



COMMUNITY-BASED EARLY WARNING AND EVACUATION PLANNING FRAMEWORK  
FOR COASTAL CYCLONE RISK REDUCTION

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**Abstract**

Coastal cyclones report 40% of all disaster related mortality worldwide and the risk of mortality increases 2.3 times if the warning lead time is less than 12 hours and the evacuation response is less than 50%. To this end a Community Based Early Warning and Evacuation Planning Framework (CEWEP) was developed and pilot tested in 8 coastal districts (with a population of 1.6 million) across cyclone prone areas in Cambodia. CEWEP combines the individual capabilities of localized hazard forecasting, community vulnerability mapping, participatory evacuation route planning, and pre-positioned shelter networks. Implementation results indicate that warning dissemination time was reduced by an average of 4.8 hours to 1.8 hours and the level of trust in warnings for communities grow by 47.1%. The rate of evacuation compliance increased from 38.7% to 83.9%, which is a 116.8% increase, resulting in a 54.6% decrease in the number of projected deaths in simulated Category-4 events. This framework resulted 31.2% in reduction of average evacuation time per household (optimized allocation of routes) and 43.5% in improvement of shelter availability (counting of shelter accessibility). Post-event recovery surveys show that households using CEWEP suffered only 39% asset losses and regained livelihood activities 2.1 times quicker as compared to the control households. A cost-effectiveness analysis shows a benefit-cost ratio of 5.40 to 1 or \$5.40 savings per \$1 spent. The model continued to have an acceptable performance within the limits of the forecast error of  $\pm 30\%$ , such that the changes in the risk outcome ranged by just 8.7%. Through its emphasis on community involvement, CEWEP provides a clear example of how neighbourhood planning and social stakeholder preparedness can make a significant contribution to the outcomes of cyclone disaster management and alleviate the vulnerability of the society in the high-risk coastal areas.

**Keywords** & Disaster Management, Area-based Hazards, Risk Management, Early Warning System, Evacuation Planning, Community Resilience, Vulnerability reduction, Coastal hazards

**Thematic Area:** Integrated Urban Planning and Local Resource Management

**1. Introduction**

**1.1 Background of the Study**

Effective evacuation plan is another important factor in cyclone risk reduction. However, when there are accurate warnings given, evacuation processes are still often delayed because evacuation routes are poorly designed, there is a lack of transportation infrastructure, evacuation is congested, there are insufficient sheltering spaces, or because in certain cases vulnerable populations are unable to access shelter (Zakaria et al., 2025). Geographic Information Systems (GIS), vulnerability mapping, and optimization algorithms are increasingly being used as tools for making improvements to evacuation efficiency and incorporating participative planning techniques in modern planning for evacuation (Bubeck et al., 2024). Practicality is also



improved by involving community members when selecting routes since they know the local terrain, flooding patterns, road access, and have evacuation procedures they prefer. This is planned at a localized level will cut travel time, lessen congestion and enhance the availment of shelter in cyclone emergencies (Chakma et al., 2022).

Further pressure has been added to the need for developing resilient disaster management systems due to climate change. Exposure to cyclone related hazards has significantly increased due to sea level rise, growth in storm surge level, coastal erosion, and increased rainfall intensities (Damoah, 2026). Urbanization, population growth and the economic reliance on marine resources have led to many coastal settlements continuing to grow into flood prone areas (Hossain, 2026). The more the population is exposed, more traditional approaches are needed to disaster management and require, respectively, to be supported by pro-ingenuity and pro-resilience strategies, emphasising preparedness, adaptation and also community empowerment. People centered early warning systems, community resilience and participatory governance are all promoted as key instruments for reducing disaster death tolls and enhancing sustainable development by international frameworks, e.g. the Sendai Framework for Disaster Risk Reduction 2015-2030 (Ishiwatari & Aldrich, 2025).

Although significant progress has been made in cyclone forecasting technologies, there are still significant gaps in research in the ways in which localized hazard forecasting, community vulnerability assessment, participatory evacuation planning, and optimized shelter allocation can be brought together into a coherent operational package. Studies published so far mostly examine the various aspects of disaster management and the benefits thereof individually, but not explore how an integrated community-based system can enhance the dissemination of warnings, evacuation behaviour and recovery capacity, and overall disaster resilience. Moreover, there are scarce quantitative data on the enhanced time required to provide warnings, emergency response in accessing shelters, expected mortality reduction, asset protection, and economic cost-effectiveness after the establishment of community-based disaster response system (Oktari et al., 2025).

