Research in
AGRICULTURE, LIVESTOCK and FISHERIES
ISSN : P-2409-0603, E-2409-9325
An Open Access Peer-Reviewed International Journal

Article Code: 440/2024/RALF
Article Type: Research Article

Res. Agric. Livest. Fish.
Vol. 11, No. 1, April 2024: 69-77.

ASSESSING THE MARKET OPPORTUNITIES FOR PESTICIDE-FREE VEGETABLES IN BANGLADESH: CONSUMERS' PREFERENCES AND WILLINGNESS TO PAY

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ARTICLE INFO

Received
23 March, 2024

Revised
27 April, 2024

Accepted
28 April, 2024

Online
May, 2024

Key words:

Market opportunities
Pesticide-free vegetables
Consumers' preferences
Ordered logit model
Price premium

ABSTRACT

The excessive use of fertilizers and pesticides in agriculture poses threats to ecosystems and human health. To mitigate these risks, researchers have turned their attention to pesticide-free production methods. This study aimed to assess the market opportunities for pesticide-free vegetables (PFVs) through determining consumers' preferences and willingness to pay (WTP), along with identifying factors influencing consumers' WTP decision in three major cities of the country, namely Dhaka, Khulna, and Mymensingh. Employing a multistage cluster sampling method, 150 samples were selected and data collection utilized the android-based app Kobo through direct interviews. The contingent valuation method (CVM) and double-bounded dichotomous choice model (DBDC) were used to estimate WTP and preferences while ordered logit model were employed to identify influencing factors. The findings indicated that over 90% of consumers in Mymensingh and over 92% in Dhaka and Khulna were willing to pay a premium for pesticide-free tomatoes and brinjal. Additionally, more than 18% and 19% of consumers expressed willingness to pay a 20% premium for brinjal and tomato, while over 39% were willing to pay for both a 10% premium. The study revealed that factors such as age, sex, education, household size, and income significantly influenced consumers' WTP decisions, with age showing a negative correlation, while education and income were positively associated with interest in consuming pesticide-free vegetables. Overall, the study underscores the increasing demand for pesticide-free vegetables in urban areas, emphasizing the need for governments and stakeholders to develop supportive policies for sustainable market development.

To cite this article: Yeasmin H., M. R. Rima, M. A. Rahman, K. M. Akter, 2024. Assessing the market opportunities for pesticide-free vegetables in Bangladesh: consumers' preferences and willingness to pay. Res. Agric. Livest. Fish. 11(1): 69-77.

DOI: https://doi.org/10.3329/ralf.v11i1.73087

INTRODUCTION

Bangladesh has emerged as one of the fastest-growing vegetable producers globally, doubling its overall output over the past decade (Rahman et al., 2020). Despite cultivating over 100 types of vegetables across 4.55 lakh hectares, the country meets only 70% of its daily requirement, despite their critical role in health and nutrition (BBS, 2023; WHO, 2015). Vegetables not only contribute to financial gains but also combat hunger. However, farmers often resort to toxic chemicals for crop production and pest control, leading to adulteration and health hazards. This adulteration, considered a "Silent Killer" in Bangladesh, poses challenges in sourcing fresh, unadulterated vegetables (Sarma, 2020). Although pesticides boost yields, their environmental and health impacts are significant (WHO, 2002), prompting policymakers to enact food safety laws. These regulations, such as limiting pesticide use or residue, may impact stakeholders across the food chain. As a result, there's a growing demand for convenient, healthy vegetables, fueling a multibillion-dollar global industry, driven by urbanization, population growth, and changing consumer habits (Francis et al., 2012). Organic farming is gaining traction in Asia, including Bangladesh, due to its benefits in food security, income, and environmental conservation (Angelina, 2000; Uddin et al., 2012; Sarker, 2010). Studies on consumers' preferences and willingness to pay are crucial to address market failures and ensure food safety, security, and profitability (Lusk, 2013a; 2009b; Lister, 2014). Promoting consumption of PFVs not only combats malnutrition but also reduces cereal intake, boosts income, and enhances food security. Moreover, it can increase vegetable export volumes through extensive cultivation. Sustainable production requires collaboration, capacity building, and regulatory frameworks. This study aims to assess the opportunity of market through determining consumers' preferences and WTP for PFVs along with identifying the factors influencing WTP decision in three major cities: Dhaka, Khulna, and Mymensingh.

