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Original paper

Evacuation Preparation Scenarios of Households during Early and Emergency Evacuation: A Case Study of Cyclone Bulbul in Southwestern Coastal Bangladesh

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Abstract Bangladesh is one of the most disaster-prone countries worldwide. Every year, the country sees a small- or large-scale disaster, with past disaster history showing that cyclones have been a major phenomenon. Cyclone Bulbul made landfall on the southwestern coast of Bangladesh on November 10, 2019, with an average storm surge height of 1.0 to 1.5 meters—resulting in the inundation of low-lying areas in 14 coastal districts. This study conducted a questionnaire survey of 413 households in Gabura, a union under Shyamnagar Upazila of Satkhira District, from mid-February to mid-March 2020 to investigate respondents' evacuation experience during Cyclone Bulbul. The questionnaire survey comprised both qualitative and quantitative approaches that analyzed disaster preparedness level, successful evacuation scenarios, and early evacuation decisions and their implementation in Gabura Union during Cyclone Bulbul. The survey results revealed that approximately 55% of the respondents evacuated during Cyclone Bulbul. Among them, 47% made early evacuation decisions, but an analysis of their evacuation starting time revealed that only 35.5% of them evacuated early before Cyclone Bulbul made landfall. Moreover, this research highlighted the importance of having adequate preparation time before starting evacuation, with most of the household respondents stating that they needed 2 hours in preparation time before starting evacuation. However, the preparation time varied between 1 and 6 h depending on the evacuation stage, the type of preparation activities, and the presence of vulnerable members in the house. Both categories of respondents, that is, those who made early evacuation decisions and those who followed through, cited evacuation companions, the presence of sick members

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in the house, distance from home to shelter, evacuation travel time, and socio-economic characteristics as common influential factors. Respondents in the emergency evacuation category identified previous disaster experience, the presence of sick members in the house, and socio-economic aspects as the factors that they considered while making evacuation decisions during Cyclone Bulbul. This analysis of factors influencing early evacuation decisions, early evacuation, and emergency evacuation helped shed light on people's perceptions about disasters, which can guide authorities in taking policy actions to improve early evacuation possibility and issuing early evacuation orders to ensure safe and successful evacuation during cyclones or other disasters in the future.

Keywords: Cyclone Bulbul, Evacuation Preparation Time, Primary Stage of Cyclone, Early Evacuation Decision, Early Evacuation

1. INTRODUCTION

Evacuation plays a vital role in reducing disaster damage. This study mainly focused on the early evacuation scenario and the possibility of early evacuation during future disasters, especially cyclone disasters. For the analysis, the study chose three wards in Gabura Union of Shyamnagar Upazila (sub-district) of Satkhira District, one of the worst-hit communities during Cyclone Bulbul, which struck the southwestern coast of Bangladesh on November 10, 2019.

Early evacuation decisions define whether households decide to evacuate before they receive the official evacuation order. Early evacuation decision means that after hearing the first warning signal, respondents decide their possible evacuation before they receive the official evacuation order—10 h before the predicted landfall of the cyclone. Similarly, if in actual cases, households make their evacuation before they receive official evacuation orders from a responsible authority, this is distinguished as early evacuation. There is no official early evacuation order from the perspective of Bangladesh during cyclones. This research examined the possibility of early evacuation based on the current official evacuation order. Evacuation during a disaster facilitates successful and safe evacuation, which is important for reducing physical damage. The Bangladesh Meteorological Department issued a cyclone warning at four stages: the first stage is the cyclone alert stage, 36 h before the predicted landfall; the second stage is the cyclone warning stage, 24 h before the predicted landfall; the third stage is the cyclone disaster stage, 18 h before the predicted landfall; and the last stage is the cyclone great-danger stage, 10 h before the predicted landfall (Parvin *et al.* 2019). These four stages of warning signals are the current organizational framework for the Bangladesh Government Disaster Management Ministry to disseminate the warning and evacuation orders during cyclones. The official evacuation order is given at the cyclone great-danger stage, 10 h before the predicted landfall. This research investigated the details of early evacuation decisions and

early evacuation and the associated influential factors that affect the safe and successful evacuation.

Although the complexities and rules of early evacuation are different for different disasters, researchers agree that early evacuation is important to mitigate damage during tsunami disasters (Yun and Hamada 2012). However, that study focused only on the starting time of evacuation during a tsunami disaster, rather than determining the early evacuation time. An effective evacuation plan and timely evacuation are very important for safe evacuation—reducing casualties and property damage. Kruger *et al.* (2019) confirmed that successful evacuation involves various components, such as governmental and non-governmental organizations' participation, disaster response capabilities, sources of information, and aspects related to communication sources. Bangladesh is recognized as one of the most disaster-prone countries worldwide, as it frequently experiences cyclones and other disasters. Therefore, many people are vulnerable, both physically and economically, leading their lives in danger. The coastal zones are low-lying areas situated on the deltas and floodplains of the three major rivers. Cyclones formed during the monsoon season from June to September are usually associated with storm surges. Because of such storm surges, high tides make the coastal land and embankments unstable, causing huge loss of life and property damage. Various governments and international organizations have reported that because of climate change-driven sea-level rise and cyclonic storm surges, around 20 million people in coastal districts are expected to be displaced (Ali *et al.* 2012). Concerning the evacuation decision-making process, many previous studies have focused on warning systems, cyclone shelters, information dissemination, route selection, destination, and evacuation behavior during disasters (Ahsan et al. 2016; Haque and Blair 1992; Haque 1995; Paul 2012; Roy *et al.* 2015). Furthermore, several studies have investigated the factors that affect people's evacuation decisions during emergencies.

The coastal areas in Bangladesh are vulnerable to cyclone disasters. As various factors, including evacuees' behavioral responses, pose challenges to successful evacuation, it is important to evacuate early to reduce loss of life and damage to property (Paul 2012). People living in Bangladesh's coastal areas are at risk, but they usually decide to evacuate in the last minute; thus, it becomes very difficult to complete the evacuation, especially given the weather conditions (Haque and Blair 1992). Additionally, in coastal areas, over 90% of evacuees walk the evacuation routes, but poor road conditions and communication systems sometimes make travel from their home to the shelter impossible. This state of affairs reasonably agrees with the conclusions of previous studies that acknowledged distance as an important issue in evacuation decisions in coastal Bangladesh (Chowdhury *et al.* 1993; Ikeda 1995; Mallick 2014; Paul and Dutt 2010; Paul *et al.* 2010; Paul and Routray 2013). Risk perceptions and previous cyclone experiences influence evacuation decisions (Ahsan et al. 2016; Das et al. 2018; Paul and Dutt 2010; Paul et al. 2010). Many people could not evacuate during Cyclone Sidr in 2007 because they delayed acting and eventually realized that time was not enough for evacuation because of the distance to evacuation shelters and inconvenient evacuation modes (Paul and Dutt 2010). In the coastal area of Bangladesh at the community-level, Cyclone Preparedness Program (CPP) volunteers disseminate cyclone warning and other information among the

communities through hand-mikes, megaphones, sirens, and individual house visits and help them to evacuate to shelters or safer places (Paul 2009; Paul and Dutt 2010; Haque 2012). This research also investigated the involvement of CPP volunteers with local level authorities and the dissemination of warning information during Cyclone Bulbul. In Bangladesh coastal areas, people usually receive warning and evacuation information through radio and TV. However, no system has yet been developed to disseminate warnings through mobile phones. Besides, responsible local government authorities also disseminate the warning and other information directly to the community. Interviews with government representatives ensured that they gave warning dissemination and evacuation information through CPP volunteers to the individual community due to disruption of dissemination from the national government because of bad weather conditions. Interviews with CPP volunteers also noted that they went to individual communities to disseminate the information by megaphones, sirens, and sometimes individual households.

To ensure safe and complete evacuation, it is necessary to determine the preparation type and time required before starting the evacuation. Furthermore, it is important to identify the factors that influence the evacuation decision. This would help the responsible authorities adhere to the early evacuation time to ensure safe and successful evacuation to shelters or other safer places. Previous research did not pay close attention to early evacuation possibilities and the effects of the starting time of evacuation from home to shelters, which are very important for the completion of successful and safe evacuation. A previous study investigated early evacuation possibilities by considering people's perceptions and investigated gender-based evacuation preparation time before starting evacuation (Parvin et al. 2019) but did not calculate the number or percentage of early evacuation cases based on their starting time of evacuation. Similarly, Lindell *et al.* (2020) estimated the household evacuation preparation time based on six task completions before starting evacuation concerning hurricane disasters. All previous research mentioned earlier studied early warnings, investigated evacuation influential associated factors, and estimated evacuation preparation time. However, no previous research has investigated household evacuation preparation time, early evacuation possibility, and associated factors based on evacuation starting time. This research investigated the details of household evacuation preparation time and associated influencing factors related to not only evacuation but also early evacuation decisions and behavior. This research also investigated this aspect, which has implications for reducing disaster-related damage and managing disaster situations more effectively in the future. This research analyzed factors that affected peoples' perceptions about and decisions regarding early evacuation during Cyclone Bulbul, which struck on November 10, 2019, and past disasters. This study also investigated various factors such as primary warning, primary preparation, evacuation decision, household evacuation scenario, evacuation preparation type and time, evacuation route and destination, travel time, and shelter type, which influenced people's early evacuation decisions. It mainly focuses on factors that affect the outcomes of safe evacuation decisions during cyclone disasters. Demographic, socio-economic, and other household characteristics also play a role in evacuation decisions.

This study investigated early evacuation and evacuation behaviors during the 2019 cyclone disaster to shed light on the conveniences or inconveniences faced during evacuation. This understanding can help inform policy to ensure safe evacuation and reduce damage during future disasters, especially physical damage. First, the study presents the findings related to the evacuation decision-making process, such as previous disaster experience, preparation type and time, household evacuation scenario, and demographic conditions, and outlines the factors influencing early evacuation and evacuation decisions. Second, the study reveals the percentage of people who evacuated early during Cyclone Bulbul. This was done by classifying the respondents into two categories based on their evacuation starting time before cyclone landfall to distinguish whether they evacuated early or not. The study presents the results of the analysis of factors that prompted an evacuation response in people, including household evacuation scenario, evacuation preparation before the start of evacuation, the presence of vulnerable members in the house, distance to shelter, travel time, and demographic conditions during the disaster.

