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Economic Benefits of an Eco-town for Slums in Dhaka City of Bangladesh: An Application of Discrete Choice Model

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Abstract

Environmental changes in general, and those associated with climate change in particular, are increasingly recognized as growing drivers of establishing the slums. Climatic victims come to slums of major cities of Bangladesh for resettlement. They have less job opportunity and bound to lead substandard life under the surrounding urban environment. Urbanization, in general, is frequently blamed for greenhouse gas (GHG) emissions and hence for climate change. From the production perspective, if cities concentrate energy intensive production, this will push up their average GHG emission per person. In addition, unplanned waste management and sanitation of slum pollute environment in several ways. Greater congestion of slums has already leaded to severe health and security problems. As a result, poor slums dwellers suffer a lot, and their livelihood standard degrades as well. Eco-town based green growth plays an important role to get rid of these unexpected environmental hazards and improve the livelihood condition of slum dwellers. This study is conducted through questionnaire survey (n = 327) in the major slums of the Dhaka city and attempts to apply choice experiment approach to assess consumer attitudes, that is, the preference and willingness to pay (WTP) for establishment of attributes of solar photovoltaic (PV) system, improved sanitation, waste collection, waste based biogas plant for transmission of gas for households and monthly payment at different levels of eco-town for environmental changes and livelihood diversifications. Random parameter logit and multinomial logit models are used to quantify the slum dwellers perceptions on the attributes of eco-town. Attributes of solar PV system, improved sanitation, and waste collection, educational attainment, and age are found statistically significant and positive. The estimate of WTP on solar PV is higher than the WTP on other attributes in the study area. The findings in this study provide a robust basis for both policy makers and government to make more specified policies to make a low carbon society and eradicate poverty in the urban slums.

Keywords: Eco-town; Slum Dwellers; Choice Model; Marginal Willingness to Pay; Compensating Surplus

1. Introduction

Dhaka is one of the most densely populated cities with thousands of millions living in slum and squatter settlements. Most of its slum dwellers are the victim of climate-induced migration or forced displacement resulting from rapid onset disasters (man-made or natural) and long-term environmental change (Johnson and Krishnamurthy, 2010). Salinity, water logging, river bank erosion, land slide, cyclones and storm surges, floods, seasonal food insecurity, monga,[1] etc., work as push factors of migration or force displacement for slum dwellers. At present, the numbers of slum dwellers have been continuously increasing in this city. They cannot cope with the urbanization process and city life due to acute poverty and a lack of adaptive capacity. An average of 50% of slums dwellers live at the

1 Monga is a Bangla word that has been derived from "Mehenga" meaning "expensive" which indicates high food price, consequently poverty and hunger.

level of extreme poverty (Harpham and Stephens, 1992). They have less job opportunity and bound to lead substandard life under the surrounding urban environment. Poor slum dwellers suffer a lot and their livelihood standard are continuously degrading and hence, they are considered as a burden to the economy and surrounding environment simultaneously.

Slums are characterized by inadequate housing conditions; deficient urban services (water supply, sanitation, drainage, solid waste disposal, roads, and footpaths (Majale, 2008). These are also the common features of the slums in Dhaka. Slums are blamed to degrade the environment of Dhaka. A major portion of slum dwellers do not have access to improve sanitary means of excreta disposal due to major sanitation challenges. Despite the great need for sanitation improvements of slums, there has been limited progress. The factors limiting sanitation progress include low prioritization by stakeholders, inadequate funding, implementation of inappropriate (unsustainable) technologies, difficulties of shared responsibilities, lack of recognition of actual drivers of demand for sanitation improvements, and the unrecognized complexity of providing sanitation services of slums (Isunju et al., 2011). Unlike in rural settings where young children are allowed to defecate in the yard or on land surrounding the household, in slums, the lack of improved sanitation leaves parents with limited options for disposal of children's feces, which are, in turn, left in common alleyways or drainage ditches (Shordt, 2006; Yeager et al., 1999). Inadequate access to sanitation compels slum residents to use unhygienic pit latrines or discharging into nearby open drains (Isunju, 2010; Ahmed, 2005; Allan, 2003; Hanchett et al., 2003). The main polluting constituents of the slums are pathogens which originate from human excreta that endanger human health and nutrients and may cause eutrophication of surface water and pollute groundwater (Katukiza et al., 2010; Chinyama et al., 2012).

Solid waste disposal poses a greater problem in the slums because it leads to contaminate the soil through direct waste contact, water pollution by dumping in low lands and air pollution by burning of wastes. Mismanagement and uncollected disposal of waste on nearby streets and other public areas of slums clog drainage system and contaminate the water resources and contribute to the breeding of mosquitoes, insects, rodent vectors, and the spread of diseases (Bahauddin and Uddin, 2012). In addition, large amount of uncollected waste of slums, a high proportion of which is organic, makes nuisance and pollutes the local environment rapidly. The dumped solid waste is mainly responsible for the emission of methane and enhances the greenhouse gases (GHGs). Emissions of GHGs are leading to unprecedented transformations in the earth's climate, creating new forms of vulnerability to rapid onset disasters and long-term environmental change (Anthes et al., 2006; IPCC WG-I, 2007; IPCC WG-II, 2007; WBGU, 2008). Uncontrolled releases of methane in slums by anaerobic decomposition of waste are also pushing up average GHG emission per person.

