



## HOUSEHOLDS' WILLINGNESS TO PAY FOR NATURAL HAZARD INSURANCE IN THE SOUTHWESTERN COASTAL REGION OF BANGLADESH

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### Abstract

The southwestern coastal region of Bangladesh is enormously susceptible to natural hazards due to global environmental change, triggering economic instability in coastal households. Hazard microinsurance might be a decent option for them to build financial resilience. Accordingly, this research attempted to estimate households' willingness to pay (WTP) for natural hazard insurance (NHI) in Bagerhat Sadar and Rampal *upazilas* of Bagerhat district in southwestern coastal Bangladesh. The contingent valuation method's double-bounded dichotomous choice (DBDC) technique was exerted on the 120 randomly interviewed households' dataset to estimate the WTP for NHI considering three experimental bid values, BDT 300, 500, and 200 per month as initial, maximum, and lower bids respectively. The assessment revealed that, on average, 73 percent of the coastal households experienced yearly financial losses (i.e., damage to crops, fish-shrimp enclosures, integrated farms, and houses) due to natural hazards. Almost two-thirds of the total samples were interested in taking alternative financial support after a massive coastal hazard, and the mean WTP was approximately BDT 284. Amongst the interviewed households, more than 80 percent were willing to pay for the initial bid value of BDT 300. Non-parametric correlation coefficient estimation results indicate that the initial and maximum bids are highly associated, while the lower bid is moderately associated with the WTP for NHI. Such findings provide inputs for policymakers, development agencies, and the government to explore implementing microinsurance schemes as post-hazard economic facilitation for coastal victims

**Keywords:** Microinsurance, Willingness to pay, Natural hazard insurance, Economic resilience, Coastal Bangladesh

### Introduction

Global warming affects weather events and ultimately leads to natural hazards. Natural hazards are catastrophic events of geological and hydrological origins (i.e., tidal surges, thunderstorms) that initiate monetary losses, property losses, and social-environmental disruptions. Consistent with the Intergovernmental Panel on Climate Change (IPCC, 2007), climate change triggers global warming, persistent natural hazards, rising sea levels and groundwater salinization (Parry et al., 2007, Islam et al., 2019).

Due to salinity and the upsurge in the sea level, there is a problem of reduced production in maximum rice-rabi (hybrid irrigation) crop fields and fish-shrimp enclosures of coastal areas. Numerous hazards occur in coastal areas every year, including floods and river bank erosion. Consequent to the Ecological Threat Report (ETR), 2021, about 30 countries, including Bangladesh, face the highest level of environmental threats, home to 1.26 billion folks. They have low socio-economic resilience and high disastrous ecological threats (IEP, 2021). The People's Republic of Bangladesh is a country in South Asia. According to the Global Climate Risk Index, 2010, Bangladesh seemed the most vulnerable to climate change and tiered as the 7<sup>th</sup> terrific country which is frequently affected by natural hazards (Harmeling, 2010). As per the World Risk Index, 2016, in less than a decade, Bangladesh ranked 5<sup>th</sup> among the world's top 171 countries exposed to natural hazards (Garschagen et al., 2016).

The 19 prime districts of the coastal region of Bangladesh are- Khulna, Bagerhat, Satkhira, Jashore, Narail, Pirojpur, Patuakhali, Barguna, Jhalokathi, Barishal, Gopalganj, Laxmipur, Noakhali, Shariatpur, Feni, Bhola, Chandpur, Chattogram, and Cox's Bazar (Khan et al., 2011; Ahmad, 2019). Precisely, the southwestern coastal part

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of Bangladesh is an excessively hazard-prone area. Cyclones, coastal floods, and saline intrusion are all common hazards in Bangladesh's southwestern areas (Ahmed et al., 2016). The primary sources of income of the people in the area are agriculture, aquaculture, fishing from the Bay of Bengal, and resource exploitation from the Sundarbans. During 1998-2017, Bangladesh experienced 190 dangerous climate events, resulting in over 2.4 million USD in damages and 636 deaths yearly (Vinck et al., 2020).

Natural hazards such as floods, water shortages, and earthquakes could affect more than 80 percent, while tropical storms affect more than 70 percent of the population. Intense floods occur every 4-5 years, covering an average of 60 percent of the total land area (World Bank, 2018). Bangladesh's most remarkable and devastating floods which occurred between 1974 and 2007, were highly damaging and seriously threatened lives and the economy (Choudhury, 2009; Rahman et al., 2017). Analyzing a cyclone report by GoB (2008), a category-4 cyclone named SIDR hit southwestern coastal Bangladesh in 2007 and the estimated loss from SIDR was at around BDT 115.6 billion (USD 1.7 billion). In 2009, cyclone Aila also caused significant damages across the southern part of Bangladesh; the total damages were estimated at approximately BDT 18.8 billion (USD 270 million). With limited resources, it is challenging for Bangladesh and its people to cope with natural hazards, including the effects of climate change (Khan and Nahar, 2014). Meanwhile, the southwestern coastal Bangladesh faces growing threats due to the changing climate day by day, coastal communities need to build resilience to be financially secure against the after-effects of massive natural hazards (Vinck et al., 2020). In this case, insurance coverage might be a financial resilience builder.

Insurance coverage is the monetary support of risk or liability covered for an individual or unit through insurance services (Chen, 2021). In this case, an agreement is made between the policyholder and the insurance company and attractive insurance packages are set up with various benefits depending on the risk category. General insurance categories include dental health, hazard, home, motor vehicles, property, profitmaking and business insurance (The Economics Times, 2023). Insurance also consents for loss reduction, economic stability, and the promotion of trade and commercial processes, which results in sustainable socio-economic development and growth.

