many countries have researched least cost Kyoto compliance policies	High - Government currently preparing compliance policy	Should be feasible once strategy study complete	On-going study in Hong Kong
Water Quality	Market prices (dose response), or WTP	Yes - numerous empirical studies	Moderate in context of rail development	Market prices straightforward, WTP method well known and practised	-
Land Contamination	EIAO is from perspective of development constraints	Assessments of clean up costs have been done - would be included in CAPEX costs	Moderate in context of rail development	Easy - part of engineering cost estimates.	-

- It should be noted that the table provides a general guide only. In particular, many of the issues raised are scheme or location specific and the table therefore only provides a simple overview of key issues.

## 4. MECHANISMS FOR "CAPTURING" BENEFITS TO THE COMMUNITY

### 4.1 Introduction

4.1.1 The ideas set out in this Key Issues Paper were presented to the Second ESMG for RDS-2. During the subsequent discussion ESMG members enquired about the types of mechanism that could be employed which would enable railway developers to benefit from the broader benefits generated by their projects. Therefore, to identify how such mechanisms might exist in a practical sense, this section briefly outlines, for information purposes, examples of possible means of achieving this goal. Institutional issues are being dealt with in more depth elsewhere in the RDS-2 study.

### 4.2 Background

4.2.1 Internationally, Hong Kong's urban rail operators are almost unique as they are able to develop and operate urban rail systems at a profit. From a network development point of view, the rail companies have therefore had no need in the past to try and "capture" the broader community benefits (such as environmental benefits or highway decongestion benefits) which their projects have generated. In essence, the community is "free-riding" on the spin-off benefits derived from the railway companies' operations. However, in countries where heavy rail development has not been profitable, many rail operators have had to seek financial assistance of one form or another in order to permit the development and operation of their rail networks.

4.2.2 The financial assistance is typically regarded as being the price public authorities must pay on behalf of the community to ensure that the social benefits of rail development over road based forms of transport are realised. (It should be noted, in passing, that most highways in Hong Kong are wholly financed from the public purse - in this respect private vehicle owners are heavily subsidised in contrast to rail passengers who must pay the full cost of their journey). It should be noted though that support is rarely given which "pays" the rail company for all the benefits it is providing society. Instead, a more common approach is to provide only as much assistance as is needed to make the scheme financially viable (i.e. making an adequate return for rail operators).

4.2.3 This policy is known as "additionality" within the European Union and refers to the principle that only financial support which allows additional, beneficial investment to proceed is provided. Therefore, if the project provided \$500 million of community benefits but was profitable the rail operator would receive nothing, but if the project provided \$500 million of community benefits and needed \$300 million to be viable then \$300 million of assistance would be provided to the rail operator in some form (see below).

### 4.3 Types of Financial Assistance Offered to Other Rail Developers

4.3.1 Outside Hong Kong, financial assistance provided by public authorities has typically fallen into one of the following categories:

- *Operating Subsidies.* Many state owned rail companies receive on-going annual subsidies in order to cover capital expenditure and operating deficits. For example, the Paris regional transit authority, RATP, and the New York Subway both operate with annual subsidies from city or national administrations. Even in the UK, where the rail network is now in private hands, subsidies are granted

to most operators (franchises are awarded to rail companies on the basis of the lowest request for subsidies in an attempt to put downward pressure on levels of public spending).

