Chapter 1 INTRODUCTION

1.1 Motivation and Objective

A well-developed transportation infrastructure is vital to a country's economic development. Therefore, transportation has always been an important priority in national development plan. As for the case of Taiwan, it can be seen that from the early "Ten Major Construction Projects" in the 1970s to the most recent "Challenge 2008 National Development Plan", improving the transportation infrastructure was made one of Taiwanese government's major tasks.

Moreover before the government undertakes transportation programs it is essential to undertake the feasibility study. This is mainly because the transportation programs naturally are predominantly funded by central governments, the parliaments often explicitly call for feasible studies to seek justifications for spending taxpayer funds. The fundamental principle to conduct the feasible study is to compute potential positive and negative impacts accurately. In order to reach a conclusion as to the desirability of a project all aspects of the project, economic and non-economic, must be expressed in terms of their equivalent money values. A project's proponents will anticipate the overall positive effects for the validation to carry out the project.

Despite the fine process of evaluating a project, there have been numerous disputes resulting from project implementation. The controversies primarily could be attributed to two reasons. The first explanation is insufficient framework in project assessment. It is well known that cost-benefit analysis (CBA) is the most frequently used technique in project evaluation. In fact CBA has come to dominate other methods of evaluations in the project appraisal CBA estimates and totals up the equivalent money value of the benefits and costs to the community of projects to establish whether they are worthwhile. The accuracy of the outcome of a CBA hinges on how precisely costs and benefits have been estimated. The formal CBA approach generally focuses on computing the impact of economic variables and is lacking adequate tools to handle non-economic variables. In particular for an environment-sensitive transportation project the CBA approach has difficulty calculating the effects from the environmental aspects. Neglecting environmental dimension in CBA analysis may be argued to be a substantial risk in planning, because inaccuracies are likely to lead to inefficient decisions.

Given the problems in the CBA assessment, there was an attempt to develop the "Environmental Impact Assessment (EIA)" to supplement the CBA. The EIA

principally includes environmental features in the evaluation process. However, the widely-adopted exercise which involves the “EIA and the traditional CBA in a sequential way may be flawed with a failure to calculate the resultant economic and environmental impacts in a same setting and at the same time.

In addition great efforts have been devoted to constructing the Contingent Valuation Method (CVM). CVM could take environmental factors into account and by far is the most frequently applied methodology. Actually CVM has emerged as an alternative instrument in project assessment. Nonetheless, the CVM mainly deals only with the environmental impacts, paying not much attention to the economic impacts and still falling short of expectations.

In summary the current evaluation methodologies have been conducted with restrictions. There is a need to develop an integrated cost-benefit model for an environment-sensitive transportation project. Specifically when the subject of sustainable development has become an increasing concern around the globe, it is imperative to build up a comprehensive method in project appraisal.

The second reason for controversies in project enforcement is inappropriate classification of interest groups. This is predominantly prevalent in the environment-sensitive transportation projects. In recent years protecting the environment and natural resources has become a central concern around the world. Environmental protection is extremely important for sustainable economic growth and social progress. The elements of environmental protection objective involve reducing the direct and indirect impacts of transport facilities and their use on the environment of both users and non-users. The environment impacts of concern include noise, atmospheric pollution of differing kinds, vibration, and other pollutants. While some of these can be quantified and monetized, others are much more difficult to define and analyze.

Given the difficulty in sorting and quantifying pollution factors the interest of specific groups which are influenced by pollution will inevitably be overlooked. It will lead to certain interest groups have not been identified in the project evaluation process. This problem could be further amplified by the fact that the current procedure could not handle environmental factors properly. Consequently it is necessary to classify interest groups appropriately in project appraisal

Based on the above descriptions, this study aims to fill the gap of the framework of project appraisal. It will explore the often neglected but important environmental impacts of project evaluation. Accordingly the purposes of this study could be illustrated as follows:

(1) Developing an advanced methodology of project evaluation:

Given current limitations of project evaluation this study seeks to construct a complete technique of project evaluation. It first emphasizes on identifying the scope of environmental goods and the interest groups. This will be followed by incorporating existing CBA and CVM. We will employ CVM to appraise the value of environmental goods. It should help the transportation planners to deal with widening scope of environmental subjects more confidently in the future.

(2) Establishing the redistribution mechanism of economic benefits accruing from transportation projects

It is common that more interest groups are affected by the transportation projects due to the widespread effects of environmental factors. There is a perceived need to develop methods and procedures that can be used by transportation planners to evaluate the distributional impacts of projects. This study is set to construct redistribution mechanism of economic benefits accruing from transportation projects. This should enable us to ascertain socio-economic factors that affecting evaluation of environmental goods. As a result it can alleviate the dissatisfaction from the affected interest groups and to facilitate the project enforcement.

Accordingly, the contribution of the study is twofold. Firstly, this study has developed an efficient process in evaluating an environment-sensitive project. As we know environmental impacts are qualitative in nature and are hardly and difficult to be converted into monetary terms. By monetizing the environmental impacts, the study shows that it is feasible to integrate the CBA with the environmental factors on an equal basis.

The second contribution of the study comes from the empirical case. This study employed the Pinglin Interchange for the case study. The empirical results show that an integrated CBA may produce an entirely different conclusion from the one resulting from the common traditional environmental assessments. This inspiring result may be served as an important milestone for social planners in evaluating the environmental-sensitive projects in the future.

1.2 Research Scope

As described earlier this study sets to improve the current project evaluation methodology and derive the redistribution system accordingly. Therefore the scope of the research consists of two parts. The first part is to go a step further than the previous research by developing a step-by-step process which integrates the CBA with the CVM to assess the overall effects (both the environmental and economic

impacts) for a transportation project.

The second part of the research scope is to apply a case for the illustration. The empirical base of the study draws on the case of the Pinglin Interchange in Taiwan. Pinglin, as a tiny rural town in northern Taiwan with only about six thousand residents, is famous for its green tea and rapidly-growing tourism business. The debate was originated from the contraction of No. 5 highway. Ever since the plan was announced for the No. 5 Freeway, which will connect Taipei to Yilan through one of the world's longest tunnels, Pinglin residents have been agitating for a full-fledged interchange at their town. The predominant motivation for them was economic consideration. They alleged that if there is no full function interchange in Pinglin, most of the travelers will not stop in Pinglin and Pinglin may lose its tourists to Yilan.

On the other hand the official evaluation reports did not support the full function interchange for the environmental reason. This is because the interchange lies within the catchments area of the Feitsui Reservoir, which supplies drinking water to near five million inhabitants within the Taipei metropolitan area. However since the government reports did not identified and monetized environment factors appropriately, the impacts of pertinent groups have not revealed consequently. The credibility of the reports has been questioned to a great extent.

For the purpose of this study we will develop an integrated cost-benefit method. Following the methodology the subject of Pinglin interchange will be selected as an instructive example. The survey was conducted over the period from April to October in 2004 and in the end 466 reliably questionnaires were obtained. Admittedly, the case of the Pinglin Interchange is relatively small and simple, but the process presented in the study may serve as a reference point for a bigger and more complex case.

In order to resolve the problems occurred in the governmental reports in the following work we will classify the sources of pollution into three pollutants: air pollution, water pollution and noise. The people are affected by the pollutants can be categorizes into two groups accordingly. The first group is Pinglin residents and passengers who are mainly affected by air and noise pollutants. Taipei metropolitan residents who rely on Feitsui Reservoir for drinking water can be regarded as second group, since Pinglin interchange may contaminate Feitsui Reservoir pollution.

According to the above descriptions this study is organized as follows. Chapter 1 is the introduction, which describes the motivation, objective and scope of this dissertation. Chapter 2 will first reviews the evolution of methods in evaluating environment-sensitive projects. This will be followed by the overview of the CVM approach. Chapter 3 illustrates the methodology of the survey. Chapter 4 provides an

overview of the Pinglin case and the survey results are discussed subsequently. In chapter 5 we further extend the case study by examining the impacts of imposing user on pollution reduction. The conclusions and the directions for future research are presented in the finial chapter.

In summary the structure of this dissertation is shown in Figure 1.1.

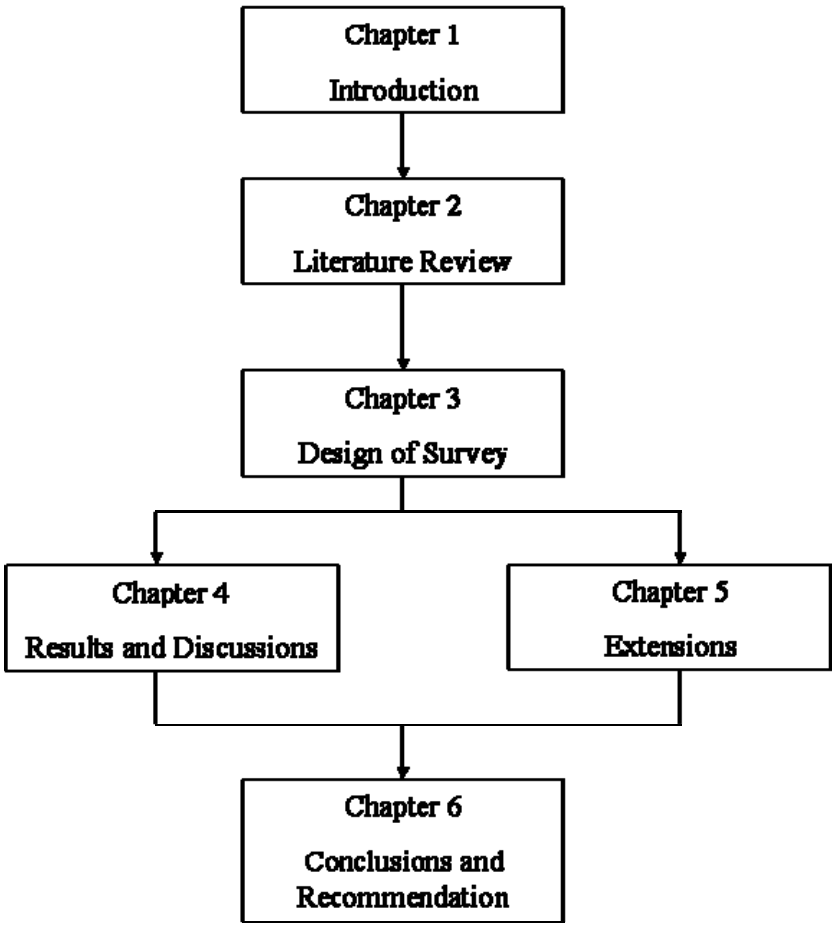


Figure 1.1 Structure of the Dissertation

CHAPTER 2 LITERATURE REVIEW

The primary objective of this study is to develop an integrated transportation project appraisal methodology by incorporating cost-benefit analysis (CBA) with Contingent Valuation Method (CVM). Therefore it would be necessary to understand the current progress of related works. In this chapter we will first outline the current applications of CBA. This will be followed by the overview of CVM.

2.1 The Applications of CBA in Transportation Projects

CBA is the most frequently used method in transportation project evaluation. Actually CBA has dominated other evaluation methods in the transportation project appraisal.

2.1.1 Environmental factor values embedded into formal CBA hardly

Table 2.1 lists the categories of transportation project for CBA evaluation in different countries. It can be seen that direct impacts, environmental impacts and socio-economic impacts are major dimensions in evaluating transportation projects. In principle there is a high degree of consensus among countries on calculating direct impacts. The items included in the direct impacts are rather easy to measure. On the other hand, the range of environmental impacts varies considerably across countries. Noise and local air pollution are always included in the environmental impacts, but other factors are not necessarily incorporated in the environmental scope. The main reason for that is some environmental factors are hard to quantify. In many countries the CBA is supplemented by a quantitative and/or qualitative appraisal to include environmental factors which are not monetized for technical reasons. Finally, it is a lot more complicated to evaluate socio-economic impacts. There are some countries even excluding socio-economic impacts from project evaluation. The socio-economic impacts are difficult to identify and measure in nature. The recent development on this aspect is to estimate socio-economic impacts based on economic efficiency and focus on user's benefits. Nonetheless, there is still a lot more work to be accomplished in this area. It will never be possible in practice to value all impacts, but we should aim to extend valuation to as many as we can.

Table 2.1 Impact categories of transportation project for CBA evaluation

	DEN :Road	FIN	FRA	GER	IRL	ITA	NRL	POR	SPA	USA	SWE :Road	UK :Road	JPN :Road	TWN :Road
DIRECT IMPACTS														
Capital														
Construction Costs							MCA							
Disruption Costs														
Land and Property Costs														
Recurring														
Maintenance Costs							MCA							
Opterating Costs							MCA							
Vehicle Operating Costs							MCA							
Revenues														
Passenger Cost Savings														
Times Saving							MCA							
Safety							MCA							
Service Level														
Financing/Taxing														
ENVIRONMENTAL IMPACTS														
Noise							MCA							
Vibration														
Air Pollotion - Local							MCA							
Air Pollotion - Grobal														
Severance														
Loss of Important Sites														
Visual Intrusion														
Resource Consumption														
Landscape														
Ground/Water Pollution														
SOCIO - ECONOMIC IMPACTS														
Land Use							MCA							
Economic Devrlopment							MCA							
Employment														
Economic & Social Cohesion														
International Traffic														
Interoperability														
Regional Policy							MCA							
Conformity to sector Plans														
Peripherality/Distribution														

Source: Complied from Bristow and Nellthorp, 2000; Morisugi, 2000; MOTC, 2005.

2.1.2 Geography identifying the gains and loses inside the totality

The Benefit Incidence Table (BIT) is the normally useful framework. As shown in Table 2.2, BIT enables the user to qualitatively identify the origin, transfer and incidence of the various impacts of the project, without double counting and leakage, and provides good foundation in project assessment (Morisugi, 2000). BIT can be narrowed down to a practical scale, which can help planner to recognize associated

interest groups. Furthermore, in addition categorizing the source of impacts, efforts have been made to identify affected groups of the transportation projects. The effects of transportation infrastructure are related the road use and location. The classification of Table 2.2 does not submit to the characterization of transportation infrastructure.

Table 2.2 Classification of affected groups for the transportation projects

			road user			household				industry						government				
		road corporation	road under plan	alternative existing road	pedensttain	consumer	employee	land user	resident	producer	employer	land user	industry in other regions	road space pccupier	land owner	municipality	prefecture	nation	world	total
Road use	savings in travel time		+◎	+◎																+◎
	savings in vehicle operaing cost		+◎																	+◎
	reduction of traffic accidents		+◎	+◎																+◎
	enhancement of driving comfort		+○	+○																+○
	enhancement of safety and comfort on sidewalk				+△															+△
	toll payment		+◎																	−◎
Environment	change in air pollution								+◎		+○									+◎
	change in noise								+◎		+○									+◎
	change in scenery		±○	±○	±○				+○		+○									±○
	change in ecological system								±△										±△	±△
	global warming																		±◎	±◎
Civic life	utilization of road space													+△						+△
	network redundancy for emergency								+△	+△	+△									+△
	enlargement of communocation opportunity								+△	+△										+△
	enhancement for publicservice availability								±△											±△
	upkeep of population								±△											±△
Reginal economy	production increase with industrial location									+○			−○							0
	increase in employment and income						+○				−○									0
	change in price of commodity and service					+○				−○										0
	increase in asset value							−○				−○			+○					0
Fiscal expenditure	savings in public service cost									−○						+○	+○	+○		0
Tax revenue	local tax						−○			−○				−○		+○	+○			0
	national tax						−○			−○				−○				+○		0
Public subsidy	subsidy	+◎																−◎		0
	investment	+◎														−◎	−◎	−◎		0
Toll revenue	toll revenue	+◎																		+◎
Project cost	construction cost	−◎																		−◎
	maintenance cost	−◎																		−◎

+: positive effect −: negative effect ±: unknown sign
◎: measurable in monetary terms ○: roughly measurable △: difficult to measure

Source: Morisugi, 2000

The interest groups for interchange use can be classified into three types: road users, roadside communities and regions, and public sectors (Lee Jr., 2000; Morisugi, 2000; Quinet, 2000; Rothengatter, 2000). We will amend classification of affected groups in common use BIT.

2.1.3 Formal CBA ignoring the gain-loss distribution among interest groups

The formal CBA evaluates from totality of society benefit and ignores distributions among stakeholders. The pluralism considers the policy design of environmental issue should be refer to the multi-valuation and the environmental right of all interest groups. Anderson and Leal (1991) provide "free market environmentalism (FME)". They consider "free market environmentalism is a system of well-specified property rights to natural and environmental resources". Property rights provide the foundation for markets, and so establishing property rights in environmental resources enables individuals and organizations to pursue environmental goals in the marketplace.

FME seeks to create and expand markets in environmental resources through the extension of market institutions to cover environmental resources that were heretofore external to market processes. In 1991, FME may have been "more theoretical than applied". Now there are models that illustrate the FME paradigm in practice. Anderson and Leal take advantage of this fact, providing numerous examples of FME principles put to practice in the real world. The result is a blend of theory and implementation that provides a highly useful introduction to the power of market institutions to advance environmental protection. This study tries to build up a base for further development of a redistribution mechanism.

Pricing policy has not been suggested as an efficient alternative for environment protection, but the revenue from user fee can be provided for funding additional measures of environmental protection Downing, 1984; Urry, 1990). This kind of solutions have put into practice in many regions around the world, notable examples being Sofia Bay, Bulgaria (McClelland, 1997), the Gold Coast, Sydney (Pradeaux, 2000), the British National Parks and the Lake District National Park (Transport for London, 2001), and Hurricane Mitch, Nicaragua (Johnson and Baltodano, 2004).

2.2 Environmental economic value

Environmental economic value (EEV) can be characterized differently according to the type of economic value arising. It is usual to divide EEV into use and non-use values. Use values relate to actual use of the good in question (for example, a visit to

a national park), planned use (a visit planned in the future) or possible use. Actual and planned uses are fairly obvious concepts, but possible use could also be important since people may be willing to pay (WTP) to maintain a good in existence in order to preserve the option of using it in the future. Option value thus becomes a form of use value. Non-use value refers to willing to pay to maintain some good in existence even though there is no actual, planned or possible use. The types of non-use value could be various, but a convenient classification is in terms of (a) existence value, (b) altruistic value, and (c) bequest value. Existence value refers to the WTP to keep a good in existence in a context where the individual expressing the value has no actual or planned use for him/herself or for anyone else. Motivations here could vary and might include having a feeling of concern for the asset itself (for example, a threatened species) or a "stewardship" motive whereby the value feels some responsibility for the asset. Altruistic value might arise when the individual is concerned that the good in question should be available to others in the current generation. A bequest value is similar but the concern is that the next and future generations should have the option to make use of the good.

Figure 2.1 shows the characterization of EEV by types of value. SP techniques are suited to eliciting all these kinds of value, although in practice it is usually not possible to disaggregate individual types of non-use value, nor is it usually relevant to a decision to secure that breakdown. But differentiating use and non-use values can be important because, as will be seen, the latter can be large relative to the former, especially when the good in question has few substitutes and is widely valued. In addition, non-use value remains controversial, so that it is important to separate it out for presentational and strategic reasons.