*Sadharan Bima* (General Insurance) Corporation's (SBC) services include protecting public and private property threats; providing claim insurance coverage; reinsurance of hazard by non-life policy (NPL) holders; risk improvement services; industrialization across equity investments; and human resource development for the insurance sector (ICA, 2019; SBC, 2021). According to SBC, all insurance corporations in Bangladesh are governed by the Insurance Development and Regulatory Authority (IDRA), Bangladesh. IDRA have been operating since 2010 to regulate and develop the insurance sector of Bangladesh. IDRA aims to defend the interest of insurance consumers and beneficiaries while ensuring the stability of insurance agencies (IDRA, 2013). However, the majority in Bangladesh do not participate in any insurance schemes as willingly as in the developed world. Although, the microinsurance market has experienced substantial expansion in recent years, the average annual growth rate is around 10 percent (Lloyd's and Microinsurance Centre, 2009).

According to Lloyd's global underinsurance report, 2012, Bangladesh seemed the most prominent insurance disparity (around 2.1 percent) in the gross domestic product (GDP), equivalent to USD 6 billion, and leading to significant yearly natural hazard damages. Bangladesh's insurance cost remained less than USD 3 per capita, which is 0.51 percent of the country's GDP in 2007 and had grown to almost USD 7 per capita by 2012. It still comprised only 0.94 percent of the country's GDP (Sultana and Kaiser, 2021).

Natural hazard insurance (NHI) is a microinsurance scheme, often mentioned as a practical risk-coping mechanism to get monetary assistance after massive natural hazards. Several developing countries are adapting risk insurance support to help marginalized people to cope with the growing risks of natural hazards (Botzen and van den Bergh, 2008; Akter and Fatema, 2011; Segal, 2021).

Despite the extreme consequences of natural and other hazards, people in third-world nations, including Bangladesh, are not sufficiently encouraged to practice hazard insurance to get post-hazard financial coverage. Only one-third of worldwide financial hazards are insured on average, with the residue falling into the protection gap (Siddiqui, 2019). In developing countries, a few schemes offer microinsurance coverage against natural hazards or are in the initial stages of putting them into practice (Mechler et al., 2006). However, numerous research findings indicate that intended participation in any insurance scheme is lower than expected by its supporters (Akter and Fatema, 2011). Hence, this study's purpose was to estimate coastal households' willingness to pay (WTP) for natural hazard insurance (NHI) in southwestern coastal Bangladesh.

Nevertheless, the authors supposed community-centered financing can be a convenient solution to build resilience for after-hazard financial security with a complete package of insurance facilities according to consumers'

chosen microinsurance premium(s). Considering the assorted consumers' preferences is vital for policy scheming of a hazard insurance. Therefore, this research scrutinized the southwestern households with a hypothetical natural hazard insurance proposal in line with developed countries to help them cope with monetary losses after natural hazards.

### **Materials and Methods**

The tools and methods adopted in the study are illustrated in this section. It represents the analytical explanation of the mentioned research's objective and outlines methodological steps for estimating households WTP for NHI, fixing experimental bid values, focusing on picking a valuation approach, and econometric specifications.

#### ***Study's Nature and Areas' Rationale***

This WTP study has been conducted based on a primary dataset collected from three (03) villages (i.e., *Kbanpur*, *Jhanjhania*, and *Gabbuniya*) of Bagerhat Sadar and Rampal *upazilas* (sub-districts) of Bagerhat district, which are highly hazard-prone southwestern coastal areas and very close to the Pasur River and Mongla seaport. Bagerhat Sadar *upazila* spans a total area of 272.73 km<sup>2</sup> and has 45,527 households [i]. The leading income sources of the people of Bagerhat Sadar *upazila* include agriculture (42.01 percent), commerce (21.31 percent), service (10.61 percent), transportation (4.55 percent), non-agricultural labor (7.41 percent), and the rest 14.11 percent others (Banglapedia, 2021a; BBS, 2012). Rampal *upazila* covers a total area of 335.46 km<sup>2</sup> and has 33,119 households [ii]. Prime income sources of the people of Rampal *upazila* include agriculture (52.4 percent), non-agricultural labor (7.7 percent), industry (0.8 percent), commerce (20.7 percent), transportation and communication (3.64 percent), service (5.3 percent), construction (1.3 percent), religious services (0.24 percent), rent and remittances (0.16 percent), and the rest 7.8% others (BBS, 2012; Banglapedia, 2021b). Selected villages are considered the primary sampling unit of this study. Mentioned areas of Bagerhat district have been purposively selected as these are on the brink of Mongla seaport; undergo natural hazards which cause great damage to natives' life and living; the main occupations are informal sector jobs (i.e., agriculture, aquaculture, fishing, day-labor, and so on). Thus, these areas were considered precise to meet the study's objective and were considered as the representative units of the entire southwestern coastal Bangladesh.

#### ***Sampling Technique***

Households were selected through a simple random sampling technique. The authors randomly sampled a total of 120 households by picking 40 households from each of the three (03) primary sampling units, i.e. three villages. A structured interview schedule was used to administer the interview to the nominated respondents. Three experimental bid values [i.e., an initial bid of BDT 300 [USD 2.91), a maximum bid of BDT 500 (USD 4.85), and a lower bid of BDT 200 (USD 1.95)] were considered to be chosen as NHI premiums per month (exchange rate during the interview period was 1 USD = 103 BDT). The interview schedule addressed issues allied to sources, problems, choices, coping activities, alternative compensations, choices of hypothetical bid values, willingness to pay, and amount of paying. To maintain data safety and accuracy, this data was collected with Kobo Toolbox (ODK Based Software) during August, 2022.

#### ***Theoretical Framework***

When dealing with non-market goods, public goods or services, the contingent valuation (CV) method is widely applied for concerned studies. The hypothetical market can be modeled on non-market goods where survey-based methods, like contingent valuation (CV), can be applied to estimate consumer participation, preferences, and willingness to pay for targeted services. The CV method's simple data collection processes, supervision system, and computational advantages compared to the choice experiment (CE) method are some reasons behind choosing this method to estimate WTP for NHI (Mitchell and Carson, 1993; Banerjee and Sarkhel, 2012; Moorthy et al., 1997, Doherty et al., 2021).