MATERIALS AND METHODS

Sampling design

To determine consumers' preferences for PFVs in this study, three major cities of the country, Mymensingh, Dhaka and Khulna were chosen. The study areas were chosen based on their accessibility, high cooperation, and potential for reliable data from respondents. The region with the most vegetable consumption is Dhaka, while Mymensingh and Khulna are well-known producers of vegetables. In these cities, an initial survey was carried out to collect feedback and obtain a comprehensive understanding of customer preferences. The study aimed to select 150 representative individuals from different income groups through multistage cluster sampling method each city with 50 respondents. The sample size was large enough to allow for degrees of freedom in statistical analysis. The data collection was done through direct interviews using a predesigned questionnaire developed on android-based App kobo. The survey questionnaire focused on varying attributes covering consumers' basic information, knowledge, attitudes, and institutional capacity towards PFVs.

Data collection and analysis

The study collected primary data from household heads in February-April and August-October 2023. All respondents were informed of the study's nature and purpose, and assured of the confidentiality. Questions were systematically asked, and data was recorded instantly, which was then re-checked after each interview. Descriptive statistics and WTP was analyzed using both Microsoft Excel and STATA.

Analytical techniques

The study utilized likert items to gauge consumers' perceptions and preferences on PFVs and related issues, using five-point likert scales to measure agreement, neutrality, disagreement, and strong disagreement where 1 means "Strongly Agree", 2 means "Agree", 3 means "Neutral", 4 means Disagree and 5 means Strongly Disagree.

The contingent valuation method (CVM) was used for direct estimation of WTP, utilizing various elicitation techniques. Double bounded dichotomous choice (DBDC) questions were asked to obtain reliable data from consumers without purchasing imaginary items to measure. we elicited WTP by asking respondents to indicate how much prices they would be willing to pay, choosing from 5 classes of price premiums: 0%, no more than 5%, 6 to 10%, 11 to 15% and 16 to 20%. The premium, consumers want to pay for the PFVs was set under the bidding arranged with the initial bid as 10% premium of the 1 kg of the vegetable cost. Consumers initially decide whether to pay a premium for PFVs, with zero WTP if no, and offered initial bid of 10% premium if yes. Consumers can choose to bid for pesticide-free vegetables, with higher premiums requested if they answer 'Yes' or lower if they answer 'No'. The most possible combinations from the DBDC choice results will be expressed in four as like 'Yes-Yes', 'Yes-No', 'No-Yes' and 'No-No'.

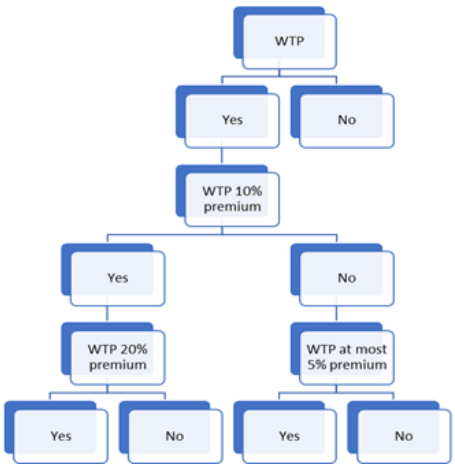

Figure 1. DBDC format

This study used ordered logistic regression analysis to identify influential factors of WTP decision for PFVs. The dependent variable is represented as multiple response variables with an innate order, requiring an ordered qualitative response model. The WTP model is expressed as a latent variable, with five categories based on consumer responses as follows:

$$\lambda^*_i(WTP)^* = \sum_{i-1}^{n} X_i \beta + \varepsilon_i \text{ ..... (i)}$$

Where, λ* is the latent (or unobserved) WTP, X is a vector of variables thought to influence WTP, β is a vector of parameters reflecting the relationship between WTP and variables in X and ε is an identically distributed error term with mean zero and variance one and γ is the threshold parameters or the cut-off points.