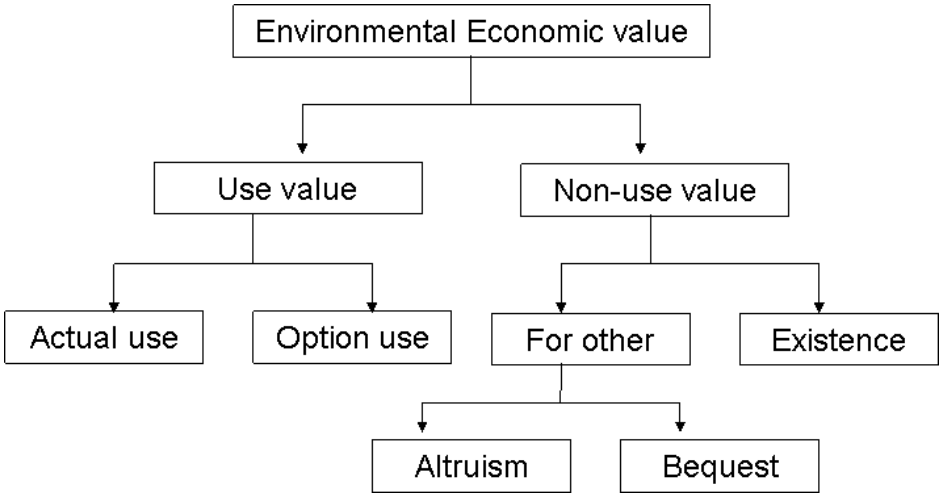


Fig. 2.1 Environmental economic values

Source: Bateman *et. al.*, 2002

How do stated preferences relate to the concept of EEV? Figure 2.2 shows how the various valuation techniques apply to the major component pats of EEV. Non-use values, which are likely to be especially important in contexts where the good being valued has few or no substitutes, can only be estimated using stated preference techniques. Since non-use values tend not to leave a "behavioral trail", that is, some behavioral change which affects a price or quantity which can be observed, revealed preference techniques are unlikely to elicit non-values.

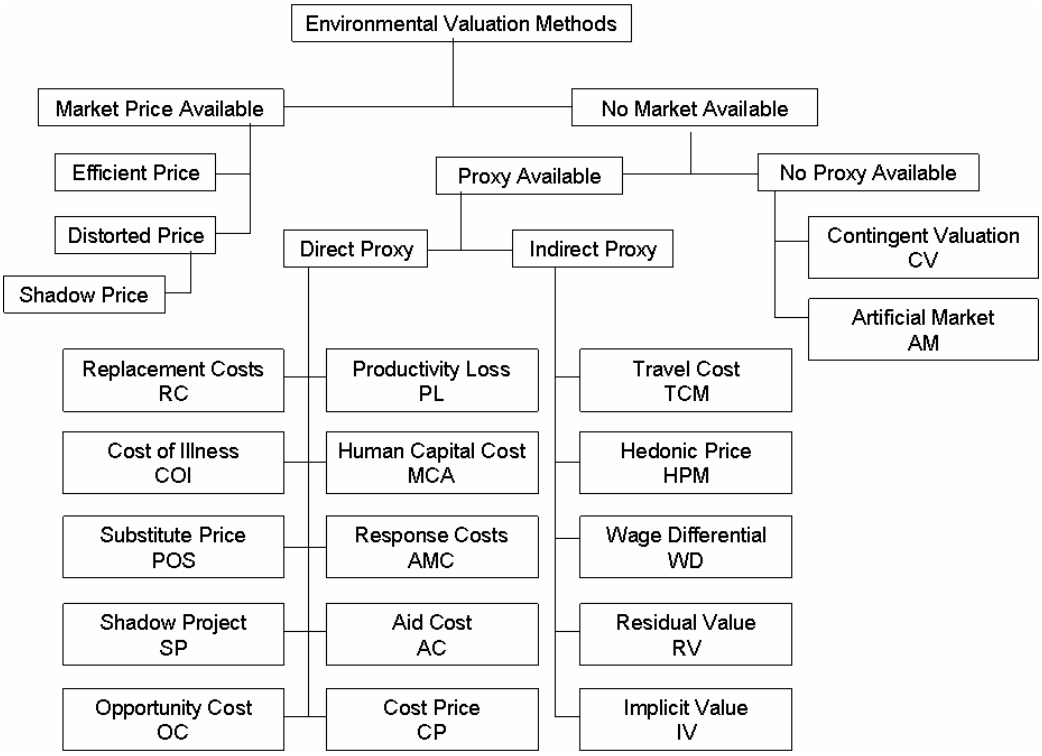


Fig. 2.2 The taxonomy of valuation techniques

Source: World Bank, 2002

Contingent valuation (CV) is a method of estimating the economic value of non-market environmental goods (and public goods in general) through survey questions that elicit individuals' preferences. Respondents express their preferences in terms of willing to pay to purchase or restore that good, or, alternatively, what they would be willing to accept to no longer be able to purchase or fully utilize that good. To elicit these values, individuals are presented with a hypothetical market for the good, thus the resulting "willingness to pay" and "willingness to accept" values are contingent upon the interviewer's description of the hypothetical market, and the approach became known as the contingent valuation method.

The major advantage of this approach compared to proxy methods, such as Hedonic price method, Travel cost method and so on, is that the CV method can elicit both use and non-use values, and indeed it is the only possible technique for the evaluation of non-use values. Another attraction of this method is that it may be applied at varying levels of complexity according to the time and financial resources available for the research and according to the mode of survey used to capture the individual's value.

2.3 Reviews for Contingent Valuation Method

CV asks consumers to directly state their values within a hypothetical context rather than inferring values from actual market behavior, it is perhaps the most controversial of all methods used to value non-market environmental goods. Of course, CV is not the only empirical method that uses data from surveys; many large data sets commonly used by economists consist of survey data (i.e. census surveys, consumer expenditure surveys).

CV surveys differ from traditional data surveys in that the respondents are asked to make a hypothetical value trade-off rather than simply report their own characteristics or actual expenditures. The hypothetical nature of CV introduces unique challenges when respondents do not correctly understand the good or service being valued, or when they cannot accurately state their willingness to pay in monetary terms. Nonetheless, as mentioned earlier, CV is the only economic method available for measuring non-use values associated with nature.

There are many researches regarding CVM in Taiwan, but few are in transportation field. These are national park effect (Wu, 2005), leisure effect (Jeng, 2003), wildlife conservation economic effect (Lo, 2003), water quality improvement effect (Hung and Shaw, 2005) and air quality improvement effect (Shaw *et. al.,* 1996). Transportation researchers may employ CVM in related fields.

2.3.1 Economic Concept of CVM

The CVM is a technique that allows the value of an environmental good or service to be estimated. Individuals are asked to value their willingness to pay (WTP) or willingness to accept (WTA) for a change in the provision of an environmental good, usually by way of a questionnaire survey. The individual maximum WTA or the minimum WTA compensation for an environmental change is assumed to be the value the individual attaches to such a change.

An individual can be asked to express his/her subjective valuation of possible environmental changes in different ways:

1. Environmental improvement. The value of the environmental improvement in such a situation can be measured either by:

(1) The individual's maximum willingness to pay (max WTP) to obtain the environmental improvement (estimated by the compensating surplus-CSU); or by

(2) The individual's minimum willingness to accept (min WTA) as compensation to forgo the environmental improvement (estimated by the equivalent surplus-ESU).

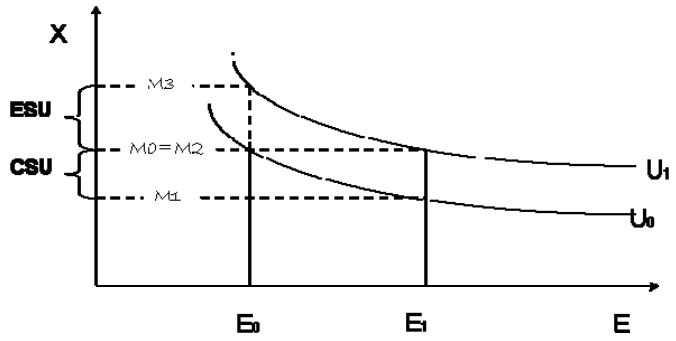
2. Environmental damage. The value of the environmental damage in such a situation can be measured either by:

(1) The individual's maximum WTP to avoid the environmental damage (estimated by the ESU); or by

(2) The individual's minimum WTA as compensation to agree to the environmental damage (estimated by the CSU).

One basic issue in CV method studies for the estimation of environmental values is the choice of whether to ask individuals their maximum WTP or their minimum WTA for a given environmental change.

To understand the conceptual difference between the maximum WTP and the minimum WTA, let us focus on the case of the valuation of an environmental improvement. With an environmental improvement the individual, currently at the utility level U0, ceteris paribus, is brought to U1, as shown in Figure 2.1. The maximum amount of money the individual is willing to pay to secure this improvement is such that after the payment s/he would at most be back to U0, (s/he should not be prepared to pay any amount of money such that s/he falls below the utility level U0). This maximum amount of money is the compensating surplus (CSU).



Note: The segments in bold are the budget sets and the points in bold are budget constraints for different levels of environmental good. The good X is money allocated to consumption.

Fig. 2.3 Environmental improvement: compensating surplus and equivalent surplus

If, however, the same individual is already enjoying (or has a right to) the improvement, ceteris paribus, and has the utility level U1, then s/he considers it a loss to have to give up the environmental improvement and asks to be compensated for this loss. To calculate how much to ask as minimum compensation s/he look at the utility level attainable with the environmental damage (that is, without the environmental improvement). This is U0. S/he will then ask at least a monetary compensation high enough to reach the level of utility U0 gain back to the level U1. This is the equivalent surplus (ESU).

It is apparent that the appropriate measure of the value of an environmental asset is related to the property rights of the individual on such an asset. The CSU measure assumes the individual has no consolidated rights in the environmental improvement, assuming therefore as a benchmark the utility level without environmental improvement U0. The ESU measure assumes instead that the individual somehow deserves, or has a right to, the environmental improvement, and puts the individual at the higher utility level U1 attained (or attainable) with the environmental improvement.

Randall and Stoll (1980), suggested that the possible different between the compensating surplus and equivalent surplus are barely significant in most practical situations. However, Hanemann (1991) shows that this is not always the case, especially when the environmental good/service has no close substitutes. In such cases, the minimum WTA can exceed the maximum WTP several times over. Carson (1991) also argues that when individuals are asked to state their minimum WTA, they tend to state their expectation of the maximum they could hope extract as compensation, rather than their true minimum WTA. On these grounds also Mitchell and Carson (1989) and Pearce and Turner (1990) advise caution on the use of the WTA approach.

From the above discussion, it leads to the following conclusions: WTP measure rather than the WTA measure is the proper measure of value that should be used in the CV studies (Cummings et al., 1986; NOAA, 1993).

2.3.2 Primary Elements of CVM

A contingent valuation survey consists of three primary elements (Figure 2.4). The first is a carefully crafted description of the good or commodity to be valued. This description should detail the baseline existing situation, the features of the good itself, its extent or magnitude and duration, the parties responsible for its provision, its expected consequences, a description of a default scenario if the good were not provide, the availability of substitutes for the good, and how it would be paid for. A

thorough examination of the elements required in a commodity description is provided by Fischhoff and Furby (1988). The validity of the CV results depends mainly on the level and nature of information provided to the respondents through the scenarios. The nature of the information provided has been found to affect the results both positively as well as negatively (see Bergsrtom et al., 1990). One crucial question that has not yet been properly addressed in the CV literature is that what is the optimum level of information, since the information provided in the CV scenarios do affect the WTP values.

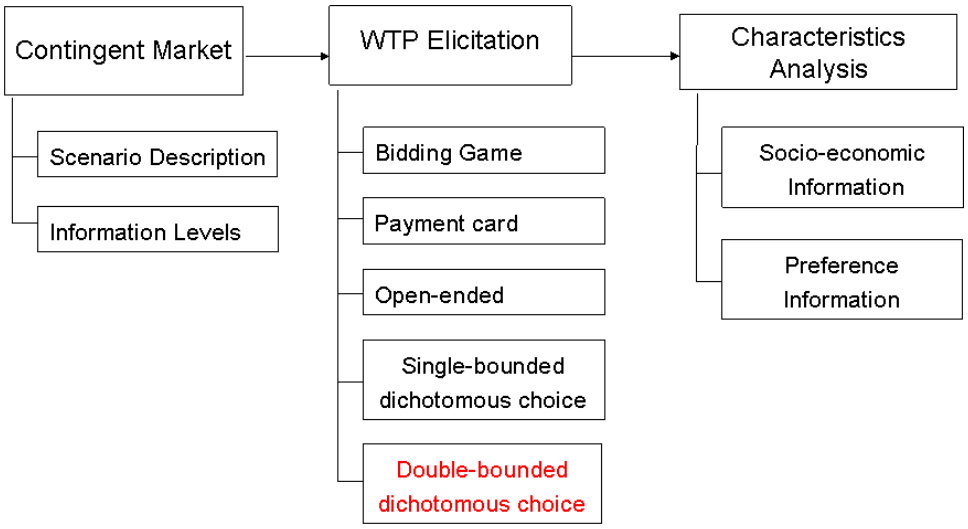


Fig. 2.4 Primary Elements of CVM

The second primary element in a CV questionnaire is elicitation. The respondent is asked either to provide the actual maximum amount that he would pay for the commodity described (an open-ended response format) or to indicate whether or nor he would vote in a public referendum for it to be provided if it cost hid household a specific dollar amount (the referendum format). The value of the good/service in the CV technique is elicited through an elicitation technique which is an important component of any CV method (Portney, 1994; Mitchell and Carson, 1989). The elicitation technique (or approach) used in CV studies is of different types. As of now, there are four major types of elicitation techniques available in the literature, namely, the bidding game, payment card (PC), open-ended (OE), and dichotomous choice (DC) approach (Boyle et al., 1996). The dichotomous choice approach is further divided into two types as: single-bounded dichotomous choice or take-it; and double-bounded dichotomous choice or take-it-or-leave-it with follow-up. It is a question to choice elicitation technique from above.

The third element of a CV survey are questions that probe respondent characteristics and behaviors that may influence their preferences for the good being valued. Socio-economic information, previous purchasing experience with goods relevant to the commodity in question and indicators of use of the good itself are elicited to provide insight into respondents' valuation responses. A valuation function is estimated using these indicators that are predicted by economic theory to explain respondent preferences for the good. The better the ability of the data to explain the observed preference information, the greater the confidence in the results of the survey.

2.3.3 Elicitation Method

The value of the good/service in the CV method is elicited through an elicitation technique which is an important component of any CV method (Portney, 1994; Mitchell and Carson, 1989). The elicitation technique (or approach) used in CV studies is of different types. As of now, there are four major types of elicitation techniques available in the literature, namely, the bidding game, payment card (PC), open-ended (OE) and dichotomous choice (DC) approach (Boyle et al., 1996). The dichotomous choice approach is further divided into two types as: single-bounded dichotomous choice or take-it-or-leave-it; and double-bounded dichotomous choice or take-it-or-leave-it with follow-up. An extended version of the latter approach which is called 'triple bounded dichotomous choice' that extends the double-bounded DC 'for a further question' has also been used in some of the CV studies (see Bateman et al., 1999). Let us discuss briefly each one of the elicitation techniques mentioned above.

The bidding game is the oldest elicitation technique among all the techniques (Mitchell and Carson, 1989). The bidding game approach goes as follows: the respondent in a CV study would be randomly assigned a particular bid from a range of predetermined bids. The bid assigned may be either a lower or higher level bid. The respondents would then be asked to say 'yes' or 'no' to that particular bid, and the process would continue until 'the highest positive response is recorded' (Randall et al., 1974). Davis was the one who first used the bidding game approach for estimating the benefits from goose hunting in 1963. This approach has been later on used by many authors for estimating the value of public goods (e.g. Randall et al., 1974; Brookshire et al., 1982). Moreover, this is the approach which has been widely used in a relatively large number of CV studies conducted in developing countries (e.g. Whittington et al., 1990, 1992).

Using the bidding game approach for estimating the benefits from the abatement of aesthetic environmental damage associated with power plant and coal mine,

Randall et al. (1974) conclude that the bidding game was successful in meeting the valuation objective. However, the authors suggest that considerable amount of care should be taken in designing the bidding game so as to obtain reliable results. The results of many of the developing country CV studies on water supply (Whittington et al., 1991, 1992; Briscoe et al., 1990) that utilized bidding game approach suggest that this approach works well in developing countries. One of the advantages of this approach is that it provides relatively better results since it gives a 'market-like' situation to the respondents in which they could research their preferences (Cummings et al., 1986). Another advantage of this approach is that the researcher could obtain maximum willingness to pay value (Cummings et al., 1986). However, Cummings et al. (1986) argue that the cost of implementing the bidding game is comparatively higher in the sense that it involves presence of interviewers during the interview, etc. Another problem with bidding game is that the starting points used in the bidding game might influence the final value of the stated WTP. Apart from these problems, Loomis (1990) argues that the bidding is impracticable in mail surveys.

The second oldest technique is payment card approach, introduced by Mitchell and Carson (1984). The payment card would contain a range of WTP values for the public good under question from which the individuals have to choose their maximum WTP value. The respondents are facilitated with another benchmark version of the payment card that contains the average WTP amount paid by households for other public goods. Even though the payment card approach has some advantages such as its ability to elicit the maximum willingness to pay value, the problem with the payment card is that there is a chance that the WTP values would be possibly affected by range bias and centering bias (Mitchell and Carson, 1989). Moreover, the payment card approach may have limited use especially in rural areas of developing countries where the people have very limited experience with using payment cards.

The open-ended elicitation technique involves asking the maximum amount that the individuals are willing to pay for a public good or policy. The open-ended approach is convenient to answer, does not require an interviewer and does not result in any starting point bias (Walsh et al., 1984). For those studies which aim at deriving a value that would provide a conservative estimate, the open-ended approach would be efficient in the sense that this approach would provide a lower level conservative value than the bidding game approach (Walsh et al., 1984). However, this approach is prone to criticisms. Desvousges et al. (1993) point out that the open-ended approach tends to create large number of nonresponses or protest bids since respondents either find it difficult to answer or do not have incentive to provide true answer (Carson et al., 1996). Hanemann (1994) argues that the open-ended questions may attract

strategic bias and people may tell the cost rather than true value.

Due to problems with the techniques mentioned above, Bishop and Heberlein (1979) introduced take-it-or-leave-it approach (or single-bounded dichotomous choice approach). It involves assigning a single bid from a range of predetermined bids that potentially reflect the maximum willingness to pay amounts of the respondents for a particular good. The respondents are asked to state only 'yes' or 'no' to that bid on all or nothing basis (Mitchell and Carson, 1989). The major advantage of the single-bounded dichotomous choice approach is that it facilitates the respondents to complete the valuation process. Moreover, the strategic bias in the WTP values may be minimised since this approach is an incentive compatible one (Carson et al., 1996; Hanemann, 1994). Despite its advantages, the single-bounded dichotomous choice approach has some disadvantages as well. One of the disadvantages is that one can derive only the maximum willingness to pay/minimum willingness to accept value from this approach but not the actual willingness to pay amount (Boyle et al., 1996). This approach also attracts starting point bias (Ready et al., 1996). On the property of incentive compatibility, this approach may not work in two circumstances: when the public good is provided through voluntary contribution and when a new private or public good is provided (Carson et al., 1996). Moreover, this approach is less applicable in areas where the households have already decided about their willingness to pay value (Venkatachalam, 2004). Another problem is that it requires a large number of observations for identifying the distribution of values (Alberini, 1995; Cameron and Quiggin, 1994).