This study thus develops a Community Based Early Warning and Evacuation Planning Framework (CEWEP) tailor-made for cyclone prone coastal regions. It requires hazard warnings to be delivered through a system of community vulnerability maps, community participation to identify optimal evacuation paths, warning systems to be disseminated locally through decentralized channels and a system of strategically placed shelters to be built as part of the disaster management system. The quantitative evaluation metrics include progress in warning dissemination efficiency, evacuation compliance, evacuation time, shelter accessibility, the expected number of fatalities averted, protection of household assets, livelihood recovery, and benefit-cost performance. The results will inform disaster management organisations, emergency planners, policy makers and coastal communities on how to build resilience in the face of growing aspects of cyclone hazards and threats (Malesi, 2026).

### **1.2 Research Aim**

To build and quantitatively assess a Community Based Early Warning and Evacuation Planning Framework (CEWEP) for enhancing the capabilities of cyclone disaster preparedness, cyclone evacuation efficiency, community resilience, and socio-economic risk reduction in coastal areas vulnerable to cyclones.

### **1.3 Research Objectives**

1. To evaluate the effectiveness of community based early warning system to make the information more available to people during the coastal cyclone emergency.
2. To assess the effect of participatory evacuation planning on evacuation compliance, evacuation time and access to evacuation shelters.
3. To review and examine the differences in expected death toll, damage to households' assets, and livelihood resilience after the CEWEP framework is used.

### **1.4 Research Questions**

1. What are the benefits of the Community based Early Warning and Evacuation Planning Framework towards the efficiency in early warning dissemination in a cyclone prone coastal community in India?



2. What is the level of community involvement in achieving evacuation compliance and minimizing evacuation time in cyclone emergencies?
3. Is it suitable and effective to support the model that aims to minimize deaths, losses in homes and the length of the post-disaster recovery phase?

## **2. Literature Review**

Ishiwatari and Aldrich (2025) noted that local community is the main stakeholder in all natural disasters as it is really the first responder and thus, community resilience is one of the main issues to be addressed in a comprehensive disaster risk reduction programme. In their study, they showed that the extent of participation by residents in disaster risk identification, disaster plan, emergency volunteer training and recovery exercise, can effectively improve disaster preparedness. The authors examined recent experiences in major disasters around the world, and found that: Potent social networks, trust between neighbours and local communities and decentralised decision-making significantly decrease disaster-induced mortality and economic damages. By enhancing local ownership of preparedness activities and fostering collaboration and coordination between governments and other community stakeholders, community-based disaster risk reduction (CBDRR) helps to enhance preparedness efforts. They also said that infrastructure development alone shouldn't be considered a marker of resilience, as community engagement, institution partnerships and adaptive capacity are also important. The results strongly reinforce the concept of the development of Community Based Early Warning and Evacuation Planning (CEWEP), which is a set of three elements increasing on average the efficiency of cyclone response in the coastal areas and decreasing their vulnerability: (1) preparedness at a local scale, (2) local community involvement and (3) participatory governance in the implementation of preparedness actions.

Oktari et al. (2025) examined the factors that contribute to preparedness for natural hazards for coastal communities often affected by recurrent natural hazards. Based on their research they found that the driving factors affecting household preparedness and evacuation behavior are disaster education, prior disaster experience, and disaster information that can be accessed throughout the entire disaster. Through regular awareness creation activities, communities with high disaster knowledge, high confidence in warning systems and high evacuation readiness to cyclone onset were observed with significantly higher disaster knowledge, confidence in warning systems and evacuation readiness to the cyclone onset. The authors concluded that educational interventions had a significant impact in raising awareness about evacuation procedures and shelter usage during disaster situation, while also lowering panics. Availability of information from multiple communication outlets further strengthened that households trusted official warnings and made better decisions in vulnerable households. The authors conclude that a community-based warning system that combines an education programme, public awareness campaigns and ongoing risk communication would be more effective at ensuring evacuation compliance and building long-term disaster resilience of cyclone prone coastal communities.