$$\lambda_i = j \leftrightarrow \gamma_{j-1} < \lambda^*_i < \gamma_j$$

The final logistic regression model to fit the success logit to predictors, converting predicted values back into odds using the exponential function as follows:

$$\text{Logit } Y_i = Log_e \left[\frac{Y_i}{1-Y_i}\right] \text{ ..... (ii)}$$

$$Log_e \left[\frac{Y_i}{1-Y_i}\right] = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + U_i$$

$$= \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + U_i$$

$$L = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + U_i \text{ ..... (iii)}$$

Here,

Y_i= consumers who are willing to pay for pesticide free vegetable, $\beta_0 = Constant$ X_1= Age (years), X_2=Sex, X_3=Household size, X_4= Education (years), X_5= Marital status, X_6= Religion, X_7= Income (monthly), X_8= Expenditure (monthly)

B_1 to B_8= Co-efficient to be estimated L, the log of the odd ratio; is not linear in X but also linear in parameters. L is called the Logit, hence the name Logit model. To estimate the model, we need apart from X_i, the values of the Logit L. But now we run into some difficulties. If we have data on individual or micro level i.e. X_i = 1 indicates those consumers who are willing to consume vegetables that is pesticide free vegetables and X_i = 0 otherwise and if we put these values directly into the Logit L, we obtain,

L_1 log (0/1) if consumers are willing to consume vegetables that is hydroponic

L_1 = log (1/0) otherwise.

RESULT AND DISCUSSION

Consumers' knowledge, awareness and preference for PFVs

PFVs pose a significant concern in our country, with only a limited selection available. Survey data analysis from Table 1 indicates that a mere 17.66% of respondents were unaware of the existence of pesticide-free vegetables, while approximately 82.34% were informed. Despite this awareness, a majority of respondents (60.33%) still prefer to shop regularly at nearby fresh vegetable markets, with only 2.33% opting for malls and 15% for supermarkets. Over 57.93% of respondents prioritize food safety consistently, while 42.07% consider it less important. A significant 78.22% of respondents had prior knowledge of PFVs, primarily sourced from the internet (40.97%) and newspapers (25.88%). Moreover, more than two-thirds (66.59%) occasionally purchase organic products, with 12.05% being regular buyers. Health consciousness and the absence of chemical residues were cited as the main factors driving PFV purchases, with respondents believing them to be healthier for their families (68.56%), free from pesticides (63.99%), and containing more nutrients/vitamins (58.22%). These findings are consistent with previous research by (Gan et al., 2016).

Consumers' perception and preference for PFVs

The survey analysis shows that the first statement on the adverse effects of chemical fertilizer garnered the highest "strongly agree" responses in all cities: Dhaka (65.56%), Khulna (65.33%), and Mymensingh (59.33%). This suggests that a majority of consumers in these cities believe that pesticide and synthetic chemical usage in agriculture harms the environment. Concerning the second statement, a significant majority in Dhaka (51.14%) and Khulna (52.67%) expressed worry about the safety and quality of products. The third statement revealed substantial concern about pesticide residues in food, with Khulna (57.71%) showing the highest level of apprehension. Additionally, Dhaka (55.02%) reported the highest instances of food-borne illnesses due to pesticide residues. Dhaka had the highest percentage (65.44%) of "strongly agree" responses regarding food labeling. Concerning farmers' engagement in cultivating PFVs, Dhaka also had the highest percentage (69.45%) of "strongly agree" responses. The majority of respondents from Khulna (77.24%), Dhaka (75.61%), and Mymensingh (69.67%) strongly agreed that consuming PFVs enhances their overall health and well-being.