A modified version of the take-it-or-leave-it approach has been introduced by Hanemann (1984, 1985) and Carson (1985) which is called, 'double-bounded dichotomous choice (DB-DC) approach' (or 'take-it-or-leave-it-with follow up'). This involves assigning one more bid to the initial bid (in the single-bounded approach), whose direction depends on the 'yes' or 'no' answer to the initial bid. This approach has been first applied by Carson and Steinberg (1990) and Hanemann et al. (1991). The major advantage of this approach is that one could identify the location of the maximum willingness to pay value from the data derived from this approach. This approach is an incentive compatible one. The DB-DC approach is statistically more efficient than the single-bounded dichotomous choice approach (Kanninen,1993; Hanemann,1991). Conducting an econometric analysis of the simulated data, Alberini (1995) concludes 'to obtain more powerful goodness-of-fit tests so that a poor specification of the model can be detected and corrected in the early stages of the data analysis, the CV researchers are advised to plan discrete choice surveys with a follow-up bid . . .'. A problem with this form of dichotomous choice approach is that

it requires a larger sample size, sophisticated econometric techniques, etc. which results in increased cost of the survey. Moreover, the results derived from the DB-DC approach are vulnerable for starting point bias and 'yea-saying' problem (Ready et al., 1996).

Many studies have provided results which suggest that, in general, the WTP value elicited using DC are greater than that of OE method (Carson et al.1996). This phenomenon is attributed to various reasons: (a) occurrence of strategic bias (especially, understatement) in OE, whereas this is not the case in DC which is considered to be incentive compatible; (b) 'yea-saying' in the case of DC format; and (c) tendency of the respondents to provide a lower WTP value when faced with a more difficult open-ended WTP questions (see, Brown et al., 1996). In recent years, a shift from using OE to DC is taking place in the CV literature but this shift demands for a sophisticated statistical analysis of the CV data. Modeling the DC data within the framework of random utility model (RUM) is a rigorous exercise and different kinds of DC formats require different kind of statistical analysis. Hanemann and Kanninen (1999) provide excellent description about various models, which could be used for analyzing the DC data to arrive at relevant measures.

It should be noted from the above discussion that different elicitation techniques have got different kinds of advantages and disadvantages. This being the case, the question one has to address in a CV survey is which one of these techniques should be used to elicit the value of public goods. Mitchell and Carson (1989) report that the open-ended method works smoothly in situations where the respondents are familiar with paying for the goods under question while many others conclude that DC approach is more incentive compatible than other elicitation techniques especially in the case of non-use values (NOAA, 1993; Hanemann, 1991; Hanemann and Kanninen, 1999).

2.3.4 Estimation of willingness-to-pay

In a DB–DC response model respondents are asked whether they would be willing-to-pay a specific amount ('yes–no') in support of a water quality improvement policy. If the answer is "yes", then a follow-up question with a higher amount will be raised. On the contrary, if the respondents refuse the initial bid, then in the second round they will be tested with a smaller amount. The underlying idea is to reflect the respondents' evaluation of their environmental utility. If the respondents think that their WTP for the described scenario exceeds the stated bid, and then they will agree to pay, otherwise they will reject the bid. The observed respondents' decisions regarding the two bid amounts are offered in sequence as a proxy variable for the

unobserved values. For each respondent, five possible response outcomes are produced: "yes–yes", "no–no", "yes–no", "no–yes" and 0. The complete elicitation procedure is shown in Fig.2.5.

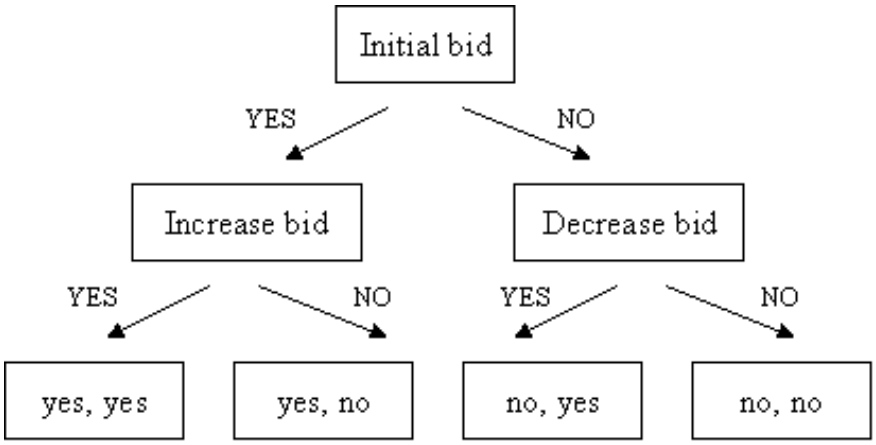


Fig. 2.5 Elicitation questions for the survey: double dichotomous choice format

The probability (Pr) of respondents' 'yes' to a given bid amount can be expressed as a difference between indirect utility functions:

$$\Pr\{response='yes'\} = \Pr\{\upsilon(p, y - A, s; q_j^1) + \varepsilon_1 \geq (p, y, s; q_j^0) + \varepsilon_0\} \quad (2\text{-}1)$$

where υ (.) is the indirect utility function derived from the consumer's utility maximization problem, q_j^i is a environmental quality attribute where index I indicates different states of the world and index j the water body in question; prices of market goods, p; the individual's income, y; the hypothetical bid amount or proposed cost of the policy to the individual household, A; a set of individual characteristics, s; and a stochastic term, ε. The stochastic term is due to characteristics of the individual's preferences which are physically unobservable, giving rise to the nomenclature 'random utility model'. In our case of WTP for an environmental quality improvement we observe the economic welfare measure compensating variation (C) defined as;

$$\Pr\{response='yes'\} = \Pr\{c(q_j^0, q_j^1, p, y, s, \eta) \geq A\} \quad (2\text{-}2)$$

where C(.) is itself a random variable with $\eta = \varepsilon_0 - \varepsilon_1$. In order to model WTP we

must assume a probability distribution function $f_\eta(.)$ for η, the coefficients of which can then be estimated using the contingent valuation data. In the DC–DB model the first question is followed up by a second yes–no question. Respondents' unobserved WTP (w) can then be identified as belonging to intervals bounded by the bids to which they replied 'yes' and 'no'. Model coefficients are estimated using maximum likelihood techniques (Greene, 1993). The log-likelihood function for the DC–DB model is defined as follows:

$$\ln L = I_0 \ln F(0) + I_{nn} \ln[F(A_1), F(0)] + I_{ny} \ln[F(A), F(A_l)] + I_{yn} \ln[F(A_h), F(A)] + I_{yy} \ln[1, F(A_h)] \quad (2\text{-}3)$$

Here I is an indicator function taking the value of one when responses are in relevant category (y='yes', n='no', 0=true zero) and zero otherwise, while F is the chosen cumulative density function. In this study the lognormal and truncated normal distributional assumptions were selected for estimating WTP. Because the DC–DB model is not a normally distribution, up-bound and low-bound may bias E(w), we have to defined WTP as:

truncated normal:
$$E[W] = \mu + \sigma \frac{\phi(-\mu/\sigma)}{1 - \Phi(-\mu/\sigma)} \quad (2\text{-}4)$$

where E[w] is the expected WTP; μ is a location parameter; σ is a scale parameter; ϕ is a standard normal probability density function (p.d.f.); and Φ is a standard normal cumulative density function (c.d.f.) (Barton,2002).

Explanatory factors for WTP model depends context. Various variable types can be added such as choice characteristics, site characteristics or environmental conscience variables. WTP models contain social and economic variables. WTP model on the other hand, are more or less interpreted in a fashion analogous to simple regression results. It has been modeled as shown in Equation 2-5:

$$\log WTP_i = \beta_0 + \beta_k \chi_{ik} + \mu_i \quad (2\text{-}5)$$

with all indexes interpreted as previously. Policy makers would like to respond to the variables that appear to affect negatively the WTP, e.g. by improving education or by providing more information to certain groups of people (Safarikas *et al*., 2005).

2.3.5 Reliability of CV Results

Despite the efforts to find elicitation formats that allow the controlling of some biases, other biases can occur in CV studies and be tackled with appropriate

questionnaire design. Among these the most important are information bias, hypothetical bias, strategic bias and starting point bias (Venkatachalam, 2004).

(1) Information bias

The 'information' in a CV method plays a crucial role. The CV results depends mainly on the level and nature of information provided to the respondents through the scenarios. The nature of the information provided has been found to affect the results both positively as well as negatively (see Bergsrtom et al., 1990). The scenario in a CV study contains two major elements, namely, (a) the value-enhancing element (for instance, different levels of quantity of water supplied); and (b) the value neutral elements (such as photographs shown to describe, say, the visibility). Considerable amount of research has been carried out in the case of value-enhancing elements (e.g. Whitehead and Blomquist, 1990). The value enhancing-element in CV studies is of three types, namely, (i) the information about the good to be valued; (ii) the budget constraints and other peoples' CV values; and (iii) the information about the related environmental goods that are supposed to affect the WTP values for the good under consideration. For instance, information about related environmental goods that may be substitutes or complements has been found to influence stated willingness to pay. If substitutes are not presented, then the stated WTP becomes an overstated one while the absence of a reminder of complementary goods leads to understate the stated WTP (Whitehead and Blomquist, 1990).

Does reminding of the budget constraint and substitute goods affect the WTP value? An empirical study by Whitehead and Blomquist (1990) looks into the impact of the information about the related environmental goods (substitutes and complements) on WTP values. The study found that information about the substitutes reduces the WTP while information about complements increases it. In Adamowicz et al.'s (1993) study found that the information about the substitute goods has led to reduction (especially in the Hockey ticket treatment) in the disparity between the WTP and WTA values. Neill (1995) and Ajzen et al. (1996) also demonstrated that reminding of budget constraint and availability of substitutes influence the WTP values in laboratory experiments.

The results regarding the information effect are mixed. But an important aspect to be noted is that the influence of the additional information on the WTP value depends mainly on the level of information possessed by the individuals. This implies that the CV studies should be capable of addressing the linkage between the levels of information possessed and the WTP value influenced by the additional information provided. In other words, if there exists asymmetric information across individuals,

then the additional information provided in the CV studies should influence the WTP value as desired (Bergsrtom et al., 1990).

(2) Hypothetical bias

The nature of the market created in a CV survey is mainly hypothetical, and therefore, it may attract a bias called 'hypothetical bias' (Neill et al., 1994). This bias is defined as the potential divergence between the real and hypothetical payments (Cummings et al., 1986). Many CV studies have reported that the hypothetical WTP values are found to be greater than the real WTP values (Brown et al., 1996; Neill et al., 1994; Kealy et al., 1990). For instance, Duffield and Paterson (1991) in an experiment estimate the WTP for maintaining the river flow that would facilitate protection of two rare fish species. Two independent samples were used to estimate the nonuse value of the fish species in this case. Respondents in one sample group were asked to state their hypothetical WTP for the Montana Nature Conservancy—a body that would maintain the stream flow in the river and respondents in the other sample group were asked to actually contribute to the same organization. The results of this study show that the amount of hypothetical WTP exceeds the actual WTP. In another study by Seip and Strand (1992), hypothetical WTP value was elicited from a sample group for membership fee for a Norwegian environmental organization. The same sample group then was asked to contribute 'actual payment' towards the membership fee. In this case, it is reported that the hypothetical WTP value was greater than the actual contribution. Foster et al.'s (1997) study compares the actual donations to environmental preservation and the hypothetical WTP values derived from six UK CV studies for comparable environmental amenities. The important finding of the study is that there exists a divergence between the actual and hypothetical WTP values, especially the hypothetical value being greater than the actual value. The results of an earlier study by Brookshire and Coursey (1987) indicate that the WTP value of a hypothetical CV market for expansion/reduction in the tree cover in a particular locality is greater than that of the actual laboratory experiment for the same issue.

Many studies report hypothetical WTP value to be higher than the actual WTP value. It should be noted that many of these studies are found to be laboratory experiments that involve mainly private goods. There are some problems with the laboratory experiments. The first problem is that since students involved in these studies are not true representatives of general population, these experiments would become irrelevant and misleading. The second problem is that in many of these experiments, mainly the private goods are used, and therefore, the results may be less relevant for addressing the issues of public goods. Apart from these criticisms, one

more aspect to be noted is that in laboratory experiments the subjects in most of the cases are provided some money prior to the survey so that they could not experience any 'budget constraint'. But in actual markets, the individuals' WTP is constrained by the income. Moreover, results of many CV studies suggest that the 'familiarity issue' plays a dominant role in minimizing the hypothetical bias in CV studies. More precisely, the more a respondent is familiar with the good, the less will be the level of hypothetical bias in a CV method (Mitchell and Carson, 1989). This implies that the WTP values elicited for those public goods, which are traded in the markets or which the individuals are familiar with, would be free from hypothetical bias (Whittington et al., 1991).

(3) Strategic bias

The strategic bias is another problem in CV studies. There are two forms of strategic behavior, namely, free riding and over pledging (Mitchell and Carson,1989). Free riding would occur if an individual understates her true WTP for a public good on the expectation that others would pay enough for that good, and therefore, she need not have to pay. On the other hand, over pledging occurs when an individual assumes that her stated WTP value would influence the provision of good under question, provided that the stated WTP would not form any basis for the future pricing policy.

Many of the CV studies take a stand that the strategic bias is not a major problem in CV experiments (Griffin et al., 1995; Schulze et al., 1981). According to Mitchell and Carson (1989), the following reasons make the strategic behavior very weak for most of the CV respondents: (a) the amount of information required for strategic behavior are great; (b) CV surveys convey to the respondents that a larger number of people are interviewed, and therefore, respondents get the impression that their stated WTP would not influence the overall outcome; (c) the payment vehicles used in CV studies remind the respondents about the budget constraint so that the respondents could not overstate their true WTP; and (d) the understatement of true willingness to pay might be discouraged given the respondents' impression that the good under investigation may not be provided. Apart from these aspects, it has been found that using incentive compatible elicitation techniques (such as dichotomous choice technique) would minimize the impact of strategic bias (see Carson et al., 2001). Having reviewed different kinds of experiments on strategic bias, Mitchell and Carson (1989) suggest that the CV questionnaires should be designed such that it would not give any 'hint' to the respondents that makes them behave strategically.

(4) Starting point bias

Starting point bias could be characterized as the interviewer's initial bid may

affect respondent final bids and thereby results in the biased outcome. Conceptually the starting bid is merely a tool to begin the bedding process and should not influence the final bids of the respondents. In other words respondents' final bids are invariant to the starting bids that they have received. However in practice the starting point bias may take place in a number of situations. It may arise when the item being valued is poorly defined or not markedly recognized by the respondent. Starting point bias may also occur if the respondent's final bid is significantly different from the initial bid. The respondent is tired of this bidding process and attempts to fasten the process before his willingness to pay is disclosed.

There are several studies showing the evidence of starting point bias. On the other hand, some studies found no clear indication of starting point bias. In general the results of empirical evidence of starting point are mixed. The literature on starting point bias indicates that in the bidding game when respondents are asked their willingness to pay, the result can be influenced by the starting point. Hence the tests for start point are necessary and should be included in the research framework to assure the reliability of outcome. Therefore the next step is to have solid methods to test the starting point bias.

Thayer (1981) has used consumer choice model to illustrate the occurrence of starting point bias. He uses a utility function to represent the respondent satisfaction in a CVM survey. He argues that the respondent faces a trade-off between taking time to provide an honest final and giving a dishonest final bid to terminate the bidding process.

Another possible extension is to include the factor of vehicle pollution in estimating appropriate user fee in pollution control. In this study the source of pollution is only from garbage of tourists, but in reality another plausible pollution source is from motor vehicles. It is more important in tourist spots where the public transportation is not convenient and people have to rely on motor vehicles. In this respect the pollution from vehicle should be included and the government may use vehicle entrance fee as an alternative instrument to control pollution. As in the Pinglin case the authority could consider levying user fee on tourist and on vehicles to alleviate pollution.

Table 2.3 CVM bias and improvement methods

The type of bias	The reason of bias	The method for improvement
Information bias	The CV results depend mainly on the level and nature of information provided to respondents. As a result, respondents may have different WTPs which will lead to the information bias	Providing respondents adequate and complete information to reduce the bias. Applying statistical test to examine the robustness of the survey results.
Hypothetical bias	The potential divergence between the real environment and hypothetical scenarios may influence WTPs of respondents.	The survey should be designed in a way that respondents are more familiar with the questions and environment.
Strategic bias	To protect their own benefits the respondents are not willing to reveal their true preferences.	The survey should be designed such that it would not give any hint to the respondents that make them behave strategically.
Starting point bias	The interview's initial bid may affect respondent final bids and thereby results in the biased outcome.	Offering the respondents with different starting bids and run the statistical test to examine whether different starting points would affect the outcome.

(5) CV reliability test

The most useful CV reliability test, namely, the 'test–retest method' involves conducting CV for a particular issue among a particular sample households and then repeating the same study either among the same sample in two time periods or among different sample households in the same population (see Hanley et al.,1997). Using a private good (candy bars) and a public good (de-acidification of lakes), Kealy et al. (1990) tested the reliability of WTP values obtained from open-ended and dichotomous choice techniques using test–retest method. The time gap between the first test and the second test was 2 weeks. The difference between the WTP values of both the techniques has been found to be statistically insignificant in both the time periods, which suggests that the results obtained are reliable. However, too short of a time gap between the two tests is supposed to have resulted in a recall effect, i.e., respondents recalling their answer in the previous test (Teisl et al., 1995). This leads to another question, namely, whether the time gap between two studies could explain

the convergence between the WTP values. Loomis (1990) used a test–retest procedure for open-ended and dichotomous choice techniques for different levels of water quality in Mono Lake. The time gap between the two tests in this case was 9 months. The results of this study show that there is no statistically significant difference between the values obtained through open-ended and dichotomous choice techniques in two time periods. Teisl et al. (1995) conducted a test–retest procedure using open-ended and dichotomous choice techniques for moose hunting permits among sample respondents with and without the moose-hunting experience with a time gap of 5 months. The authors conclude that the WTP estimates are found to be reliable for both experienced and no experienced moose hunters. In general, a majority of the studies that conducted the reliability tests conclude that the contingent valuation method is capable of generating reliable WTP results.

One of the important issues still to be resolved in the case of test–retest method is that what should be a 'reasonable' time gap between the first test and the second test so that any recall effect or the impact of larger changes in the socioeconomic variables of the individuals/households could be addressed properly in the analysis. Another problem is that one particular elicitation technique is assumed to be the 'perfect' measure of value so that the other one could be compared with the perfect one for assessing the reliability of the results (see Smith, 1992). However, the empirical evidence shows that different elicitation techniques have different kinds of problems and no single elicitation technique has been proved to be perfect in eliciting the true economic value.

2.3.6 Guidelines for Conducting CV Studies

The NOAA panel constituted to evaluate the use of contingent valuation method in estimating the non-use values concluded that the CV could be used to derive useful information about the non-use values provided that the panel's guidelines are followed while conducting CV study. Some of the important guidelines are: (a) using probability sampling for damage assessment studies; (b) minimizing nonresponse; (c) using personal interview rather than mail surveys and telephone interviews; (d) pretesting for interviewer effect; (e) reporting about the definition of population sampled, sampling frame used, sample nonresponse rate, etc; (f) pretesting the CV questionnaire; (g) using conservative values while the responses are ambiguous; (h) using the WTP format rather than WTA format; (i) using the referendum format rather than open-ended; (j) describing the programme or policy accurately to the respondents; (k) pretesting the photographs used in describing the scenarios; (l) reminding the respondents about the availability of the undamaged substitutes; (m) making sure adequate time lapse between the survey and the environmental insult so that the

respondents find complete restoration of the damage plausible; (o) eliciting the reasons for yes/no answers for the valuation questions; and (p) reminding of the respondents of alternative expenditure possibilities.