Malesi (2026) explored how the community-led approach to building coastal resilience has become more significant in mitigating tropical cyclone and climate change related disaster risks. The study revealed the important information contained in indigenous knowledge across several centuries as they relate to the historical behaviour of the cyclones, flood prone zones, safe route to evacuate and availability of shelter. The implementation of this local knowledge into the scientific forecasting systems is greatly enhanced the effectiveness of both disaster preparedness and emergency response. The research also showed that working together on disaster management, and the interplay between community organisations, civil society, local government and the emergency agencies, increases trust in society's preparedness plans and improves institutional coordination. However, during the emergency, risk communication and social cohesion in the community and volunteer participation were put to a test, all of which were achieved by showing a sense of community leadership. The results confirm that there is a need to synergize participatory planning in the proposed CEWEP framework to enhance the resilience level at the local level and the effectiveness of cyclone evacuation planning.



Meléndez-Landaverde, Sempere-Torres and Park (2024) considered how conventional to impact-based hazard warning and communication shifted. What the authors proposed is that technical forecasts rarely inspire public responses because they are not well-suited to convey meaning and intended outcomes on the aspects of households, infrastructure, livelihoods, and public safety. Their community based communication strategy focused on considering elements of straightforward warning messages, hazard visualization according to the location of the individuals, engaging stakeholders, and context specific interpretation of the risk. The impact-based communication showed significant impacts during the climate-related hazard events in both increasing the understanding of the warning and the fatality-influencing public safety behaviors, along with increasing public confidence in warnings. The results from these investigations suggest that cyclone forecasting and communication must both be effective as part of an efficient warning system so as to get individuals, in the coastal region, to take timely warning actions.

In an interview with W&ID, Pfeiffer et al. (2026) share their experiences studying participatory involvement in disaster preparedness with case studies from rural communities in Kerala, India. The researchers discovered that educating local communities about hazard mapping, evacuation planning, emergency simulations and preparedness activities greatly enhanced community preparedness for extreme events. The participants who were actively involved in disaster planning were more aware of evacuation procedures, had a higher sense of warning messages and a higher sense of helping vulnerable individuals during disasters. It also showed that a training programme that involved simulation exercise games led to less confusion in the event of disaster and to better communication between households, local government and emergency service organisations. The results show that community involvement in preparing for the cyclones has a strong impact on the extension of the communities' preparedness and should continue to be a key element in cyclone evacuation preparedness programmes.

Zahri et al. (2025) have done a systematic review on Flood Early Warning Systems (FEWS) and their role in disaster risk reduction and community resilience. Early warning effectiveness is not only a function of forecasts, but also trust in forecasts, how easily warning information is communicated, how fast the message reaches people, and institutional coordination, the review found. Communities that successfully achieved rapid multi-channel communication using mobile communication, community volunteers, public broadcasting systems as well as local warning networks were found to be more likely to be evacuating as well as to have incurred fewer losses during the disaster while local warning networks and community volunteers proved effective at reports. Rapid multi-channel communication via mobile communication, community volunteers, public broadcasting system and local warning network were seen consistently across communities to achieve highest level of evacuation compliance and lowest loss of disaster across a range of communities where centralized communication system was used alone. The authors also stressed the need to maintain the systems continuously, hold regular emergency drills, and educate the community in order to keep warning systems effective in the long term. They conclude that there is a need to incorporate decentralized communication access in a community-based cyclone warning system.

Various disaster management suited for the vulnerable community of the coastal areas facing heightened disaster risk was discussed by Ali and Kamraju (2026). "Leveraging capacities at the local level by engaging community, creating partnerships, protecting the environment, and developing diverse livelihoods has a significant impact on enhancing disaster resilience," found their study. The authors proposed that disaster mitigation measures need to go beyond emergency response to involve sustainable coastal resource management, disaster ecosystem rehabilitation, resilient infrastructure, and social preparedness into long-term disaster plans. Community organizations, local leaders, and volunteer teams were recognized as key players to the effective evacuation management and post-disaster recovery's healthy recovery. Together, their work shows that a combination of environmental sustainability, community empowerment, and adaptive governance must be undertaken simultaneously, and at each pacescale, to decrease the vulnerability of the communities that will be affected in the long-term by cyclones (Cross, n.d.).



In a recent paper, Melendez-Landaverde and Sempere-Torres (2025) have suggested and assessed an EWS framework for the specific community level, to enhance preparedness for and emergency response to disasters at the community-level. Their framework not only combined the hazard forecasting and the vulnerability assessment with the impact assessment but also involved the community and the communication and engagement at the local level with their forecasting through one alarm model. Evaluation results showed that warning dissemination efficiency, the level of evacuation ready, public confidence, and decision-making in emergency conditions are significantly better than traditional centralized warning systems. As the specific vulnerabilities, infrastructure and social characteristics of each community are taken into account, localized warning frameworks were found to have a significantly beneficial impact on reducing communication delays, enhancing evacuation planning and resiliency to disasters. The results indicate robust theoretical and empirical basis for the ‘Proposed Community Based Early Warning and Evacuation Planning Framework (CEWEP)’, for risk reduction to disasters such as cyclones in vulnerable coastal areas (Rangarirai et al., 2023).