Slum dwellers face a risky situation especially in terms of health care and livelihood security as there are the scarcity of clean drinking water, lack of hygienic sanitation system, absence of proper drainage system, and practice of mismanagement of waste. Life is very vulnerable, complex and uncertain to unsanitary, dehumanizing and overcrowding living conditions of slums which lead further to increase morbidity, a decreased ability to work and high health costs relative to income. Slum dwellers have higher rates of child malnourishment, prevalence of diarrhea, malnutrition and hunger, and prevalence of human immunodeficiency virus/acquired immunodeficiency syndrome; and, as a result, lower life expectancy (UN-Habitat, 2006; Isunju et al., 2011). Children frequently suffered diarrhea and most of them have breathing problems like breathing faster than usual with short, quick breaths or difficulty in breathing (Barkat et al., 2015). Stunt growth, illness, malaria, skin diseases, jaundice, dysentery, and other food, and waterborne diseases are commonly occurred in slums in Dhaka (Democracy Watch, 2014).

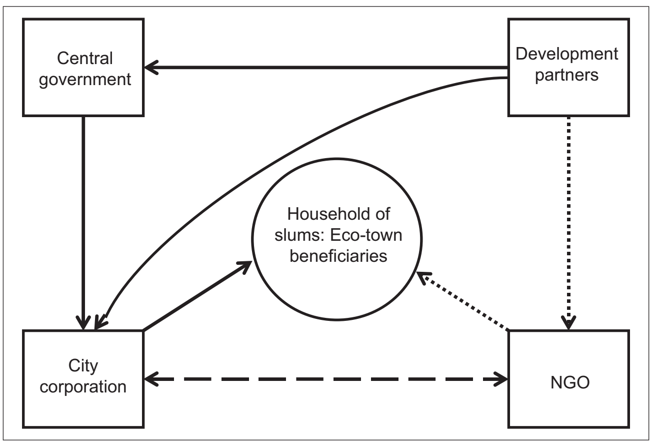
Traditional planning paradigms and practice for slums and state sponsored and donor assisted slum improvement project of Bangladesh are incompatible to manage waste and mitigate methane from open dumping of waste, efficient use of energy and use of hygienic and improved sanitation for health protection of slum dwellers in Dhaka. Inappropriate approach of top-down planning fails to create greater opportunity for the slum dwellers. Under the provision of traditional planning paradigm, it is impossible to enhance the livelihood condition of slum dwellers. In that perspective, alternative structural adjustment policies and practices for improving the existing scenario of urban slum and livelihood conditions of its dwellers are highly required. Eco-town based planning and practice plays an important role to create more job opportunity. An eco-town is a settlement that does not harm the environment because it meets the needs of people without damaging the environment. Under the provision of eco-town, it is easy to manage waste, efficient use of water and energy, building a secure, friendly and safe society, harmonizing between residence and environment and enhance the low carbon society (LCS). LCS is a combined concept that can develop a sustainable model which can meet economic development, lifestyle improvements, climate change effects mitigation, using renewable energy, and final capacity building which contributes to the sustainable development of the total society (Matsouka et al.,2012). The effectiveness of LCS is driven from eco-town that demonstrates real and measurable sustainable living.

The success of effective eco-town depends on the role of different actors e.g., central government, city or local government (city corporation), non-governmental organization (NGO), and development partners. Interinstitutional relationship at the national and local levels in planning, implementing, and monitoring the eco-town are shown in Figure 1.

Due to the limited resources, financial constraint and lack of technical knowhow, development partners of Bangladesh such as Japanese International Cooperation Agency, World Bank, Asian Development Bank, Islamic Development Bank, United Nations Development Programme and other similar organizations are needed to assist Government of Bangladesh (GoB) through providing of grants and loans, funding, and technical assistance. Non-NGO can also get support from them to further improvement or establishment of eco-town for slum dwellers. However, the direction and magnitude of supports from them are not similar like government. Government is the main key actor for constructing of eco-town. Strong intervention of government and political commitment are highly required for land acquisition and settlement, relocation, funding, and training for further improvement of eco-town. Coordination, policy formation, monitoring, and evaluation also come from the government. Government can implement and construct eco-town through city corporation as a whole. City corporation can provide and maintain waste management service, sanitation, biogas plant, and photo voltaic (PV) system through the provision of payment from slums dwellers. NGOs can also ensure these services through the provision of payment from slum dwellers like city corporation.

The findings of this study can ensure improved and quality slum environment. GoB can get relevant R&D based slum development policy from this study as GoB is obligated to ensure the provision of basic necessities of life for all citizens of all corners. The facts, findings and policy of this study will help to formulate and finalize the future planning paradigms and practice for slums and meet the main goals (e.g., Goal 1 - no poverty, Goal 3 - good health and well-being, Goal 6 - clean water

Figure 1: Key actors and their roles for constructing of eco-town



Source: Prepared by the authors based on Ghafur, 2000 and sanitation, Goal 7 - affordable and clean energy, and Goal 11 - sustainable cities and communities) of sustainable development goals. This study also provide a robust basis for policy makers, planners, researchers, and development partners for further research, project implementation for slums, and developed specified policies. The findings of this study are helpful for similar slums to lessen the vulnerability and boost up the livelihood conditions of their residence.