It should be noted that these guidelines are general in nature and applicability of these guidelines, particularly in developing countries, depends mainly on the socioeconomic–institutional aspects prevailing in the study area. Therefore, the CV practitioners will have to be selective in using these guidelines.

2.4 Summary

1. The most common forms of evaluation methodologies for transport Project member states are CBA.

2. In many countries, including Taiwan, the CBA is supplemented by a quantitative and/or qualitative appraisal to include other impacts which are not monetized for technical reasons.

3. BIT can be narrowed down to a practical scale, which can help planner watching all interest groups. It will explore CBA from macro to micro vision.

4. CBA will provide more information about the cost and gain allocations between the different stockholders to the government going redistributing.

5. CV method can elicit both use and non-use values, and indeed it is the only possible technique for the evaluation of non-use value.

6. Integrate CV result into traditional CBA is a good way to improve the defect of CBA, that traditional CBA can not calculate environmental impacts with the other effect.

7. As the most stated preference methods, the variability and reliability of CV results are argued. The resent CV studies provide some solutions to this issue.

   (1)WTP format is preferred.

   (2) Face-to-face interviewing is the most reliable results.

   (3) Pro-testing is essential element in CV study.

   (4) Accurate information on the valuation situation must be presented to respondents; particular care is required over the use of photographs.

   (5) Accurate information provided can avoid hypothetical bias.

   (6) DB-DC estimation method can avoid strategic bias.

(7) Test-retest method can test the CV reliability, particularly at information bias and starting point bias.

8. Estimating WTP is not the end, CV studies in advance realize respondent characteristics and behaviors that may influence their preferences for the good being valued.

9. A valuation function is estimated using these indicators that are predicted by economic theory to explain respondent preferences for the good. The better the ability of the data to explain the observed preference information, the greater the confidence in the results of the survey.

CHAPTER 3 DESIGN OF THE SURVEY

In this chapter the design of the survey for this research will be explored. We will first elaborate on the research framework of the study and it will be followed by addressing the subject of survey conducting. The background information of the Pinglin case is then discussed in the final section of this chapter.

3.1 Research Framework of this Study

Figure 3.1 shows the research framework for the study. The central theme of this study is to develop a process which integrates the CBA with CVM to evaluate the overall effects. It is worth bearing in mind that the current methodologies of assessing projects have limitations and have led to biased outcome. Such biases are even prevalent in the environment sensitive project. Therefore it is exceedingly important to examine and modify the current methods. In doing so we could establish the redistribution mechanism of economic benefits and it may raise the credibility of project in the future.

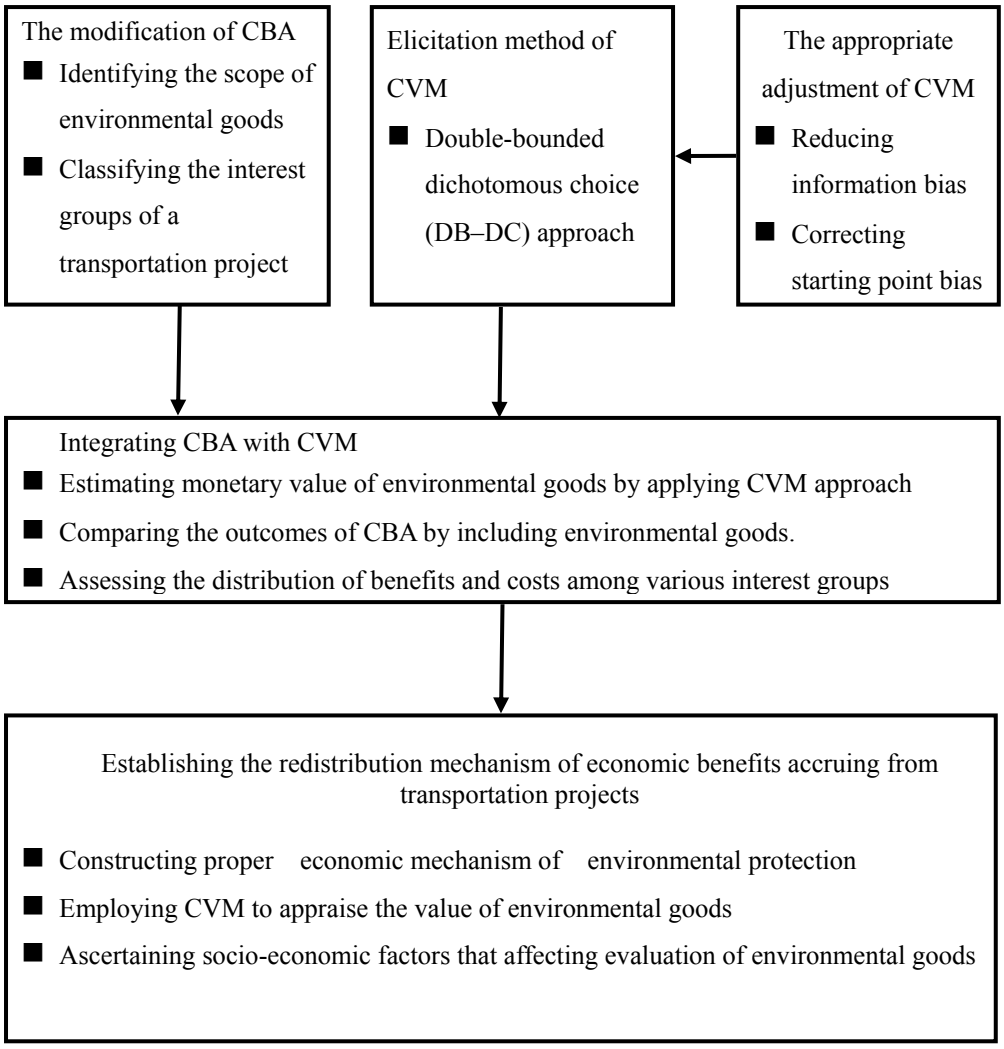


Fig. 3.1 Research framework of dissertation

3.1.1 The modification of CBA：Identify sources of pollution and pertinent interest groups

As mentioned in previous chapters given the complicated nature of pollution it is hard to indicate the sources of pollution in an environment sensitive transportation project. Consequentially the impacts of affected interest groups may be ignored which may lead to inaccurate evaluation results.

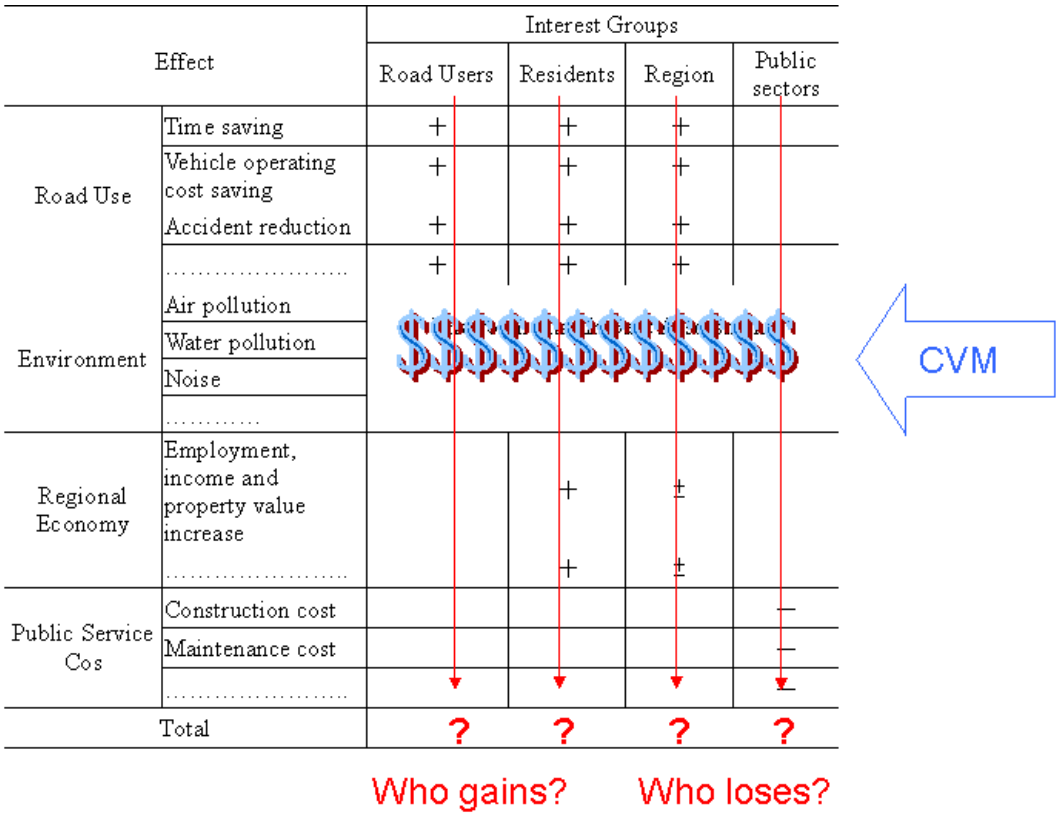


Fig. 3.2 Identify sources of pollution and pertinent interest groups

For the purpose of this study given the characteristics of the Pinglin case we focus on three pollutants: air pollution, water pollution and noise pollution. The people are affected by these pollutants can be categorizes into two groups. The first group is mainly affected by air and noise, we can consider air pollution and noise as a kind of local environmental pollution. In this regard Pinglin residents and passengers are affected group.

The classification of pollution and interest group is listed in table3.1.

Table 3.1 The sources of pollution and affected interest group

Groups / Pollutants	Pinglin residents	Passengers	Taipei metropolitan residents
Noise	✓	✓	
Air	✓	✓	
Water	✓	✓	✓

3.1.2 The elicitation method of CVM：Double-bounded dichotomous choice (DB–DC) approach

Given the above framework we may further develop the model to incorporate the environmental effects. In the model we use a double-bounded dichotomous choice (DB–DC) approach to estimate the monetary values of the environmental effects. The DB–DC approach is the most widely used elicitation technique for the CVM. The DB–DC approach elicits data via the questionnaire.

In the questionnaire survey, the respondents are asked if they are willing to pay (WTP) a specific amount (‘yes–no’) to support an environmental good. If the answer is “yes”, then a follow-up question with a higher amount will be raised. On the contrary, if the respondents refuse the initial bid, then in the second round they will be tested with a smaller amount. The underlying idea is to reflect the respondents’ evaluation of their environmental utility. If the respondents think that their WTP for the described scenario exceeds the stated bid, and then they will agree to pay, otherwise they will reject the bid. The observed respondents’ decisions regarding the two bid amounts are offered in sequence as a proxy variable for the unobserved values. For each respondent, five possible response outcomes are produced: “yes–yes”, “no–no”, “yes–no” and “no–yes”. The complete elicitation procedure is shown in Fig.3.2.

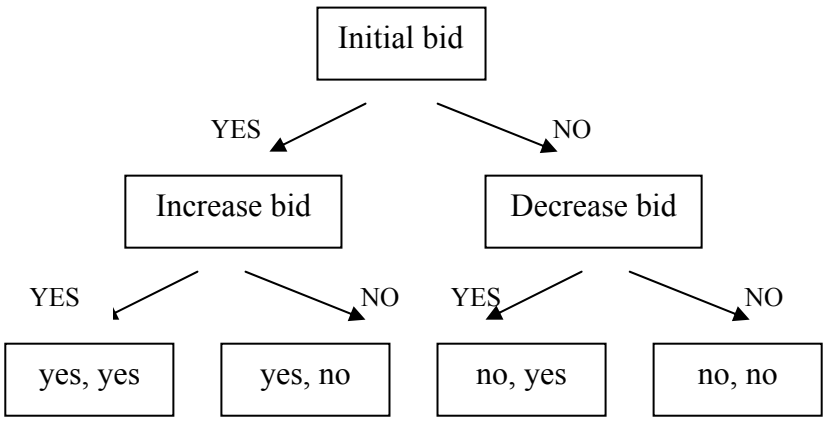


Fig. 3.3 Elicitation questions for the survey: double dichotomous choice

The model’s coefficients are estimated by using the maximum likelihood technique. The log-likelihood function for the DC–DB model is defined as follows:

$$\ln L = I_0 \ln F(0) + I_{nn} \ln[F(A_1), F(0)] + I_{ny} \ln[F(A), F(A_l)] + I_{yn} \ln[F(A_h), F(A)] + I_{yy} \ln[1, F(A_h)] \quad (3\text{-}1)$$

Here, I is an indicator function which takes the value of one when responses are in a relevant category (y='yes', n='no', 0=true zero); otherwise, its value is zero. For example, I_{ny} refers to a response where the first bid was not accepted, but the second bid was accepted. In addition, A refers to the initial bid, A_h to the increase bid, and A_l to the decrease bid. F is the chosen cumulative density function, and $[F(A), F(A_l)]$ is the chosen cumulative density function between A and A_l. In this study, the CV estimation is identified as:

Truncated normal:
$$E[W] = \mu + \sigma \frac{\phi(-\mu/\sigma)}{1 - \Phi(-\mu/\sigma)} \quad (3\text{-}2)$$

Where E[w] is the expected CV; μ is a location parameter; σ is a scale parameter; ϕ is a standard normal probability density function (p.d.f.); and Φ is a standard normal cumulative density function (c.d.f.) all parameters are calculated using the software package SPSS according to the samples.

3.1.3 The appropriate adjustment of CVM

1. Reducing information bias

The "information" plays a vital role in a CV method. The validity of the CV results depends crucially on the level and the nature of the information that respondents received during the survey. Information bias may arise whenever respondents are forced to value attributes with which they have little or no experience. In such cases, the amount and type of information presented to respondents may affect their answers.

As in our case Pinglin interchange could facilitate transportation convenience but generate environmental pollution. The public usually are only aware of the direct environmental impacts (e.g. the air is not fresh or the water is contaminated), but the indirect environmental impacts (e.g. drinking polluted water is not good for health) are often overlooked. As a result, as we conduct the CV assessment, it is imperative to

provide respondents adequate information and to reduce the bias.

In the survey we will try to examine the influence of information on the CV survey. As we know the public generally ignore the indirect environmental impacts; it is essential to make sure adequate information of water pollution is provided in the survey. In principle the respondents are offered 3 different levels of information in the test. (See Table 3.2)

Information level 1 was given only a very brief description of the Taipei-Ilan Freeway, Information level 2 was given more information to illustrate that more trips may pollute water resources, and the Information level 3 was given a very detailed description that the Taipei-Ilan Freeway may contaminate Feitsui Reservoir catchments area and may cause some diseases.

Table 3.2 The Outline of Information Levels

Information levels	Explanations
1	The Taipei-Ilan Freeway crosses the Feitsui Reservoir catchments area and builds an interchange in Pinglin.
2	The Taipei-Ilan Freeway crossing the Feitsui Reservoir catchments area and builds an interchange in Pinglin that might pollute water resources.
3	The Taipei-Ilan Freeway crossing the Feitsui Reservoir catchments area and builds an interchange in Pinglin that might pollute water resources. Polluted water may hurt human health.

2. Correcting starting point bias

Starting point bias take places in the iterative bidding framework when the initial bid influences the final bids of respondents. It is well known that the bidding game has become the most common used method of asking the valuation question in CV studies. A bidding process typically begins with an interviewer offering and initial bid (starting bid) to a respondent. If the respondent is willing to accept the initial bid, the interviewer adjusts the bid downward until a negative reply is acquired. On the other hand if a negative response is found in the initial bid, the interviewer will revise the bid downward until a satisfactory amount is accepted.

There are several reasons for starting point bias. It may come from the item

being valued is inadequately defined or not clearly perceived by the respondent. Starting point bias could arise if the initial bid is significantly different from a respondent real willingness to pay; the respondent may become impatient with the bidding and abbreviate the process before the actual willingness to pay is revealed.

To resolve the starting point bias this study will follow the approach of Thayer (1981).Thayer has developed a consumer choice model to explain the occurrence of starting point bias in the bidding process. The general method to avoid starting point bias is to offer the respondents with different starting bids and run the statistical test to examine whether differences in the starting point would affect the estimated WTP values. As in this survey we will follow the same approach to test the extent of starting point bias.

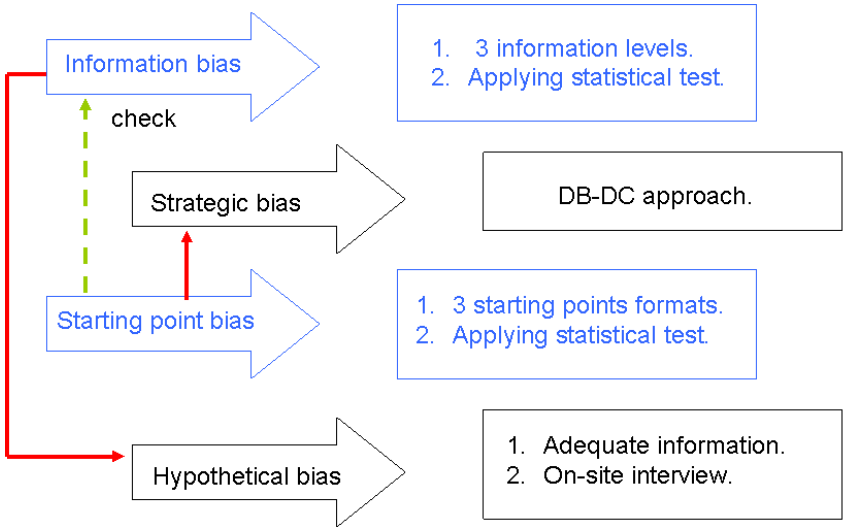


Fig. 3.4 The appropriate adjustment of CVM

3.1.4 Establishing the redistribution mechanism of economic benefits accruing from transportation projects

After distinguishing pollutants and pertinent interest groups clearly, we are able to assess the distribution of benefits and costs among various interest groups. Environmental protection is now perceived by many as the major concerns in transportation projects. By including environmental goods this framework has developed methods and procedures that can be used by transportation planners to evaluate the distributional impacts of projects.

Moreover from the survey we could further explore the characteristics of respondents that can influence their willingness to pay. This should enable us to find

out socio-economic factors that affecting evaluation of environmental goods. As a result it can lessen the pressure from the affected interest groups and to expedite the project implementation.

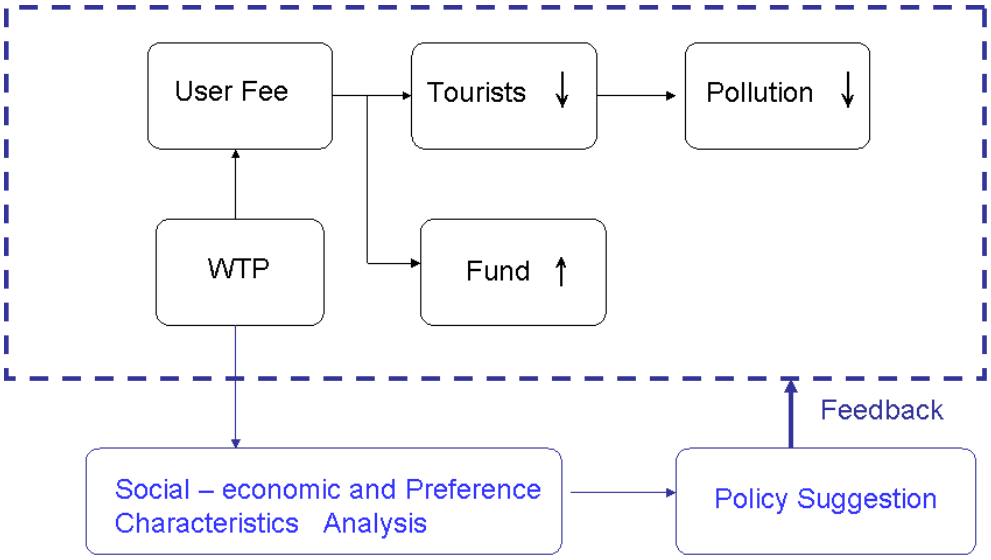


Fig. 3.5 The redistribution mechanism

Explanatory factors for WTP model depends context. Various variable types can be added such as choice characteristics, site characteristics or environmental conscience variables. In the Chapter 5, WTP models contain social and economic variables. WTP model on the other hand, are more or less interpreted in a fashion analogous to simple regression results. It has been modeled as shown in Equation 3-3:

$$\log WTP_i = \beta_0 + \beta_k \chi_{ik} + \mu_i \qquad (3\text{-}3)$$

with all indexes interpreted as previously. Policy makers would like to respond to the variables that appear to affect negatively the WTP, e.g. by improving education or by providing more information to certain groups of people.