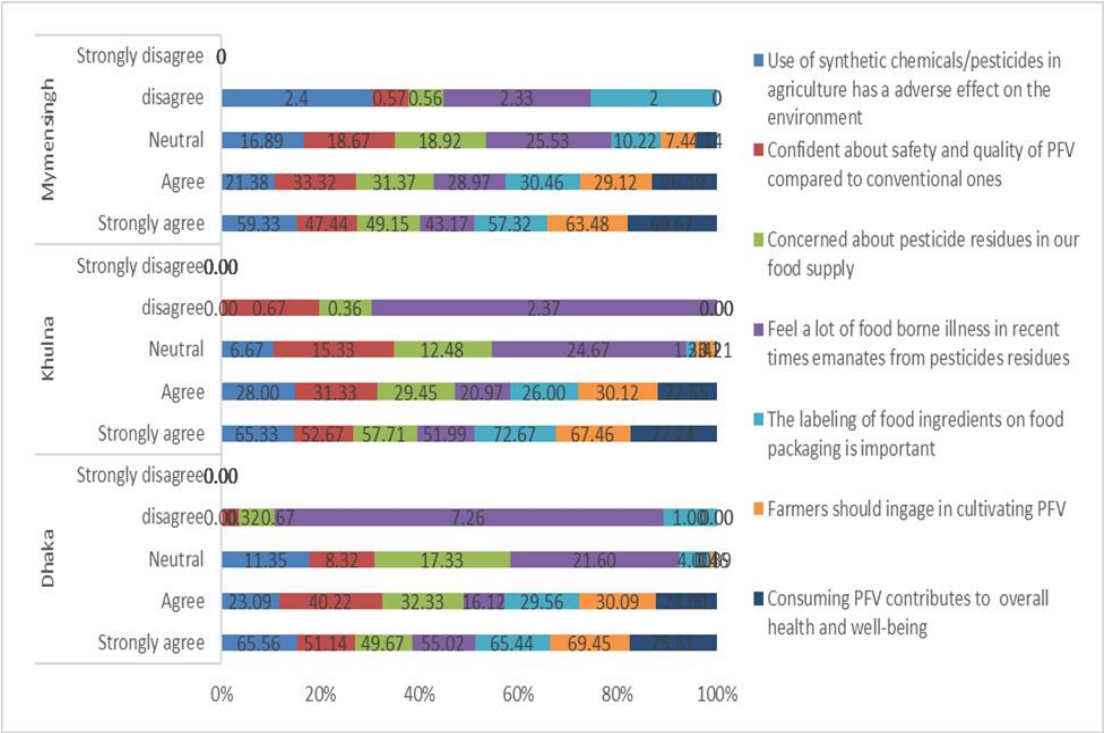

Figure 2. Consumers' concern and preference for PFVs

Table 1. Consumers' knowledge and awareness about PFVs

Statement	Alternatives	Percentage (%)
Familiar with PFVs	Yes	82.34
	No	17.66
Reasons for buying PFVs	Enriched with nutrients/vitamins	58.22
	Free from pesticides	63.99
	Healthier for family members	68.56
	High quality	30.78
	Better taste	15.88
	Others	2.34
Heard of or read any news report about PFVs	Yes	78.22
	No	21.78
Sources of PFVs information	Internet/social media	40.97
	Newspaper	25.88
	Television/radio	7.55
	Government safety net programs	3.19
	Friends or relatives	15.26
	Nutritionist	5.87
	Others	1.28
Places from they typically shop vegetables	Convenience store	22.34
	Fresh vegetable market	60.33
	Supermarket	15
	Others	2.33
Frequency in purchasing PFVs	Always	12.05
	Frequently	21.36
	Occasionally	66.59
Food safety a concern before shopping	Yes	57.93
	No	42.07

Source: Field survey outcome

Consumers' willingness to pay (WTP)

The primary data estimates from Table 2 below confirm that about 94.53%, 94.15% and 91.33% of respondents from Dhaka, Khulna and Mymensingh are WTP a higher price premium for pesticide free tomatoes in the sampled cities. Similarly, about 90.55%, 91.78% and 89.66% of the respondents confirmed their WTP higher price for pesticide free brinjal. These results are similar with the previous research study undertaken by (Hayati et al., 2017) by using contingent valuation method. For brinjal and tomato 18.87% and 19.31% of the consumers respectively had will to pay 20% premium whereas 39.26% and 39.88% respectively had WTP for 10% premium.

