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Estimating Willingness to Pay for Improving River Water Quality Using Contingent Valuation Method: A Conceptual Framework

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Abstract

This paper presents a conceptual framework to help in the interpretation or design of contingent valuation studies for improving river water quality in a developing country setting. An extensive literature review helped design this conceptual framework. Though the betterment of the river water quality has drawn the attention from various stakeholders, dearth of studies to deliver precise information about the value of the water quality appears a major drawback in developing countries to implement improvement plans. The major objective of this paper is to review the recent developments on non-market valuation e.g., contingent valuation method to design an appropriate economic valuation study for the river water quality. This study provides useful information which may help for further improvement of the water quality in an alike problem of developing countries. Future studies should validate empirically the proposed research framework.

Keywords: Willingness to Pay, Contingent Valuation Method, River Water Quality, Developing Countries.

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Introduction

Globally, the freshwater resources are in serious threat due to anthropogenic ecological degradation (Hermoso, Filipe, Segurado, & Beja, 2015; Sarkar, Pathak, & Lakra, 2008). The situation is more direct in developing countries where the rapid expansion of industrialisation and urbanisation is taking place with the pace of economic growth exerting indiscriminate pollution on its water environment. While the river provides several ecosystem services, continuous pollution caused by human intervention poses negative effects on its quality. The protection of wetland water quality from pollution has been proved to be an urgent issue worldwide (Benson, 2006; Majumdar, Deng, Zhang, & Pierskalla, 2011; Mitchell & Carson, 1981; Wang, Shi, Kim, & Kamata, 2013). Though several studies have progressed to solve this problem, many issues of restoring water quality still are in question, particularly in developing countries (Durand-Morat, Wailes, & Nayga, 2016; Nallathiga & Paravasthu, 2010). Usually, policymakers in developing countries have faced a dilemma in considering the protection measure to such natural resources because of much other public importance still unfulfilled. On the other hand, scarce information about the value of natural amenities yielded by the freshwater put the decision-makers in dubious. Therefore, policy makers require comprehensive information about the value of such resources before implementing the expensive conservation measure, e.g., water quality restoration of an impaired river (Poff et al., 1997; Terer, Ndiritu, & Gichuki, 2004; Zedler & Kercher, 2005).

However, the economic damage due to water pollution and the benefit of improving water quality has not been clear to the policymakers of many developing countries due to not having adequate information. On the other hand, incorporating findings of developed countries into developing nation's decision-making may not be appropriate because of differences in socio-demographic, economic and other contexts (Choe, Whittington, & Lauria, 1996; Marsh, 2009). While the future water improvements activities depend on proper valuation studies which will inform the values of cleaner surface water to the policymakers, a serious need has been emerged to design a restoration plan for the wetlands in developing countries. In such case, the project will not be started unless the decision-makers have a full understanding of the costs-benefits associated with such improvement projects. This paper conceptualizes a framework to value surface water quality improvement of an impaired river in the urban area of developing Bangladesh. The aim of this paper is to give current knowledge, theoretical underpinnings and methodological steps for valuing water quality improvement using the contingent valuation method (CVM), a popular method for non-market valuation.

Literature Review

Significance of Non-Market Valuation

The environment gives most of the significance inputs to life supporting mechanism on this planet. The essential natural resources without of which living organism feel difficult to survive often seriously overlooked in the regular market transactions. Having the characteristics of public goods, these environmental resources can be externally costly if human activities result in pollution. Thus, the tangible costs from the

environmental degradation need to be assessed. The reason is imperative because the benefits from environmental services and costs of pollution are not always immediately obvious or because they are not priced and exchanged. On the other hand, management of such environmental resources needs benefit and cost valuation ignorance of which can have serious consequences for human health, income and well-being (Gunatilake, 2003; Haque, Murty, & Shyamsundar, 2011).

Due to the market failure, the valuation of environmental services become problematic, economists thus consider this problem and have endeavored to develop special tools and methods in measuring non-market resources. In fact, valuation studies of natural resources are now predominant in the literature of environmental economics. Economists have highlighted some reasons why the monetary value of non-marketed environmental goods should be estimated. In the book of "Environmental Valuation in South Asia", Haque et al. (2011) have emphasized the value of environmental goods; they asserted that the increased prominence of environmental valuation is large because it provides information that can be used for (a) designing policies in order to use natural resources in sustainable manner, (b) making choice of investment for projects which have environmental impacts and risks , and (c) accurately measuring a country's Gross Domestic Product/Net National Product (GDP/NNP) after accounting for the contribution of natural resources.