3.2 Background Information of the Pinglin Case

The empirical base of the study draws on the case of the Pinglin Interchange in Taiwan. Pinglin, as a small rural town in northern Taiwan, lies between Taipei and Yilan. The major connection of Pinglin is Route 9 which is known for its zigzag feature. It will regularly take 2 hours for driving from Taipei to Yilan.

Pinglin is famous for its green tea and rapidly-growing tourism business. The area around it has some nice tea-related stores and a tea museum that attract a fair number of tourists from the cities. On the other hand only few people are aware that the Pinglin area is environmentally sensitive because it is located in the middle of the water catchments of the Feitsui Reservoir. Feitsui Reservoir is the largest reservoir in

Taiwan which supplies drinking water to about 5 million Taipei metropolitan residents.

In order to save the driving time and accelerate the economic development the Taiwanese government has decided to construct No. 5 Expressway which could reduce driving time between Taipei to Yilan to about 40 minutes. The debate was originated from the Pinglin interchange. Pinglin residents have been chased for a full function interchange at their town. The principal motivation for them was economic consideration. They claimed that if there is no full function interchange in Pinglin, most of the travelers will drive through Pinglin and Pinglin may lose its tourists to Yilan. As a result it will seriously damage Pinglin's economy. The Pinglin residents even held a referendum at one point to demand their "rights."

On the other hand since the Pinglin interchange lies within the catchments area of the Feitsui Reservoir (Figure3.6), the Taipei city government and environmental groups are concerned that increased traffic in the area will increase emissions and contaminate water in the area. To protect the drinking water of the 5 million residents of greater Taipei, the city government and the environmental groups have opposed the full function interchange, they claimed that the Pinglin interchange at most could only be designed as an emergency exit and the central authority has to inspect water quality frequently to preserve the environment.

Fig. 3.6 The Location of Pinglin Interchange

In order to settle the dispute, the central government reevaluated the effects of full function Pinglin interchange. According to "Before and After Analysis of the Taipei-Ilan Freeway Construction Project Report" (TNEEB, 2004), the full function Pinglin interchange would pass the environmental assessment test. Table 3.3shows the official CBA results in 2010 (target year), which has evaluated three effects on the road use, local economy and public service costs due to Pinglin interchange opening. According to the official CBA result, the Pinglin Interchange was expected to generate NT$550 million annual benefits. The benefits mainly are from road use and local economy. The effects on the road use taking the form of time saving, vehicle operating cost saving, and accident reduction. The local economy would benefit from the flocking-in of tourists to Pinglin. On the other hand, the construction of the Pinglin Interchange would incur public service costs, including waste disposal costs and facility and maintenance costs.

Table 3.3 The official CBA results for the Pinglin Interchange opening

Unit: NT$ 1,000 per year

Effects		Value
Road use	Time saving	95,749
	Vehicle operating cost saving	158,006
	Accident reduction	20,430
Local economy	Income increase	331,152
Public service cost	Waste disposal	-1,239
	Facility and maintenance cost	-54,000
Net effect value		550,098

Source: TNEEB, 2004

The residents of Taipei metropolitan who are affected by water pollution can be regarded as second group. Water pollution can be characterized as regional environmental pollution; since opening of Pinglin interchange may contaminate Feitsui Reservoir which supplies the drinking water to Taipei metropolitan residents.

CHAPTER 4 RESULTS AND DISCUSSIONS

In this chapter we will first text the robustness of the study by conducting the preliminary study. In the preliminary study the information bias and starting point bias of the survey will be examined. This will be followed by the presentation of survey results and the further discussions of the results.

4.1 Testing the information bias

The “information” plays a vital role in a CV method. The validity of the CV results depends crucially on the level and the nature of the information that respondents received during the survey. For example, it is well known that Pinglin interchange could facilitate transportation convenience but generate environmental pollution. The public usually are only aware of the direct environmental impacts (e.g. the air is not fresh or the water is contaminated), but the indirect environmental impacts (e.g. drinking polluted water is not good for health) are often overlooked.

Table 3.5 shows the increase of environment index value of the Pinglin interchange use. Those science volumes are interest for the experts, but the public without professional training has no idea about Table 3.5. We have to translate the environment index value to visible situations, such as the quality of drinking water being worse and worse. Too many “TP” in the body will increase the possible of disorder and dementia.

As a result, as we conduct the CV assessment, it is imperative to provide respondents adequate information and to reduce the bias. This section first tries to examine the influence of information on the CV survey. As we know the public generally ignore the indirect environmental impacts; it is essential to make sure adequate information of water pollution is provided in the survey. In principle the respondents are offered 3 different levels of information in the test. (See Table 4.1)

Information level 1 was given only a very brief description of the Taipei-Ilan Freeway, Information level 2 was given more information to illustrate that more trips may pollute water resources, and the Information level 3 was given a very detailed description that the Taipei-Ilan Freeway may contaminate Feitsui Reservoir catchments area and may cause some diseases. The original questionnaires are shown in Appendix 1.

Table 4.1 The Information Levels

Information levels	Explanations
1	The Taipei-Ilan Freeway crosses the Feitsui Reservoir catchments area and builds an interchange in Pinglin.
2	The Taipei-Ilan Freeway crossing the Feitsui Reservoir catchments area and builds an interchange in Pinglin that might pollute water resources.
3	The Taipei-Ilan Freeway crossing the Feitsui Reservoir catchments area and builds an interchange in Pinglin that might pollute water resources. Polluted water may hurt human health.

The survey was conducted over the period extending in March, 2004. The sample size was 220, who are a part of our target sample were from the Taipei metropolitan area and were randomly selected in our survey. Those who responded were first asked if they have lived in the Taipei metropolitan area for at least 5 years. Those who meet the residence requirement were then given a brief description of the study and were asked if they are willing to play a part in answering the questions. The telephone survey began with the following preface:

We are now going to ask you a hypothetical question. Bear in mind that if you pay to completely avoid being ill this time, you have to give up some other use for this money. For example, you may reduce your expenditure for entertainment or education.

Suppose you were told that the Taipei government plans to levy a fee by adding a water toll. It will be used to provide water-cleaning equipment for the Feitsui Reservoir catchments' area.

Respondents that received the information level 2 of information were told:

The Taipei-Ilan Freeway that reduces the number of accidents between Taipei and Ilan will attract more vehicles and will increase the impacts on the Feitsui Reservoir catchments' area. The impacts from use include a reduction in water quality and an increase in trash.

Respondents that received the information level 3 received the same information as at the information level 2, plus additional information such as the following:

Water pollution may hurt health or increase the sanitation budget. Water pollution causes many diseases, such as cancer, liver damage, calculus, anemia, endocrine disorder and dementia.

In three information levels, respondents were asked his WTP by open format.

How much money would you pay to counteract the water pollution every month?

Table 4.2 shows the socio-economic characteristic of samples. Statistics is Table 4.3 shows that WTPs of respondents in three information levels are different. WTPs of respondents between information level 1 and information level 2 are significantly different; WTPs of respondents between information level 2 and information level 3 are insignificantly different. As a result we selected the level 3 for the following empirical test.

Table 4.2 Socio-economic background of the respondents (information levels)

Item/Description	Sample	Weighted Average of Population of Taipei City And County (Taipei metropolitan area)*
	Mean/Percentage	Mean/Percentage
Average Age	47.32	40.06
Sex		
Male	45.30%	49.45%
Female	54.70%	50.55%
Chi-test	0.89	
Education		
Primary School	31.82%	36.12%
High School	33.18%	30.40%
College	30.92%	30.2%
Graduate School	4.09%	3.3%
Chi-test	0.99	

Source: * Official Statistics of Taipei City Government and Taipei County Government

Table 4.3 ANOVA results of information levels

	Source	SS	Degrees of Freedom	MS	F	P-value
Level 1 V.S. Level 2 V.S. Level 3	Treatment	259864.4	2	129932.2	220.3	6.22E-74
	Error	387560.7	657	589.8945		
	Total	647425.1	659			
Level 1 V.S. Level 2	Treatment	175560.3	1	175560.3	419.0	7.8E-66
	Error	183509.5	438	418.97		
	Total	359069.7	439			
Level 2 V.S. Level 3	Treatment	1760	1	1760	2.0	0.16
	Error	383002.5	438	874.4349		
	Total	384762.5	439			
Level 1 V.S. Level 3	Treatment	212476.3	1	212476.3	446.1189	8.42E-69
	Error	208609.5	438	476.2773		
	Total	421085.7	439			

4.2 Survey Conducting

1. Survey process

The survey was conducted over the period from April to October in 2004. Following the definition of the official reports, Taipei metropolitan citizens include those who are affected by water pollution and road users including residents at Pinglin and tourists who are affected by noise and air pollution. Accordingly the survey conducted for the study covered these two types of samples. To ensure that the sample as a whole is as representative as possible, the survey was administered not only on weekends, but also on weekdays. In the case of families, only one member of each family is selected to answer the questions. In the end, 466 reliable copies of questionnaires were obtained. Those who met the respondent requirement were given a brief description of the study and were then asked if they would be willing to play a part in answering the questions prepared. The whole description of the survey can be summarized as follows:

We are now going to ask you a hypothetical question. Suppose you were told that Pinglin Interchange project will reduce the number of accidents and attract more vehicles to Pinglin Township. It will reduce water quality of the Feitsui Reservoir and increase noise and air pollution in Pinglin. The official EIA for the Pinglin Interchange is of quality, but some people worry the resultant long-tern pollution may hurt health or increase the sanitation budget, even more cause many diseases, such as

cancer, liver damage, calculus, anemia, endocrine disorder and dementia. The study wants to know your willingness to pay for providing those environmental pollution, which may help us to calculate your welfare injure due to the water pollution, noise and air pollution from Pinglin Interchange.

Bear in mind that if you are willing to pay to protect the environmental, you have to give up some other use for this money. For example, you may reduce your expenditure for entertainment or education.

- Respondents being Taipei metropolitan citizens were asked:

How much money would you pay to counteract the water pollution every month?

- Respondents being Pinglin residents or tourists were asked:

How much money would you pay to counteract the water pollution every month?

How much money would you pay to counteract the noise pollution every month?

How much money would you pay to counteract the air pollution every month?

The interview ended with several socio-economic characteristic attribute (e.g., age, gender, and income) (Appendix 2). In the end, the respondents prove to be representative of the inhabitants within the Taipei metropolitan area. The influence of socio-economic on the survey will be elaborated on the following chapters.

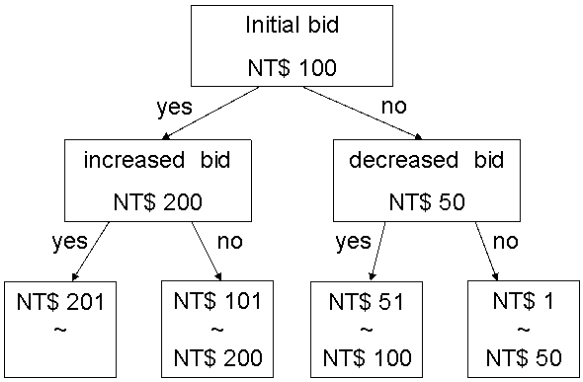


Figure 4.1 WTP bid structure for pollution protection for the Pinglin Interchange

2. Testing the starting point bias

Starting point bias is another bias that may arise from the CV method. We have followed the idea of Thayer (1981) to test the starting point bias. In the survey we presented our biding questions to the respondents with three different starting bids (namely NT$100, NT$500, and NT$1,000). The statistics of the WTP for the environmental effects in relation to the individual starting points are presented in Table 4.4 to Table 4.6 respectively. We run the T tests between each pair of the starting points to examine whether or not differences in the starting point would affect the estimated WTP values. The results, as shown in Table 4.7 to Table 4.9, suggests that the estimated WTP values are free from the starting point bias. Therefore, to make our analyses simplified, we base our analyses on the results of NT$100 as the starting point.

Table 4.4 Statistics of the WTP for the environmental effects

(Starting Point: NT$100)

WTP Bids	Water pollution	Air pollution	Noise
	Frequency (%)	Frequency (%)	Frequency (%)
NT$ 0	42 (9.01 %)	8 (6.67 %)	5 (4.17 %)
NT$ 1 ～ NT$ 49	203 (43.56 %)	65 (54.17 %)	14 (11.67 %)
NT$ 50 ～ NT$ 100	91 (19.53 %)	22 (18.33 %)	58 (48.33 %)
NT$ 101 ～ NT$ 199	68 (14.59 %)	8 (6.67 %)	38 (31.67%)
NT$ 200 ～	62 (13.30%)	17 (14.17 %)	5 (4.17 %)
Total	466 (100 %)	120 (100 %)	120 (100 %)

Table 4.5 Statistics of the WTP for the environmental effects

(Starting Point: NT$500)

WTP Bids	Water pollution	Air pollution	Noise
	Frequency (%)	Frequency (%)	Frequency (%)
NT$ 0	74 (15.88 %)	27 (22.50 %)	11 (9.17 %)
NT$ 1 ～ NT$ 199	392 (84.12 %)	93 (77.50 %)	105 (87.50%)
NT$ 200 ～ NT$ 499	0 (0 %)	0 (0 %)	4 (3.33 %)
NT$ 500 ～ NT$ 799	0 (0 %)	0 (0%)	0 (0%)
NT$ 800～	0 (0%)	0 (0 %)	0 (0 %)
Total	466 (100 %)	120 (100 %)	120 (100 %)

Table 4.6 Statistics of the WTP for the environmental effects

(Starting Point: NT$1,000)

WTP Bids	Water pollution	Air pollution	Noise
	Frequency (%)	Frequency (%)	Frequency (%)
NT$ 0	307 (65.88 %)	81 (67.50%)	71 (59.17%)
NT$ 1 ～ NT$ 499	159 (34.12 %)	39 (32.50 %)	49 (40.83 %)
NT$ 500～NT$ 999	0 (0 %)	0 (0 %)	0 (0%)
NT$ 1000～NT$ 1999	0 (0 %)	0 (0%)	0 (0%)
NT$ 2000～	0 (0%)	0 (0 %)	0 (0 %)
Total	466 (100 %)	120 (100 %)	120 (100 %)

Table 4.7 Statistical tests of WTP for the water pollution

starting point	NT$100	NT$500	NT$1,000	NT$500	NT$1,000	NT$100
mean	80.69	84.12	85.12	84.12	85.12	80.69
variance	6472.97	14079.16	14079.16	14079.16	14079.16	6472.97
observations	466.00	466.00	466.00	466.00	466.00	466.00
degree of freedom	931.00		931.00		931.00	
P(T<=t) two-tailed	0.40		0.84		0.49	

Table 4.8 Statistical tests of WTP for the air pollution

starting point	NT$100	NT$500	NT$1,000	NT$500	NT$1,000	NT$100
mean	72.50	77.50	81.25	77.50	81.25	72.50
variance	6491.62	1758.40	13826.16	1758.40	13826.16	6,516.81
observations	120.00	120.00	120.00	120.00	120.00	120.00
degree of freedom	239.00		239.00		239.00	
P(T<=t) two-tailed	0.56		0.74		0.51	

Table 4.9 Statistical tests of WTP for the noise pollution

starting point	NT$100	NT$500	NT$1,000	NT$500	NT$1,000	NT$100
mean	97.92	84.20	66.67	84.20	66.67	97.92
variance	3,293.94	428.03	12,324.93	428.03	12,324.93	3,293.94
observations	120.00	120.00	120.00	120.00	120.00	120.00
degree of freedom	239.00		239.00		239.00	
P(T<=t) two-tailed	0.06		0.06		0.06	

4.3 The Empirical Results

First of all, the environmental impacts resulting from the opening Pinglin Interchange includes three pollutants: air pollution, water pollution and noise. In order to measure the magnitudes of the above pollutants we draw on previous estimations for environment index value (see Table 4.10).

Table 4.10 The increase of environmental impacts of the Pinglin interchange use

	Increase of environmental impacts
Air Pollution	Holliday: SO_2 :0.6~0.8ppb NO_2 :0.7~1.0ppb CO:0.06ppm TSP:4.6~6.3μg/m^3 Working day: SO_2 :0.3 ppb NO_2 :0.3~0.4ppb CO:0.03ppm TSP:2.3~2.9μg/m^3
Water Pollution	Holliday: BOD & SS:0.0026~0.0068 mg/l NH_3-N :0.0008~0.0021mg/l TP :0.0001~0.0003 mg/l Polluted water:110 m^3 /day Working day: BOD & SS:0.0014~0.0035 mg/l NH_3-N :0.0004~0.0009mg/l TP :0.0001~0.0003 mg/l Polluted water:31 m^3 /day
Noise	Holliday: Day:0.9~8.4 db(A) Night:3.9~9.4 db(A)

Source: TNEEB, 2004

Secondly, as mentioned before, the people are affected by these pollutants can be categorizes into two groups. The first group is Pinglin residents and passengers who are mainly affected by air and noise. The residents of Taipei metropolitan who are influenced by water pollution can be regarded as second group. The population of Pinglin Township stands at 6,207 and that the population of Feitsui Reservoir serves are 3,840,880. The stay time of passenger depends upon the purposes of traveling. Therefore, it is necessary to convert time of passenger stay into "man-days" equivalence.

Feng and Wang (2005) define MD as the number of man-years spent by passengers and E_i as the average days of per stay for trip purpose i.

$$MD = \sum_{j=1}^{2} V_{ij} * D_j * E_i \qquad (4\text{-}1)$$

Where:

MD = the number of man-years spent by non-resident road users

V_{ij} = trips of trip purpose i at time period j

D_j = days of time period j

E_i = average days of per stay for trip purpose i

i = trip purpose i = 1 means passengers stopping off in local en route to another destination
i = 2 means passengers making the journey specifically to visit local
j = time period j = 1 means weekends and holidays
j = 2 means weekdays

The following figures could be obtained from "Before and After Analysis of the Taipei-Ilan Freeway Construction Project Report (TNEEB, 2004)": V_{11} = 3,942 persons, V_{12} = 2,038 persons, V_{21} = 1,733 persons, V_{22} = 284 persons, D_1 = 110 days/year, D_2 = 255 days/year, E_1 = 0.08 day/person and E_2 = 0.17 day/person. Finally we could derive MD being 494,987man-day. That is equivalent to 1,356 residents.

Table 4.11 lists the characteristics of the sample. The average age of the respondents is 44 and the average monthly income is NT$56,700. More than half of the respondents are female. The distribution of the education level is relatively even. As for occupation category, corporate employee accounts for the largest share and the public employee represent only about 21% of the respondents.