2. STUDY AREA

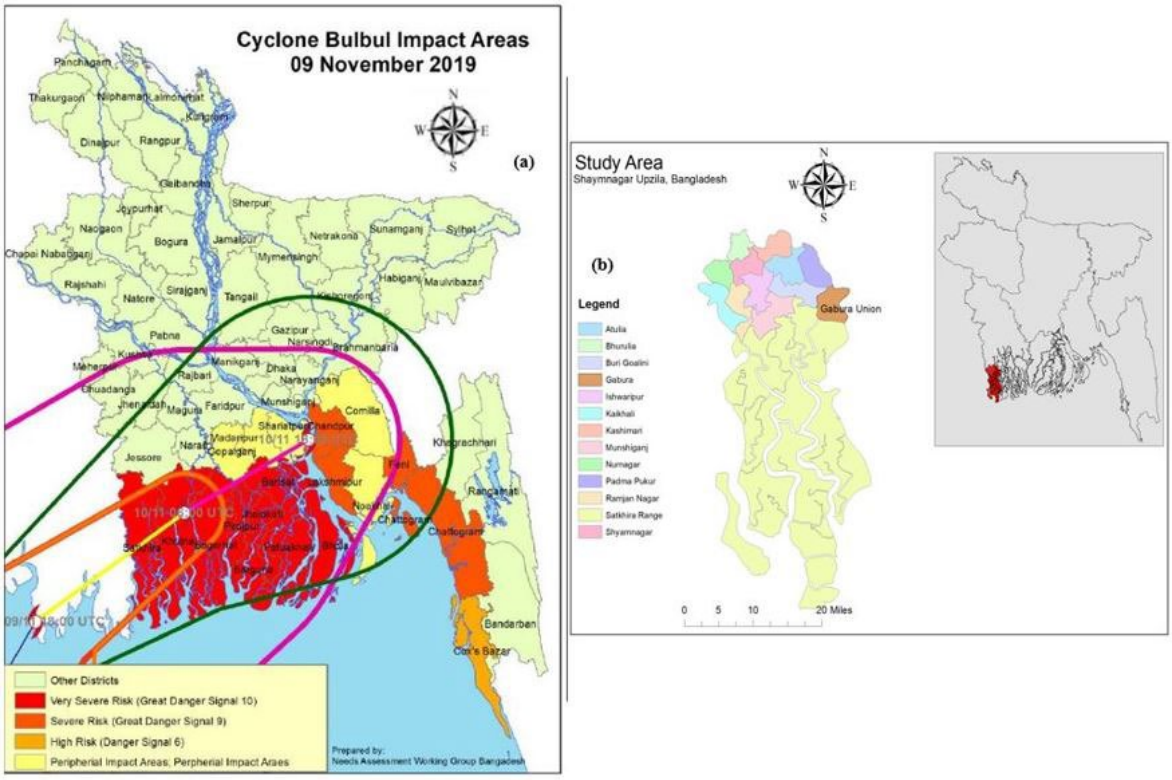

Figure 1. (a) Cyclone Bulbul Impact Areas (Need Assessment Working Group Bangladesh, November 9, 2019), (b) Study area (created by the authors using ESRI ArcGIS)

Cyclone Bulbul made landfall in Parsegonj, West Bengal, India on November 9, 2019, between 8:30 pm and 11:00 pm, and hit Bangladesh on November 10, 2019, at around 1:00 am

local time. The study area was Shyamnagar Upazila, Satkhira District, in the division of Khulna, Bangladesh. Shyamnagar is located at 22.3306°N and 89.1028°E. It has 46,592 households and a total area of 1968.24 km². It comprises 12 union parishads, 127 Mouzas, and 216 villages. Among these 12 unions, Gabura was selected for this study, as this union (Figure. 1) was the most severely affected community during Cyclone Sidr (2007) and Cyclone Aila (2009), as well as the recent Cyclone Bulbul.

Cyclone Bulbul directly affected 13 districts in Bangladesh's coastal region. Because of high winds and heavy rainfall, the cyclone highly affected the coastal area. Cyclone Bulbul—categorized as a "Category 2" cyclone—had an average wind speed of 130–148 km/h around the circulation center and average precipitation of approximately 100–200 mm/h. The cyclone lasted for approximately one-and-a-half days in Bangladesh, making it one of the longest-lasting cyclones that the country had witnessed in the last 52 years (Iqbal 2020). A Daily Sun news report (2019) quoted Md Shah Kamal, senior secretary at the Ministry of Disaster Management and Relief, as saying that nearly 0.3 million vulnerable people from Bhola, Barguna, Patuakhali, Barishal, Pirojpur, Jhalakathi, Bagherhat, Khulna, and Satkhira and their offshore islands and chars (smaller islands) had been moved to cyclone shelters or other safer places by noon. Bulbul was expected to damage over 250,000 hectares of croplands and 150 households in the 13 districts, with at least 25 people killed during or shortly after the storm. Among these 13 districts, Barisal, Satkhira, and Khulna were reportedly the worst affected. In Satkhira, 25,000 hectares of paddy crops were fully or partially damaged, while 2,000 hectares of vegetables, betel leaf, mustard, and plums were damaged (Dhaka Tribune report 2019).

3. RESEARCH OBJECTIVES

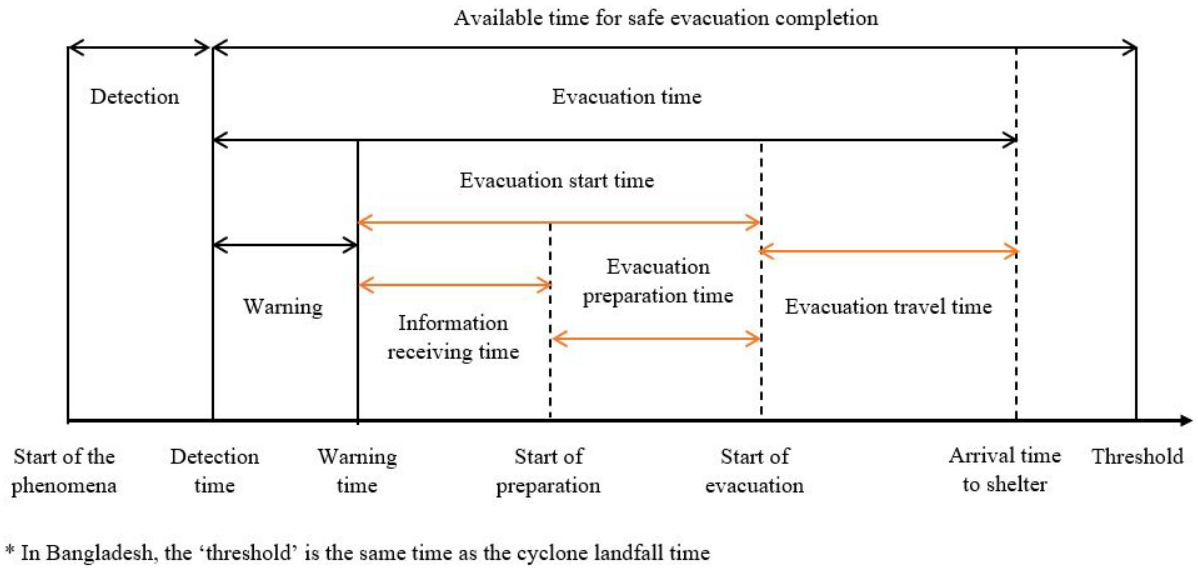

Figure 2. Schematic of the cyclone evacuation timeline (created by author)

The overall objective of this study was to analyze people's perceptions of and experiences with early evacuation decisions and early evacuation. Furthermore, it also attempted to evaluate the factors associated with early evacuation decisions, early evacuation, and emergency evacuation at different evacuation stages during the most recent cyclone Bulbul. According to Figure 2, after receiving a cyclone warning, respondents decided whether to evacuate. If they decide to evacuate, they then prepare for evacuation commencement. Following the cyclone warning signal, some respondents evacuated before the evacuation order, while others evacuated after the evacuation order. Based on the evacuation starting time concerning evacuation orders, identified who made early evacuation and emergency evacuation.

The specific objectives of this study were:

- To determine people's perception of weather conditions, the presence of vulnerable members in the house, previous disaster experiences, and demographic and socio-economic aspects affecting their evacuation decisions.
- To understand the consequences and complexities of early evacuation decisions for evacuees because of the different kinds of challenges they faced when attempting to come up with suitable solutions for the problems. Additionally, to determine the importance of household preparation time for safe and successful evacuation during a cyclone disaster, and
- To understand why only a few people evacuated early and many others did not during the cyclone, and to identify the critical factors that influenced people's early evacuation.

4. METHODOLOGY

In this study, both qualitative and quantitative approaches were applied to achieve its objectives. A field survey was conducted between mid-February and mid-March 2020, three months after Cyclone Bulbul made landfall on November 10, 2019 (local time around 1:00 am in the targeted area), in Gabura Union of Shyamnagar Upazila in the Satkhira district of Bangladesh. For the quantitative approach, a community-level structured questionnaire was used to conduct surveys in Gabura Union to understand people's perceptions about early evacuation possibilities and emergency evacuation. This type of questionnaire survey of the affected community made it possible to understand evacuation behavior and identify the factors influencing early evacuation decisions. The questionnaire comprised different variables related to people's perceptions about and the possibility of early evacuation, preparation, emergency response, evacuation order, and early evacuation decision-making issues. First, the author collected all household information, such as house numbers from the local government office. The primary data were collected via personal visits to the field from community members in the designated area using random sampling based on house numbers. If the randomly selected household respondents were absent during the survey, the household respondents were interviewed later. Although we mentioned 413 households, each household's response to the questionnaire had one household head representative. Here, household respondents are the

household heads responsible for household decision-making. Primary data were collected using questionnaires targeting 413 households from 1,971 total households in one union in three wards or villages in the study area, most affected by cyclone Bulbul 2019. According to government representatives, these three wards are recognized as hard-to-reach areas, and internal communication is not good. People face difficulties accessing social service facilities during the rainy season and disaster time. The questionnaire comprised three sections and a total of 38 questions. The questionnaire sections used were 1. Early preparedness and warning for Cyclone Bulbul, 2. Evacuation decision, preparation time, and scenario information during Cyclone Bulbul and 3. General information about respondents and households before conducting the survey. The author tested the validity of the questionnaire through dummy data collection with several households and then modified the questionnaire again for the survey. For data collection, there was one college teacher and two former NGO members who went to individual households to gather responses according to the questionnaire. The author also joined alternatively with each selected person during data collection. It took approximately 20 to 30 minutes to complete the questionnaire responses for each household. The original questionnaire survey was drafted in English and distributed in the selected area after being translated into the Bengali language.