The protection of the environment is a time-proven issue which needs immediate intervention. Despite developing tools and techniques for environmental management, many issues related to environmental protection are still in question. Questions arise to know the volume of environment that should be under protection measure and its costs and benefits. However, it's found ambiguity to the answer to such questions on many grounds. For example, some works have been conducted on evaluating the costs of various environmental protection policies and projects which summarize with the huge cost of protecting the environment. Though costs of environmental protection are known to some extent, a limited result prevails about the benefits of environmental protection policies and projects (Freeman III, Herriges, & Kling, 2014). Therefore, significance should be given to valuing such environmental resources so that benefits appear to the policy makers as more transparent and understandable for implanting projects toward protecting natural resources (Garrod & Willis, 1999).

Why non-market valuation is required for the natural resources has also been accentuated by Daily (1997), Farber, Costanza, and Wilson (2002) and Freeman (1979); they summarized that the previous economic valuation studies focused on goods and services which have the price tag, ignoring the social costs and benefits remain unseen or unacknowledged for non-market environmental goods. In contrast, non-market valuation methods can be an appropriate way to measure economic value (intrinsic and instrumental) of environmental goods and services which provide the total economic value (TEV) of the ecosystem services. They also emphasize a combined effort to adopt non-market valuation entailing of ecologists, social scientists, and environmental managers to evaluate natural amenities.

Although the costs-benefits analysis (CBA), which is based on individual preferences, has widely been used over the years in UK and USA to assess the

economic value of natural amenities, it's failed to evaluate the non-use value of the resources of an environmental kind. In support of this statement, Bateman (2004) and Carson (2007) pointed out that the major drawbacks of using the costs-benefits approach in valuing environmental goods and services are that it's ignoring the individuals' preferences of non-use value. To avoid this problem, unified and standard measurement of value should be chosen for all individuals that are to use non-market valuation which takes accounts of both the use and non-use value (Carson, 2012).

The significance of non-market valuation has felt crucial for policy-making in developed countries over the times. Regarding non-market valuation, the environmental valuation reference inventory (EVRI) has made a database for developed countries. The EVRI is the largest database of non-market valuation studies in the world. Up to 2009, the EVRI database has been recorded more than 45% of the non-market valuation studies from USA showing that USA is the pioneer of non-market valuation (Ndebele, 2009). In comparison with developed countries, the attempt to value non-market goods and services in third-world nations is very scarce and remaining one of the great challenges for the researchers. Ndebele (2009) also summarized that 84% of the total non-market valuation studies have conducted in high-income countries while in lower income countries its only 6%. Therefore, application of non-market valuation techniques to estimate value is advised and must be studied outside of the US. Mendelsohn and Olmstead (2009) argued that the need for valuation of environmental resources in developing countries is crucial where resources are limited, and the problem is multidimensional. Challenges from scarce data must be overcome.

The Economic Value and the Value of Freshwater

The economic value of goods and services can be defined and measured by several possible ways. In economics, the value of things is based on the concept that goods and services to be valued which have the ability to satisfy human wants and needs and to increase utility or well-being of the individuals (Freeman III et al., 2014; Hitzhusen, 2007). Although different types of value are often important, economic value is very useful when it's come to make an economic choice because its help to make choice among tradeoffs in resource allocation. What people want, or the people's preference is the strong basis of measuring economic value. Who are the best judges of want? Economists conclude that individuals are the best evaluator of what they want but not the government in general. Thus, peoples' preferences and choice give the underlying foundation of the economic theory of valuation. Under some given constraints such as income or time available, individuals make their tradeoffs or choice through preferences (Carson & Mitchell, 1993; Mendelsohn & Olmstead, 2009; Wattage & Mardle, 2008).

In measuring environmental resource value, the concept of economic value is broadly accepted as the defensible means. Therefore, the term "value" used in this thesis means the economic concept of value. However, whether the non-market value can be explained by the value of environmental attributes which have no market to buy and sell is an important idea to ponder. For example, if people get enjoyment freely by visiting a river with clean water or obtain aesthetic satisfaction from that river, the here market is unable to give any sort of value of clean water to the society. In contrast to that, marketed goods, such as a car can be valued because it has a market price to be bought

and sold (Mitchell & Carson, 2013). Therefore, non-market valuation turns up with central attention in measuring the economic value of natural goods and services. The renowned ecosystem valuation website defines how economic value is measured, they state:

"The economic value is measured by the most someone is willing to give up in other goods and services in order to obtain a good, service, or state of the world. In a market economy, dollars (or some other currency) are a universally accepted measure of economic value, because the number of dollars that a person is willing to pay for something tells how much of all other goods and services they are willing to give up getting that item. This is often referred to as 'willingness to pay' (see, http://www.ecosystemvaluation.org)."