Table 4.11 Socio-economic characteristic of the respondents (pollution)

Item/Description	Sample (Water pollution) (1)	Sample (Noise and air pollution) (2)	Weighted Average of Population of Taipei City And County * (3)
	Mean/Percentage	Mean/Percentage	Mean/Percentage
Size	466	120	
Average Age	42.27	40.13	40.06
Average Monthly Income(NT$ 10,000)	5.88	4.99	6.52
Sex			
Male	51.25%	55.30%	49.45%
Female	48.75%	44.70%	50.55%
Chi-test (1) V.S. (3)	0.97		
Chi-test (2) V.S. (3)		0.91	
Education			
Primary School	29.20%	25.20%	36.10%
High School	35.10%	39.60%	30.40%
College	33.20%	28.20%	30.2%
Graduate School	2.50%	7.00%	3.3%
Chi-test (1) V.S. (3)	0.99		
Chi-test (2) V.S. (3)		0.99	
Occupation			
Government Employee	21.00%	20.55%	
Corporate Employee	38.80%	31.30%	
Self Employee	23.40%	23.90%	
Others	16.70%	24.25%	

Source: * Official Statistics of Taipei City Government and Taipei County Government

Following the methodology presented in chapter 3 and the survey information in Table 4.5 we could obtain the subsequent estimation results.

The monetary values of the water pollution

$$= 81 + 114 \frac{0.51(-81/114)}{1 - 0.30(-81/114)} = 47 \quad (4\text{-}1)$$

The monetary values of the noise pollution

$$= 73 + 108 \frac{0.50(-73/108)}{1 - 0.31(-73/108)} = 43 \quad (4\text{-}2)$$

The monetary values of the air pollution

$$= 98 + 113 \frac{0.60(-98/113)}{1 - 0.28(-98/113)} = 51 \quad (4\text{-}3)$$

Table 4.12 shows the monetary values of the environmental effects. The damage of water pollution, air pollution and noise are NT 2.4 billions, 4.45 millions and 5.2 millions respectively in 2010. In addition the results of the official CBA and our integrated CBA are further summarized in Table 4.13. It illustrates that the inclusion of monetized environmental effects in a cost-benefit analysis will lead to an entirely different outcome. In the case of the Pinglin Interchange, the net annual benefit was estimated at NT$550 million per year when the environmental effects are excluded. If the environmental effects are monetized and taken into consideration, the net deregulated effect will become negative NT$1,954 million per year.

Table 4.12 The monetary values of the environmental effects

Unit: NT$1,000 per year

		Water pollution	Air pollution	Noise
Estimation monetary value	(1)	0.054	0.051	0.057
Population of relevant groups	(2)	3,840,880	7,563	7,563
Environmental cost per year	(3)	2,494,477	4,585	5,217

Note: (1) are the results of CV estimation. The figures for 2010are calculating from 2004 by assuming 2% annual growth rate which is the Taiwan Central Bank's one-year deposit rate
(3)= (1)*(2)*12

Table 4.13 The results of the official CBA and the integrated CBA

Unit: NT$ 1,000 per year in 2010

Effects		Official CBA	Integrated CBA
Road use	Time saving	95,749	95,749
	Vehicle operating cost saving	158,006	158,006
	Accident reduction	20,430	20,430
Local economy	Income increase	331,152	331,152
Public service cost	Waste disposal	-1,239	-1,239
	Facility and maintenance cost	-54,000	-54,000
Environmental cost	Water pollution	---	-2,494,477
	Air pollution	---	-4,585
	Noise	---	-5,217
Net effect value		550,098	-1,954,181

Three aspects stand out from the empirical results. Firstly, the results support the hypothesis made in the first section, namely: the widely-adopted exercise for evaluating an environment-sensitive project that the EIA and the traditional CBA are conducted in a sequential way may not be sufficient and appropriate. The EIA is qualitative in nature and reflects technical views, which ignores that the monetary value of the environmental factor depends on the micro and macro economic settings. The value of a same unit of environmental factor may have different prices in different socioeconomic contexts. Without denying the value of the EIA, the paper has managed to show that the socially optimal decision for an environment-sensitive project had better depend on an integrated CBA, incorporating both the resultant environmental impacts and economic impacts at the same time and in a same setting (namely in monetary terms), which neither can the EIA nor the traditional CBA alone adequately encapsulated.

Secondly, the case study highlights the importance of integrating the traditional CBA with CVM for the evaluation of an environment-sensitive project. The study has shown that the monetized evaluation of the environmental factor can be integrated into the traditional CBA framework, which will allow for the possibility of evaluating the economic and environmental impacts on an equal footing. Although the case study focused mainly on the traffic related pollution, such as air pollution, noise and water pollution, but other environmental goods may be evaluated by using the same framework.

Thirdly, the case study has demonstrated an easy way to integrate the CBA with the CVM. The CVM can be conducted by independent researchers, like the authors. When taking away the environmental factors, our study works on a consistent basis as the traditional or official CBA. As a result, it is appropriate to adopt an integrated CBA, as proposed in the paper. The research results may facilitate the development of a fully-integrated CBA which addresses as many kinds of monetized impacts as possible. In addition, by referring to the case of the Pinglin Interchange, our results have come out with a different conclusion from the current one. Should the government have had our empirical results before making the decision, different regulations may have been adapted, for example regarding the traffic volume control, user fee charging and more environment-friendly infrastructure?

Moreover, Table 4.14 presents net benefits for related interest groups and Table 4.15 shows the average net benefits for residents and water users. It should be noted that the relatively high average net benefit for Pinglin residents has provided them sufficient incentives to form a powerful pressure group to convince the government to open the Pinglin Interchange. By contrast, the average loss for the water users is

considerably small such that the water users may not pay attention to this issue. The water users thus constitute a silent majority in this case.

Finally the use of our evaluation approach can throw more light on the conflicts between related groups, but it cannot, in and of itself, solve the problems that underlie these conflicts. Many countries have established a platform for interaction and communication between related groups. Working through this platform, individual interest groups can bargain with one another on the basis of their own opportunity cost, lobbying other interest groups to agree to their proposals, and thereby achieving an equitable distribution of benefits between interest groups. This mechanism could also be used to resolve cases where the needs of local economic development and the needs of environmental protection come into conflict.

Table 4.14 Net benefit for related groups

Unit: NT$ 1,000 per year in 2010

Effect		Residents	Passengers	Water users	Public sector
Road Use	Time saving	--	95,749	--	--
	Vehicle operating cost saving	--	158,006	--	--
	Accident Reduction	--	20,430	--	--
Environment	Air pollution	-3,763	-822	--	--
	Water pollution	-4,031	-881	-2,489,565	
	Noise	-4,282	-935	--	
Local economy	Income increase	331,152	--	--	--
Public service cost	Waste disposal	--	--	--	-1,239
	Facility and maintenance cost	--	--	--	-54,000
Net Benefit		319,076	271,	-2,489,565	-55,239

Table 4.15 Average net benefit for residents and water users

Unit: NT$ 1,000 per year in 2010

	Residents	Water users
Net benefit	319,076	-2,489,565
Population	6,207	3,833,317
Net benefit per head	51.41	-0.65

CHAPTER 5 EXTENSIONS

The previous chapter has shown the importance of extending the methods of project appraisal to add in environment impacts. This chapter further examines the issue: whether the government is able to levy charges on road users to mitigate environmental damages. Traditionally, pricing policy has been suggested as an efficient alternative for environment protection. On the one hand, the revenue from user fee can be provided for funding additional measures of environmental protection. On the other hand, the collection of a user fee will normally lead to a reduction in the number of tourists visiting the area, thereby lowering the level of environmental pollution (e.g., Downing, 1984; Urry, 1990). This kind of solutions have put into practice in many regions around the world, notable examples being Sofia Bay, Bulgaria (McClelland, 1997), the Gold Coast, Sydney (Pradeaux, 2000), the British National Parks and the Lake District National Park (Transport for London, 2001), and Hurricane Mitch, Nicaragua (Johnson and Baltodano, 2004).

This chapter seeks to investigate the framework further shown in Figure 5.1 that imposing a user fee on tourists can enrich funding for environmental protection and lead to a reduction in the number of tourists and further reduce environmental pollution. To this end, we use a logit model and in-depth interviews to determine which factors affect the WTP of respondents.

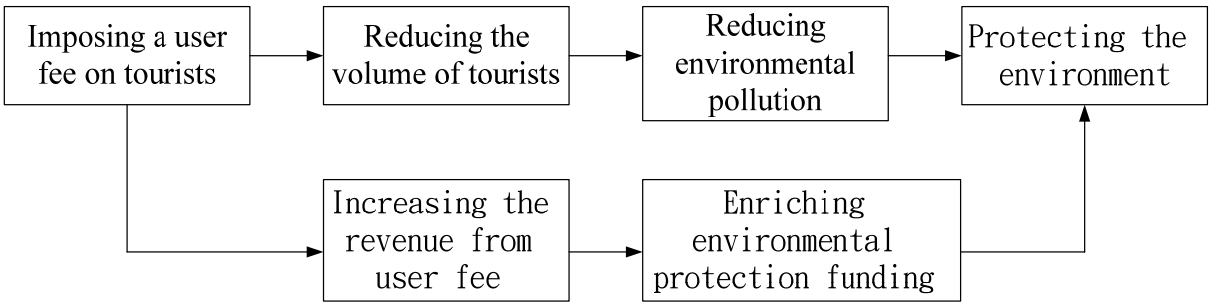


Figure 5.1 The framework of user fee in pollution control

5.1 Elicitation

5.1.1 Survey Design

Following the survey conducted in chapter 3, we have asked respondents another set of questions. The objective of the new questions is to have respondents assess the

value of water protection and tourist interests. To define the tourism experience and the importance of water quality protection, we asked each respondent to read the Pinglin interchange environmental impact evaluation report, which states that the Pinglin interchange will attract more tourists and pollute the Taipei metropolitan water quality. After describing Pinglin's tourist attractions and related water pollution, each respondent was asked the following valuation question:

We are now going to ask you a hypothetical question. Suppose you were told that the Taipei government was planning to deregulate the Pinglin interchange, which would reduce the number of accidents and attract more vehicles to Pinglin township. At the same time, this would reduce the water quality of the Feitsui Reservoir and increase in noise and air pollution in Pinglin. Such pollution might damage health or increase the sanitation budget, or even cause serious diseases, such as cancer, liver damage, calculus, anemia, endocrine disorder and dementia. This study would like to know your willingness to pay for providing the needed environmental protection, which will help us to calculate your loss of welfare due to the water, noise and air pollution from the deregulation of the Pinglin interchange.

Bear in mind that if you pay to guard against environmental pollution, you will have to give up some other use for this money. For example, you may need to reduce your expenditure on entertainment or education. (Show Fig. 3)

- How much money would you pay to visit Pinglin via the Pinglin interchange each time?

Each respondent was given one DB–DC approach. According to the results of a survey on domestic tourism in Taiwan conducted by the Tourism Bureau in 2003, "toll-type" user fees for tourist attractions and leisure facilities in Taiwan range from NT$10 per person up to NT$250 per person. To ensure that this range of prices was included, a bid structure was formulated as shown in Figure 5.2 below:

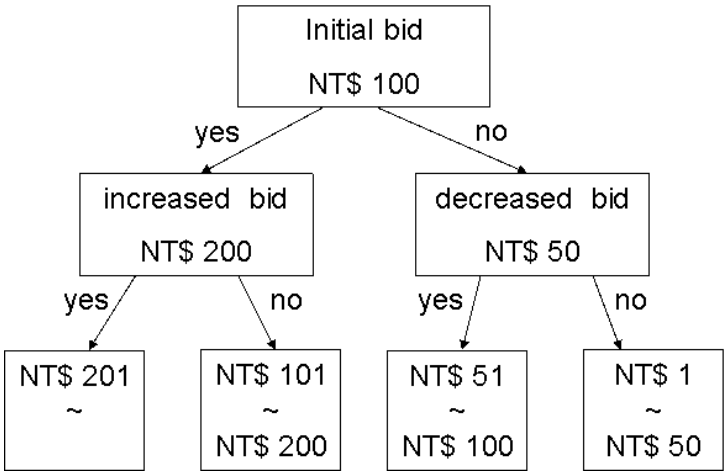


Figure 5.2 The bidding structure of user fee

5.1.2 Estimating WTP

Following the above bidding framework we are able to carry out the survey. By applying CVM approach we have collected 120 reliable samples. The frequency of the survey is listed in Table 5.1. There are over 95% of the respondents are willing to pay to visit Pinglin. Table 5.2 shows the socio-economic characteristic of the respondents.

Table 5.1 Distribution of WTP for user fee

CV	Frequency	Percentage (%)
NT$ 0	4	3.40%
NT$ 1 ～ NT$ 49	26	22.00%
NT$ 50 ～ NT$ 100	29	24.00%
NT$ 101 ～ NT$ 199	43	35.60%
NT$ 200 ～	18	15.00%
Total	120	100.00%

Table 5.2 Socio-economic characteristic of the respondents (user fee)

Item/Description	Sample
	Mean/Percentage
Average Age	44.29
Average Monthly Income(NT$ 10,000)	5.67
Sex	
Male	45.30%
Female	54.70%
Education	
Primary School	20.80%
High School	39.10%
College	23.20%
Graduate School	17.00%
Occupation	
Government Employee	21.00%
Corporate Employee	38.80%
Self Employee	23.40%
Others	16.70%
Residential	
Taipei City and County	85.67%
Others	14.33%

The user fee can be obtained accordingly by calculated the truncated normal of the samples.

$$\text{WTP}= 114 + 137 \frac{0.56(-114/137)}{1-0.28(-114/137)} = 62$$

5.2 Results

5.2.1 Controlling the Number of Tourists by Pricing

From the above results if the government sets the user fee as NT$62, 76% of the respondents would accept this price and would keep visiting Pinglin (see Figure 5.3). On the contrary, the other 24% of the respondents would experience a negative impact on their welfare, and they would not visit Pinglin. Overall, the establishment of the user fee system would reduce the level of demand for travel to Pinglin. Consequently the government's objective to use user fees as a tool to reduce the number of tourists visiting Pinglin can be achieved.

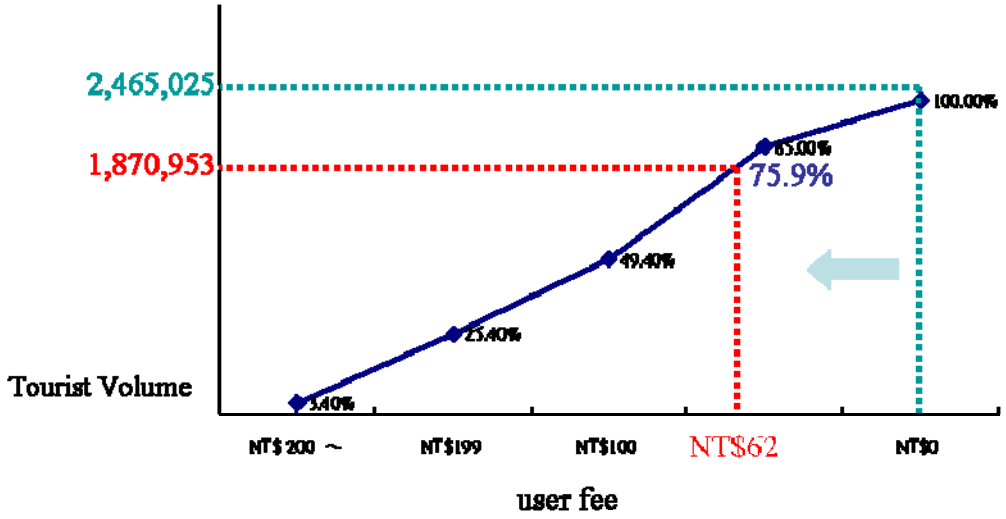


Figure 5.3 The frequency of WTP for user fee

In addition on the basis of the Taiwan National Expressway Engineering Bureau's (TNEEB)(2004) statistics that indicate that, on average, Pinglin receives 2,465,025 tourists a year (see Table 5.3), assuming that the unit price of entrance is set at NT$62, the number of tourists would be reduced by 24%. In other words, using a user fee regulation toll, the number of Pinglin tourists could be reduced to 1,870,593 (see Table 5.4).

Table 5.3 Pinglin Tourists and Disposal Volumes

	Tourism types	Tourists/day	Days	Disposal Volume (kilogram)	Volume of Polluted Water (Liter)
Weekends & Holidays	Partial day	6,812	110	0.3 kg/person	10 *l* /person
	All day	5,953		0.6 kg/person	40 *l* /person
Weekdays	Partial day	3,574	225	0.3 kg/person	10 *l* /person
	All day	1,141		0.6 kg/person	40 *l* /person
Total		2,465,025 man-trip		1,012,974 kg	51,996,900 *l*

Resource: TNEEB (2004) Before and After Analysis of the Taipei-Ilan Freeway Construction Project Report.

5.2.2 Reducing Pollution of Tourists

Moreover the user fee is very effective in reducing pollution. According to Table 5.2, it is estimated that each partial-day tourist generates 0.3 kg disposal and 10 liters of polluted water, and each all-day tourist makes 0.6 kg disposal and 40 liters of polluted water. If the user fee is set at 62, the disposal will be diminished to 768 thousand kilograms. The volume of polluted water also decreases to 3.95 million liters. Each is below its respective level of maximum environmental load (see Table 5.4).

Table 5.4 Disposal and Pollution Volumes of Pinglin Tourists in different control tools

Type of control	Tourists / per year	Disposal Volume / per year (kilogram)	Pollution Water Volume / per year (Liter)
No user fee	2,465,025	1,012,974	51,996,900
User fee at 62	1,870,954	768,847	39,465,647
Maximum Environmental load *	1,890,200	803,399	42,535,850

Resource：* Estimated by Taiwan Area National Freeway Bureau (2004)

5.3 Socioeconomic Factors Affecting WTP

5.3.1 Logit model analysis

In this section, we will further examine the factors which influence WTP. The logit model is used to estimate the tourists' WTP on the basis of their socioeconomic characteristics. After testing the logit model by using several sets of variables, we chose one of the variable sets in which the log-likelihood ratio (LR) was the highest. The final results are presented in Table 5.5.

Table 5.5 WTP Equations

Variable	Explanation	Coefficient
Gen	Gender; male = 1, female = 0	-5.49**
Occ	Occupation; public sector employee =1, others=0	0.25*
Re	Resident; Taipei metropolitan area residents =1, others=0	1.93*
Income	Income (per month)	
Icm1	Icm1: ≦NT$ 30 thousands (T)	-3.89**
Icm2	Icm2: NT$ 30 T <income≦ NT$ 60 T	-2.57**
Icm3	Icm3: NT$ 60 T <income≦ NT$ 90 T	-2.52**
Icm4	Icm4: NT$ 90 T <income≦ NT$ 120 T	-2.34**
Icm5	Icm5: NT$ 130 T <income	--
Age	Age	
age1	age1: 21 ~30 years	2.82**
age2	age2: 31~40 years	2.99**
age3	age3: 41~50 years	2.84**
age4	age4: 51~60 years	3.50**
age5	age5: above 60 years	--
Education	Education	
edu1	edu1: Grade school	0.50*
edu2	edu2: High school	1.04**
edu3	edu3: College	0.18*
edu4	edu4: Post graduate	--
	Log-Likelihood	-943.45
	Chi-Square	835.89

* Significance level p<0.05
** Significance level p<0.01

From Table 5.5 we can observe that female respondents, high income individuals, Taipei metropolitan area residents, less educated respondents, public sector employee and those under the age of 60 tend to have higher WTP.