The qualitative research approach was based on a literature review and analysis of the collected survey data. The qualitative research approach focused on distinct threats, challenges, and problems prevalent in the early evacuation context. It also determined the relevant consequences for evacuees when they considered the possibility of early evacuation. To obtain clear information about distinct problems and challenges, this study conducted interviews with four people to obtain qualitative data. People were selected based on their knowledge and involvement with the evacuation process during emergencies. The objective of each interview was to obtain information about each person's judgment about the evacuation process during a disaster. However, the interviews did not exactly follow the strict list of questions. Among the four persons, there was a chairman (head of the union) and, a member (head of one ward in the union) local government representative, a college teacher, and a CPP unit team leader respectively. The interview with the chairman and CPP unit team leader took place at the local government office, while interviews with members and college teachers took place at community meetings.

By analyzing the results through descriptive statistics, this study examined the relationships among different variables, such as reasons for non-evacuation, preparation type and time, evacuation companions, livestock, evacuation mode, route selection, travel time from home to shelter, distance, and demographic characteristics to determine how they influenced early evacuation and evacuation decisions. Furthermore, the study analyzed factors that affected evacuation completion during Cyclone Bulbul based on the starting time of evacuation and the travel time to shelters for each household.

5. RESULTS

5.1 Cyclone Primary Stage/ Warning Stage

The cyclone warning stage, occurring between 10 hours and 36 hours before the predicted landfall of a cyclone, defines the cyclone primary stage. When people receive the first warning signal, they consider or start making evacuation plans. They begin preparations for evacuation and plan when to evacuate. All survey respondents said they received a warning about Cyclone Bulbul.

The results of the questionnaire survey revealed that all respondents (100%), both men and women, received the primary warning signal (Table 1). The results confirmed the success of local and national authorities in disseminating the primary warning, but the communication did not happen simultaneously in the same area.

Table 1. Receipt of primary warning signal during Cyclone Bulbul

Gender	Yes (%)	No (%)	Total (%)
Male	324 (100)	0 (0)	324 (100)
Female	89 (100)	0 (0)	89 (100)
Total	413 (100)	0 (0)	413 (100)

5.2 Reasons for Non-Evacuation During Cyclone Bulbul

There are different reasons why respondents did not evacuate during Cyclone Bulbul. Of the 413 respondents, 185 did not evacuate during Cyclone Bulbul, with these respondents citing 16 reasons for not evacuating. Among the reasons cited, the main reasons for non-evacuation varied for men and women.

As shown in Figure 2, male respondents had five main reasons, with 61.5% of respondents saying, “I thought I would be able to move during the cyclone,” followed by 60% who said, “the weather outside was dangerous.” Approximately 55% of respondents said that they could not move because the road was damaged, 45% said they wanted to protect their home by not evacuating, and 55% reported feeling that their house was safe to stay. Although the percentages were not very high, the presence of a sick member in the house (33%), work (31.5%), a distance of the cyclone shelter from home (22%), and unsafe cyclone shelters (22%) were also cited as reasons for not evacuating.

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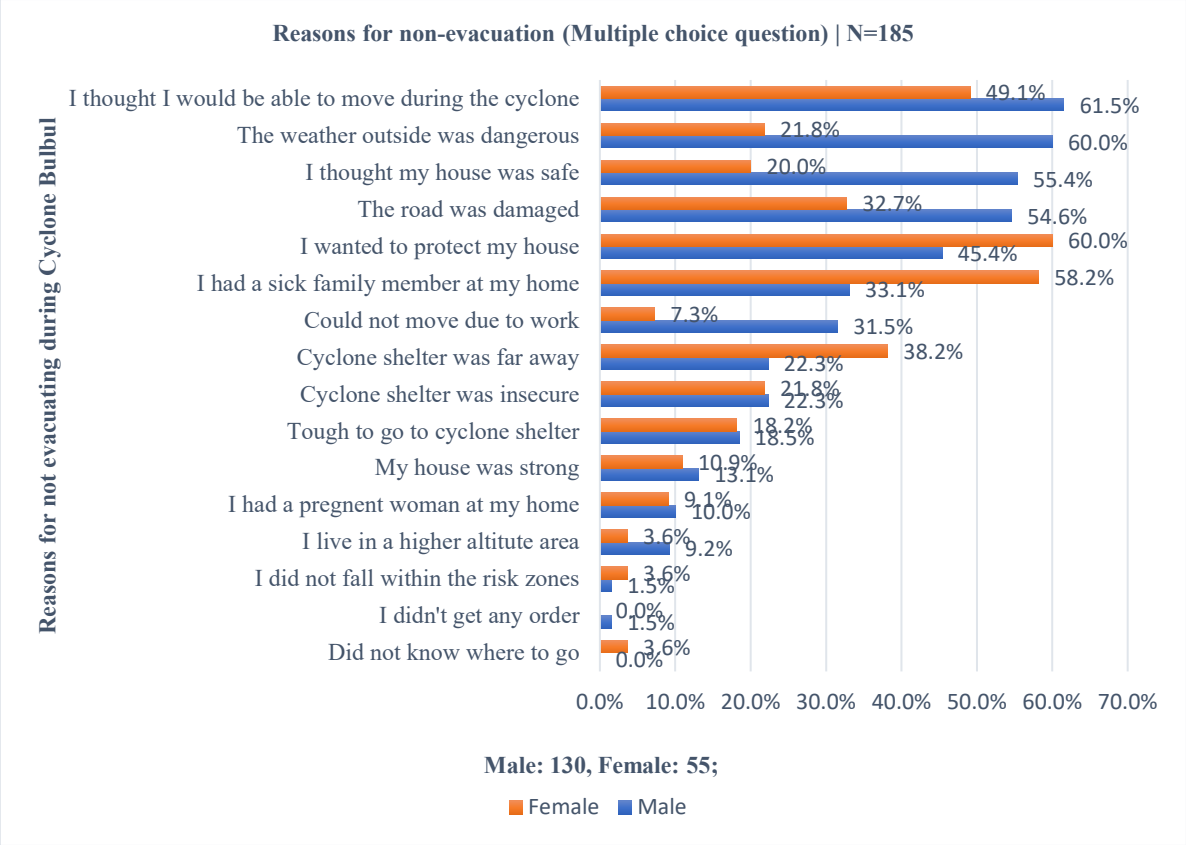

Figure 3. Reasons for non-evacuation during Cyclone Bulbul

Female respondents cited four main reasons, as shown in Figure 3. Sixty percent of the respondents said, "I wanted to protect my house," followed by 58% who claimed that they had a sick member in the house, which is not surprising as women are usually responsible for taking care of family members. Like male respondents, around 49% of female respondents said, "I thought I would be able to move during the cyclone." Furthermore, around 38% of respondents mentioned that the shelter was far away, and 33% said the road was damaged, making it difficult to go to cyclone shelters. Although the percentages were not very high, the dangerous weather outside (22%), unsafe cyclone shelters (22%), and their belief that their house was safe to stay in (20%) were also cited as reasons for not evacuating.

5.3 Previous Disaster Experience

Previous disaster experience is an important factor that guides people in making more effective decisions during future emergencies. Figure 4 shows people's past experiences of a super-cyclone before Cyclone Bulbul. The survey results showed that of the 413 respondents, 188 (45.5%) had experienced a cyclone four times in the past, followed by 148 respondents (35.8%) who had experienced a cyclonic disaster three times, and 63 respondents (15.3%) had experienced a cyclone twice. Thirteen respondents (3.1%) had experienced a cyclone five times, and one respondent had experienced a cyclone once in the past.

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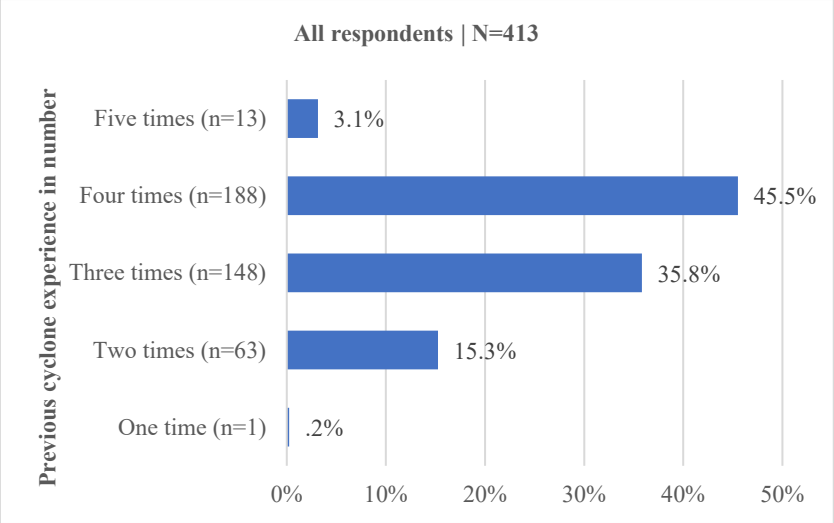

Figure 4. Respondents' previous cyclone experience before Cyclone Bulbul

5.4 Evacuation During Cyclone Bulbul

Table 2. Evacuation during Cyclone Bulbul

Gender	Yes (%)	No (%)	Total (%)
Male	194 (59.9)	130 (40.1)	324 (100)
Female	34 (38.2)	55 (61.8)	89 (100)
Total (%)	228 (55.2)	185 (44.8)	413 (100)

In Bangladesh, males are generally the head of the household and are in charge of making household decisions. Those households that represent female respondents mean that they are divorced, widowed, or the male stays outside the village due to work or other reasons. Thus, those females are now responsible for taking care of households and households' decisions on different issues. Table 2 shows the percentage of respondents who evacuated during Cyclone Bulbul by gender. Of the 324 male respondents, 194 (59.9%) said they had evacuated. Only 34 of the 89 female respondents (38.2 percent) said they had evacuated. The evacuation rate is lower among women than men because the latter is usually the head of the household and responsible for making decisions and executing them, while women are more likely to be involved in caring for family members and managing household activities.