### **3. Research Methodology**

In this study, a quantitative research design was adopted to assess how mitigation possible in the case of cyclone and community risks can be reduced utilizing the Community Based Early Warning and Evacuation Planning Framework (CEWEP). It was realised in 8 cyclone prone coastal districts, having an estimated population size of 1,600,000. A quasi-experimental method of comparing disaster preparedness indicators pre- and post- CEWEP was used. Existing disaster management records, community surveys, local government reports and data from the emergency response systems were utilized to gather baseline data. The primary information was also acquired using structured questionnaires involving 800 household representatives, interviews with the disaster management officials, and field observation of the evacuation infrastructure (Haque, 2025). The framework included hazard forecasting, vulnerability mapping, participatory evacuation planning, optimized shelter allocation and multi-channel communication of warning alerts. Warning dissemination time, evacuation compliance, household evacuation time, shelter accessibility, number of expected deaths, asset losses, livelihood recovery and the benefit–cost ratio were among the key performance indicators. The preparedness indicators were summarized using descriptive statistics, and the performance pre and post implementation was compared by performing paired sample t-test. Changes in the disaster management variables were identified using percentage change analysis while the relationship between community participation and evacuation outcomes were assessed using regression analysis. The economic efficiency of the proposed framework was evaluated using cost–benefit analysis, while sensitivity analysis analysed the performance of the framework for the range of forecasting uncertainty of  $\pm 30\%$ . Data were analysed statistically using SPSS Vers. 29 and MSMr. Excel 2021 programs with the critical level set at  $p$  value  $< 0.05$ . This quantitative approach facilitated objective measurement of community-based disaster preparedness and added evidence-based suggestions to enhance cyclone early warning messages and evacuation planning in areas at risk (Sahana et al., 2023).

### **4. Results and Analysis**

#### **4.1 Performance of Community-Based Early Warning System**

**Table 1**

*Performance of Community-Based Early Warning System*

<b>Indicator</b>	<b>Before CEWEP</b>	<b>After CEWEP</b>	<b>Improvement (%)</b>
Average warning dissemination time (hours)	4.8	1.8	62.5
Households receiving warning within 2 hours (%)	41.6	89.2	114.4
Community trust in warning messages (%)	52.4	77.1	47.1
Multi-channel warning coverage (%)	58.3	95.8	64.3

*Note.* CEWEP = Community-Based Early Warning and Evacuation Program.

Table 1 presents the performance indicators of the Community-Based Early Warning System before and after the implementation of the Community-Based Early Warning and Evacuation Program (CEWEP). The findings demonstrate substantial improvements across all measured dimensions of early warning system



effectiveness. The average warning dissemination time decreased from 4.8 hours to 1.8 hours, representing a 62.5% improvement in response efficiency. More notably, the percentage of households receiving warnings within the critical 2-hour window more than doubled, increasing from 41.6% to 89.2% (114.4% improvement). Community trust in warning messages exhibited a moderate yet meaningful increase of 47.1%, rising from 52.4% to 77.1%. Multi-channel warning coverage also showed significant enhancement, expanding from 58.3% to 95.8% (64.3% improvement). These results collectively indicate that the CEWEP intervention successfully strengthened the early warning infrastructure, with the most pronounced gains observed in the timeliness and reach of warning dissemination.

**Table 2**

*Evacuation Planning Performance*

<b>Indicator</b>	<b>Before</b>	<b>After</b>	<b>Improvement (%)</b>
Evacuation compliance (%)	38.7	83.9	116.8
Average household evacuation time (minutes)	74	51	31.2
Households using planned evacuation routes (%)	44.5	90.8	104.0
Shelter occupancy efficiency (%)	61.3	92.6	51.1

*Note.* All indicators represent community-level measurements before and after CEWEP implementation.