The WTP regulation is an ultimate concept in economics and finance castoff to measure the value of a product or service to a consumer [iv]. It is constructed on the belief that the consumer is willing to pay for a product or service up to the point where the marginal benefit of consuming the product or service is equivalent to the marginal cost of generating that. As per WTP's regulation, consumers will only pay if they rely on a product or service that is worth it. Over the last decade, WTP experiments have been conducted in southwestern coastal Bangladesh focusing on various concerns. A combined analysis of WTP literatures' (i.e., Islam et al., 2019; Islam et al., 2018) results exhibited that coastal people expressed their willingness to pay a portion of their monthly income



The core computational mechanism of this research is highlighted through the flow chart of Figure. 1. We presented BDT 300 (USD 2.91) as the initial bid value ( $B_I$ ). Once they were willing to pay for  $B_I =$  BDT 300 as a monthly NHI premium, they said 'Yes (=1)' and proceeded to the next bid. An initial bid value ( $B_I$ ) and a maximum bid value ( $B_M$ ) = BDT 500 (USD 4.85) were fixed to pick as NHI premiums per month with "Yes-Yes" and "Yes-No" choices and maximum bid value ( $B_M$ ) was only asked when they primarily accepted initial bid value ( $B_I$ ).

Thus, the WTPs' percentage for both premium bids "Yes-Yes" was evaluated; these consumers agreed to invest their maximum as per our hypothetical NHI payment plan and were also willing to pay higher than the maximum bid offered. On the contrary, the acceptors of  $B_I$  who rejected  $B_M$  were indicated as "Yes-No" interval, denoting that respondents' WTP within the initial and higher bid offered.

While they declined the initial bid value ( $B_I$ ), the opportunity of picking the maximum bid value ( $B_M$ ) is automatically escaped, however, they could choose at least the lower bid value ( $B_L$ ) = BDT 200 (USD 1.95) to pay a least monthly amount for NHI. If they consent lower bid value ( $B_L$ ), then the relationship is signified as "No-Yes" term and denotes their WTP within the initial bid and lower bid offered. Conversely, rejecters of an initial bid ( $B_I$ ) who also rejected the lower bid ( $B_L$ ) were coded as "No-No" interval, denoting that their WTP is positive but less than the proposed lower bid ( $B_L$ ).

Systematically, once a respondent approves to pay, the respondent's  $WTP > 0$ . We prioritize households' opinions. Therefore, we merged a random bidding ( $< B_L$ ) option to offer in the DBDC computational loop (Figure 1) of this research to remove hypothetical biases from this non-market CV design. Thus, the respondents who discard both the initial and lower bids (No-No), would get an open bidding opportunity or express their ability to participate in the NHI payment plan. In point of fact, "No-No" relationship often generates some haziness and controversies, which are particular concerns of DBDC valuation. Thus, all categories of controversies are lopped off for this research. Whereas, in our sample, all were willing to pay for at least the lower bid value ( $B_L$ ) = BDT 200 (USD 1.95), who said that they were willing to participate (80 of 120) for NHI (Adams et al., 2015; Banerjee and Sarkhel, 2012; Halstead et al., 1992; Islam et al., 2019; Seifouri et al., 2018).

**Econometric Specifications**

Equation 1 presents the contingent valuation model of this research (Islam et al., 2019; Bhattarai, 2019; Paopid et al., 2020).

$$WTP_{(i)} = \beta_i X_i + \varepsilon_i \dots \dots \dots (1)$$

Where,  $\beta$  = coefficient,  $\varepsilon_i$  = standard error.

By elaborating equation (1) with multiple explanatory variables, we assumed a linear relationship between predictor variables and log odds ( $WTP_{i=1,0}$ ) [iii]. The linear relationship extended to the case of multiple explanatory variables:

$$WTP = \beta_0 + \beta_1 Gender_i + \beta_2 occup_i + \beta_3 hhminc_i + \beta_4 hhmexp_i + \beta_5 finloss_i + \beta_6 damasset_i + \beta_7 damassetp_i + \beta_8 damvalue_i + \varepsilon_i \dots \dots \dots (2)$$

The mean WTP has been estimated by using the binary logit (BL) model [iii] as follows:

$$mWTP = \frac{\beta_0 + (\sum \beta_{ni} X_{ni})}{-\beta_1} \dots \dots \dots (3)$$

Here,  $\beta_0$  = estimated constant,  $\beta_n$  = parameters of the coefficients,  $X_n$  = the mean values of explanatory variables, and  $\beta_1$  = co-efficient of the bid amount.

Table 1. Explanatory Variable(s)

Name of Variable	Description of the Variable	Related Literature
Willingness to pay ( <i>WTP</i> )	Households' willingness to pay for natural hazard insurance can take only two values: 1 if the household wants to pay and 0 if the household is not willing to pay. [Dependent variable]	Paopid et al., 2020; Islam et al., 2019, and Seifouri et al., 2018
Gender of respondent ( <i>gen</i> )	Gender of household head, either male or female. [Explanatory variable]	–
Respondents' occupation ( <i>occup</i> )	Occupation of household head included farmer, fisherman, integrated farmer, labor and other in category. [Explanatory variable]	Paopid et al., 2020; Adams et al., 2015
Household monthly income ( <i>hbminc</i> )	Total (Primary/Secondary income of household considering all earning members) monthly income of the household, measured in BDT. [Explanatory variable]	Paopid et al., 2020; Islam et al., 2019; Song et al., 2019 and Seifouri et al., 2018; Adams et al., 2015
Household monthly expenditure ( <i>hbmexp</i> )	Total monthly expenditure (considering all members of household). [Explanatory variable]	Paopid et al. (2020)
Households' Financial Losses ( <i>finloss</i> )	Households facing financial losses due to natural hazards every year; 1 if Yes, 0 if No. [Dependent variable]	–
Claimed damaged asset ( <i>damasset</i> )	Households would like to claim hazard insurance to recover damage of assets. [Explanatory variable]	–
Damage asset/s value ( <i>damassetp</i> )	Damaged asset market price/value according to study area, in BDT. [Explanatory variable]	Paopid et al. (2020)
Damage value ( <i>damvalue</i> )	Value of damages (except asset price) in BDT. [Explanatory variable]	Paopid et al. (2020)
$\epsilon_i$	Error estimation. Zero-mean error term	Islam et al. (2019); Paopid et al. (2020); Seifouri et al. (2018)