5.5 Evacuation Preparation and Preparation Time

People prepare themselves and for evacuation after receiving a cyclone warning, by organizing things that they will need before or just after the cyclone makes landfall. According

to Parvin *et al.* (2019), the preparation process from the time of receipt of warning to cyclone landfall and the prioritization of activities ahead of evacuation vary from person to person depending on individual considerations. Most people prioritize organizing emergency goods that they would need at the shelter. They also consider the safety of domestic animals and want to bring their animals along with them when evacuating to shelters or other safer places. Thus, evacuation preparation and preparation time depend on people's perceptions of the type of preparation needed for either emergency evacuation or early evacuation (Parvin *et al*. 2019).

People were involved in various activities before the start of the evacuation during Cyclone Bulbul, and they believed that all of those activities were important. As shown in Figure 5, people prioritized activities such as organizing drinking water and medicine (87%), preparing all family members (85.5%), and preparing food for use at the shelter (82.5%). They were also engaged in other similarly important activities, such as ensuring the safety of the house (80%) and attending to children (77%) and older members (79%) who needed special care before evacuation. Therefore, if there are children or older members in the house, a longer preparation time is needed to prepare them for evacuation.

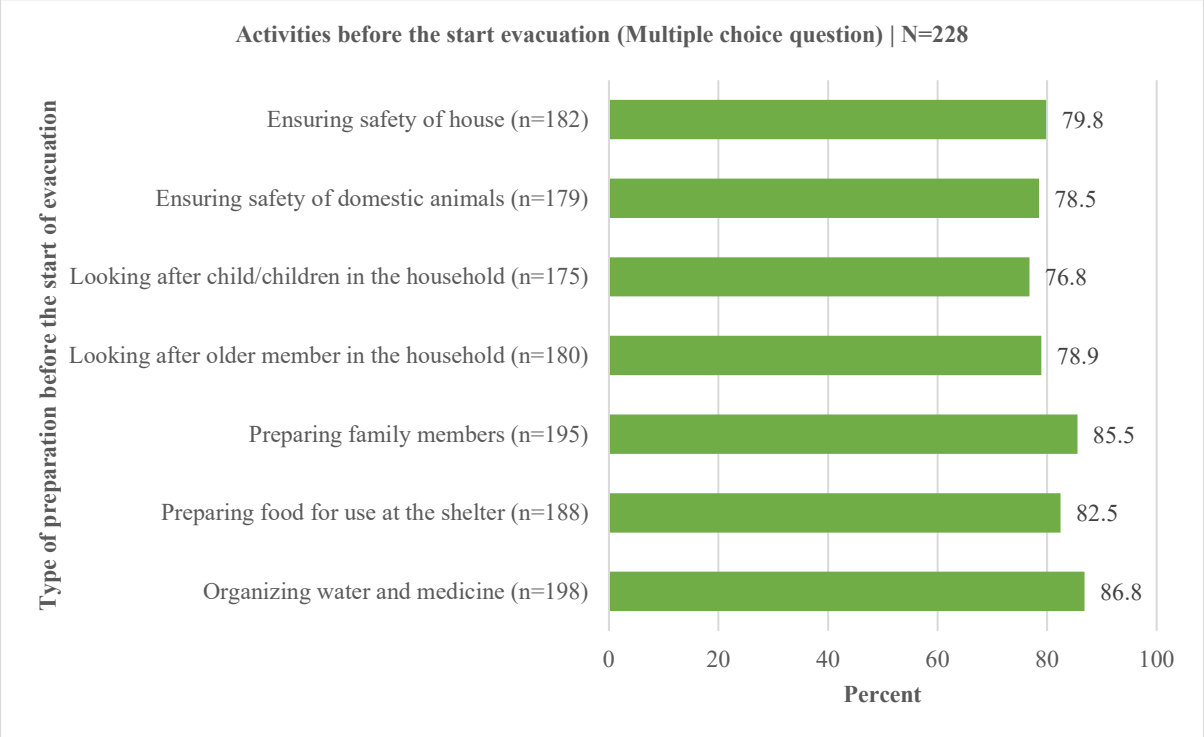

Figure 5. Respondents' activities before the start of evacuation

Figure 6 shows the respondents' responses regarding individual household preparation time before the evacuation commencement during Cyclone Bulbul. Most of the respondents (73%) said their preparation time ahead of evacuation was 2 hours. Very few respondents (18%) said

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they only took one hour, while about 9% of the respondents took between 3 and 6 hours to prepare for evacuation.

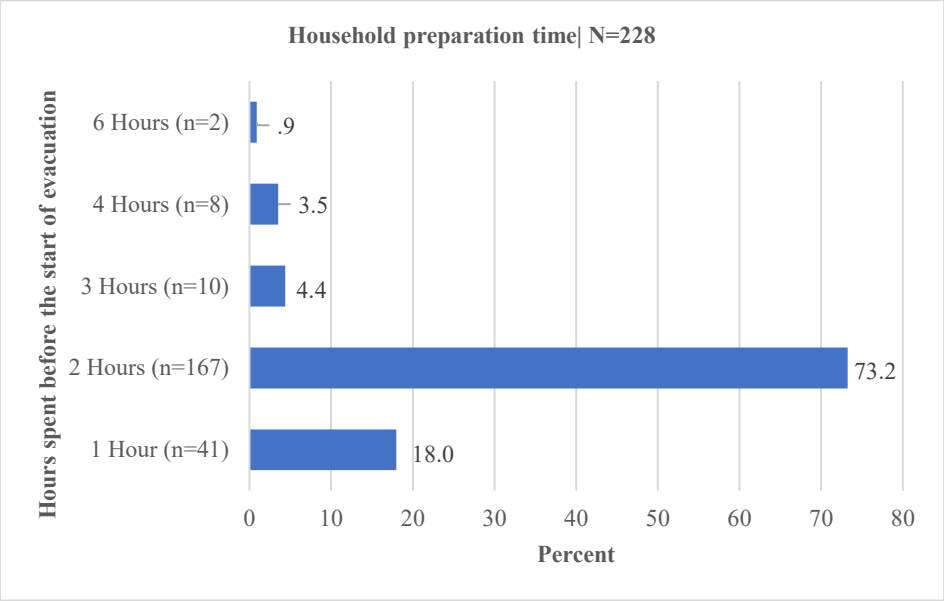

Figure 6. Household preparation time before the start of evacuation during Cyclone Bulbul

5.6 Early Evacuation Decision During Cyclone Bulbul

Table 3 shows the percentage of respondents who made an early evacuation decision during Cyclone Bulbul by gender. Of the 324 male respondents, 171 (52.8%) decided to evacuate early, while only 23 (25.8%) of the 89 female respondents made an early evacuation decision.

Table 3. Early evacuation decision during Cyclone Bulbul

Gender	Yes (%)	No (%)	Total (%)
Male	171 (52.8)	153 (47.2)	324 (100)
Female	23 (25.8)	66 (74.2)	89 (100)
Total (%)	194 (47.0)	219 (53.0)	413 (100)

5.7 Early Evacuation Based on Starting Time of Evacuation During Cyclone Bulbul

This research analyzed the target population's starting time of evacuation from their house based on the time Cyclone Bulbul made landfall on November 10, 2019 (local time 1:00 am in the targeted area). The starting time of evacuation before cyclone landfall depended on various

factors associated with household characteristics, risk perception, and the prevalent situation. As seen in Figure 7, the resulting cumulative distribution graph confirms that among the respondents who evacuated during Cyclone Bulbul, most began evacuating 8 to 12 hours before landfall. Approximately 40% of household respondents started their evacuation 8 h before landfall—categorized as emergency evacuation. Around 33% started evacuating 10 to 18 hours before landfall—categorized as early evacuation. Only 20% started their evacuation 1 to 7 h before the cyclone made landfall.

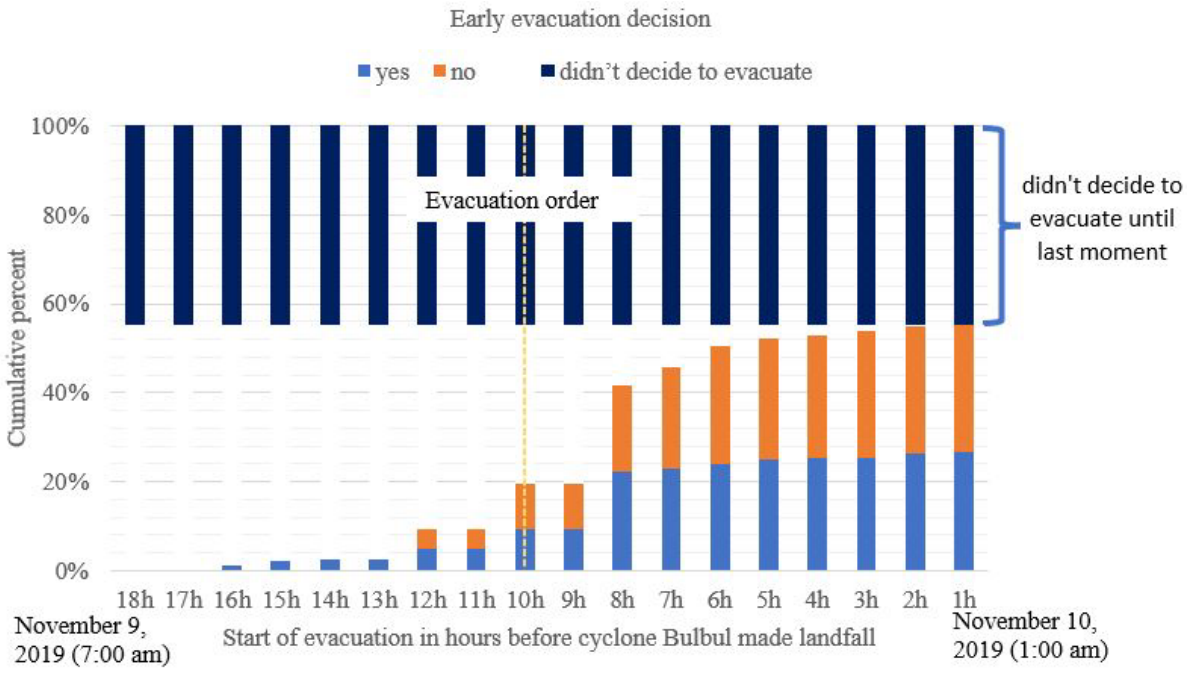

Figure 7. Relationship between early evacuation decision and starting time of evacuation of individual households before Cyclone Bulbul made landfall

6. FACTORS PROMPTING EARLY EVACUATION DECISION AND EARLY EVACUATION

This research analyzed the factors that influenced early evacuation decisions and actual early evacuation during Cyclone Bulbul and the relationship between those factors and the actual evacuation commencement.