Water has given monetary value only when its relative demand is higher than its supply or when the supply of water is scarce. The scarcity and nature of applicability for different water use yield high economic value (Ward & Michelsen, 2002). The trends of demand for freshwater have been overserved on increasing sharply over the world. The study shows that a person requires maximally 4 liters of water for daily drinking while producing a daily meal for a single person needs water of 2000 litters to 5000 litters. Water is an inevitable input of production which has countless demand in the household, agricultural and industrial use. Agriculture sector alone is the highest consumer of the global freshwater, study shows that 1 kg of wheat, rice and beef need 1000 liters, 1400 liters and 13000 liters of water respectively (Zimmer & Renault, 2003).

However, amenities of various kinds delivered by surface freshwaters have no visible price tag, good quality water (water with no pollutants) for example which has no market to buy and sell (Wilson & Carpenter, 1999). Therefore, economists use a surrogate market for observable behaviors of the individuals to evaluate the economic value of the non-market environmental services (Choe et al., 1996). Freeman (1993) and Portney (1994) stated that combined expertise of social and natural science is needed to use methods available for quantifying the value of surface water and the aquatic ecosystem, but the multidisciplinary approach is still in embryonic, vague and debatable (Bingham et al., 1995; Chee, 2004; Diamond & Hausman, 1994; Farber et al., 2002).

Water quality is often considered as a final ecosystem service, but researchers argued that rather than final service it is contributing crucially in many other services such as recreation and human health (Keeler et al., 2012). To value water quality means estimating the value of ecosystem services that water quality provides. Why individuals place value on water quality depends on changing the status of water quality because changes in its forced to change in the wetland's ecosystem goods and services. The following Figure 1 depicts the framework showing that how changes in water quality work in changing the value of ecosystem goods and services.

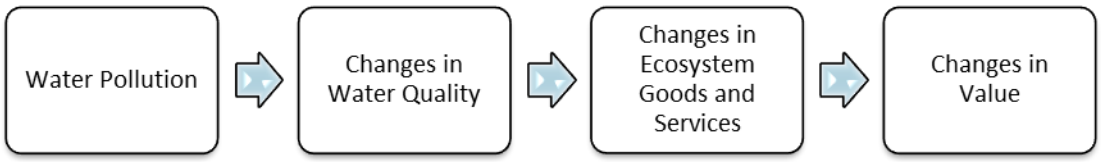

Figure 1 Linking water pollution to the value of water quality-related ecosystem services
Source: Adapted from Keeler et al. (2012)

Theoretical Framework for Measuring Value

Neoclassical welfare economics gives the underlying base for measuring the value. According to the theory of welfare economics, individuals have strong preferences for the bundle of goods and services and the preferences are ordered based on the utility which comes from the consumption of each bundle (Bateman, 2004; Flores, 2003). Both the goods of the market and non-market may help comprise the preference ordering for the consumption bundles. One of the assumptions of standard neoclassical price theory is that the quantity demanded market goods depend on people's preference, comparative prices of market goods and income. However, the demand curve for non-market goods cannot be observed directly. At this end, Flores (2003) suggests that the demand for non-market goods can be observed by assuming the number of market goods is a function of income, relative prices of other market goods and some rationed level of non-market goods. Individuals place value on the non-market goods. If some changes happen in non-market goods, the value of goods of that market can be measured by asking individuals that what amount they are willing to pay or receive what would leave them as well off as before a change.

Economists derive value from water quality-related ecosystem services by adopting various non-market approaches which broadly fall into two major categories, the stated preference and revealed preference method. However, in the literature of non-market valuation of wetland's ecosystem services, values are distinguished between tangible and intangible or value in use and non-use (Huang, Haab, & Whitehead, 1997; Ojeda, Mayer, & Solomon, 2008). The value in use further separated into two; direct use value and indirect use value. For instance, fishing from rivers gives direct benefit to the humans is refers to the direct use value of river while indirect use value is that river ecosystem services which are enjoying by human and other diversified species.