Source: Authors' Compilation

A logit analysis (i.e., binary logit) was performed to identify households' WTP's probability and maximum likelihood. Logit regression is an appropriate analysis (Paopid et al., 2020; Seifouri et al., 2018), when the variables are dichotomous (1 = Yes, 0 = No). Logit regression labels data and simplifies the association between one dependent variable (binary) and one or more nominal, ordinal, or ratio-level explanatory variables (Seifouri et al., 2018). Willingness to pay is a dependent variable; which proceeds with dichotomous values (Yes/ No). For figuring WTP for NHI, agreed households were asked to respond with an initial bid ( $B_I$ ). When respondents answered 'yes' to the initial bid, they were offered a maximum bid ( $B_M$ ). If the initial response was 'no', a lower bid ( $B_L$ ) was offered. Hence,  $B_L < B_I < B_M$ . (Islam et al., 2019; Paopid et al., 2020; Seifouri et al., 2018; Bhattarai, 2019). Households' responses have been categorized into the following four conditional intervals:

WTP (Yes-Yes): When households answer "yes" to both  $B_I$  and  $B_M$ ,  $B_M \leq WTP < \infty$ .

WTP (Yes-No): When households answer "yes" to  $B_I$  and "no" to  $B_M$ ,  $B_I \leq WTP < B_M$ .

WTP (No-Yes): When households answer "no" to  $B_I$  and "yes" to  $B_L$ ,  $B_L \leq WTP < B_I$ .

WTP (No-No): When households answer "no" to both  $B_I$  and  $B_L$ ,  $0 < WTP < B_L$ .

Here,  $B_I$  = Initial bid value [BDT 300];  $B_M$  = Maximum bid value [BDT 500];  $B_L$  = Lower bid value [BDT 200];  $Pr$  = Probabilities' of adopting bid value.

Therefore, we uniformed the following four probability ( $Pr$ ) equations as per the above-mentioned intervals, which estimated the maximum likelihood of this study. Here,  $\alpha$ ,  $\beta$ , and  $\gamma$  are parameters, and  $Z$  points towards the socio-economic characteristics of respondents:

$$Pr_{(yes,yes)} = 1 - F(B_M) = 1 - \frac{1}{1 + e^{(\alpha + \beta B_M + \sum \gamma Z_n)}} \dots \dots \dots (4)$$

$$Pr_{(yes,no)} = F(B_M) - F(B_I) = \frac{1}{1 + e^{(\alpha + \beta B_M + \sum \gamma Z_n)}} - \frac{1}{1 + e^{(\alpha + \beta B_I + \sum \gamma Z_n)}} \dots \dots \dots (5)$$

$$Pr_{(no,yes)} = F(B_L) - F(B_I) = \frac{1}{1 + e^{(\alpha + \beta B_I + \sum \gamma Z_n)}} - \frac{1}{1 + e^{(\alpha + \beta B_L + \sum \gamma Z_n)}} \dots \dots \dots (6)$$

$$Pr_{(no,no)} = F(B_L) = \frac{1}{1 + e^{(\alpha + \beta B_L + \sum \gamma Z_n)}} \dots \dots \dots (7)$$

Logit model can be estimated by applying log-likelihood function (Bhattarai, 2019; Islam et al., 2019). From equation no. (4-7) here we calculated with maximum likelihood, where the log likelihood function for study's DBDC model is:

$$\log L = \sum_{i=1}^n \left[ \left[ (DR_i^I DR_i^M) \log \left[ F \left( \frac{B_i^M - \beta x_i'}{\sigma} \right) \right] + DR_i^I (1 - DR_i^M) \log \left[ F \left( \frac{B_i^M - \beta x_i'}{\sigma} \right) - F \left( \frac{B_i^L - \beta x_i'}{\sigma} \right) \right] + DR_i^L (1 - DR_i^I) \log \left[ F \left( \frac{B_i^L - \beta x_i'}{\sigma} \right) - F \left( \frac{B_i^M - \beta x_i'}{\sigma} \right) \right] + (1 - DR_i^I)(1 - DR_i^M) \log F \left( \frac{B_i^L - \beta x_i'}{\sigma} \right) \right] \dots \dots \dots (8) \right]$$

Here, in Equation no. 8,  $DR_i^I$  indicates the dichotomous response ( $DR$ ) for the initial bid and  $DR_i^I = 1$  indicates households' acceptance of the initial bid.  $DR_i^M$ , and  $DR_i^L$  are used for denoting the responses for maximum and lower bid values of hypothetical NHI premiums accordingly. When households accepted both initial and maximum bid values then,  $DR_i^I = 1$  and  $DR_i^M = 1$ , and when they are rejected both initial and maximum then responses for lower bid value,  $DR_i^L = 1$ .

Moreover, the Pearson goodness-of-fit test is administered to estimate the chi-square ( $X^2$ ) value with level of significance, and Kendall's Tau-b ( $T_b$ ) test to clear the levels of significance and association between WTP and NHI's mentioned bids [i.e., an initial bid of BDT 300 (USD 2.91), a maximum bid of BDT 500 (USD 4.85), and a lower bid of BDT 200 (USD 1.95)]. The said sequential steps were conducted to clarify the research's econometric analysis and to ensure the possible accuracy of the results. All of the stated methods have tried to fulfill the objective of this research. The variables were arranged based on several literatures and the study areas' characteristics. Accordingly, the next section epitomizes the statistical analysis, results, and policy discussions.