6.1 Factors Prompting Early Evacuation Decision during Cyclone Bulbul

As part of the questionnaire survey, respondents were asked whether they evacuated family members individually or together, with 100% saying they evacuated all members together showing great concern for the family during a disaster. The household members here are

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categorized as relatives, disabled members, older members, and others. Notably, disabled members are those who cannot move alone, and therefore need assistance from other members during evacuation. While categorizing others, they mention their neighbors or surrounding households who are not well-known to each other. Figure 8 reveals the relationship between evacuation companions and early evacuation decisions during Cyclone Bulbul. The survey results indicated a significant correlation between evacuation companions and early evacuation decisions. Approximately 46% and 28% of respondents with children and older members in their household, respectively, decided to evacuate early. Conversely, around 50% and 37% of respondents with children and older members in their household, respectively, did not make early evacuation decisions.

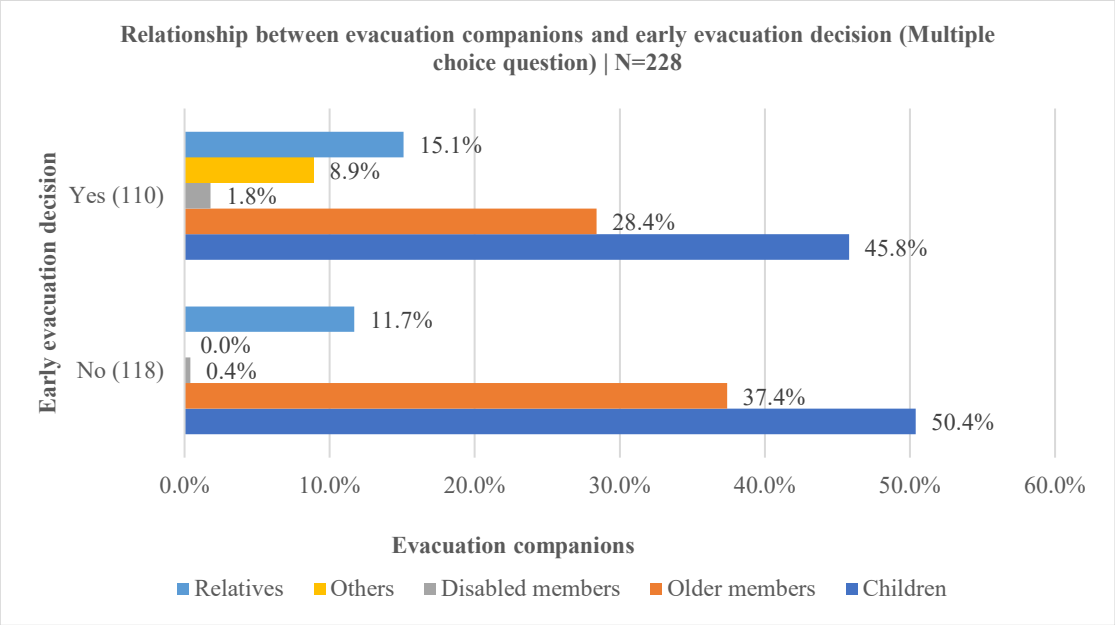

Figure 8. Relationship between evacuation companions and early evacuation decision during Cyclone Bulbul

Respondents were asked about their preparation time before evacuation to determine the relationship between preparation time and early evacuation decisions. Figure 9 illustrates, among respondents who made an early evacuation decision, around 71% took 2 hours as preparation time, while around 11%, 9%, and 7% took 1 h, 3 h, and 4 h, respectively, as preparation time before evacuation. Conversely, among those who did not make an early evacuation decision, the majority (75%) took two hours, while only around 25% took one hour.

This study also adopted demographic and socio-economic approaches to determine the relationship between factors that prompted an early evacuation response (based on people's perception) among the respondents during Cyclone Bulbul. Eight factors were considered in this study. Table 4 shows that of the eight factors, four are demographic variables, namely respondent gender, age group, household size, and the presence of a sick member in the house.

Only two of these four demographic variables, respondent gender and the presence of a sick member in the house, were found to have a significant correlation with early evacuation decisions. Approximately 53% of male respondents made early evacuation decisions. Then again, only around 26% of the female respondents made early evacuation decisions, indicating that women are less likely to be involved in the decision-making process and more likely to be engaged in taking care of family members during a disaster. A relatively high percentage of respondents with a sick member at home (approximately 74%) did not make an early evacuation decision, indicating that having a sick member in the house makes it difficult to evacuate because the travel time and shelter distance pose a great challenge. Age group and household size had no significant influence on the early evacuation decisions.

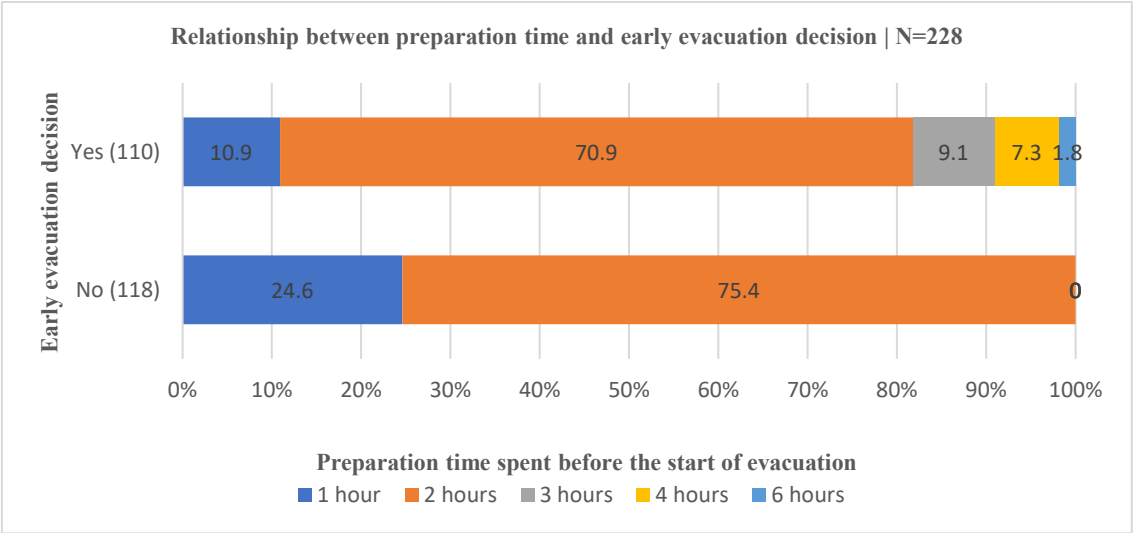

Figure 9. Relationship between preparation time before evacuation and early evacuation decision during Cyclone Bulbul

Concerning the two socio-economic variables, occupation category, and income group, occupation category had no significant correlation with early evacuation decisions. The survey results showed that most respondents in the study area were either farmers or daily workers. All occupation category respondents showed similar trends in early evacuation decisions. However, the income group had a significant influence on the early evacuation decisions. Around 81% of the respondents whose income was higher than 5,000 BDT (around $59) and around 47% of those whose income was less than 5,000 BDT did not make an early evacuation decision.

Table 4. Factors prompting early evacuation decision during Cyclone Bulbul

		Early evacuation decision during Cyclone Bulbul					
		Yes		No		Total	
Respondent gender P=.000*	Male	171	52.8%	153	47.2%	324	100.0%
	Female	23	25.8%	66	74.2%	89	100.0%
Age Group P=.632	18–40	77	46.1%	90	53.9%	167	100.0%
	41–60	85	48.6%	90	51.4%	175	100.0%
	>60	32	45.1%	39	54.9%	71	100.0%
Occupation Category P=.847	Housewife	7	36.8%	12	63.2%	19	100.0%
	Farmer/Daily Worker	174	47.2%	195	52.8%	369	100.0%
	Retired	4	66.7%	2	33.3%	6	100.0%
	Business/Job	9	47.4%	10	52.6%	19	100.0%
Income Group P=.000*	500–5000 BDT	180	52.9%	160	47.1%	340	100.0%
	>5000 BDT	14	19.2%	59	80.8%	73	100.0%
Household Size P=.663	<=5	138	46.3%	160	53.7%	298	100.0%
	>5	56	48.7%	59	51.3%	115	100.0%
Sick Member P=.000*	No	168	53.8%	144	46.2%	312	100%
	Yes	26	25.7%	75	74.3%	101	100%
Shelter Distance Group P=.000*	100–1000 m	68	40.2%	101	59.8%	169	100.0%
	>1000 m	42	71.2%	17	28.8%	59	100.0%
Travel Time to Shelter P=.000*	2–30 min	50	35.7%	90	64.3%	140	100.0%
	31–60 min	59	72.0%	23	28.0%	82	100.0%
	>60 min	1	16.7%	5	83.3%	6	100.0%

* The chi-square test statistic is significant at the 0.05 level

Table 4 also shows that the early evacuation decision rate was higher among respondents whose houses were far from shelters compared to those whose houses were near shelters. This difference confirmed a significant correlation between the shelter distance and early evacuation

decisions. Approximately 71% of respondents for whom the distance from their house to the shelter was over 1000 meters made an early evacuation decision, whereas the corresponding rate was around 40% for respondents for whom the distance was 100–1000 meters. Similarly, travel time to the shelter also showed a significant influence. According to the survey results, most respondents (140 out of 228) took less than 30 minutes to travel from home to the shelter suggesting the distance to the shelter was 100–1000 meters for most of them. The evacuation decision rate was higher for those who took 31–60 min to evacuate at 72%. Conversely, the percentage was much lower among the other groups; six respondents (17%) took over 60 minutes to evacuate.

6.2 Factors Prompting Early Evacuation Based on Evacuation Starting Time during Cyclone Bulbul

Table 5. Respondent category based on their actual evacuation starting time

Starting time of evacuation (before cyclone landfall)	Number	Percent
Less than 10 hours	147	64.5
10 hours or more	81	35.5
Number of evacuated people	228	100

According to the Bangladesh Meteorological Department (BMD), a cyclone evacuation order is given at the cyclone great-danger stage or 10 h before the cyclone landfall time. Based on this evacuation order time, this study divided respondents into two groups considering the actual time when they began evacuation during Cyclone Bulbul. One group evacuated 10 hours or more before the cyclone made landfall, while the other group evacuated less than 10 hours before the cyclone made landfall. Respondents who evacuated 10 hours or more before landfall were categorized into the early evacuation group, and the other group was categorized as the general or emergency evacuation group. Table 5 shows the distribution of respondents based on the starting time of evacuation to a safer place during Cyclone Bulbul. The percentage of respondents who carried out emergency evacuation (147 of 228 [64.5%]) was higher than that of early evacuees (81 228 [35.5%]).