This study examines the possibilities of establishing eco-town concepts on the basis of the perceptions of the slum dwellers to manage and mitigate adverse effects of the vulnerable livelihood conditions of slum dwellers in Dhaka city and improve its surrounding environment. Perception or choice or preference based pro-poor participatory planning, management, and practice play an important role for establishing LCS and affecting living conditions of the slum dwellers. In addition, this study attempts to estimate the economic benefits of eco-town and measure the marginal willingness to pay (WTP) of the residents of slums.

2. Theoretical Framework

2.1. The choice experiment method

Individuals are traders. They consciously or subconsciously make decisions by comparing alternative and selecting an action which is known as a choice outcome. This study will draw on ideas from economic and psychology perspective, starting with the notion that it is an individual's preferences for specific alternatives that best determine what alternative is chosen.

The overall utility associated with the i^{th} alternative can be divided into the contributions that are observed by the researcher and those that are not observed by the researcher. Suppose these sources of relative utility represent as V_i and ε_i. V_i is the deterministic portion of the utility and ε is common notation which is used to refer to the unobserved influences as an error or random error term. In choice analysis both V_i and ε_i have great relevance. It is assumed that there is a strong relationship between V_i and ε_i. These two components are independent and additive. A utility function is strongly additive if it can be written as:

$$U = \sum_{i=1}^{n} f_i(q_i) \quad (1)$$

Where f_i are increasing. The additive is a special case of separability[2]. Any utility function that has a monotonic transformation[3] which is additive may be treated as being additive for all theorems applicable to additive functions (Henderson and Quandt, 1980). An additive utility function has the property that all cross partials equal zero, i.e.,

$$\delta^2 U/\delta q_i\, \delta q_j = 0 \text{ for all } i \neq j \quad (2)$$

It will take the form under the strict quasi-concavity condition and the two variable cases as follows:

$$f_{11} f_2^2 + f_{22} f_1^2 < 0 \quad (3)$$

The behavioral choice rule can be explained by Lancasterian theory of value and random utility theory (RUT). The following parts briefly explain these two issues.

2.1.1. Lancasterian theory of value

Lancaster (1966) asserted that the good does not give utility to the consumer, it possesses characteristics, and these characteristics give rise to utility; a good will possess more than one characteristic and

2 A utility function is strongly separable in all of its arguments if it can be written as $U = F\left[\sum_{i=1}^{n} f_i(q_i)\right]$

3 A (positive) monotonic transformation is a way of transforming one set of numbers into another set of numbers so that the rank order of the original set of numbers is preserved. It is thus a function, f mapping real numbers into real numbers which satisfies the property that if $x>y$, then $f(x)>f(y)$.

many characteristics will be shared by more than one good and goods in combination may possess characteristics different from those pertaining to the goods separately.

Assumed that an individual good or a collection of goods as a consumption activity and associate a scalar with it. It is also assumed that relationship between the level of activity k and y_k the goods consumed in that activity to be linear and objective, so that, if x_j is the j^{th} commodity.

$$x_j = \sum_k a_{jk} y_k \tag{4}$$

With activity vector

$$x = Ay \tag{5}$$

Since the relationships are assumed to be objective, the equations are assumed to hold for all individuals, the coefficients a_{jk} being determined by the intrinsic properties of the goods themselves.

It is also assumed that each consumption activity produces a fixed vector of characteristics and that relationship is again linear, so that, if z_i is the amount of the i^{th} characteristic:

$$z_i = \sum_k b_{ik} y_k \tag{6}$$

With activity vector like Equation (5).

$$z=B_y \tag{7}$$

Again it is assume that the coefficients b_{ik} are objectively determined for some arbitrary choice of the units of z_i.

It is assumed that the individual possesses an ordinal utility function on characteristics U_z and that he will choose a situation which maximizes U_z. U_z is provisionally assumed to possess the ordinary convexity properties of a standard utility function.

The chief purpose of making the assumption of linearity is to simplify the problem. A viable model could certainly be produced under the more general set of relationships.

$$F_k(z,x)=0;\ k=1\ldots\ldots\ldots m \tag{8}$$

In this model, the relationship between the collections of characteristics available to the consumer-the vectors z-which are the direct ingredients of his preferences and his welfare and the collections of goods available to him-the vectors x-which represent his relationship with the rest of the economy, is not direct and one-to-one, as in the traditional model, but indirect, through the activity vector y (Lancaster, 1966).

2.1.2. RUT

The concept of RUT and the random service theory are almost the same which plays an important role to explain consumer behavior. RUT says that not all of the determinants of utility derived by individuals from their choices are directly observable to the researcher, but that indirect determinants of preferences are possible (McFadden, 1974; Manski, 1977). The utility function for a representative consumer can be decomposed into observable and stochastic sections:

$$U_{an}=V_{an}+\varepsilon_{an} \tag{9}$$

Where, U_{an} is the latent and unobservable utility held by consumer n for choice alternative a, V_{an} is the systemic or observable portion of utility that consumer n has for choice alternative a and ε_{an} is the random or unobservable portion of the utility that consumer n has for choice alternative a. Research is focused on a probability function, defined over the alternatives which individual faces, assuming that the individual will try to maximize his utility (Bennett and Blamey, 2001; Louviere et al., 2000). This probability is expressed as:

$$P(a/C_n) = P\left[\left(V_{an} + \varepsilon_{an}\right) > (V_{jn} + \varepsilon_{jn})\right] \forall_a \neq j \tag{10}$$

For all j options in choice set C_n, a and n are also described as:

$$P(a/C_n) = P\left[\left(V_{an} - V_{jn}\right) > (\varepsilon_{jn} - \varepsilon_{an})\right] \quad \forall_a \neq j \tag{11}$$

Equation (11) holds the principle of RUT which exhibits the stochastic components are independently and identically distributed (IID) with a Gumbel or Weibull distribution. This leads to the use of multinomial logit (MNL) or conditional logit (CL) or basic model. It helps to determine the probability of choosing *a* over *j* options (Hanley et al., 2001; Alpizar et al., 2001).