## Results and Discussion

This section displayed an overall analytical estimation and possible discussion according to southwestern households' willingness to pay for natural hazard insurance. Here, all econometric estimations were performed using SPSS (v.25), Kobo-toolbox (ODK-based software), Kobo-analyzer, and MS Excel.

### Descriptive Statistics

**Table 2** portrays WTP, gender, occupation, income, expenditure, damage information, and such other important issues collected through household interviews. It revealed a statistical analysis of explanatory variables. **Table 2** displayed multiple explanatory variables' mean, standard error of the mean, standard deviation, variance, and coefficient of variation. These are imperative to understand the valuation and the linkage between explanatory and dependent variables.

WTP is a dependent variable where households' willingness to pay for natural hazard insurance could able to take only two values: 1 if the household wants to pay and 0 if the household is not willing to pay for NHI. According to Table 2, 67% of the total sample households initially said yes (1), where the coefficient of variation's value estimated as 0.7 (<1) means the lower value and precise estimation.

Households' occupation, income, and expenditure data have been collected to highlight their financial well-being. It is important to consider the households' capacity and the kinds of damages they might face due to the natural hazards. This interview revealed that on average, 73 percent of coastal households experienced financial losses (i.e., damages to crops, fish and shrimp enclosures, integrated farms, and houses) yearly due to natural hazards (Table 2). Table 2 represents a whole combination of mostly claimed damaged assets of households according to study areas; average market values of claimed damaged assets, average damage values due to hazard, and average percentages of households' responses that they suffered financial losses due to hazard every year, the average market values of integrated farms are at their highest and lower average market values of damaged assets and houses.

Natural hazards cause financial losses in 67 percent of houses, 97 percent of fish-shrimp enclosures, 75 percent of integrated farms, 60 percent of livestock, and so on (considering 120 randomly sampled households). These percentages are calculated by considering each interviewed household's claimed damaged assets separately as a categorical variable unit and calculating as a percentage of assets. According to this study's estimation, the average percentage of coastal households' damages (compared with claimed assets' market values and damage values) is 22 percent (the value of loss per unit of personal wealth ( $s$ ) is considered proportionally). Therefore, they expressed

their willingness to get on average 73 percent (70 percent minimum and a maximum of 85 percent damage coverage) financial coverage by hazard insurance; where the coefficient of variance value is estimated at 0.04 (<1).

Table 2. Descriptive Statistics of Explanatory Variables and Symmetric Measures

Name of Variables	Max	Min	Mean ( $\mu$ )	Mean S.E( $\epsilon_i$ )	S.D. ( $\sigma$ )	Var.	C <sub>v</sub>
Willingness to pay (WTP)* 1= Yes, 0= No	1	0	0.67 (67%)	0.04	0.47	0.22	0.7
Gender of respondent(gen) 1=Women; 2=Men	2	1	2	0.02	0.23	0.05	0.1
Household's occupation (occup)*	1	3	2.48	0.07	0.72	0.52	0.2
Household monthly income (hhminc)	25,000	7,500	14,358	298.9	3274.02	-	0.2
Household monthly expenditure (hhmexp)	22,500	8,000	13,349	264.8	2,901.02	-	0.2
Households' Financial Losses (finloss)	1	0	0.73 (73%)	0.04	0.44	0.19	0.6
Claimed damaged asset (damasset)*	7	1	4.2	0.20	2.3	5.26	0.5
Damaged asset market price/ value (damassetp)	200,000	0	93,916	3,824	41,886	-	0.4
Damage value (damvalue)	60,000	0	20,491	946	10,368	-	0.5
Initial bid [BDT 300 (USD 2.90)] for WTP (initial_bid)	1	0	0.58 (58%)	0.05	0.5	0.25	0.8
Maximum bid [BDT 500 (USD 4.85)] for WTP (max_bid)	1	0	0.18 (18%)	0.04	0.4	0.15	2.1
Lower bid [BDT 200 (USD 1.90)] for WTP (low_bid)	1	0	0.08 (8%)	0.03	0.3	0.08	3.5
Households preferred percentages of insurance coverage (hhpcovg %)	85	70	73	0.32	3.6	12.60	0.04
<b>Valid Observations (N)</b>							<b>120</b>

\*Dependent Variable: WTP

S.E. = Standard Error, Var. = Variance, CV= Coefficient of Variance; Occupation (1=Farmer, 2=Fisherman, 3=Day-Laborer, 4=Homemaker, 5=Integrated Farmer, 99=Others); Claimed damaged asset (1=House, 2=Fish and shrimp farm, 3=Crops, 4=Fishing accessories, 5=Trees, 6=Livestock, 7=Integrated Farm, 99=Others)

Source: Authors' Compilation

### **Households' Willingness to Pay for NHI (Bidding with DBDC Strategy)**

The DBDC strategy estimated that almost 67 percent (80 out of 120) of the total households agreed to take such alternative financial support after a massive coastal hazard. Amongst these households, 87.5 percent (n =70) were willing to pay for the initial bid value (BDT 300/ USD 2.91), of whom 27.5 percent (n = 22) were willing to pay both the initial bid and the maximum bid value (BDT 500/ USD 4.85). The remaining, 12.5 percent (n =10) were willing to take only the lower bid value (BDT 200/ USD 1.90) as the monthly premium of NHI. DBDC also estimated the percentage (33.3) of protest bidders who were unwilling to pay for NHI, just chose the 'No' option for accepting NHI, but through attending the interview sessions, they answered all other sections of the interview schedule, and shared their experience of former natural hazards. The study omitted their worthless responses to avoid biases in WTP. Among them, people have chosen self-funding, micro-loans, and reliefs as their main sources of monetary support (Seifouri et al., 2018; Islam et al., 2019; Halstead et al., 1992). Consistent with the dichotomous test data of bidding price, Figure 2, has been plotted to show the accepting and rejecting probabilities. This dichotomous test supported the probability equations mentioned in the section of the econometrical analysis section of this research.