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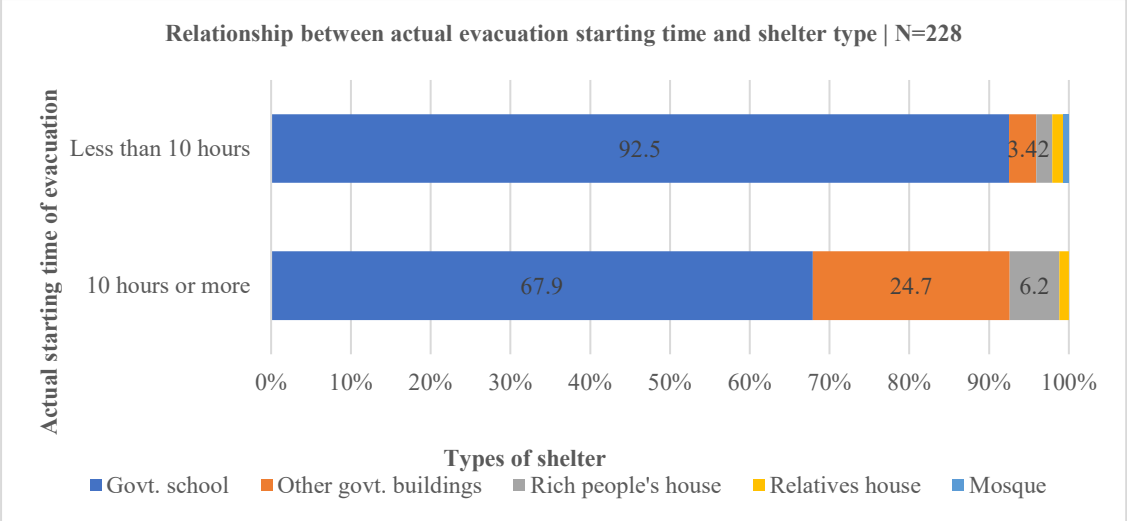

Figure 10. Relationship between actual evacuation starting time and shelter type during cyclone Bulbul

Respondents were asked about the types of shelter that they evacuated during Cyclone Bulbul. Figure 10 shows the relationship between the actual evacuation start time and shelter type chosen by the respondents. Among respondents who evacuated less than 10 hours before the cyclone made landfall, the majority (92.5%) chose a government school as the designated cyclone shelter, while 3.4% and 2% chose other government buildings and rich people's houses, respectively, as their evacuation places. The survey results revealed more variation in the choice of cyclone shelter when respondents carried out an early evacuation. Nearly 68% of the respondents chose a government school, around 25% chose other government buildings, and some 6% chose rich people's houses as their evacuation place.

Figure 11 shows the relationship between evacuation companions and early evacuation during Cyclone Bulbul. The results indicated a significant correlation between evacuation companions and early evacuation. Among respondents who did not evacuate early, around 49% said they evacuated with children, and 40% evacuated with older members. A significantly lower percentage of respondents evacuated with others and relatives at approximately 2.1% and 8.3%, respectively. Similarly, among respondents who carried out early evacuations, approximately 47% said they evacuated with children. A relatively lower percentage of respondents confirmed that they evacuated with older members, with others, and with relatives at around 21%, 8%, and 22%, respectively. Households with older members tend to evacuate early because they already know the consequences of evacuation, such as longer preparation times and longer travel times. Considering these difficulties, for their safe and complete evacuation, they are more likely to evacuate early.

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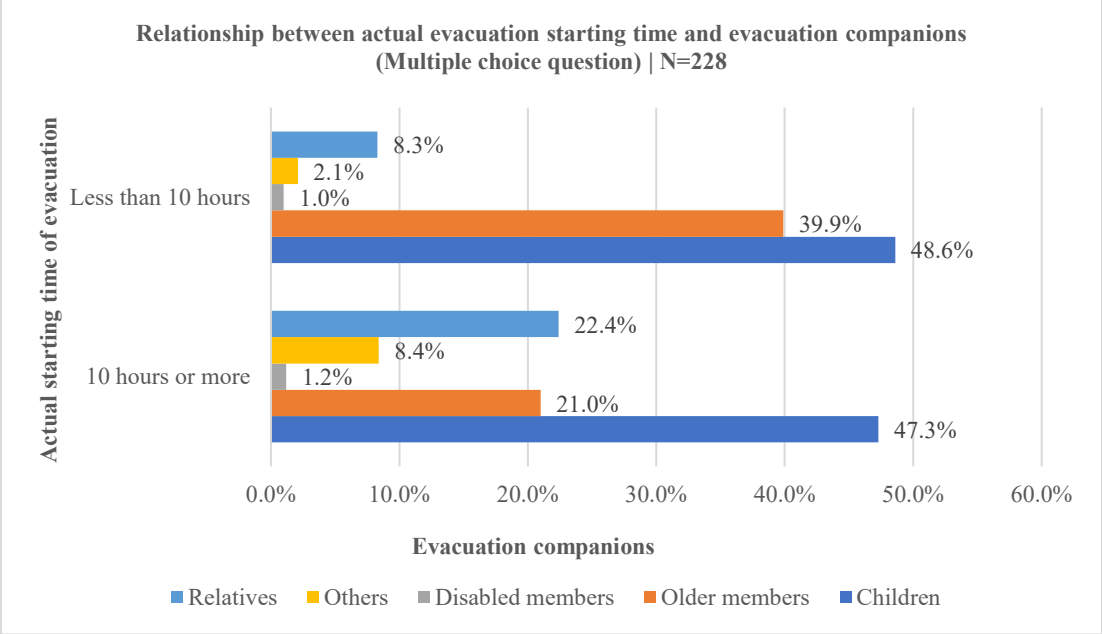

Figure 11. Relationship between actual evacuation starting time and evacuation companion during Cyclone Bulbul

The survey results showed that only 24.5% of households had sick members at home. Figure 12 shows that among respondents who did not evacuate early, only around 12% said they had a sick member, while the percentage was much higher at around 32% among early evacuees during Cyclone Bulbul. If sick members in the house were also intended to evacuate early because of longer preparation and travel times.

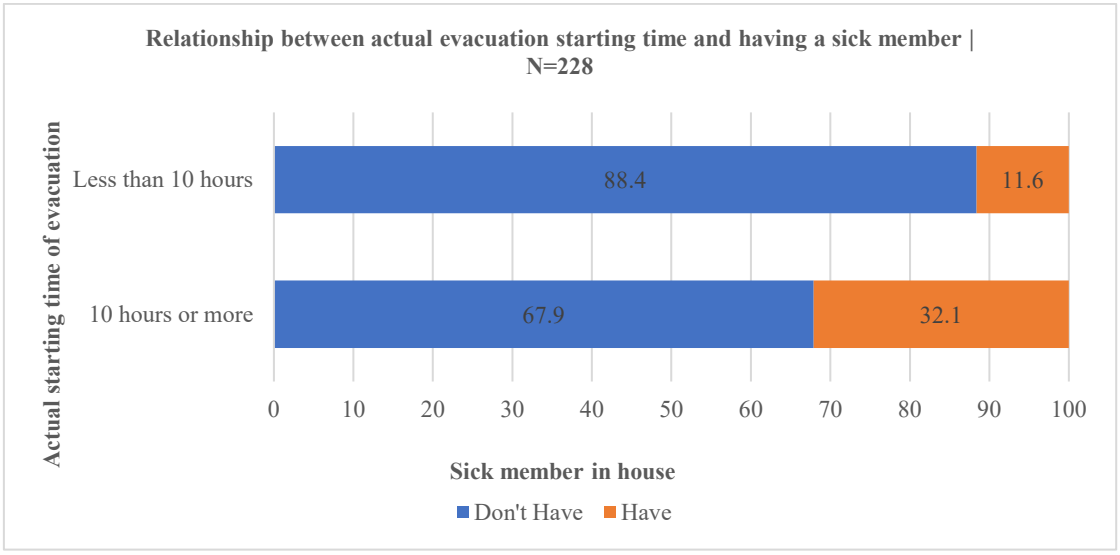

Figure 12. Relationship between actual evacuation starting time and having a sick member in the house

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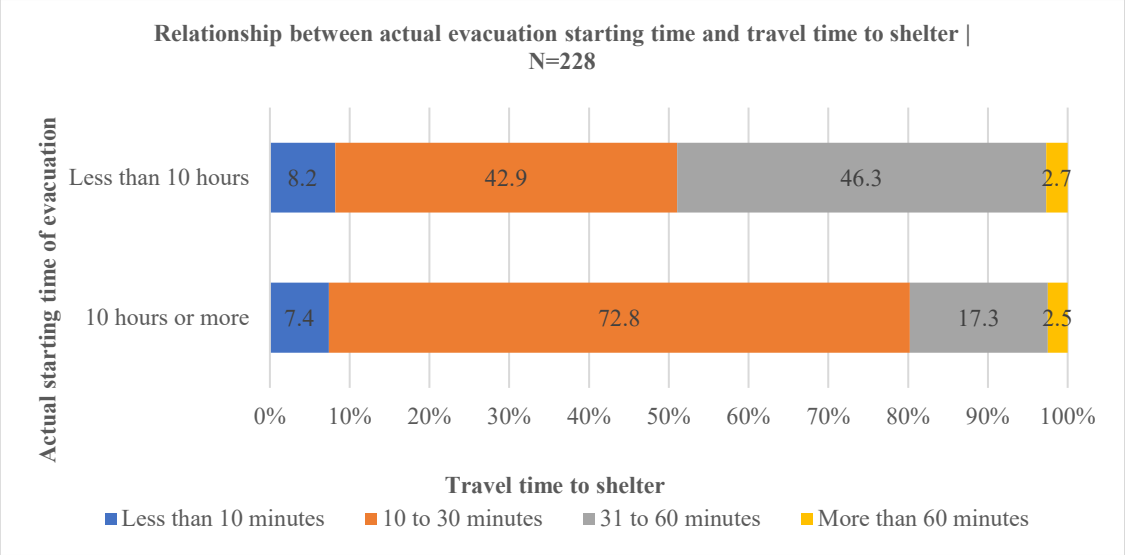

Figure 13. Relationship between actual evacuation starting time and travel time to shelter

The travel time from home to shelter is also an important factor that influences evacuation decisions. Figure 13 suggests that most of the household respondents in both groups took 10–60 minutes of evacuation travel time. Among respondents who did not evacuate early, nearly 43% took 10 to 30 minutes and 46% took 31 to 60 minutes in evacuation travel time. Among respondents who were early evacuees, the majority (73%) took 10 to 30 minutes, while only around 17% took 31 to 60 minutes in evacuation travel time during Cyclone Bulbul. For respondents in both groups, the distance from their house to the shelter was between 100 and 1000 m, explaining why they took a similar time even though the percentage was different.