- *Capital Expenditure Support.* A number of rail companies receive one-off capital grants to enable investments in new or upgraded lines and rolling stock which have been identified as being desirable from the community perspective. The capital grant is designed to be just large enough to ensure the financial viability of the rail project once operational (i.e. without a need for on-going subsidy). This is the financial regime now in place on the London Underground, where London Underground Limited (LUL) is obliged to cover on-going operating costs but does receive capital grants towards construction of new lines such as the Jubilee Line Extension (JLE). This is also the policy adopted by the European Commission when funding various urban rail schemes in countries such as Ireland, Spain or Greece.
- *Provision of Associated Infrastructure.* Rail systems are part of a complex urban fabric and, for example, need numerous connections to roads, utilities and labour markets. In order to aid rail schemes public authorities have often provided such connections. The development of public transport interchanges, where various rail and bus transport modes meet to form part of a broader network, is one example that is popular as it improves networks available to passengers and boosts patronage for public transport operators. In some senses, this is similar to both capital and operating subsidies as it includes both upfront and operating support, although it merits consideration separately because no money is provided directly to the rail developer.
- *Granting of Assets or Development Rights.* Land, land development rights or other assets are also often granted to the rail developer. This practice has been common in Hong Kong. The approach has also been used recently in the United Kingdom for the Channel Tunnel Rail Link, where the rail services provider (the train company Eurostar) was granted to the consortium which won the public tender to construct the new high speed rail link from central London to the Channel Tunnel.
- *Developer Contributions.* Under this scheme the rail developer negotiates (or Government negotiates on its behalf) with property owners or developers in an area where access is to be improved, with the aim being to gain capital contributions from those parties who will benefit most from improved accessibility. The absence of some form of enforcement can be problematic. In the UK, and again with regard to the JLE, LUL negotiated a 400 million pound (Sterling) capital grant from the developers of the Canary Wharf office complex, Olympia and York (O&Y). However, this deal illustrated the problems of such approaches - it was extremely time consuming to negotiate as the developer believed that the railway would be developed anyway, it was inequitable as only large land owners were targeted (leaving many to benefit without making contributions), and by the time the deal was agreed, O&Y were about to go bankrupt as a result of a severe downturn in the property sector. An alternative approach is the US's Special Assessment District which mandates an increase in property taxes in affected areas to finance new transport infrastructure. This tax mechanism overcomes the "free rider" problem and spreads the burden more equitably amongst all beneficiaries. In Los Angeles, this approach was used and funded five percent of the Wilshire Corridor Metro project construction costs.

- *Hypothecated Taxes.* Hypothecated taxes are those which are collected and then allocated to a specific expenditure budget, unlike most taxes which are placed into a central "pot" before distribution by Government in accordance with the various spending priorities. They are quite common in the transport sector with, for example, revenues from parking often being allocated to other transport purposes. Such taxes are particularly common in continental Europe. For example in France, the *Versement de Transport* encompasses all towns with a population of over 30,000 inhabitants. The tax is a percentage of salary and is paid by employers. The funds raised are used to maintain and develop the transport infrastructure of the town and the tax was a key source of revenue for the regional high-speed RER network in the Isle-de-France region (which includes Paris). Vienna has a similar tax which is devoted exclusively to developing the city's underground Metro network. In Germany, the *Mineralölsteuer* is a tax on mineral oils which was introduced specifically to fund local transport schemes. The monies raised are used for road, rail, pedestrian and cycle schemes.

4.3.2 It can therefore be seen that there are a number of potential financial mechanisms that could be used to support the development of rail projects where:

- financial assistance is needed before the scheme becomes viable; and
- community benefits can be identified and quantified.

4.3.3 Whilst the selection and development of suitable mechanisms for Hong Kong is well beyond the scope of this issues paper, it should be clear from the above that mechanisms do exist and are actively used in other countries which would allow the railway developer to benefit from the broader community benefits of railway projects which, in turn, may mean that more sustainable transport links could in future be pursued. The following section provides some initial thoughts of those mechanisms which may be more relevant to the Hong Kong situation, subject to further study and investigation at an appropriate stage.

#### 4.4 The Hong Kong Context

4.4.1 Having outlined the main methods by which the wider community benefits of rail schemes are monetised and "repaid" to rail operators in other countries, this section very briefly highlights the perceived key issues relating to each in the Hong Kong context, taking account of our unique geographical, institutional and political circumstances.

- *Operating Subsidies.* There is no theoretical reason why operating subsidies should prove problematic. However, international experience has shown that the practicalities of Government budgeting, and shifting political priorities, have meant that subsidies are now generally regarded as undesirable where consistent support for public transport cannot be guaranteed. Even in countries such as France, which has had a strong commitment to fund the development of the national rail network, operators have been hampered by changing public subsidy allocations, making a mockery of attempts at long term network planning. In the UK, LUL has sought to end dependence on operating subsidies for precisely these reasons. In Hong Kong, with its traditional antipathy towards

Government subsidies of any sort (however well justified they might be), subsidies might prove to be particularly unpopular.