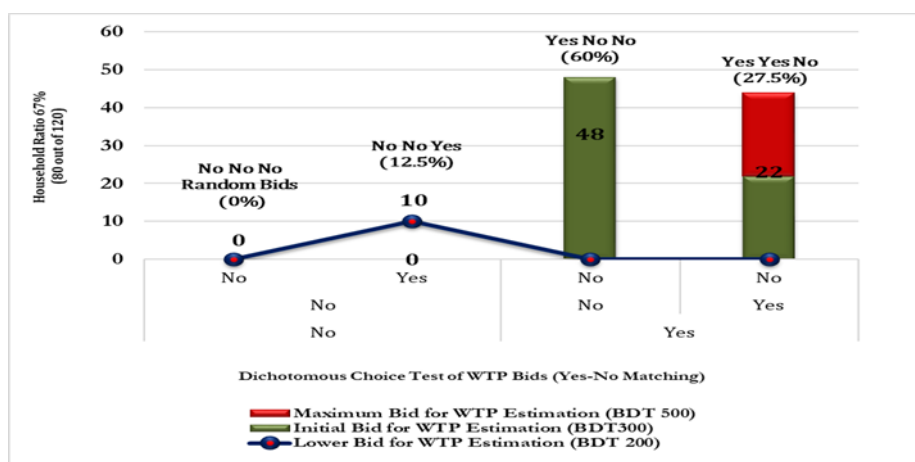


Figure 2. Households' Willingness to Pay for NHI (Dichotomous choice of WTP bids) (Source: Authors' compilation)

### Households' Willingness to Pay for NHI (Logit Analysis and Pearson Goodness of Fit Test)

Logit model is also a parametric method that can analyze binary data. It allows dependent variables in the class variable formula (Calderon et al., 2008). **Table 3**, estimated parameters with logit analysis.

Table 3. Parameter Estimation with Logit Analysis

LOGIT*	Parameter	Estimated Value	Std. Error	Z	Sig.
*Logit model:	occup	-0.11	0.26	-0.40	0.6
Log (p/ (1-p)) = Intercept + BX	hhminc	0	0	0.24	0.8
**Statistics based on individual cases differ from statistics based on aggregated cases.	hhmexp	0	0	-0.28	0.7
Variable(s) entered: Occupation (occup), Household monthly income (hhminc), Household monthly expenditure (hhmexp), Financial loss due to hazard (finloss), Claimed damages asset (damasset), Market value of damaged asset (damassetp), Value of damage (damvalue), Initial bid of 300 BDT (initial_bid), Maximum bid of 500 BDT (max_bid), Lower bid of 200 BDT (low_bid), Household preferred coverage percentages (hhpcovg %), Preferred duration of contract (durcntrct(y)), Sig. = Significance, Std. Error= Standard Error.	dasset	0.03	0.46	0.06	0.9
	damassetp	0.02	0.16	0.14	0.8
	damvalue	0	0	0.29	0.7
	initial_bid	0	0	-0.06	0.9
	max_bid	3.98	1.05	3.81	0
	low_bid	-0.07	0.38	-0.18	0.8
	hhpcovg%	4.02	1.12	3.60	0
	Intercept	-0.03	0.06	-0.56	0.5
		-1.36	4.62	-0.29	0.7
	<b>Average of Expected Responses:</b>				0.67 (67%)
	<b>Average of Residual</b>				-0.01
	<b>Average of Probability (any of three bids)</b>				0.35 (35%)
	<b>Pearson's Goodness of Fit Test</b>		<b>Chi-Square Sig.</b>		5.29**
	<b>Mean WTP (BDT) [in USD]</b>				**p<0.01 283.60 (2.75)

Source: Authors' Compilation.

The average probability of accepting any of the three proposed bid values was estimated at 35 percent of the total households. The Pearson goodness-of-fit test estimated a chi-square value of 5.29, which was statistically significant at a \*\*p-value of < 0.01. The mean willingness to pay (mWTP) was approximately BDT 283.60 ≈ BDT 284 (USD 2.75), which was approximately 1.98 ≈ 2% of households' mean income per month and close to the initial bid value of BDT 300 [USD 2.91]. Mean WTP was estimated with an interval of BDT 266 [USD 2.58] to BDT 304 [USD 2.95] at 95 percent (%) confidence level, with variables in equations estimated values (**Table 2, 3**).

### Households' Willingness to Pay for NHI (Kendall's Tau\_b Correlation Coefficient Analysis)

The non-parametric approach is a significant way of estimating the willingness to pay tactic of the contingent valuation method. This relates to utility theory as the probability of a yes/ no (dichotomous) test which only

depends on the size of the bids (Calderon et al., 2008). Kendall's Tau has been used here to understand the strength of the relationship (correlation coefficient) between two variables. It could be nominal to nominal and ordinal to ordinal. Calculating the accurate mean of a categorical variable is quite impossible in a WTP study. So, this section adjusted Tables 4 and 5 to show the result of Kendall's test.

Table 4 displayed the correlation coefficient estimation and significance level between WTP and three experimental bid values [i.e., an initial bid of BDT 300 USD 2.91), a maximum bid of BDT 500 (USD 4.85), and a lower bid of BDT 200 (USD 1.95)]. When Kendall's tau values are less than (<) 0.20, it indicates that both of the estimated variables are associated very weakly with each other. If the calculated value is more than (>) 0.25, then these seem moderate, and if the values are above 0.35, then it indicates that both variables are highly associated with each other. This research tests several matches of Kendall's correlation coefficients (Matching 1, 2). By plotting Table 4, in a scatter plot, we got Figure 3.