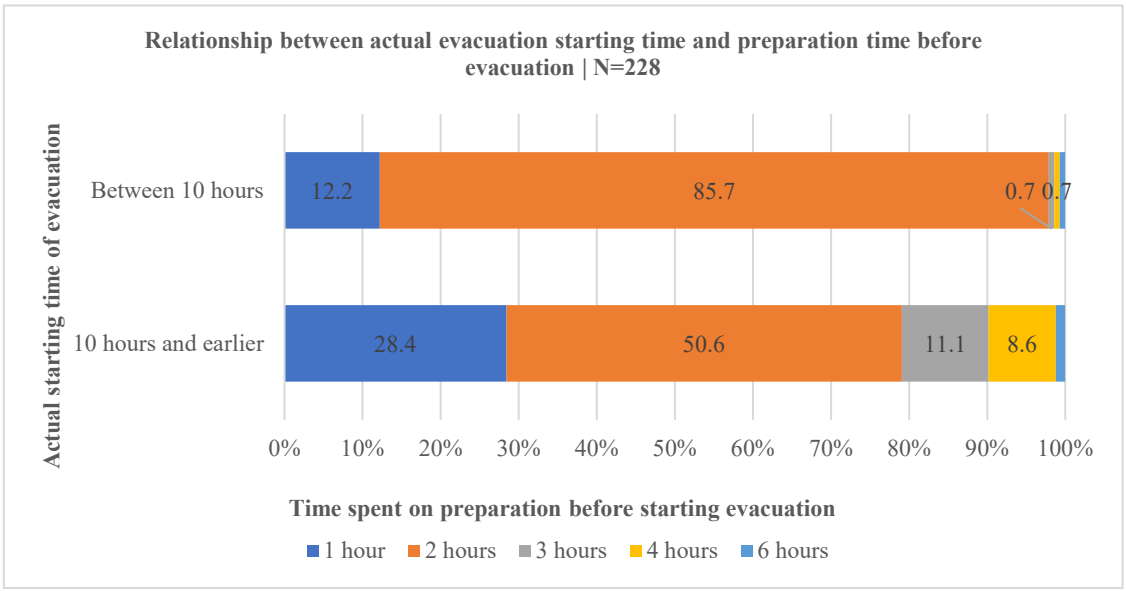

Figure 14. Relationship between actual evacuation starting time and preparation time

Respondents were asked about their preparation time before starting the evacuation to determine the relationship between the preparation time and actual evacuation starting time. Figure 14 shows that a little over half of the early evacuees (51%) took 2 h in preparation time, while approximately 28%, 11%, and 9% took 1 h, 3 h, and 4 h, respectively. Among those who did not evacuate early, the majority (86%) took two hours, while only around 12% took one hour. Earlier evacuation shows a variation in preparation time—ensuring sufficient time for preparation before starting evacuation.

7. FACTORS PROMPTING EVACUATION RESPONSE DURING CYCLONE BULBUL

Figure 15 shows that among respondents who were not driven to take steps to evacuate during Cyclone Bulbul, around 26% had experienced a disaster two times in the past, 40.5% three times, 31% four times, and 2% five times. Among those who were prompted to evacuate, nearly 7% had experienced a disaster twice in the past, 32% three times, 57% four times, and 4% five times. The result indicated that those who had experienced disasters more times took effective evacuation decisions compared to those who had less experience, showing their effectiveness during an emergency.

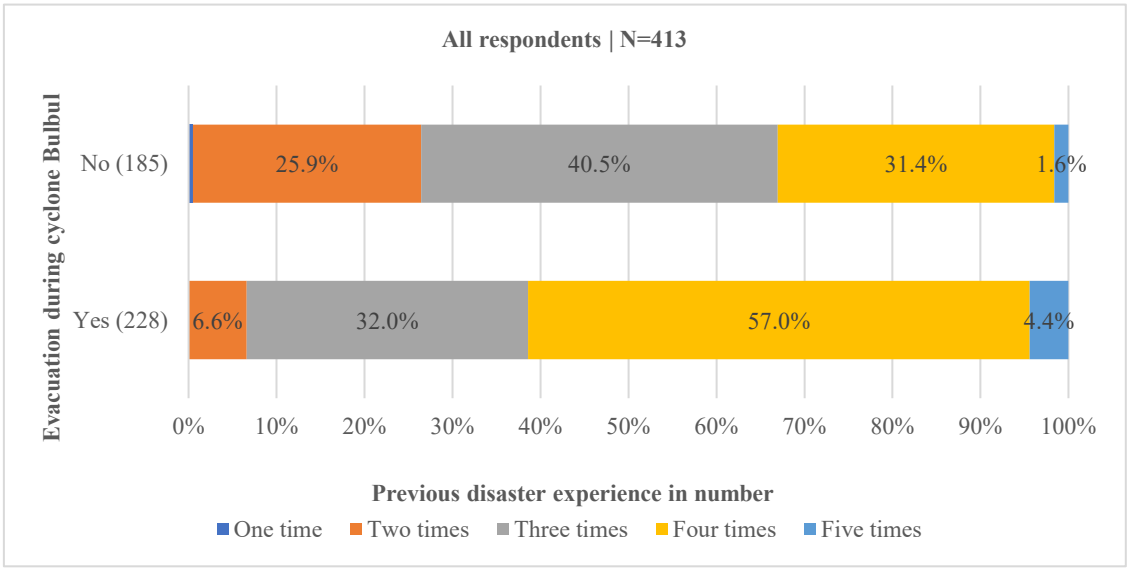

Figure 15. Relationship between previous disaster experience and evacuation during Cyclone Bulbul

Table 6. Factors prompting evacuation during cyclone Bulbul

		Evacuation during Cyclone Bulbul					
		Yes		No		Total	
Respondent gender P=.000*	Male	194	59.9%	130	40.1%	324	100.0%
	Female	34	38.2%	55	61.8%	89	100.0%
Age Group P=.179	18–40	83	49.7%	84	50.3%	167	100.0%
	41–60	103	58.9%	72	41.1%	175	100.0%
	>60	42	59.2%	29	40.8%	71	100.0%
Occupation Category P=.004*	Housewife	3	15.8%	16	84.2%	19	100.0%
	Farmer/Daily Worker	212	57.5%	157	42.5%	369	100.0%
	Retired	4	66.7%	2	33.3%	6	100.0%
	Business/Job	9	47.4%	10	52.6%	19	100.0%
Income Group P=.000*	500–5000 BDT	172	50.6%	168	49.4%	340	100.0%
	>5000 BDT	56	76.7%	17	23.3%	73	100.0%
Household Size P=.579	<=5	162	54.4%	136	45.6%	298	100.0%
	>5	66	57.4%	49	42.6%	115	100.0%
Sick Member P=.003*	No	185	59.3%	127	40.7%	312	100.0%
	Yes	43	42.6%	58	57.4%	101	100.0%

* The chi-square test statistic is significant at the 0.05 level

This study used demographic and socio-economic approaches to determine the relationship between factors that prompted an evacuation response among respondents during Cyclone Bulbul in the same way as it did for early evacuation decisions. Six factors were considered in this study. Table 6 shows that of these six factors, four are demographic variables, namely respondent gender, age group, household size, and the presence of a sick member in the house. Only two of the four demographic variables, respondent gender and the presence of a sick member in the house, had a significant correlation with evacuation. Approximately 60% of the male respondents evacuated during Cyclone Bulbul. Only 38% of the female respondents evacuated. The results also showed that the evacuation rate was higher among respondents who did not have a sick member in the house (59%) than among those who had (43%), suggesting

that it was difficult and unsafe to evacuate with a sick member. Age and household size had no significant influence on evacuation.

Table 6 shows that both the socio-economic variables, occupation category, and income group, had a significant influence on evacuation during Cyclone Bulbul. Respondents from all occupational categories had almost similar trends for evacuation except housewives as they are more likely involved in taking care of family members and related things than in managing evacuation during a disaster. Similarly, the income group also had a significant influence on evacuation. The evacuation rate was around 77% among those whose income was higher than 5,000 BDT and around 51% among respondents whose income was less than 5,000 BDT. An informal conversation during the questionnaire survey confirmed that low-income people always want to protect their house during a disaster, they are therefore reluctant to evacuate and want to stay home during an emergency.

8. FINDINGS AND DISCUSSION

This study analyzed survey data to evaluate perceptions about the early evacuation and emergency evacuation during Cyclone Bulbul, including the factors that influenced evacuation decisions and the reasons for non-evacuation. The survey results revealed that evacuation with all family members was a great concern in both early and emergency evacuations. The findings of this study are significant as they shed light on the reasons for non-evacuation and people's evacuation behavior. This understanding can contribute to a safe and successful evacuation during a cyclone or related disaster. The key findings of this study are explained in detail.

Regarding people's response to an evacuation order and reasons for not evacuating during a cyclone, many previous studies conducted in the last two decades have focused on different perspectives. This research acknowledges the reasons for non-evacuation during cyclone disasters identified in previous research. According to Bern et al. (1993), trust in warning signals/evacuation orders is important, as most of the respondents did not follow the evacuation order during the 1991 cyclone because of their previous experience of receiving a false warning. The lack of cyclone shelters and facilities and the distance to shelters are also important reasons for non-evacuation during a cyclone (Haque et al. 2012; Paul and Rahman 2006). During Cyclone Bulbul, all respondents admitted that they received an early warning, but half of them did not follow evacuation orders (Table 3). For male respondents, the four main reasons for non-evacuation were "I thought I would be able to move during the cyclone," "the weather outside was dangerous," "I thought my house was safe," and "the road was damaged." For female respondents, the three main reasons for non-evacuation were "I wanted to protect my house," "I had a sick family member in my house," and "I thought I would be able to move during the cyclone" (Figure 2). Therefore, it is important to understand the reasons for non-evacuation from both male and female perspectives, which will make it easier to address gender-specific reasons carefully. The analysis of the survey results showed that the reasons for non-evacuation during Cyclone Bulbul were mostly related to weather conditions and

shelter characteristics. Because of the bad weather conditions before the cyclone made landfall, the condition of the roads deteriorated and made it difficult to travel to shelters. Furthermore, shelter distance and lack of proper facilities were major reasons for non-evacuation.