Table 2. Percentage distribution of the WTP responses of tomato and brinjal

WTP responses (n=150)	Dhaka (n=50)		Khulna (n=50)		Mymensingh (n=50)	
	Tomato (%)	Brinjal (%)	Tomato (%)	Brinjal (%)	Tomato (%)	Brinjal (%)
Zero WTP	5.67	9.45	5.85	8.22	8.67	10.34
NO-NO	17.35	16.22	18.11	14.34	15.32	13.18
NO-YES	18.34	16.55	18.66	18.52	20.44	18.79
YES-NO	37.45	39.33	40.96	40.23	35.24	38.22
YES-YES	21.19	18.45	16.42	18.69	20.33	19.47

Source: Field survey outcome

Table 2 analysis illustrates consumers' willingness to pay (WTP) for PFVs, showing a slight discrepancy between tomato and brinjal across all studied cities. In Dhaka, Khulna, and Mymensingh, approximately 5.67%, 5.85%, and 8.67% of households respectively were unwilling to pay for tomato, while for brinjal, these figures were 9.45%, 8.22%, and 10.34% respectively. Zero WTP instances were more prevalent for brinjal compared to tomato. The majority of respondents fell into the 'Yes-No' and 'Yes-Yes' categories, indicating their willingness to pay a premium of either equal to or greater than 10%, with some even consenting to a 20% premium for PFVs. Specifically, for tomato, 21.19%, 16.42%, and 20.33% of households from Dhaka, Khulna, and Mymensingh respectively were classified as 'Yes-Yes', while the majority, 37.45%, 40.96%, and 35.24%, fell into the 'Yes-No' category. 'No-Yes' category percentages for the cities were 18.34%, 18.66%, and 20.44% respectively. A comparison of these categories with brinjal indicates that many consumers are willing to pay a higher price for brinjal as well, compared to its regular price.

Factors influencing the WTP for PFVs

Ordered logistic regression was run to find out the factors that influences consumers' WTP for PFVs in sampled areas. The R^2 estimate from the restricted and unrestricted likelihood function was used to specify the model. The null hypothesis, according to which the overall effect of coefficients was zero, is tested using the likelihood ratio test. The model was statistically significant at the 95% confidence interval, as indicated by the p-value of 0.000. The conventional R^2 value is limited in qualitative models, and its use is recommended to avoided. A pseudo R^2 can be used to evaluate multiple models predicting the same results on the same set of data, indicating which model better predicts the results (Gujrati, 1995; Bruin, J. 2006). To avoid complications such usage was done in this study accordingly.

Table 3. Ordered logistic regression results of factors influencing the WTP for pesticide free tomato

Variables	Dhaka			Khulna			Mymensingh		
	Co-efficient	Standard error	P-value	Co-efficient	Standard error	P-value	Co-efficient	Standard error	P-value
Age	-0.001	0.047	0.866	0.111***	0.327	0.001	-0.003***	0.527	0.005
Sex	1.750**	0.621	0.024	1.530**	0.828	0.032	1.760**	0.729	0.052
Religion	1.819	1.324	0.170	17.004	1283.79	0.679	19.004	1.529	0.679
Marital Status	0.008	0.831	0.793	0.576	0.786	0.413	0.776*	0.687	0.093
Education	0.185*	0.109	0.076	0.302***	0.113	0.000	0.503***	0.113	0.004
Household size	0.469**	0.186	0.048	-0.172	0.161	0.286	0.182	0.151	0.297
Income	0.00007**	0.00003	0.057	0.00004**	0.00005	0.037	0.00006**	0.00005	0.057
Expenditure	0.00001	0.00004	0.962	0.00002*	0.00004	0.073	0.00002	0.00004	0.573
Chi-square	35.76			76.71			67.88		
Pseudo R^2	0.297			0.476			0.513		
Log Likelihood	-98.379			-76.387			-71.223		

***,** and * indicate significance levels at 1%, 5% and 10%.

Analysis from Table 3 reveals that, at the 1% level of significance, the age regression coefficient for tomatoes in Khulna city was positive and statistically significant. In order for older Khulna consumers were willing to purchase pesticide-free tomatoes at a higher rate than younger ones. Regarding sex, the data indicates a positive correlation with a 5% level of significance for consumers' purchasing pesticide-free tomatoes across all cities. Regarding education, there was a positive regression for pesticide-free tomato consumers in all cities, but the statistical significance varies. Specifically, Dhaka has a 10% significance level, whereas Khulna and Mymensingh have 1% significance levels. For household size, only the consumers of Dhaka city have the positive and statistically significant at a 5% level of significance. That means the household with larger size shows more willing to pay for pesticide free tomato. Income coefficient of household was found positive and statistically significant at a 5% level of significance. In all the sampled areas, higher waged tomato consumers had more will to pay higher premium than the low-income consumers.