The estimated deterministic (indirect) utility function generally will have the following form:

$$P\left(U_{an} > U_{jn}\right) = \frac{\exp(\mu V_a)}{\sum j \exp(\mu V_j)} \quad \forall_a \neq j \tag{12}$$

Here, μ is a scale parameter, inversely related to the standard deviation of the error term and not separately identifiable in a single data set (Bergmann et al., 2006). The implications of this are that the estimated β values cannot be directly interpreted as to their contribution to utility, since using the MNL model choices must satisfy the independence from irrelevant alternatives (IIA) assumption, meaning that the addition or subtraction of any option from the choice set will not affect relative probability of individual *n* choosing any other option (Louviere et al., 2000; Bergmann et al., 2006). Modeling constants known as alternative specific constants (ASCs) are typically included in the MNL model. The ASC accounts for variations in choices that are not explained by the attributes or socio-economic-demographic (SED) variables and sometimes for a status quo bias (Ben-Akiva and Lerman, 1985).

The random parameter logit (PRL) or extended model provides a simple way to generalize the multinomial logit (MNL) model to permit the utilities of each alternative to be correlated and it does not require IIA assumption (Cameron and Trivedi, 2005). The random utility function in the PRL model will take the following form (Birol et al., 2005).

$$U_{in}=V_{in}+\varepsilon_{in}\equiv Z_i(\beta+\eta_n)+\varepsilon_{in} \tag{13}$$

As we know utility is decomposed into a non-random component (V) and a stochastic term (ε) and the indirect utility is assumed to be a function of the choice attributes Z with parameters β and SED variables (Agimass and Mekonnen, 2011). Hence, the probability of choosing alternative *i* in each of the choice set will have the following form (Birol et al., 2005):

$$P_{in} = \exp(Z_{in}(\beta + h_n)) \Big/ \sum \exp(Z_{jn}(\beta + h_n)) \tag{14}$$

2.2. Welfare effects

This study focused on purely discrete choices: This implies that in some cases welfare measures have to be interpreted with care, e.g., health care in some cases. In the case of a health-care experiment, the welfare measures are per patient, depending on what has been defined in the survey. Let us consider the following utility function:

$$U=h(A)+\gamma(Q,z)z+\varepsilon \tag{15}$$

Where the function $h(A)$ captures the effect of the different attributes on utility, Q is a vector of personal characteristics and z is a composite bundle. This characteristic of traditional demand theory is very relevant to the marginal utility of income as it may also be affected by the personal characteristics of the individual like the level of income. For more simplification, let us start with the common case of the constant marginal utility of income and independence of personal characteristics. Under this circumstance, the ordinary and compensated demand functions coincide (Alpizar et al., 2001). Given this functional form and the assumption of week complementary, it is possible to write the conditional indirect utility function for the purely discrete choice as:

$$U_i(A_i, P_i, y, \varepsilon) = h_i(A_i) + \overline{\gamma}(y - P_i c_i) + \varepsilon \tag{16}$$

In addition, it is possible to write the probability that alternative *j* is preferred as:

$$\begin{aligned} P\{i\} &= P\left\{h_i(A_i) + \overline{\gamma}(y - p_i c_i) + \varepsilon_i > h_j(A_j) + \overline{\gamma}(y - p_j c_j) + \varepsilon_j; \forall j \neq i\right\} \\ &= P\left\{h_i(A_i) + \overline{\gamma}\, p_i c_i + \varepsilon_i > h_j(A_j) + \overline{\gamma}\, p_j c_j) + \varepsilon_j; \forall j \neq i\right\} \end{aligned} \tag{17}$$

Equation (17) indicates that income does not affect the probability of choosing a certain alternative under the current assumptions and hence the welfare measures will have no income effects (Alpizar et al., 2001). Thus, it is possible to express the unconditional indirect utility function as:

$$U(A,p,y,s)=\bar{\gamma}\, y+\max\left[h_1(A_1)-p_1c_1+\varepsilon_1,\ldots\ldots\ldots\ldots\ldots,h_N(A_N)-p_Nc_N+\varepsilon_N\right] \tag{18}$$

The compensating surplus (Cs) is obtained by solving the equality: $V(A^0,P^0,y)=V(A^1,p^1-CS)$. Using the functional form in Equation (18), we have:

$$\begin{aligned}&\bar{\gamma}\, y+\max\left[h_1(A_1^0)-p_1^0c_1+\varepsilon_1,\ldots\ldots\ldots\ldots\ldots,h_N(A_N^o)-p_N^0c_N+\varepsilon_N\right]\\&=\bar{\gamma}(y-CS)+\max\left[h_1(A_1^1)-p_1^1c_1+\varepsilon_1,\ldots\ldots\ldots\ldots\ldots,h_n(A_N^1)-p_N^1c_N+\varepsilon_N\right]\end{aligned} \tag{19}$$