After receiving the warning, it is necessary to make evacuation decisions at the right time to ensure safe evacuation, given the risks involved. With early evacuation, the risk of property damage could be minimized by sending vulnerable members to the shelter earlier and having the household head stay at home and evacuating later (Roy et al. 2015). The present study acknowledges previous research by focusing on early evacuation decisions during Cyclone Bulbul. Early evacuation during cyclones could be beneficial for household evacuation. People who consider early evacuation during a disaster have certain priorities. For most respondents, the safe passage for specific members in the house like children or seniors is the main concern. After making an early evacuation decision, people undertake various activities and preparations before starting an evacuation. The decision to evacuate early gives people enough time for preparation. The questionnaire survey showed that households that made an early evacuation decision took 1 to 6 hours for preparation, with most respondents in this group taking two hours for preparation before evacuation. Conversely, households that did not make an early evacuation decision spent either 1 or 2 hours for preparation time, with the majority taking two hours for preparation. Demographic and socio-economic characteristics play a key role in early evacuation decisions. There was a significant difference between male and female involvement in early evacuation decisions. People along the coastal regions of Bangladesh are very poor and always evacuate since their houses are not strong enough to protect them during a disaster. The rate of early evacuation decisions among households with sick members was relatively low, given the difficulties in moving them from home to shelters. Bad access roads because of weather conditions and shelter-related aspects were cited as the main reasons for making an early evacuation decision. People who lived far from the shelter thought it would take around 30 to 60 minutes to cover the distance, it would therefore be better to evacuate early before the weather worsened.

Early evacuation ensures effective disaster preparedness and completion of evacuation to a safer place during a tsunami disaster (Yun and Hamada 2012). However, a cyclone does not strike as quickly as a tsunami; consequently, there is enough time to evacuate during a cyclone, but the consequences and complexities of evacuation are comparable. This research identified factors that influence early evacuation—a key concern for safe and successful evacuation during a cyclone disaster. The survey results indicated that around 47% of respondents made early evacuation decisions, but only around 35% of them followed up with their decisions during Cyclone Bulbul. Although most of the respondents who evacuated early chose a government school or designated shelter for evacuation, they had enough time to choose from different options. Among those who did not evacuate early, over 90% had to choose the designated shelter even when they did not know if the shelter was already full (Figure 10). This sometimes made some shelters overcrowded, but evacuees could not move to other places because of bad weather conditions. It is difficult to make evacuation decisions when there are children and elderly members in the house who need special care during evacuation (Yun and Hamada 2015; Shoji and Murata 2020; Thompson et al. 2017). Households with children,

seniors, or sick members were sometimes unable to decide whether to evacuate early because they thought it would be safer to stay at home with them, whereas other households thought if they reached the shelter at any cost, they would be safe. The preparation time and evacuation travel time also had a significant impact on early evacuation. Among households that evacuated early, half of them took two hours for preparation, while the remaining half took one hour or two to six hours. Among households that did not evacuate early, the majority took two hours (Figure 14). Respondents who evacuated early could choose any shelter regardless of the distance and faced relatively fewer difficulties as the weather was not as bad as it was just before the cyclone landfall. Concerning evacuation preparation time, female respondents took a longer time than male respondents for evacuation at different warning stages (Parvin *et al.* 2019). Therefore, to ensure safe evacuation, coastal residents must be made aware of the severity of a cyclone and have enough time for preparation before evacuation. According to the survey results, people need a longer preparation time and evacuation travel time if a vulnerable member is present in the house (Table 4, Table 6, and Figure 13).

Recently, technological advancements in natural disasters have enabled great initiatives to reduce disaster risk in various sectors. For disasters such as cyclones, typhoons, hurricanes, floods, disaster preparedness, early warning mechanisms, evacuation, and recovery after a disaster has become more systematic and effective. Despite the improvements in warning dissemination and evacuation order mechanisms, many people still did not evacuate to cyclone shelters or other safer places during Cyclone Bulbul. This study analyzed evacuation behavior during a cyclone and the factors influencing evacuation behavior. Previous disaster experience plays an important role in guiding an individual or household to be better prepared for a disaster (Figure 15). According to Lindell and Perry (2000), people who have previous disaster experience are aware of the risks and effects of the different stages of a disaster—helping them handle the situation more effectively. The analysis of the survey results found that respondents' previous disaster experiences had a significant impact on evacuation during Cyclone Bulbul. Respondents who did not evacuate had less experience with disasters than those who did. This research found that demographic and socio-economic characteristics also influence people's evacuation decisions. Gender is an important issue in the evacuation decision-making process. Ikeda (1995) noted that women are vulnerable in different ways during a disaster in terms of disaster preparedness, evacuation decisions, and sheltering stages. This study found that female respondents faced difficulties when evacuating with a sick or other vulnerable member and sometimes felt unsafe evacuating alone. Most respondents cited the presence of a sick member in the house as an important factor influencing their evacuation decisions during the disaster. People who are poor and struggle to survive daily were more concerned with protecting their properties than with evacuation, which had a significant impact on their evacuation decisions.

9. CONCLUSIONS

This research sought to determine the factors influencing early evacuation decisions, early evacuation, and emergency evacuation based on the evacuation situation during Cyclone

Bulbul. Cyclone Bulbul was identified as a very severe cyclonic storm and 0.73 million people in 29 Upazilas in the coastal area of Bangladesh were affected directly. Compared to past cyclone disasters in Bangladesh, the evacuation rate increased during Cyclone Bulbul because of improved disaster preparedness plans, better early warning systems, increased number of designated cyclone shelters, and increased awareness among people about evacuation. Additionally, the CPP plays an important role in issuing and disseminating early warnings and providing evacuation guidance to the community during the evacuation, even when essential services such as electricity are not functional. This enables the safe evacuation of evacuees to shelters or other safer places (Miyaji *et al*. 2017). Sometimes, it is difficult for local authorities to reach the community, especially when the weather condition worsens. However, informal interviews with respondents and CPP unit team leaders also mentioned that CPP volunteers assist people evacuating, but sometimes it is also difficult for them to reach the individual household as weather conditions are worse. Accordingly, it is recommended that CPP volunteers participate in the evacuation process with local authorities to make the evacuation more effective and complete it in a safer location. According to Haque and Blair (1992), people in coastal areas in Bangladesh consider evacuation at the very last moment—usually a barrier to complete and safe evacuation. This research found that, even though the evacuation rate increased, many people still did not evacuate because of the poor road network, distance to cyclone shelters, delayed dissemination of evacuation orders, concern for protecting household goods and livestock, and the presence of vulnerable members in the house. However, it is important to focus on safe evacuation to reduce physical damage, particularly casualties and injuries during a cyclone. Follow-up surveys should further explore safe evacuation as many have died over the past years because of natural disasters and people in Bangladesh's coastal areas are expected to face similar disasters in the future. Because people in Bangladesh's coastal areas lack ample knowledge about the severity of cyclones, they are worried about their timely and safe evacuation. The results revealed that household respondents are also concerned about their houses and other belongings that are needed for their daily life, and they have to protect them. Therefore, it is also necessary for the government to take initiatives to help coastal people build their houses in low-risk zones and therefore provide possible support for this, considering the long-term disaster preparedness plan.

Parvin *et al*. (2019) revealed the gender-based evacuation preparation time before starting evacuation during Cyclone Aila in 2009, which could be a great issue for evacuation at the right time. However, evacuating with household members, especially with vulnerable members, is also a great concern, particularly when it comes to early evacuation concerning evacuation preparation time. This research investigated household evacuation preparation time rather than individual time because the coastal community usually evacuates with household members, not individually. The results showed that if there are vulnerable members in the house, those households need longer preparation times and longer evacuation travel times. Similarly, this research found that women face difficulties while evacuating with sick members during a disaster. Therefore, it will be better to identify and recognize such types of households and help them safely evacuate future disasters. The data also showed that the early evacuation rate was relatively lower among households with vulnerable members. People want to evacuate early when they have vulnerable members in the house to ensure safe and successful evacuation

because they are aware of the difficulties of evacuating with such members, especially when they must evacuate by walking. Therefore, responsible authorities should focus on effective preparedness for early evacuation and plan for safe and complete evacuation during a disaster. Although this research investigated specific vulnerable members in the house in detail, it is also necessary to include the pregnant member, therefore analyzing the possible consequences of safe evacuation as well. Steps such as the early issue of evacuation orders should be taken to increase the possibility of early and safe evacuation in the future, especially when there are vulnerable members in a house. Furthermore, disaster management efforts should focus on the preparation time, as the amount of time available for organizing things before evacuation decides whether it would be an early evacuation or emergency evacuation. Identifying the right time for evacuation is important for safe and successful evacuation because various associated factors affect evacuation time, which can delay the evacuation time. Therefore, early evacuation could be an advantage for effective and safe evacuation. However, the early evacuation time is different for different disasters (Yun and Hamada 2012). The most significant contribution of this research is that it provides a better understanding of people's perceptions about early evacuation decisions and sheds light on the factors influencing early evacuation based on an analysis of the evacuation-related difficulties they faced during Cyclone Bulbul. This research revealed that almost half of the household respondents took early evacuation decisions, but in actual cases, they did not. This research recommends the issue of proper and timely evacuation orders and proper guidelines, which would help increase the early evacuation rate among coastal residents, especially when they have vulnerable members in their household, by ensuring that they have enough time to complete the evacuation safely and successfully before the weather condition changes from bad to worse during a disaster. This research recommends the issue of proper and timely evacuation orders, which would help increase the early evacuation rate among coastal residents, especially when they have vulnerable members in their household, by ensuring that they have enough time to complete the evacuation safely and successfully before the weather condition changes from bad to worse during a disaster. Responsible authorities should review existing policy actions and modify their approach where necessary to improve the possibility of early evacuation during future disasters. This may help reduce the risk of injuries and casualties during cyclones in the Bangladesh coastal regions.

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