Table 4. Ordered logistic regression results of factors influencing the WTP for pesticide free brinjal

Variables	Dhaka			Khulna			Mymensingh		
	Co-efficient	Standard error	P-value	Co-efficient	Standard error	P-value	Co-efficient	Standard error	P-value
Age	-0.127***	0.045	0.006	-0.077*	0.027	0.098	-0.227***	0.527	0.005
Sex	-1.325**	0.724	0.052	-0.505	0.782	0.332	0.230*	0.729	0.072
Religion	0.783	1.151	0.519	-0.515	1.427	0.582	11.005	1.728	0.379
Marital Status	0.009**	0.778	0.030	0..535	0.760	0.213	0.876*	0.686	0.084
Education	0.587**	0.106	0.045	0.348***	0.124	0.004	0.902***	0.113	0.000
Household size	0.522*	0.194	0.095	0.750	0.513	0.709	0.282	0.231	0.297
Income	0.00003**	0.008	0.048	0.00009***	0.00011	0.004	0.00002**	0.00006	0.029
Expenditure	0.015	0.000	0.177	0.00003**	0.00007	0.054	0.00001	0.00002	0.743
Chi-square	39.89			81.51			55.78		
Pseudo R^2	0.239			0.396			0.413		
Log Likelihood	-95.295			-78.072			-74.813		

Analysis from Table 4 shows that the age regression coefficient for brinjal in Dhaka and Khulna city were statistically significant at the 1% and 10% significance levels, respectively. This implies that older individuals were more likely to pay less than younger ones. At 5% level of significance, the regression coefficient for sex and marital status in Dhaka city were found statistically significant and negative. These indicates that women were more likely to pay for pesticide-free brinjal, also there was an inverse relationship between WTP and marital status. At the 10% significance level, the household size regression coefficient in Dhaka city was positive and significant. In other words, a larger household had more willingness to pay for brinjal. At 1% level of significance, the education regression coefficients for both Dhaka and Khulna cities were found positive and statistically significant. It indicates that those with more education were more prepared to pay for pesticide free brinjal. The regression coefficient of income was found positive in all the cities and statistically significant at 1% level of significance in Khulna and 5% in other two cities indicating that persons in higher income groups are more likely to purchase pesticide free brinjal. At 5% level of significance, the expenditure regression coefficient for Khulna city was found positive and statistically significant. That indicates Individuals with higher food expenditure tend to pay more for pesticide-free brinjal.

CONCLUSION

The survey findings shed light on consumers' preference and WTP for PFVs. Despite high awareness of PFVs, a considerable portion of consumers still favor shopping at fresh vegetable markets, indicating a preference for local produce. This also presents an opportunity for farmers and producers to capitalize on this demand by expanding their pesticide-free farming practices and increasing the availability of PFVs in the market Furthermore, food safety remains a top priority for a significant portion of respondents, reflecting growing concerns about health and dietary choices. The study underscores the strong demand for PFVs, with over 90% of consumers in major cities expressing a WTP that

extends to both modest (10%) and substantial (20%) price premiums for pesticide-free brinjal and tomato, indicating the willingness among consumers to prioritize health and sustainability over cost considerations. Various demographic and socioeconomic factors influence consumers' WTP for PFVs, including age, sex, education, household size, income, and expenditure. The study highlights the importance of understanding consumers' preferences and perceptions in promoting pesticide-free farming practices. It suggests that policymakers and stakeholders can leverage these insights to develop targeted strategies, utilizing direct-to-consumer sales platforms and online marketplaces to meet the growing demand for healthy food options and support sustainable agriculture.

COMPETING INTEREST

The authors declare that they have no competing interests.

ACKNOWLEDGEMENT

We extend our gratitude to all household heads interviewed from Dhaka, Khulna, and Mymensingh cities for their valuable time and cordial responses. We extend our thanks to the responsible officers of Ansar Guard Battalion (AGB) for their cooperation during the data collection in Dhaka city. This research work was facilitated through the Technology Innovation, Research and Development (R&D) grant received from Ministry and Technology for the financial year 2023-2024.

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