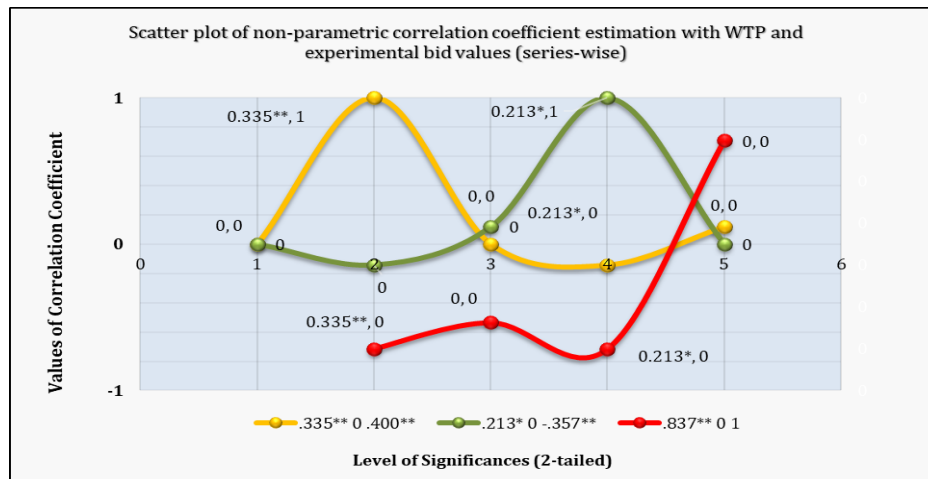
Table 4. Non-parametric Correlations Coefficient Estimation (Matching-1)

Observations		C <sup>c</sup> and Sig.	WTP	initial_bid	max_bid	low_bid
Kendall's tau-b ( $\tau_b$ )	WTP	Correlation Coefficient	1	0.837**	.335**	0.213*
		Sig. (2-tailed)	-	0	0	0.020
	initial_bid	Correlation Coefficient	0.837**	1	0.4**	-0.357**
		Sig. (2-tailed)	0	-	0	0
	max_bid	Correlation Coefficient	0.335**	0.4**	1	-0.143
		Sig. (2-tailed)	0	.000	-	0.11
	low_bid	Correlation Coefficient	0.213*	-0.357**	-0.14	1
		Sig. (2-tailed)	0.020	0	0.12	-

\* Correlation is significant at the 0.05 level (2-tailed). \*p<0.05; \*\* Correlation is significant at the 0.01 level (2-tailed). \*\*p<0.01; sig. = level of significance; C<sup>c</sup> = Correlation coefficient

Source: Authors' Compilation.

Figure 3 plotted non-parametric correlation coefficient estimation of experimental bids [i.e., an initial bid of BDT 300 [USD 2.91), a maximum bid of BDT 500 (USD 4.85), and a lower bid of BDT 200 (USD 1.90)] and willingness to pay for NHI. Initial bid (BDT 300) is highly correlated with WTP, the dependent variable of this study. The maximum bid (BDT 500) showed its correlation coefficient 0.335\*\*; \*\*p<0.01 with WTP, which indicates that WTP and the maximum bid (BDT 500) were highly associated with each other. The lower bid (BDT 200) has its correlation coefficient value with WTP at 0.213\*, \*p<0.05, which was moderately associated with WTP for NHI, according to Kendall's correlation-coefficient rules of estimation.

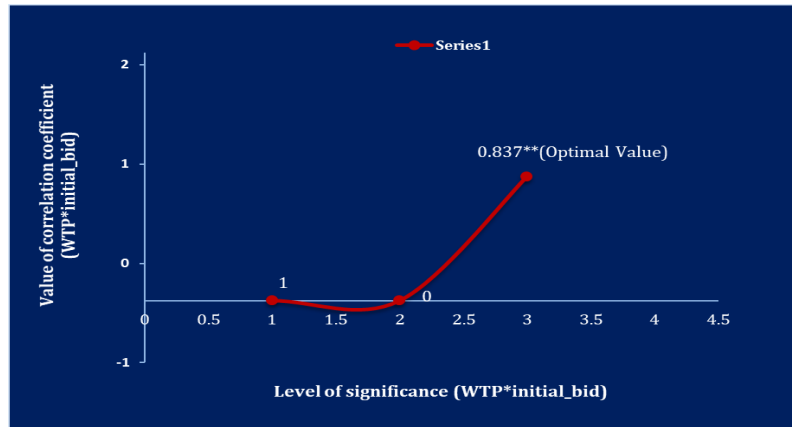


Source: Authors' Compilation (based on Table 4); \*\*Correlation is significant at the 0.01 level (\*\*p<0.01; 2-tailed); \*Correlation is significant at the 0.05 level (\*p<0.05; 2-tailed).

Figure 3. Non-parametric Correlation Coefficients' Scatter-Plot (series plotting)

Based on the estimated values of Table 4, Figure 4 displayed a highlighted plot (series 1) of Figure 3; the highest correlation coefficient value (0.837\*\*) and level of significance (\*\*p<0.01) were obtained from Kendall's tau-

b test, indicated that the initial bid value (BDT 300) and households' WTP were strongly associated and optimum value of this research. Via plotting Table 4, this research unveiled the households' maximum likelihood and maximum willingness to pay for an initial bid of BDT 300 (USD 2.91) per month (optimal value).



Source: Authors' Compilation (based on Table 4); \*\* $p < 0.01$ ; \*\*Correlation is significant at the 0.01 level (\*\* $p < 0.01$ ; 2-tailed)

Figure 4. Highlighted Scatter-plot of Non-parametric Correlation Coefficient Estimations (Series 1)

Kendall's Tau\_b ( $\tau_b$ ) trial was an outstanding non-parametric evaluation and highly statistically significant. Moreover, Table 5 displayed, a household's financial losses (0.21; \* $p < 0.05$ ), and damaged asset values (0.24; \*\* $p < 0.01$ ) are other explanatory variables that were significantly associated with willingness to pay for NHI. Besides, financial losses and damaged assets' values were significantly associated (0.22; \*\* $p < 0.01$ ) with each other.