After simplification, it is possible to solve for CV and this results in:

$$CS=\frac{1}{\bar{\gamma}}\begin{bmatrix}\max\left\{h_1(A_1^1)-p_1^1c_1+\varepsilon_1,\ldots\ldots,h_n(A_N^1)-p_N^1c_N+\varepsilon_N\right\}-\\ \max\left\{h_1(A_1^0)-p_1^0c_1+\varepsilon_1,\ldots\ldots\ldots\ldots\ldots,h_N(A_N^o)-p_N^0c_N+\varepsilon_N\right\}\end{bmatrix} \tag{20}$$

If the error terms are extreme value distributed, i.e., the MNL model, the expected CS for a change in attributes is (Hanemann, 1999):

$$E(CS)=\frac{1}{\mu\bar{\gamma}}\left\{\ln\sum_{i\in S}\exp(\mu V_{i1})-\ln\sum_{i\in S}\exp(\mu V_{i0})\right\} \tag{21}$$

Where, μV_{i0} and μV_{i1} represent the estimated indirect utility before and after the change of $\mu\bar{\gamma}$ is the confounded estimate of the scale parameter, and the marginal utility of money and S is the choice set. This measure is independent of scale and, in general, the scale parameter is set to equal one. When we consider a linear utility function and only change of one attribute, the CS for a discrete choice is given as:

$$CS=\frac{1}{\gamma}\ln\left\{\frac{e^{V_{11}}}{e^{V_{10}}}\right\}=\frac{1}{\gamma}(V^1-V^0)=\frac{\beta_k}{\gamma}(A_k^1-A_k^0) \tag{22}$$

Total WTP is the integrated part of the Cs. Cs works as a helpful concept and work as a device to measure the consumer's total and marginal WTP (MWTP) and other welfare settings. In Equation (22), it is seen that for a linear utility function, the marginal rate of substitution between two attributes is simply the ratio of their coefficients and that provides the MWTP to pay for a change in the attribute is given below:

$$MWTP_i=\frac{\beta_i}{\gamma}\Rightarrow MWTP_i=-\left(\frac{-\beta_{attribute}}{\beta_{payment\ attibute}}\right) \tag{23}$$

For policy purposes it is necessary to obtain the distribution of the welfare effects using either by bootstrapping or by Krinsky-Robb method (Krinsky and Robb, 1986). Under the bootstrapping methods, a number of new data sets are generated by resampling, with replacement, of the estimated residuals. The utility across alternatives, along with the parameter point estimates, is calculated to create the outcome variable (Alpizar et al., 2001).

3. Selection of Study Area, Methodology, and Research Plan

3.1. General features of study area (Slums (Bosti) of Mirpur, Karail, Bashbari, and Bou Bazar)

Slums of Baganbari at Mirpur, Karail at Mohakhali, Bashbari, and Bou Bazar at Mohammadpur were selected as study sites on the basis of location, type of structure, density, size, and surrounding environment. The situation of access to health, education, safe water supply, hygienic sanitation, and improved waste management system of these slums are very much limited to their dwellers. Most of the inhabitants have limited or low income and they are specified as the Rickshaw Pullers, Transport Drivers and Helpers, Motor Garage Workers, Vegetable Sellers, Cart Pullers, Maid Servants, Small Traders, Daily Labors, Garment Workers, Baggers, and Housewives. The dwelling houses of slums are largely single room with an average number of household members per room is 3.93 persons. Households of these slums share their sanitation facilities. Most of the dwellers are frequently suffering from diarrhea, skin disease, breathing problem, malaria, gastric and abdominal pain which are mostly generated from impure drinking water, unhygienic sanitation, and polluted air.

3.2. Methodology and research plan

3.2.1. Selection of attributes, their levels and customization using focus group discussion (FGD)

FGD is highly required for qualitative research. It helps reduce the amount of time and getting detailed qualitative information. Under the FGD, a structured group process is used to obtain detailed information about a particular situation. FGD plays an important role to identify the set of credible or realistic attributes and their levels in choice experiment design. In addition, it is important to identify any possible interaction effect between the attributes (Alpizar et al., 2001). If anybody wants to calculate welfare measures, it is necessary to include a monetary attribute such as a price or a cost or a payment. In such a case, the FGD will indicate the best way to present a monetary attribute. The FGD should shed some light on the task of making a succession of choices from a series of choice sets (Alpizar et al., 2001).

This study organized four FGDs which consist of 7-8 participants of each FGD occurred at 11-16 May 2016 at slums of Mirpur, Karail Bosti, Bashbari, and Bou Bazar in Dhaka city. The participants were selected in a nonrandom fashion. The objective set to each group was to identify the attributes, their levels and perceptions about eco-town. To fulfill the objective, the facilitator had each group to identify all the type of attributes that they could and then discuss their levels. After identification of the attributes, the groups were requested to separate into a smaller section of three or four persons and determine the levels of attributes. After that exercise, four key attributes and their associated levels were then chosen. The chosen attributes and their associated levels are shown in Table 1.