5.3.2 In-depth interview

To conform above results, we sample from the 120 respondents and make in-depth interviews by phone. We interview 17 respondents, their Socio-economic characteristic are showed in the Table 5.6. Two females being primary and high school degrees are not water users.

Table 5.6 Socio-economic characteristic of the respondents (in-depth interviews)

	Primary School	High School	College	Graduate School	Total
Male	1	3	2*	1	7
Female	3	3	3**	1***	10

Note: * including 1 public employee, ** including 1 public employee, *** including 1 public employee

In-depth interviews and further analysis led to the following observations:

1. Women displayed higher WTP than men

WTP was found to be higher among female respondents than among male respondents. Further exploration of the reasons for this difference indicates that women generally believe that water quality may affect human health, and are willing to pay more for high-quality drinking water. This result is consistent with the studies of Alberini, et al. (1997), McClelland (1997), Lee and Han (2002), as well as Eckton (2003).

It is worth bearing in mind that male respondents are also aware of the importance of water quality to human health, but in general they are suspicious of the effectiveness of user fee policy. Therefore, they are not willing to pay as much as the women to reduce pollution. This result is consistent with the studies of McClelland (1997) and Ardila, et al. (1998).

2. High income individuals displays higher WTP

The interview results have shown that, while most respondents were in favor of a user fee scheme for tourists, the amount that they were willing to pay depended on their disposable income. The higher the respondent's income, the more they could afford to spend on travel and leisure, hence they will demonstrate higher WTP. This phenomenon is often reported in the WTP related literature. The result is consistent with the studies of Alberini, et al. (1997), McClelland (1997), Ardila, et al. (1998), Lee and Han (2002), Eckton (2003), Huhtala (2004) and Johnson and Baltodano (2004).

3. Taipei metropolitan area residents have high WTP than other residents

WTP was significantly higher for Taipei metropolitan residents than other inhabitants. The major reason is that people living in other regions would not benefit from the maintenance of water quality, and so are less willing to pay user fees. The similar outcome could be observed in the studies by Kelvin (2000) and Eckton (2003).

4. Less Educated residents tend to have higher WTP

Most of the past literature has found that people with higher levels of education may have higher WTP. (e.g., Alberini, et al., 1997; McClelland, 1997; Ardila, et al., 1998; Lee and Han, 2002; Eckton, 2003; Huhtala, 2004; Johnson and Baltodano, 2004). However, the empirical results in the present study have obtained an opposite result. Following-up interviews have revealed that in general respondents with a higher level of education felt that, on the basis of past experience, it was likely that the government would use environmental protection as an excuse to levy fees on tourists but then fail to use the revenue effectively to assuage pollution. As a result their WTP would be lower. An analogous phenomenon was also observed in the surveys conducted by the Inter-American Development Bank to appraise the performance of its funding projects (Ardila, et al., 1998).

5. WTP was higher among respondents under the age of 60

The empirical results showed higher WTP among those respondents under the age of 60 than among those aged 60 or over. Older people tend to have lower income, making them less willing to spend money on leisure and tourism. The survey results

indicated very low WTP is found among the aged group and the older the respondents, the lower the WTP. Similar results have been found in many other surveys, such as Alberini, et al. (1997), McClelland (1997), Lee and Han (2002), Eckton (2003) and Huhtala (2004). In the follow-up interviews, some of the older respondents mentioned that they did not trust the government to supervise the work of water conservation properly once the user fee scheme was in place.

6. Higher WTP among those who working in the public sector

The results demonstrated that respondents working in the public sector had higher WTP than those working in the private sector. This can be attributed to public sector employee are likely to have more faith in the government's policy implementation ability, and are therefore more willing to pay to help maintain water quality. This result is consistent with the studies of McClelland (1997) and Ardila, et al. (1998).

To summarize the survey results discussed above, regardless of the socioeconomic characteristics, the main factors affecting WTP were the level of confidence in the government's ability to implement its policies properly, income levels and the causal relationship between the policy and the respondent's own interests.

Older respondents and those with a higher level of education tended to display a lack of faith in the government's ability to implement policy, and, as a result, these groups have a tendency to have lower WTP. If the government wishes to raise WTP in these two groups, it needs to strengthen their confidence in the government's capability to execute its policies. Other studies, such as McClelland (1997), Ardila, et al. (1998), and Venkatachalam (2004, have mentioned this point as well.

Finally the survey outcome has exhibited that aged and low income groups have low WTP. The introduction of a user fee system in tourist destinations would force members of these groups to reduce their leisure activity, creating a barrier to the enjoyment of such activity. This result is consistent with the studies of Reitveld and Verhoef (1998) and Baeten (2000). Since the range of leisure activities available to elderly and low income groups are already restricted, the government will need to provide suitable ancillary measures (Giuliano, 1992) to prevent the adoption of a user

fee system from exacerbating the existing inequality within society (Banister, 1994; Eckton, 2003).

5.4 Conclusions

The main purpose of this chapter is to look at whether user fee is an effective control instrument to manage watershed. By taking Taiwan's Pingling Township as an example, this research indicates user fee policy can reduce the number of tourists, decrease the resultant environmental pollution and generate environmental protection revenue. It shows that when the user fee is set at NT$62 per person, the number of people visiting Pinglin will be reduced 24%, which will decrease waste and polluted water.

The above results suggest that user charge have the potential to substantially reduce traffic levels. This could be achieved without entailing a financial burden on the government, indeed there could be net financial gains. In addition it has been shown that such a policy would be acceptable to the majority of the respondents. Therefore, the user charge is feasible to implement, in practice.

The chapter further applies a logit model to explore the characteristics of respondents that can affect their WTP. The estimated results demonstrate that female, high income, metropolitan resident, less educated people, public employee and people under the age of 60 tend to have higher WTP. Moreover, in-depth interview indicates that regardless of the socioeconomic characteristics, public confidence in the capability of government enforcement affects people's WTP markedly.

CHAPTER 6 CONCLUSIONS AND ECOMMENDATIONS

6.1 Conclusions

The purpose of the study is to develop and examine an integrated cost-benefit model for an environment-sensitive transportation project. It is well known that the current methodologies of assessing environment-sensitive projects have limitations. In this regard, the widely-adopted exercise which involves the “Environmental Impact Assessment (EIA) and the traditional Cost Benefit Analysis (CBA) in a sequential way may be flawed with a failure to calculate the resultant economic and environmental impacts in a same setting and at the same time. Comparatively, Contingent Valuation Methods (CVM) can take environmental factors into account and is the most frequently applied methodology by far. However, the CVM mainly deals only with the environmental impacts, paying not much attention to the economic impacts.

Given the above weakness, it is necessary to develop a process which integrates the CBA with CVM to assess the overall effects (both the environmental and economic impacts) for a transportation project (Fin.6.1). Consequentially, this study goes a step further than the previous research by developing a step-by-step process.

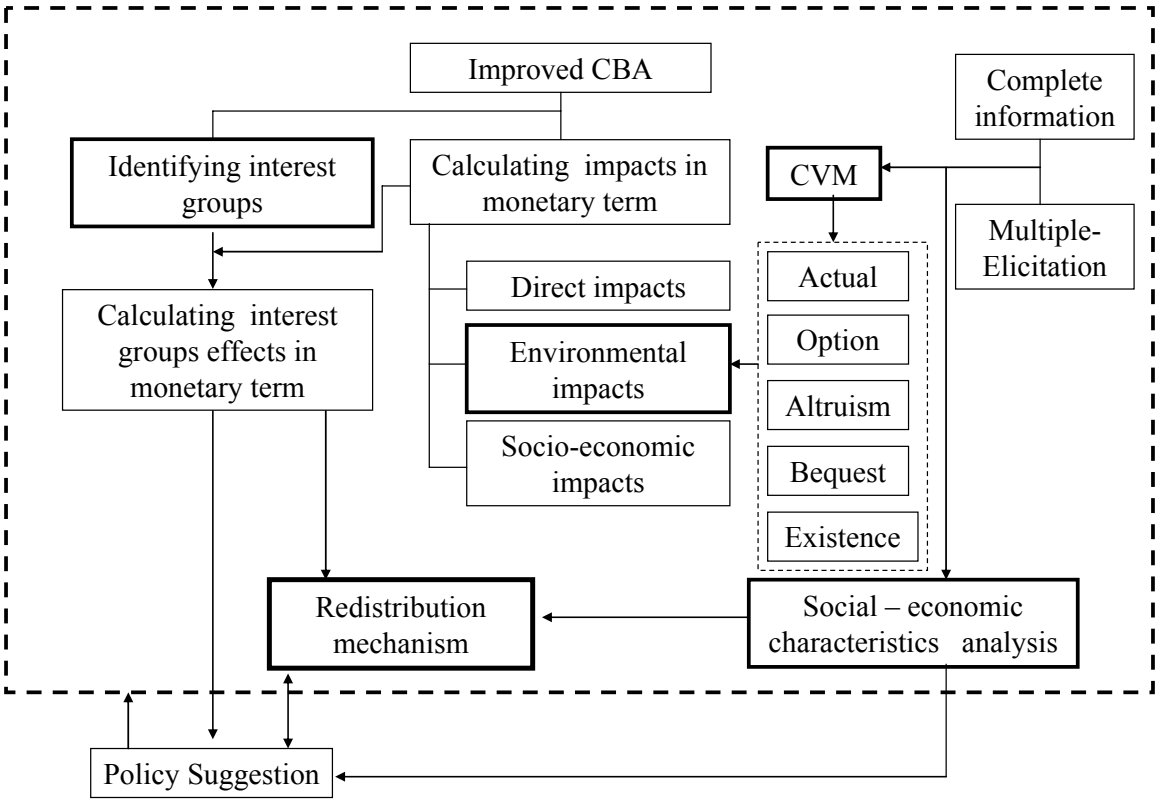


Fig. 6.1 An integrated evaluation framework

In this issue, the Pinglin Interchange appears to be an interesting case. Obviously, Pinglin Interchange is not a single case; there are some other high-profile cases, such as Taiwan high speed railway which is the biggest B.O.T., draws much public attention. However, the Pinglin Interchange does provide a manageable case to experiment with the development of an integrated CBA with environmental factors for an environment-sensitive project. Indeed, the paper goes a further step by exploring the issue at the practice level, which may be more insightful. It encourages the reader to apply this method as a reference point to more complex analysis.

The main findings of the study can be summarized as follows:

1. Ignoring environmental factors may mislead the policy decision

The empirical results of this study have shown that the integrated CBA may produce an entirely different conclusion from the one resulting from the common evaluation exercise of combining the EIA and the traditional CBA. Specifically, the results of the empirical study show that the inclusion of monetized environmental in a cost-benefit analysis will lead to an entirely different outcome. In the case of the

Pinglin Interchange, the net annual benefit was estimated at NT$550 million per year when the environmental effects are excluded. If the environmental effects are monetized and taken into consideration, the net deregulated effect will become negative NT$1,954 million per year.

From the empirical result it should be noted that the failure to evaluate the environmental impacts and economic impacts on the same scale (in the monetary terms) and at the same time may not lead to a socially optimal decision for an environment-sensitive transportation project. Consequentially, an environmentally acceptable transportation project, such as the Pinglin Interchange, though is justifiable in terms of the EIA, may not necessarily be a social optimal project.

In addition, to make the socially optimal decision for an environment-sensitive project has been troublesome for the planners because they have to take into account both the resultant environmental impacts and economic impacts. Instead of developing something new, the paper arguably has managed to find a short-cut to the above mentioned problem by integrating the CVM and traditional CBA on a same scale.

2. The importance of establishing the redistribution mechanism in project management

The integrated CBA evaluation approach can display the conflicts among related groups, but it cannot resolve the disagreements alone .To alleviate the level of conflicts, many countries have established a platform for interaction and communication between related groups. Working through this platform, individual related groups can bargain with one another on the basis of their own opportunity cost, lobbying other interest groups to agree to their proposals, and thereby achieving an equitable distribution of benefits between interest groups. It is particularly important when environmental factors have become international concerned and drawn more attentions worldwide. It should bear in mind that we should cautiously identify the affected interest groups in project evaluation. By classifying the share burden among interest groups precisely we could set up the redistribution framework and design the compensation scheme accordingly. As a result it can alleviate the dissatisfaction from the affected interest groups and to facilitate the project enforcement.

3. User fee policy is an effective instrument to reduce pollution

This study further applies the DB-DC approach to evaluate the effect of collecting user fee on the number of tourists in Pinglin. The results show that the government could set user fee at NT$62 and could reduce 24% of the tourists and the level of pollution will be reduced accordingly. In addition, the logic model is also applied to investigate the effects of socioeconomic characteristics on tourists' WTP. The estimated results demonstrate that female, high income, metropolitan residents, low level of education, public employee and people under the age of 60 tend to have higher WTP.

Finally it should be noted that the aged and low income groups have low WTP, the introduction of a user fee system in tourist destinations would force members of these groups to reduce their leisure activity, creating a barrier to the enjoyment of such activity. Consequentially, the government needs to provide suitable supplementary measures to prevent the adoption of a pricing policy from exacerbating the existing inequality within society. This is an area that decision-makers will need to pay close attention.

4. Government's credibility and capability of managing policy affect WTP

Moreover in-depth interviews have shown that regardless of the socioeconomic characteristics, public confidence in the capability of government enforcement affects people's WTP markedly. Lack of faith in the government's ability to implement its policies leads to lower WTP. Therefore, if the government wishes to increase the public support for its pricing policy, it will call for strengthening its citizens' confidence in its ability to execute its policies properly, and ensure that the policies could enhance citizens' welfare.

6.2 Recommendations

1. Constructing an integral plan for WTP approach

The results of this research can be transferred to other areas of policy-making definitely, such as recreation industry and transportation constructions which are trying to avoid environmental damages. Nevertheless, if we want to reduce impact of recreational purposes by using WTP, there is something to be noticed. First, regarding

mechanism of economic incentives, information of benefits and costs for pollution prevention should be sufficient. Therefore, when we start to take WTP survey, we need to complete an integral plan for pollution prevention, and learn the upper limit of acceptable pollution amount for each case. After that, target pricing for reducing pollution can be set accurately. Second, providing sufficient information for respondents is necessary. If respondents cannot figure out their accurate WTP, the correct policy objectives will not be achieved.

2. Identifying interested parties motivations in enforcing polices

Identifying residents' incentives and motivations is a very crucial factor of enforcing public polices. It is a good way to stimulate related parties to participate in decision–making process and make them aware public policies. It is necessary for the government authorities to recognize related parties' concerns and create fine communicative atmosphere. By doing so, the decision–making process can be more transparent and democratic and efficient communication could turn out to be achievable.

3. Facilitating the process of pursuing sustainable development

Economic development and environmental protection is not always contradicting with each other. The concept of "sustainable development" addresses both developmental and environmental imperatives, was brought into common use. It can be served as a balance point of economic development and environmental protection. However, to accomplish the goal of sustainable development it requires an integration of economic, environmental and social tools of analysis, the results of this study could serves as a benchmark for the future work.

6.3 Future Research Directions

This thesis has shown that it is imperative to encompass a wide range of environmental factors in the project appraisal process. This type of study is of great importance for decision makers to formulate their policies. There is an urgent need for more research studies to complement and extend the current environmental valuation knowledge stock. Following this study the future research directions can be summarized as follows:

1. Extending elicitation techniques in C V approach

To reflect respondents' WTP truly is an important component of CV method. In general there are four different types of elicitation technique used in CV studies: the bidding game, payment card (PC), open-ended (OE) approach and dichotomous choice (DC) approach. The dichotomous choice approach is further divided into single-bounded dichotomous choice (SB-DC) and double-bounded dichotomous choice (DB-DC). In this study we use a double-bounded dichotomous choice (DB-DC) to estimate the monetary value of the environment effects. The major advantage of this approach is that one could identify the location of maximum to pay from the survey. In fact DB-DC approach has become the most widely used technique for CV method. On the other hand, as described earlier, DB-DC has its own limitations; the major restrictions are the biases from starting point and information asymmetry. Although in this study, we have run different tests to verify such biases are not significant, it is more logical to carry out the survey through different techniques to assure the robustness and credibility of the sample.

2. Controlling the survey period to mitigate bias

To ensure the whole sample is as representative as possible, it took six months to complete the survey. However, this may also engender plausible biases. Such biases arise from different scenarios in the same survey may produce inconsistent consequences. It is well documented that WTP may vary due to the external environment. The changeable WTP may lead to inaccurate evaluation results. The longer is the survey period, the higher degree of the bias may be. As in our case the issue of whether the Pinglin interchange should be opened has been at the heart of a political tug-of-war which has escalated from local to national level during the survey period. This has affected respondents' WTP to some extent. Therefore how to conduct a more accurate survey by reducing the investigation period is another important task in the future works.

3. Identifying the tools of environment protection

In the survey we generally ask respondents the amount of money that they are willing to pay for environment protection. We have not asked or provided any further information about instruments to prevent environment pollution. It is perceived that

individual's WIP for environmental protection is affected by the types of instruments. Indeed, in our survey, some respondents alleged that would seek to protect themselves with environmental risk such as contaminated drink water. As a result their WTP would be higher if the environmental protection measures are designed for individual families. For example, they claimed that their WTP for installing pollution-reduced devices (water filters) is higher than the measures provided by the government. Therefore, providing concrete contents for environmental protection instruments is another feasible direction in the future works.

4. Combining stated preference and revealed preference data

Another extension for future research is the combination and joint estimation of revealed preference and states preference data. In our study we applied CV method to conduct the survey. The CV method is a stated preference approach that directly elicits WTP from respondents. In other words, respondents are asked about their WTP straightforwardly in the survey. The strength of the stated preference is its flexibility and the ability to measure non-use values. The major weakness of stated preference approach is their hypothetical nature. Respondents are placed in unfamiliar situations in which complete information is not available and this may lead to bias outcome.

On this regard revealed preference approach by using behavioral data to estimate the ex-post WTP can fill in this gap. Historically, researchers have seen revealed and stated preference approaches as substitutes. In recent years it is perceived that combination of revealed preference data with stated preference data could enhance the reliability of the estimation. In general, the strengths of the revealed preference approaches are the weaknesses of stated preference approaches. Recognizing this complementarily, a new approach has emerged that sough to combine and jointly estimate revealed and stated preference data. It is apparent that jointly estimated revealed-stated preference models are superior to independently estimated revealed and stated preference models. There have been some applications of this approach in the environmental economics literature but independently estimated models still dominate the valuation literature. Future environmental valuation research should continue to look for the possibilities for joint estimation.

5. Pricing automotives as an alternative to alleviate pollution

We have examined to impose user fee to alleviate pollution in this research. A possible extension is to levy entrance fee on vehicles to control pollution. In this study the source of pollution is only from disposals of tourists, but in reality another possible pollution source is from vehicles. It is more prevalent in tourist area where the public transportation is not convenient and people have to rely on motor vehicles. In this respect the pollution from vehicle should be included in the future research framework and the government may use vehicle entrance fee as an alternative instrument to control pollution. As in the Pinglin case the authority may levy user fee on tourist as well as on vehicles to mitigate pollution in the future policy considerations.

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APPENDIX A Questionnaire

問卷 1-1(Information level 1)

先生/小姐您好：

我是交大博士班研究生，目前正在進行一項學術研究的問卷調查，想要耽誤您 10 分鐘的時間接受我的訪問，您的相關資訊我們都會位您保密，不會作為學術研究以外之使用。不知道您願不願意接受訪問?