Table 5. Non-parametric Correlations Coefficient Estimation (Matching-2)

Observations	$C^c$ and Sig.	WTP	finloss	dasset	damassetp	damvalue
WTP	Correlation Coefficient	1	0.21*	-0.75**	0.14	0.24**
	Sig. (2-tailed)	-	0.02	.000	.065	0.002
finloss	Correlation Coefficient	0.21*	1	-0.242**	0.216**	0.379**
	Sig. (2-tailed)	0.02	.	.003	0.005	0
Kendall's tau-b ( $\tau_b$ )	Correlation Coefficient	-0.75**	-0.242**	1	0.013	-0.140*
	Sig. (2-tailed)	0	0.003	-	0.9	0.046
dasset	Correlation Coefficient	0.14	0.22**	0.01	1	0.600**
	Sig. (2-tailed)	0.07	0.005	0.85	-	0
damassetp	Correlation Coefficient	0.24**	0.379**	-0.14*	0.6**	1
	Sig. (2-tailed)	0.002	0	0.05	0.00	-

\* Correlation is significant at the 0.05 level (2-tailed). \* $p < 0.05$ ; \*\* Correlation is significant at the 0.01 level (2-tailed). \*\* $p < 0.01$ ; sig. = level of significance; ;  $C^c$  = Correlation-coefficient

Source: Authors' Compilation.

### Future Policy (s) and Research Options

According to study findings, households demanded an average of 73 percent coverage against their insurance, where their average damage level was estimated at around 22 percent. Considering their cases, all unintended damages are not the same; determining the good coverage level of service package(s) during policy elaboration will ensure consistency between the policyholders and consumers.

Most of the respondents' affordability to finance is deliberated as demand side optimal premium's level. Considering social and economic optimality, generating a minimal tariff rate will make people more interested to pay for such hazard microinsurance program. Otherwise, insurance companies' tariff obligations might eliminate some population from service bundles.

In addition, this study discusses the benefits and the cooperation of insurance sector to the country's GDP. A huge portion of Bangladesh's corporate tax sector is related to the insurance and banking sectors. If evaluated properly, such microinsurance would be able to create a massive stir in Bangladesh's economy. If policies would be designed with an optimal tariff and tax rate, and average financial support according to coastal community demands

and losses, insurance holders are expected to increase rapidly. Hence, such hazard microinsurance in the market will sustain at optimum premium rates, normalizing the density of microinsurance with high interests, if the transparency of Bangladesh's insurance system is restored.

This research's optimum value was the initial bid of BDT 300 [USD 2.91] and mean WTP was BDT 283.60 [USD 2.75]. When we compared them, the mean WTP carries the closest value to the initial premium bid of this research. Meanwhile, individually and collectively 58.4 percent respondents of research were positively willing to pay BDT 300 per month for this hypothetical natural hazard insurance in the southwestern coastal region of Bangladesh. They are keen to bring themselves under strong financial support as a safeguard against recurring natural hazards. Hence, the policy recommendations with optimal and mean WTP will not undergo externalities.

Besides, this research's overall scrutinizes have attempted to stretch to policymakers a vivid understanding of households' behavior in adopting such microinsurance. This research recommends government and development agencies to implement such a microinsurance scheme as post-hazard economic support for coastal victims. As a result, significant welfare might be achieved in the economy of southwestern coastal Bangladesh. WTP's estimation with contingent valuation (CV) approach may diverge the experimental strategy. Integrating further respondents from the southwestern coastal areas of Bangladesh, diversity of the overall demand(s), payment plan, bidding and participation for NHI scheme would be enthusiastic. Furthermore, by scrutinizing the demand side and valuating supply side effects, NHI scheme might be assimilated to develop the sustainable natural hazard insurance (NHI) market place in Bangladesh as well as pertinent countries. Since, this study did not cover a comparatively gigantic sample size, further analysis might administer a comprehensive assessment wrapping more households in adjacent hazard-prone areas to ensure the robustness of the study's findings.

## Conclusion

Furthermost, coastal households are not financially well-off; they need financial support to cope with the post-hazard damages. The government and NGOs provide relief funds to mitigate post-hazard losses, which detected far less than the damages. It has been observed that relief funds are provided by listing the poor households based on *upazila*/union or that some people deprived of hazards are given the facility of house restoration. Being economically unstable, coastal communities take high-interest loans from several organizations or mortgage lands to cover hazard damages. However, they would not get the chance to save for paying off the credit throughout the year to cover these losses.

Natural hazard insurance (NHI) is somewhat unfamiliar in selected areas of southwestern coastal Bangladesh. NHI is a hypothetical hazard insurance scheme in Bangladesh's panorama where consumers would be able to pay for getting financial security after a range of categorical natural hazards (i.e., floods, thunderstorms, cyclones, river erosions). People in the southwestern areas are getting help through micro-loans with high-interest rates and reliefs. Hence, at the time of collecting data a primary idea of this hypothetical hazard insurance, approximate pros and cons was shared with coastal households along with their queries; *Bangabandhu Suraksha Bima* (*Bangabandhu* Safety Insurance) was used as an example in the meantime. In that case, no influence was attempted on the respondent households to increase 'Yes' percentages and create biases. Therefore, we kept a random bidding option to offer in the computational system of this research to remove unintentional hypothetical bias from our non-market CV strategy. Thus, the respondents who discard the experimental payment plan would get an open bidding opportunity or express their net ability to participate in NHI.

The financial benefits of hazard insurance are of course dependent on the insurance premiums' value. It can be assumed that, they lead a marginal life where post-hazard expenditure is indeed an unwanted hassle for them. Therefore, they categorically need NHI coverage to lead a relaxed life span and to deal with unwanted risk-related expenses.

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### Conflict of Interest

The authors declare no conflict of interest.

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