The value other than in use (direct and indirect), people also consider waterbodies and put worth as an option. Champ, Boyle, and Brown (2012) state that "the option value is an additional sum which is kept ready to pay over and above what people are currently paying to secure an option to have the wetland available in future". Non-use value is that when people get satisfaction by knowing the existences of some species, ecosystems and ecosystem services (existence value), or the people will be used the available goods and services for the enjoyment of future generation (bequest value) (Alberini & Longo, 2006; Champ et al., 2012; Krutilla, 1967; Mitchell & Carson, 1989). The value of two kinds help entail the total economic value (TEV) of natural resources;

these are valued in use and non-use (Wattage & Mardle, 2008). Following Figure 4 gives the framework for measuring total economic value (TEV) of environmental goods and services (Zandersen, Bartczak, Czajkowski, Giergiczny, & Termansen, 2012).

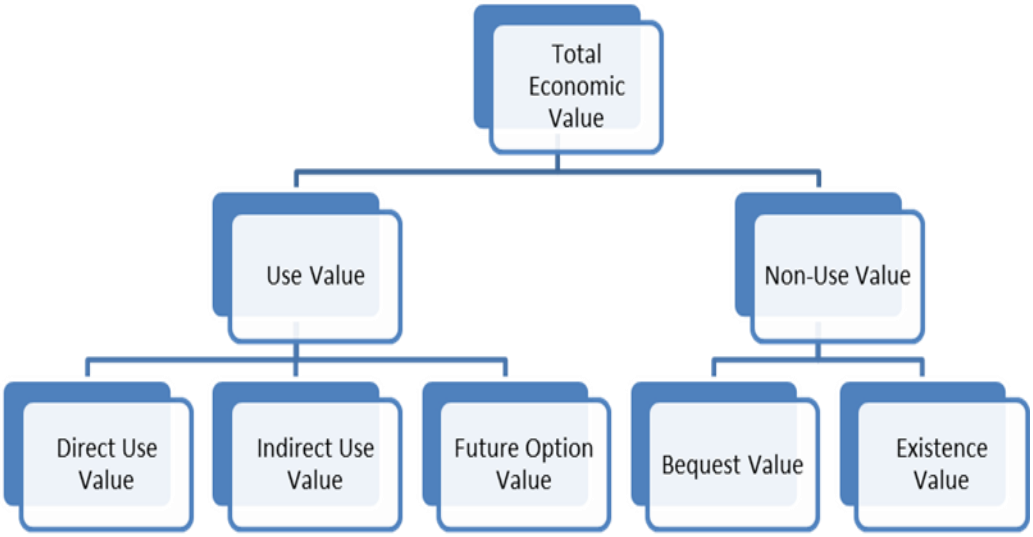

Figure 2 Framework for measuring TEV
Source: Adopted from Zandersen et al. (2012)

The several types of value illustrated above in Figure 2 give the idea that the values are highly tangible in the left-hand side while becoming less tangible in the right-hand side. The categories of value above determine which appropriate valuation techniques will be applied. For example, to estimate direct use value, researchers can use a good number of techniques available such as market valuation of physical effect (MVPE), travel cost, hedonic pricing, and discrete choice and contingent valuation method. In valuation, direct use value is more convenient compared to other forms of value to measure using market-based methods. On the other hand, in estimating indirect use value both market-based methods and asking people about their wiliness to pay can be used. However, future option value and non-use value (e.g., bequest value and existence value) can only be measured efficiently by surveying people's preferences through a willingness to pay or accept (Carson, 2000; Champ, Boyle, Brown, & Peterson, 2003; Flores, 2003).

Non-Market Valuation Methods

The approach which measures the pecuniary value of goods and services in a missing market situation can be termed as non-market valuation techniques. The goods which have no price tag or limited or incomplete market can be valued by this approach (Bateman et al., 2002; Myrick Freeman III, Herriges, & Kling, 2014). How this process is done can be well understood from the study of Haab and McConnell (2002), in their book "Valuing environmental and natural resources: the econometrics of non-market valuation" they summarize that when amenities which have no price tag, non-market

valuation approaches take this opportunity to estimate value by incorporating analytical instruments from microeconomics, welfare economics, and econometrics.