請問您是否在台北縣市居住滿五年以上?(回答否者，終止訪問)

政府現正修築北宜高速公路，通車之後可以取代目前蜿蜒的北宜公路能降低行車意外，且往來台北及宜蘭之間只需 60 分鐘。但因北宜高速公路行經翡翠水庫集水區，可能會造成水源的汙染，請問您是否願意額外支付一些水費，做為翡翠水庫集水區水源保護之用?

雖然這是一個假設性的問題，但為了調查的準確性，在此特別提醒您，您若支付了這筆款項將會減少您在其他方面的可支付用金額，例如您必須減少原本用在育樂的花費。

□不願意

□願意，請問您每個月願意支付多少錢?_____(若您是以家戶為計算單位，請將您的願付價格除以家庭人口數)

基本資料

1.性別：□男□女　　2.年齡：_____歲

3.教育程度：□國中及以下　□高中/職　□大專/學　□研究所及以上

4.工作性質：□軍公教　□私部門雇員　□自營　□學生　□其他

問卷 1-2(Information level 2)

先生/小姐您好：

我是交大博士班研究生，目前正在進行一項學術研究的問卷調查，想要耽誤您 10 分鐘的時間接受我的訪問，您的相關資訊我們都會位您保密，不會作為學術研究以外之使用。不知道您願不願意接受訪問?

請問您是否在台北縣市居住滿五年以上?(回答否者，終止訪問)

政府現正修築北宜高速公路，通車之後可以取代目前蜿蜒的北宜公路能降低行車意外，且往來台北及宜蘭之間只需 60 分鐘。但因北宜高速公路行經翡翠水庫集水區，可能會造成水源的汙染，而您目前所喝的自來水，正是由翡翠水庫所供應的；意即北宜高速公路通車後，可能會影響您家的自來水品質。請問您是否願意額外支付一些水費，做為翡翠水庫集水區水源保護之用?

雖然這是一個假設性的問題，但為了調查的準確性，在此特別提醒您，您若支付了這筆款項將會減少您在其他方面的可支付用金額，例如您必須減少原本用在育樂的花費。

□不願意

□願意，請問您每個月願意支付多少錢?_____(若您是以家戶為計算單位，請將您的願付價格除以家庭人口數)

基本資料

1.性別：□男□女　　2.年齡：_____歲

3.教育程度：□國中及以下　□高中/職　□大專/學　□研究所及以上

4.工作性質：□軍公教　□私部門雇員　□自營　□學生　□其他

問卷 1-3(Information level 3)

先生/小姐您好：

我是交大博士班研究生，目前正在進行一項學術研究的問卷調查，想要耽誤您 10 分鐘的時間接受我的訪問，您的相關資訊我們都會位您保密，不會作為學術研究以外之使用。不知道您願不願意接受訪問?

請問您是否在台北縣市居住滿五年以上?(回答否者，終止訪問)

政府現正修築北宜高速公路，通車之後可以取代目前蜿蜒的北宜公路能降低行車意外，且往來台北及宜蘭之間只需 60 分鐘。但因北宜高速公路行經翡翠水庫集水區，可能會造成水源的汙染，而您目前所喝的自來水，正是由翡翠水庫所供應的；意即北宜高速公路通車後，可能會影響您家的自來水品質。長期使用品質不佳的飲用水，可能會造成結石、貧血、肝功能受損、內分泌失調、癌症及老人癡呆症。請問您是否願意額外支付一些水費，做為翡翠水庫集水區水源保護之用?

雖然這是一個假設性的問題，但為了調查的準確性，在此特別提醒您，您若支付了這筆款項將會減少您在其他方面的可支付用金額，例如您必須減少原本用在育樂的花費。

□不願意

□願意，請問您每個月願意支付多少錢?_____(若您是以家戶為計算單位，請將您的願付價格除以家庭人口數)

基本資料

1.性別：□男□女　　2.年齡：_____歲

3.教育程度：□國中及以下　□高中/職　□大專/學　□研究所及以上

4.工作性質：□軍公教　□私部門雇員　□自營　□學生　□其他

Appendix 2

問卷編號_____　　問卷時間_____

先生/小姐您好：

我是交大博士班研究生，目前正在進行一項學術研究的問卷調查，想要耽誤您 20 分鐘的時間接受我的訪問，您的相關資訊我們都會為您保密，不會作為學術研究以外之使用。不知道您願不願意接受訪問?

雖然這是一個假設性的問題，但為了調查的準確性，在此特別提醒您，您若支付了這筆款項將會減少您在其他方面的可支付用金額，例如您必須減少原本用在育樂的花費。

一、水污染願付價格

政府現正修建北宜高速公路，通車之後往來台北及宜蘭之間只需 60 分鐘。在這中間將會開放坪林交流道，便利旅客到坪林遊憩。但因北宜高速公路跨越翡翠水庫集水區，交通的便利可能會吸引更多的遊客來此，進而會造成水源的汙染。若您台北縣市的居民，則您目前所喝的自來水，正是由翡翠水庫所供應的；意即北宜高速公路通車後，可能會影響您家的自來水品質。長期使用品質不佳的飲用水，可能會造成結石、貧血、肝功能受損、內分泌失調、癌症及老人癡呆症。

請問您是否願意額外支付一些費用，做為翡翠水庫集水區水源保護之用?

□不願意，原因_____

若原因為自覺需要受償的情況時，則以下面說明說服之：

我們了解水源受到污染時，您才是受害者，應該獲得補償。但在過去的研究中顯示，當人們有受害心態時，要求的賠償金額通常都比實際用來預防的成本高很多。所以，即使您是受害的一方，我們也想知道您到底願意花多少錢用來防範水污染，用您願意支付的防護經費，作為您受害價值的依據，會不回比

較公平，也比較精確。這樣所做的研究才比較接近真實。請問您是否願意繼續接受我們的訪問?

□願意，請問您每個月願意支付多少錢?若您是以家戶為計算單位，請將您的願付價格除以家庭人口數

（開始出價）

	出示順序	落點
起始點 100 元		
起始點 500 元		
起始點 1000 元		

二、空氣污染及噪音願付價格

交通的便利其實會吸引更多的車輛到此,那麼坪林鄉就可能無法再維持像目前這樣清新的空氣；當然汽車的噪音也會為之增加，那麼坪林鄉也可能無法再像目前這樣寧靜了。請問您是否願意額外支付一些費用，做為坪林地區空氣品質維護及噪音防治之用?

□不願意，原因_____

若原因為自覺需要受償的情況時，則以下面說明說服之：

我們了解空氣品質降低、噪音增加時，您才是受害者，應該獲得補償。但在過去的研究中顯示，當人們有受害心態時，要求的賠償金額通常都比實際用來預防的成本高很多。所以，即使您是受害的一方，我們也想知道您到底願意花多少錢用來防範水污染，用您願意支付的防護經費，作為您受害價值的依據，會不回比較公平，也比較精確。這樣所做的研究才比較接近真實。請問您

是否願意繼續接受我們的訪問?

□願意，請問您每個月願意支付多少錢做為**坪林地區空氣污染防治之用**?若您是以家戶為計算單位，請將您的願付價格除以家庭人口數

（開始出價）

	出示順序	落點
起始點 100 元		
起始點 500 元		
起始點 1000 元		

□願意，請問您每個月願意支付多少錢做為**坪林地區噪音防治之用**?若您是以家戶為計算單位，請將您的願付價格除以家庭人口數

（開始出價）

	出示順序	落點
起始點 100 元		
起始點 500 元		
起始點 1000 元		

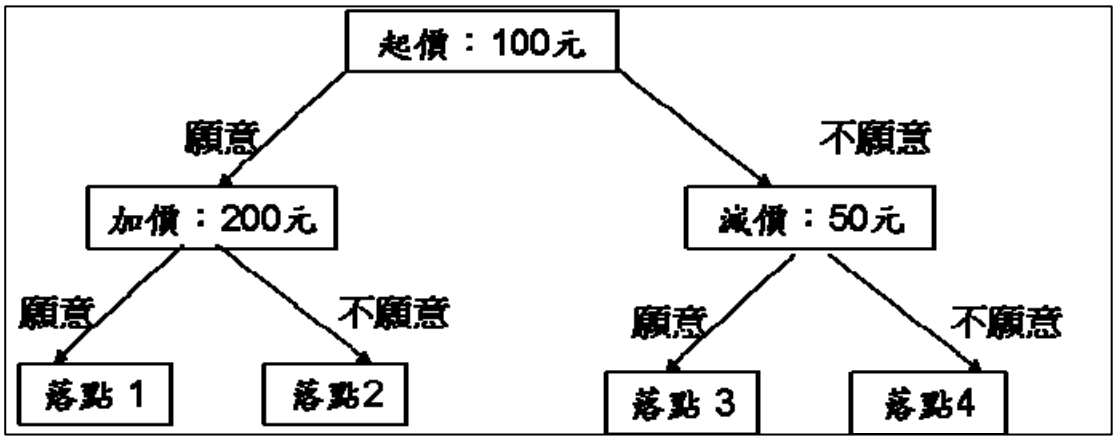
三、基本資料

1.性別：□男□女　　2.年齡：_____歲

3.教育程度：□國中及以下　□高中/職　□大專/學　□研究所及以上

4.工作性質：□軍公教　□私部門雇員　□自營　□學生　□其他

6.個人年收入：_____萬元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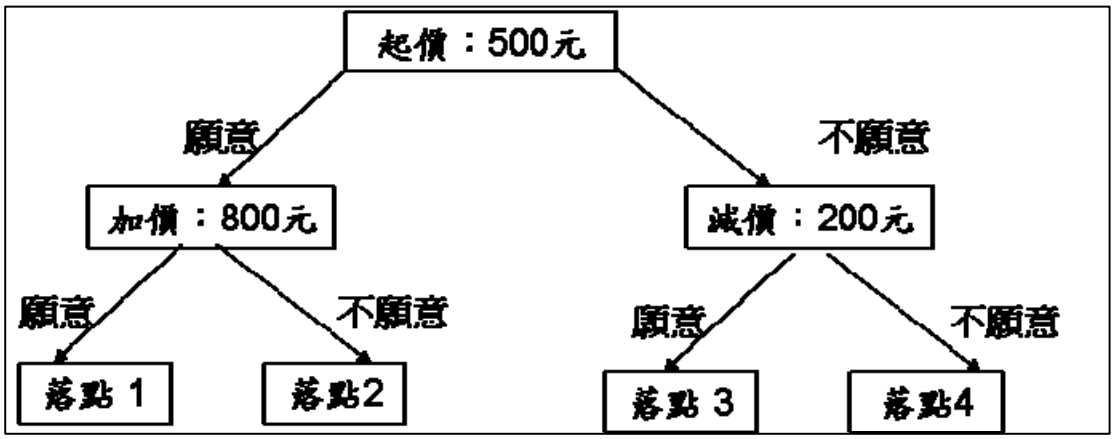
願意
不願意
加價：200元
減價：50元
願意
不願意
願意
不願意
落點 1
落點2
落點 3
落點4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不願意
加價：800元
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願意
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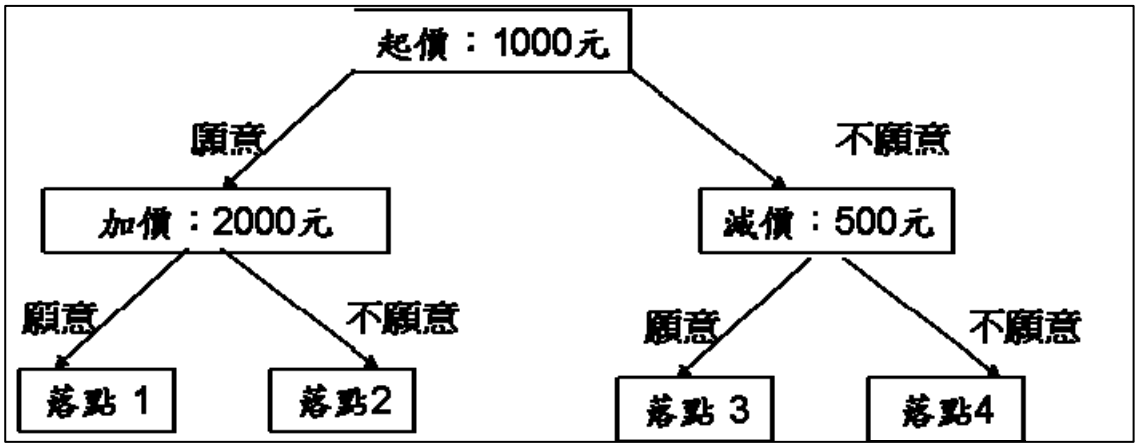
落點2
落點 3
落點4


起價：1000元
願意
不願意
加價：2000元
減價：500元
願意
不願意
願意
不願意
落點 1
落點2
落點 3
落點4

Appendix 3

問卷編號_____　　問卷時間_____

先生/小姐您好：

我是交大博士班研究生，目前正在進行一項學術研究的問卷調查，想要耽誤您 20 分鐘的時間接受我的訪問，您的相關資訊我們都會為您保密，不會作為學術研究以外之使用。不知道您願不願意接受訪問?

雖然這是一個假設性的問題，但為了調查的準確性，在此特別提醒您，您若支付了這筆款項將會減少您在其他方面的可支付用金額，例如您必須減少原本用在育樂的花費。

政府現正修建北宜高速公路，通車之後往來台北及宜蘭之間只需 60 分鐘。在這中間將會開放坪林交流道，便利旅客到坪林遊憩。但因北宜高速公路跨越翡翠水庫集水區，交通的便利可能會吸引更多的遊客來此，進而會造成水源的汙染。台北縣市居民所喝的自來水，正是由翡翠水庫所供應的；意即北宜高速公路通車後，可能會影響他們的自來水品質。長期使用品質不佳的飲用水，可能會造成結石、貧血、肝功能受損、內分泌失調、癌症及老人癡呆症。

請問您是否願意在每次使用路經坪林交流道的時候額外支付一些過路費，做為翡翠水庫集水區水源保護之用?

□不願意，原因_____

若原因為自覺需要受償的情況時，則以下面說明說服之：

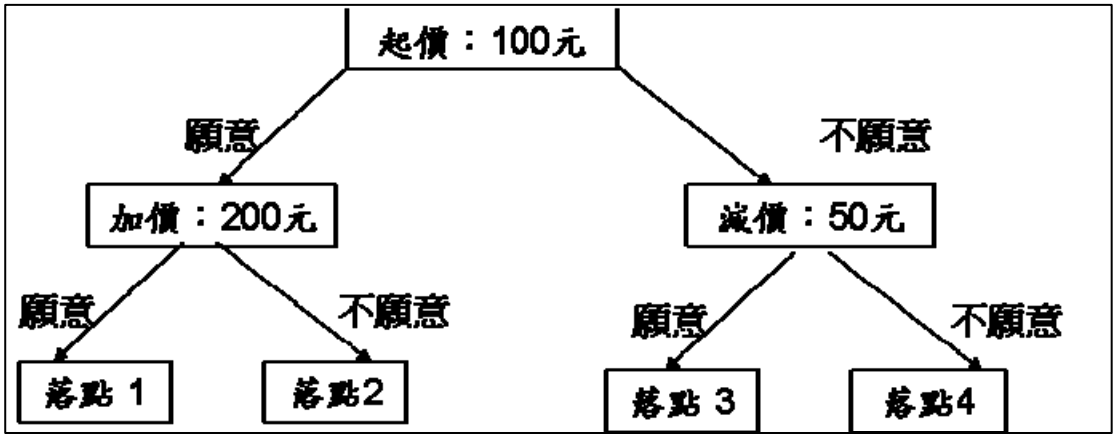
我們了解水源受到污染時，您才是受害者，應該獲得補償。但在過去的研究中顯示，當人們有受害心態時，要求的賠償金額通常都比實際用來預防的成本高很多。所以，即使您是受害的一方，我們也想知道您到底願意花多少錢用來防範水污染，用您願意支付的防護經費，作為您受害價值的依據，會不回比較公平，也比較精確。這樣所做的研究才比較接近真實。請問您是否願意繼續

接受我們的訪問?

□願意，請問您每次路過願意支付多少錢?

(開始出價)

	落點
起始點 100 元	



三、基本資料

1.性別：□男□女　　2.年齡：_____歲

3.教育程度：□國中及以下　□高中/職　□大專/學　□研究所及以上

4.工作性質：□軍公教　□私部門雇員　□自營　□學生　□其他

5.居住地：□台北市　　□台北縣　　□其他

6.個人年收入：_____萬

7.聯絡電話、e-mail 或 MSN：_____

Appendix B VITA

一、基本資料

姓名：王淑美 (Shu-Mei Wang)

生日：1969 年 1 月 28 日

聯絡方式：wangju690128@yahoo.com.tw

二、學歷：

國立交通大學交通運輸研究所	博士	90.09 ~ 96.06
國立中興大學公共政策研究所	碩士	84.09 ~ 86.06
國立中興大學財稅系	學士	76.09 ~ 80.06

三、經歷:

景文科技大學	助理教授	94.08 ~ 迄今
中華經濟研究院	顧問	92.05 ~ 迄今
行政院經建會	副研究員	89.10 ~ 91.12
行易網網路(股)公司	行銷與財務管理部經理	89.04 ~ 89.10
鼎漢國際工程顧問(股)公司	財務分析師	85.11 ~ 89.11
台灣大學建築與城鄉研究所	規劃師	81.02 ~ 85.11
勤業會計師事務所	稅務助理	80.08 ~ 81.02

四、博士修業期間之論文著作

（A）期刊論文：

1. C. M. Feng, and S. M. Wang*, An Integrated Cost-Benefit Analysis with Environmental Factors for a Transportation Project : The Case of Pinglin Interchange in Taiwan, Urban Planning and Development. (SSCI) (Accepted)
2. 王淑美*，歐盟民間參與港埠投資經驗之啟示，主要國家產經政策動態季刊 ，民國 91 年 3 月。

（B）研討會論文：

1. Hu, Jin-Li, Cheng-Min Feng and Shu-Mei Wang，Socio-economic Factors of Regional Vehicle Air Pollution in Taiwan, The Far East Meeting of Western Economic Association International, Beijing, China，2007.
2. C. M. Feng, and S. M. Wang*, The Fully Economic Evaluation for Transport Infrastructure Project. Journal of the Eastern Asia Society for Transportation Studies, Vol. 5, 2005.
3. 馮正民、王淑美*，探討坪林交流道落實使用者付費之管制機制效用，第三屆台灣地方鄉鎮觀光產業與前瞻學術研討會 ，民國 95 年 5 月。

（C）研究報告及其它：

1. 馮正民、王淑美等，修訂桃園縣綜合發展計畫，桃園縣政府，民國 92 年 10 月。(研究助理)
2. 王淑美等，國立傳統藝術中心園區民間參與營運招商投資計畫案，統一超商股份有限公司，民國 93 年 10 月。(計畫主持人)
3. 王淑美等，基隆港西 29~32 號碼頭後線土地合作投資興建倉棧設置經營自由貿易港區業務案，中國遠洋運輸(集團)總公司，民國 94 年 1 月。(計畫主持人)
4. 張緯良，王淑美等，榮民就業成功因素之研究，退輔會，民國 94 年 10 月。(研究助理)
5. 溫蓓章，王淑美等，公共建設計畫—觀光次類別建設計劃經濟效益評估作業規範規劃報告，交通部觀光局，民國 95 年 9 月。(計畫共同主持人)
6. 王淑美等，國際青年來台旅遊現況與產業發展，青輔會，民國 95 年 12 月。(計畫主持人)