3.2.2. Experimental design

Experimental design helps to create the choice sets in an efficient way. Orthogonal designs are used as the principle part of an efficient design. This study used few attributes, as stated in Table 1. A full factorial

Table 1: Attributes and their associated levels

Name of the attribute	Current level	Improvement level
Solar photovoltaic system	No measure	1. Interested 2. Not interested
Improved sanitation	No measure	1. Interested 2. Not interested
Waste collection	No measure	1. Every day 2. 2 days/week 3. 3 days/week
Waste-based biogas plant	No measure	1. Interested 2. Not interested
Payment for services/monthly	No measure	1. Tk. 1400 2. Tk. 1610 3. Tk. 1851

Source: Prepared by the authors based on the findings of FGD. FGD: Focus group discussion design includes all possible combinations of attributes and levels, results in 72 possible combinations ($2^3 \times 3^2 = 2 \times 2 \times 2 \times 3 \times 3 = 72$). Software SPSS version 20 was used for this purpose. According to orthogonal design principle, using fractional design, this study reduced it randomly to 20 for 4 versions of choice card and each version contain 4 combinations with three alternatives (options) including the status quo (Table 2). Each respondent answered twice the choice cards. A sample of a choice set provided to respondents is shown in Table 2.

3.2.3. Questionnaire development

This study followed the US National Oceanic and Atmospheric Administration and Food and Agriculture Organization guidelines for the layout of its questionnaire. Few pages of the questionnaire were used to collect household cross-section data through face-to-face interviews of the households of slums. The questionnaire was split into three parts. The first, known as the warm up component, dealt with asking questions of about the respondents' attitudes and observations about the state of surrounding environment of their slums. The second part focused on WTP through CE, and the last part included the SED data (e.g., income, age, educational attainment, and family size) of the respondents. The survey using the final version questionnaires was conducted from (07-30) July 2016 at the different slums in Dhaka city. The questionnaire was made in English language, but interviews were conducted in the local language, Bangla.

3.2.4. Sampling technique

To represent the population as a whole, a complete and accurate sample framework is necessary. In this study, households were the sample units and the sample frame was a set slum dwellers. The economic agent "household" is considered into account because decisions are taken at the household level. Usually, a male member (father or eldest son) of household was considered for an interview that had two distinct characteristics: He was the (solo or one of the) main earning member and he exercised substantial authority over family decisions. This study followed the cluster sampling technique. The surveys involved 369 households, of which 327 household representatives agreed to participate in the survey and responded to the questionnaire (response rate was 88.62%).

3.2.5. The indirect utility model specification

Two different models were used for the analysis of the choice experiment. The first model is known as the MNL or CL or basic model that estimates the parameters of attributes explaining respondents' choice across three different options in a choice set: Two alternatives with changes in attributes with associated ASC and a status quo. The second model is PRL or extended model which includes SED variables with ASC.

3.2.5.1. MNL model

The indirect utility from the proposed eco-town would take the following form:

Table 2: An example of choice task

Option example	Option A	Option B	Status quo
Solar photovoltaic system	Not interested	Interested	No change
Improved sanitation	Interested	Not interested	No change
Waste collection	3 days per week	Every day	No change
Waste-based biogas plant	Not interested	Interested	No change
Payment for services/monthly	Tk. 1400	Tk. 1851	No change
Your choice (please tike one only)	A ☐	B ☐	I would not want ☐ either A or B

$$U_i = \beta + \beta_{pfser} * pfser + \beta_{spv} * spv + \beta_{isani} * isani + \beta_{wascol} * wascol + \beta_{bgp} * bgp \quad (24)$$

Where, U_i is the indirect utility for five alternatives; β refers to the ASC and β_{pfser}, β_{spv}, β_{isani}, $\beta_{wascol,}$ and β_{bgp} are the coefficients associated with the attributes payment for services, solar photovoltaic system, improved sanitation, waste collection, and biogas plant, respectively. More specifically,

$$\begin{aligned} U_1 &= ASC_1 + \beta_{pfser} * pfser + \beta_{spv} * spv + \beta_{isani} * isani + \beta_{wascol} * wascol + \beta_{bgp} * bgp \\ U_2 &= ASC_2 + \beta_{pfser} * pfser + \beta_{spv} * spv + \beta_{isani} * isani + \beta_{wascol} * wascol + \beta_{bgp} * bgp \\ U_3 &= ASC_3 + \beta_{pfser} * pfser + \beta_{spv} * spv + \beta_{isani} * isani + \beta_{wascol} * wascol + \beta_{bgp} * bgp \end{aligned} \quad (25)$$

U_1 and U_2 represent the indirect utilities derived from environmental improvements of slums in Dhaka city, i.e., scenarios with options 1 and 2. U_3 represents the indirect utility in the status quo option. It is difficult to make any interpretation of the coefficients as they are confounded by scale parameter (Agimass and Mekonnen, 2011). But it is possible to compare the sign and difference in magnitudes of the coefficients (Bennett and Blamey, 2001).

3.2.5.2. PRL model

It is assumed that there exists consumers' homogeneity of preferences in the basic model. But it should be heterogeneous for unbiased estimates of consumers' preferences (Birol et al., 2005). Interaction of the SED characteristics with the ASC is the most commonly used solution to deal with the heterogeneity problem and possible violation of the IIA assumption (Alpizar et al., 2001; Bennett and Blamey, 2001; Birol et al., 2005; Agimass and Mekonnen, 2011). This study treated its SED variables as no. of family member, educational attainment, monthly income, age, and sex that are interacted with the ASC. Thus, we can write:

$$Ui = ASC + \beta_{pfser} * pfser + \beta_{spv} * spv + \beta_{isani} * isani + \beta_{wascol} * wascol + \beta_{bgp} * bgp + \gamma_1 (ASC * fmem) + \gamma_2 (ASC * eduatt) + \gamma_3 (ASC * moninc) + \gamma_4 (ASC * age) + \gamma_5 (ASC * sex) \quad (26)$$

Where, $i = 1, 2, 3$ for three scenario options, ASC = 0 for the status quo. Having this additive form of indirect utility of specification, the extended or MNL and basic or PRL models could be estimated using Equations 12 and 14 (Agimass and Mekonnen, 2011).