The inception of using non-market valuation started dates to the late 1940s. Since then, two broad wings such as 'stated preference' and 'revealed preference' have developed to value non-market goods and services. In the valuation of environmental goods with missing market, researchers usually use revealed preference method by inferring data indirectly from the actual market transactions. The travel cost and hedonic pricing are the two common types of reveal preference methods in practice to elicit value of natural amenities. Alternatively, the techniques of stated preference are to use a hypothetical market to infer the value of non-market goods. Contingent valuation (CV) and choice experiment methods are two common techniques in the stated preference while the CVM is a predominant technique in non-market valuation studies. The following figure illustrates the various techniques developed to measure the value of environmental goods in the following Fig. 3.

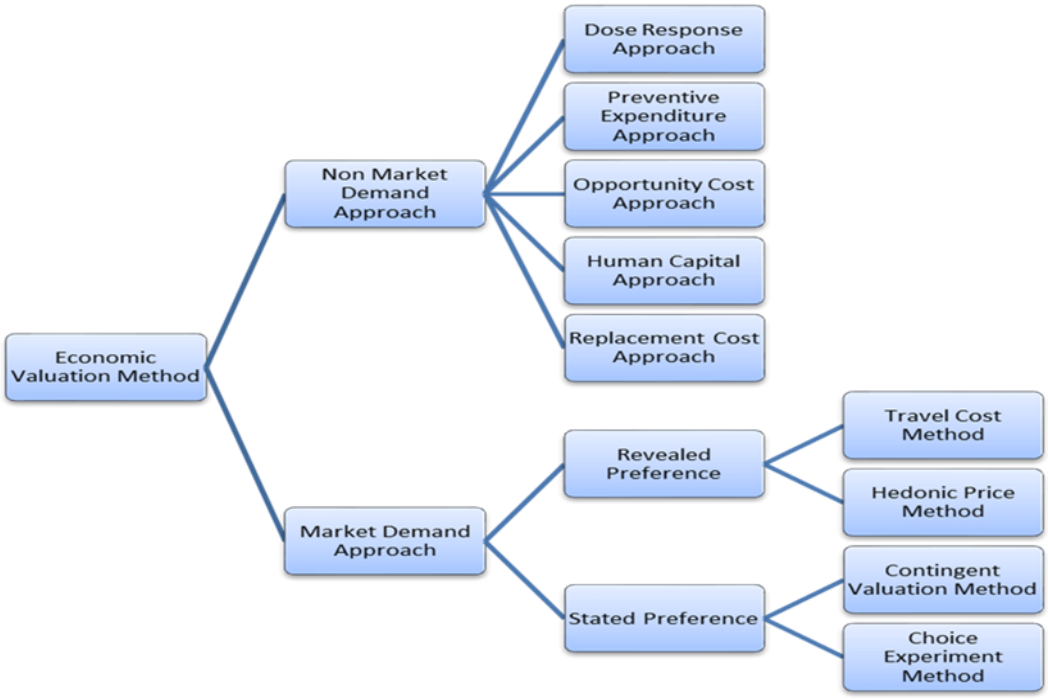

Figure 3 Economic Valuation Methods
Source: Champ et al. (2012)

Designing Contingent Valuation Method

Optimal resource allocation and welfare of the people are viewed as the most significant tasks in welfare economics. To achieve this goal, economists give importance to benefits from environmental goods and services while considering policy change or new project. The evolution of CVM was a result of growing needs in measuring the value of ecological amenities to incorporate costs and benefits in decision making with a view to achieving optimal resource allocation (Boyle & Bishop, 1988; Carson et al., 2003). The CVM is an approach to value non-market resources by using

direct technique through a cautious designing of sample survey and administer to the individual respondents. By asking people through the survey, the method wants to assess their willingness to pay (WTP) or willingness to accept (WTA) for given ecological services. WTP is a maximum amount to pay to obtain specific environmental services while WTP is the amount of compensation accepted by people so as to forgo the specific ecological amenities. (Arrow et al., 1993; Hanemann, 1991). The process involved to create a specific hypothetical scenario and asked the people to state the amount they are willing to pay basis on the contingent scenario thus this method called as contingent valuation.