- *Capital Expenditure Support.* Upfront support for investment costs is the form of support favoured by the European Commission and the national Governments of a number of EU member states. Sufficient capital support is typically granted to ensure that the railway will be financially self sustaining during the operational phase, meaning that there are no on-going subsidies. Capital grants therefore differ from on-going subsidies as they can be characterised as Government "buying" community benefits in a one-off transaction. They therefore minimise the scope for on-going budgetary uncertainty and Government or political influence/interference. For this reason this arrangement has been favoured by both rail operators and Governments.
- *Provision of Associated Infrastructure.* Given the integration of rail development into the development of new towns and other major residential and commercial developments, there would appear to be considerable scope for the provision of supporting public infrastructure such as public transport interchanges in Hong Kong.
- *Granting of Assets or Development Rights.* This has been standard practice in Hong Kong and, in truth, there is likely to be little that the SAR could learn from overseas in this regard. The development of many of the existing railways in Hong Kong have involved the extensive allocation of land and development rights to rail companies to help offset the high capital expenditure costs of developing railways in Hong Kong.
- *Developer Contributions.* Although rail companies benefit from development gains in Hong Kong at present, other adjacent landowners also derive a benefit from new or improved rail infrastructure which serves their properties. These third party developers make no contribution to rail costs at present however. Through the rating and land premium systems in Hong Kong, Government already has a mechanism to capture some of this improved land value and, should it wish, it would be possible in theory to transfer a portion of incremental revenues associated with rail developments back to the rail companies. This is not Government policy at present, but it may be worth investigating in the future if financial support becomes necessary as the increase in property taxes would only be expected to materialise if the rail development went ahead. Therefore, such a scheme would not cost the Treasury money in a real sense (if there was no project there would be no additional revenues anyway).
- *Hypothecated Taxes.* In Hong Kong, Government strives to keep the taxation system as simple and as light as possible in order to ensure a positive business environment. Much is made of this policy when promoting Hong Kong as a business centre. Therefore, new taxes introduced for the purposes of raising money for rail projects would be likely to be resisted both inside and outside the Administration. If, in the future, charges such as electronic road pricing are introduced, it may be worth examining whether or not the revenues should be hypothecated to provide a fund which could have rail developments among its beneficiaries. An alternative would be to have increments to existing taxes, such as property taxes or fuel duties. In passing, it is worth noting that one practical drawback with all hypothecated taxes is that revenues raised may not match the amount required for investment, leaving Government with a deficit or surplus in the fund. A deficit would still leave the project requiring financial



support, whilst surpluses pose problems of what to do with revenues (which may be politically problematic with an issue as high profile as public transport).

- 4.4.2 It can therefore be seen that each of the financial support mechanisms has strengths and weaknesses which will need to be examined carefully if, and when, the concepts presented in this paper are implemented.

## 5. CONCLUSIONS

### 5.1 General

- 5.1.1 The tools used in environmental economics have developed considerably in recent years and, in many cases, the environmental costs and benefits of rail based transport can be captured using economic valuation techniques, thus allowing the inclusion of these benefits and costs into a wider cost-benefit analysis framework.
- 5.1.2 The inclusion of such costs and benefits into the appraisal framework provides the decision maker with additional information on the value of such benefits, be they economic, social or other, to the community. This allows a more holistic assessment of the development and will often identify projects which, on the financial facts of the case, appear undesirable, but which can be shown to provide overwhelming positive benefits for the community.
- 5.1.3 This paper has reviewed a range of economic evaluation techniques and trends in their application to the monetisation of environmental benefits in other developed countries and has provided insights on the applicability of these to Hong Kong and specifically, to the rail transport industry. Based on the current situation and historical approaches to the financial assessment of railway developments, there are clearly policy implications if the suggested approaches were to be adopted. Much of the data that would be required to undertake environmental evaluation studies of the environmental benefits of rail developments exist in Hong Kong, although other data sets would have to be researched and developed for use in the SAR.
- 5.1.4 In conclusion, a monetary analysis of the environmental effects of rail developments could provide much useful information for transport and environmental policy makers. Such studies could play a major part in minimising the negative environmental consequences of transport provision and also assist with broader environmental policy goals. Capturing environmental benefits would help to achieve more balanced choices about the selection of appropriate developments and ensure that transport policy is guided by the broad objectives of providing the best infrastructure possible for an international city such as Hong Kong.