4. Estimation and Discussion of Results

4.1. Definition of variables

Definition of different attributes and socio-economic-demographic variables used in the basic or MNL and extended or PRL models of this study are presented in Table 3.

Table 3: Definition of attributes and variables

Attribute/Variable	Expected sign
ASC: Alternative specific constant (The alternative with changes: 1, and 0: The status quo)	(−/+)
pfser: Payment for services (Tk. 1400. Tk. 1610 and Tk. 1851)	(−)
spv: Solar photovoltaic (Interested: 1 and Not interested: 0)	(+)
isani: Improved sanitation (Interested: 1 and Not interested: 0)	(+)
wascol: Waste collection (Every day: 1, 2 days/week: 2 and 3 days/week: 3	(+)
bgp: Biogas plant (Interested: 1 and Not interested: 0)	(+)
fmem: No. of family member (Family size)	(−)
moninc: Respondent's monthly income	(+)
age: Respondent's age	(−/+)
edu: Respondent's educational level (Illiterate: 0, Primary: 1, Secondary: 2, Higher secondary: 3 and under grade or graduate: 4)	(+)
sex: Sex (Male: 1 and Female: 2)	(−/+)

4.2. Estimation and discussion of results

To estimate the WTP for eco-town for slums in Dhaka city and their attributes, logit model with different forms was developed using NLOGIT 4.0 software. Results for all 327 respondents from the logit models having two forms: MNL (basic) and PRL (extended) model are shown in Table 4.

4.2.1. MNL or basic model

The Basic model shows results when only the attributes of CE are included in the estimation involving econometrics. The coefficients are interpreted as the parameters of the indirect utility function, although the fact that they are confounded by a scale parameter means that one cannot directly interpret their numerical value. All attributes in the basic model are statistically significant at conventional levels (at 1%, 5%, and 10% levels, respectively) with expected sign.

Implications of positive sign of all coefficients of respective attributes of eco-town for slum dwellers are the probability of choosing an alternative scenario with changes in attribute improvements. It will lead to increase as the levels of these attributes increase and vice-versa. The negative sign of the coefficient of payment for services from the proposed attributes indicates that higher payment and utility are negatively correlated. The value of McFadden pseudo R^2 (goodness of fit) of 0.470985 implies that 47% of the total variation in the outcome variable (respondents utility) can be explained by the variation of attributes of this model.

4.2.2. PRL or extended model

The PRL model allows more flexibility and continuous form of preference heterogeneity. In addition, this model overcomes the independence of the IIA assumption. A large number of SED variables were

Table 4: Estimated models for eco-town

Model	Multinomial logit model (improved scenario case)			Random parameter logit model (improved scenario case)		
Variables	Coefficient	Standard error	P value	Coefficient	Standard error	P value
ASC	0.97201*	0.95653	0.0000	1.15809*	0.4509	0.0003
pfser	−0.31041*	0.0.585	0.0000	−0.21099*	0.60451	0.0000
spv	0.99187*	0.18933	0.0000	1.45934***	0.86770	0.0903
isani	0.72361*	0.09322	0.0013	1.40810*	0.39791	0.0000
wascol	0.50235**	0.11091	0.0420	0.17989**	0.21635	0.0400
bgp	0.37019***	0.39001	0.0701	0.59761**	0.10409	0.0503
fmem				−0.53190	0.09306	0.1239
moninc				−0.61872	0.77098	0.2398
age				0.18119*	0.14795	0.0000
edu				0.89445*	0.0.078	0.0012
sex				0.57025**	0.37925	0.0256
Log-likelihood	−607.6098			−440.0960		
Pseudo R^2	0.470985			0.395660		
No. of observation (n)	327			327		

Income: Mean=7181.82; Standard deviation=4915.652; Minimum value: 4500; Maximum value: 14000
Age: Mean=41.07; Standard deviation=10.202; Minimum value: 22 Maximum value: 71
Education level: Mean=1.9825; Standard deviation=0.7234; Minimum value: 0; Max. value: 2
Family size: Mean=4.36; Standard deviation=1.021; Minimum value: 2; Maximum value: 6

*Significant at 1% (0.01), **Significant 5% (0.05), and ***Significant 10% (0.10) proposed to include in the extended model based on the perceptions of slum dwellers in Dhaka city. Like the basic model, all variables are significant except a few at the 1%, 5%, and 10% levels, respectively. The coefficients of ASC along with improved sanitation, waste collection, biogas plant, age, sex, and educational attainment are significant at different levels. This indicates that SED characteristics are the important determinants of the choice of alternative scenario of improvements. It is expected that number of family members and household monthly income should be significant. However, we cannot say anything about no. of family members and monthly income due to high P-value. At the time of FGD and face-to-face questionnaire survey, most of the respondents said they have not consistent income level over the year and several times a large number of relatives come from their home place from where they migrated. Positive coefficients of attributes and SED variables indicate that provision of improved sanitation, waste collection, biogas plant, age, education and sex will lead to increase the probability of choice improvement scenario option, and vice-versa. Like the MNL model, the negative sign of the coefficient of payment for services from the proposed attributes indicates that higher payment and utility are negatively correlated. The result of the MNL model is better than the PRL model because of the high value of Pseudo R^2. The value McFadden pseudo R^2 (goodness of fit) of 0.395660 implies that 39.5% of the total variation in the outcome variable (respondents utility) can be explained by the variation of attributes and other SED variables of this model.