According to Hanley and Spash (1993), CVM can be done by following six stages: i) creating a hypothetical market, ii) to obtain bids, iii) calculating mean or median of WTP/WTA, iv) to estimate bids curve, v) to aggregate data and vi) to evaluate the CVM study. To create a hypothetical market is the first step in CVM study, for instance, Dhaka Water Supply & Sewerage System (DWASA) would like to control the water pollution of Burignaga River by installing centralize wastewater treatment plant. The wastewater of Dhaka comprises with municipal wastewater and industrial effluents which drain to the Buriganga will be treated and the discharged into the river. DWASA itself has inadequate funding to install such mega plants, urging to raise funds from its residents and industrial owner. The survey will be explained how the wastewater treatment plants work and what probable benefits will be derived from it and will also be clarified that the treatment process could go ahead if sufficient funds were generated. What is the nature of payment for services will also be presented while it will be ensured that no direct payment is currently exacted? Not only the information about the hypothetical market but also important information about the protection of the river and its associated benefits will be provided.

The second stage of CVM study consists of obtaining bids. Through several survey methods, individuals are asked to show the amount that they are wishing to pay with the aim of gaining improvement or to avoid deterioration in the quality of an environment. Alternatively, individuals are asked to show their minimum willingness to accept (WTA) for undergoing the environmental degradation or sacrificing an environmental improvement. Various survey methods are used to elicit WTP, such as web-based interview, in-person interview, mail interview, telephone interview and group-based interview techniques. Various elicitation formats are available to gain WTP/WTA bids, generally, WTP bids can be figured out by adopting a payment card, an open-ended question, a close-ended question, a dichotomous choice referendum, and an iterative bidding game.

The calculation of mean and median bids of WTP/WTA is the major task in the third stage of CVM study. This stage gives importance to identifying valid bids and omitting protest bids. The simple way of calculating average bids is to use payment-card, open-ended value or bidding game approaches in the survey. However, using of dichotomous choice referendum requires Logit equation to estimate mean WTP and the probability of "yes" answers to each suggested amount must be estimated which gives a curve. The area under this curve gives the mean value (Hanley & Spash, 1993). On the other hand, the mean value of WTP can be estimated directly by using Cameron and

James approach from a Logit or Probit equation (Cameron, 1988; Cameron & James, 1987).

Step four comprises an estimation of bid curves from a series of WTP/WTA bid amounts. Generally, a bid curve is to be estimated for WTP/WTA in relation to a range of independent variables. Sets of independent variables can be demographic, socioeconomic, societal preferences and the environmental attitudes so on. For instance, if sets of WTP bids gained on the projects of water quality improvement through installing wastewater treatment plant, WTP bids might be regressed against demographic variables (D), socioeconomic variables (SE), societal preferences (SP), and the environmental attitudes (EA).

The fifth step consists of aggregating the data in CVM study. What is an aggregation of data? Carson et al. (2003) define that data aggregation is a process where the mean bid or bids are converted to a population total value figure while making sure of inclusion all the components of value (e.g., use values, option values, non-use values). Three main issues are to be highlighted in this step, these are: i) choice of relevant population, ii) converting a value from the sample mean to total population and iii) choice of an adequate time period (Dong, 2012). Finally, the six step comprises to appraise the CVM study on the basis of survey results.

Research Methodology

Based on previous literature, this study formulates a proposed research framework to measure willingness to pay for improving river water quality. Whereby, the current study explored the published work on designing the CVM for the surface water quality improvement. The present study used the conceptual modelling methodology. Moreover, an extensive literature of conceptual and empirical papers from quality journals was reviewed by the authors to design the present conceptual framework. Additionally, books, working papers, reports and official web sites of several internal and international institutions have been reviewed.

Discussion and Conclusion

The main objective of this study is to help design an appropriate CVM which is theoretically consistent. Furthermore, the debate about adopting CVM in estimating non-markets goods is nullified by presenting theoretical and empirical supports. While a proper CV method often challenging to design, this study gives a step by step guideline to perform valuation study on river water quality. However, a typical contingent valuation method in developing countries faces challenges to overcome five issues such as interpreting responses to CV question; setting referendum prices, constructing joint public-private CV scenario and ethical problem in CV scenario (Durand-Morat et al., 2016). On the other hand, Whittington (2004) suggests using the split-sample technique while conducting contingent valuation study in developing countries to get more reliable CV result. It may be observed that the major implication of our review is that even though CV had certain limitations, this method is a promising method and it could be used to derive useful information. But this does not mean that this method could be used indiscriminately. It is strongly recommended, in line with the recommendations of

the CV literature, that the CV study should be properly and extremely carefully conducted. Otherwise, the results of the CV method would lead to misleading conclusions both in the academic and policy-making arenas.

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