4.2.3. MWTP

Due to the higher value of goodness of fit, this study depended on the MNL model to estimate the MWTP and economic welfare. When the attribute being sacrificed is a monetary one, the trade-off estimation is known as implicit price or MWTP for the attribute in question (Bennett and Blamey, 2001). It indicates the amount of money respondents are willing to pay for an improvement in the environmental attribute (Agimass and Mekonnen, 2011). MWTP expresses the amount of money respondents are willing to pay for an improvement in the environmental attribute. MWTP has a significant role for policy making (Agimass and Mekonnen, 2011). MWTP for four attributes of per household for improved eco-town in Dhaka city is estimated using Equation (23). The estimated results are presented in Table 5.

4.2.4. Estimation of welfare effects

The main purpose of a CE is to estimate the welfare effects of change in the attributes (Alpizar et al., 2001). To analysis this situation, this study assumed a simple utility function by imposing a constant marginal utility of income. But it depends on purely discrete choices. For example in the case of biogas plant or solar PV experiment of eco-town, the welfare measures depend on what has been defined in the survey. Economic welfare management involves an investigation into the difference between the utilities of the individual that could be achieved under the status quo and alternatives scenarios (Bennett and Blamey, 2001; Agimass and Mekonnen, 2011).

This paper used few alternative scenarios in its CE. The lower scenario includes not interested in solar PV system, not interested in improved sanitation, 3 days waste collection per week and not interested in waste based biogas plant. On the other hand, upper scenario includes interested in solar PV system, interested in improved sanitation, everyday waste collection, and interested in solar PV system (Table 1). The reported WTP for the scenario indicate the amount that respondents are willing to pay to experience an improvement in their utility (which results from a movement from the status quo to the changed alternative scenarios). The total WTP was estimated for improvement scenario presented as:

+ Improved scenario: Interested in solar photovoltaic system, interested in improved sanitation, everyday waste collection, and interested in waste based biogas.

Using Equation (22), the estimated result of welfare effects is shown in Table 6.

The estimated value of welfare effects is a relative value rather than absolute value. Because the initial welfare conditions of slums in Dhaka city were not defined in the questionnaire survey and choice experiment. It is noted that the relative value information appears robust because of the statistical strength of the models. Along with the upper level payment (Tk.1851) for services, per household of slums in Dhaka city decided to pay Tk. 17 more per month.

Table 5: Marginal willingness to pay for the attribute

Attribute	Coefficient value	Standard error	P value
Solar photovoltaic	$-1\left(\frac{\beta_{PV}}{\beta_{fser}}\right)=-1\left(\frac{0.99187}{-0.31041}\right)=3.195354531$	0.2901	0.0000
Improved sanitation	$-1\left(\frac{\beta_{isani}}{\beta_{fser}}\right)=-1\left(\frac{0.72361}{-0.31041}\right)=2.331142682$	0.7823	0.0613
Waste collection	$-1\left(\frac{\beta_{wascol}}{\beta_{fser}}\right)=-1\left(\frac{0.50235}{-0.31041}\right)=1.618343481$	0.5701	0.0010
Biogas plant	$-1\left(\frac{\beta_{bgp}}{\beta_{fser}}\right)=-1\left(\frac{0.37019}{-0.31041}\right)=1.192584002$	0.3319	0.0006

Table 6: Estimation of welfare effects (economic surplus)

Alternative improvement scenario	WTP for the scenario
$\frac{-1}{-0.21099}\left[(1.45934-0)+(1.40810-0)+(0.17989-0)+(0.59761-0)\right]$	Tk. 17.2754159

5. Summary and Conclusions

Eco-town is typical of many environmental issues where nonuse value may be highly significant. The lack of recognition of nonuse and other components of value by market systems and other decisions are responsible for degrading urban slums. It is important that all value should be assessed to protect the slums and enhance low-carbon society. Choice experiment is one developing nonmarket valuation approach. In this paper, this approach was applied to the value of urban slums. Perceptions and preferences of slum dwellers were examined by focusing on four environmental attributes - solar PV system, improved sanitation, waste collection, and biogas plant for gas transmission of household. Furthermore, a monetary attribute-payment for service was also included in the choice experiment. The study also limited the number of alternatives and attributes which help to reduce task complexity (Agimass and Mekonnen, 2011). The result indicated that solar PV system was highly valued. It is also found that socio-economic-demographic, e.g., respondents' age, educational attainment and sex have a positive impact on the probability of choosing a scenario with improvements in attributes.

Based on the estimated results, it can be said that strong political commitment and intervention of donor agencies, city corporation and NGOs can play an important role to boost up eco-town and LCS in urban slums. For provision of sustainable eco-town, sound management system should be given more priority. In that perspective, feed-in tariff, government investment, and foreign direct invest are suggested approach to diminish environmental problem in urban slums.

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