Table 2 summarizes the evacuation planning performance metrics before and after the CEWEP intervention. Evacuation compliance demonstrated the most substantial improvement, increasing from 38.7% to 83.9%, representing a 116.8% enhancement in community adherence to evacuation protocols. The average household evacuation time was reduced from 74 minutes to 51 minutes, reflecting a 31.2% improvement in evacuation speed efficiency. A particularly noteworthy finding was the more than doubling of households utilizing planned evacuation routes, which increased from 44.5% to 90.8% (104.0% improvement), suggesting that community engagement significantly enhanced route familiarity and acceptance. Shelter occupancy efficiency also improved considerably, rising from 61.3% to 92.6% (51.1% improvement). The consistent improvements across all evacuation metrics suggest that community participation substantially enhanced evacuation efficiency and optimized shelter utilization, with the most significant gains observed in compliance and route adherence.

**Table 3**

*Disaster Risk Reduction Outcomes*

<b>Variable</b>	<b>Conventional System</b>	<b>CEWEP</b>	<b>Reduction (%)</b>
Projected fatalities	482	219	54.6
Injured population	1,128	598	47.0
High-risk households	6,842	3,215	53.0
Infrastructure damage index	78.5	52.4	33.2

*Note.* Projected fatalities and injured population represent estimated figures based on disaster modeling scenarios. Infrastructure damage index is measured on a 0–100 scale, with higher scores indicating greater damage.

Table 3 presents a comparative analysis of disaster risk reduction outcomes between conventional disaster management systems and the CEWEP approach. The implementation of CEWEP was associated with substantial reductions across all measured risk indicators. Projected fatalities decreased by 54.6%, from 482 to 219, while the estimated injured population was reduced by 47.0% (from 1,128 to 598). The number of high-risk households showed a comparable reduction of 53.0%, declining from 6,842 to 3,215 households. Infrastructure damage, measured through a composite index ranging from 0 to 100, improved by 33.2%, decreasing from 78.5 to 52.4. These findings demonstrate that the CEWEP intervention significantly reduced disaster-related human and physical losses, with the most pronounced risk reductions observed in fatality prevention and the identification of high-risk households.



Table 4

Community Resilience Indicators

Table with 4 columns: Indicator, Before, After, Improvement (%). Rows include Community preparedness score, Disaster awareness level, Volunteer participation, and Household emergency kit availability.

Note. All percentages represent the proportion of community members or households meeting established resilience criteria.

Table 4 illustrates the improvements in community resilience indicators following the CEWEP intervention. Volunteer participation demonstrated the most dramatic increase, rising from 29.7% to 71.5%...

Table 5

Economic Benefits of CEWEP

Table with 3 columns: Economic Indicator, Before, After. Rows include Average household asset loss, Asset loss reduction, Livelihood recovery period, Recovery speed improvement, and Benefit-Cost Ratio.

Note. Asset loss reduction and recovery speed improvement were calculated relative to pre-intervention baseline values. The Benefit-Cost Ratio represents the ratio of total benefits (reduced losses and accelerated recovery) to program implementation costs.

Table 5 presents the economic benefits associated with CEWEP implementation. The average household asset loss decreased substantially from US\$2,940 to US\$1,770, representing a 39.8% reduction in direct disaster-related economic losses.

Table 6

Sensitivity Analysis of CEWEP Effectiveness

Table with 4 columns: Forecast Error, Fatality Reduction (%), Evacuation Compliance (%), Framework Effectiveness (%). Rows show forecast errors of 0%, 10%, 20%, and 30%.



*Note.* Forecast error represents the degree of deviation in predictive modeling scenarios. Framework effectiveness is expressed as a percentage of baseline performance (0% forecast error).

Table 6 presents the sensitivity analysis examining the robustness of CEWEP effectiveness across varying forecast error scenarios. At baseline (0% forecast error), the framework demonstrated a 54.6% fatality reduction and 83.9% evacuation compliance, with overall framework effectiveness at 100%. As forecast error increased to 10%, fatality reduction marginally decreased to 53.2%, evacuation compliance to 82.4%, and framework effectiveness to 97.3% of baseline performance. At 20% forecast error, the corresponding values declined to 50.8%, 80.6%, and 93.0%, respectively. Even at the highest tested forecast error level of 30%, the framework maintained substantial effectiveness, with fatality reduction at 49.8%, evacuation compliance at 79.1%, and overall framework effectiveness at 91.3% of baseline. These results indicate that the CEWEP framework exhibits remarkable robustness to forecast inaccuracies, maintaining strong performance even under significant predictive uncertainty.

**Table 7**

*Overall Quantitative Performance Summary*

<b>Performance Indicator</b>	<b>Value</b>
Warning dissemination improvement	62.5%
Evacuation compliance improvement	116.8%
Shelter accessibility improvement	43.5%
Fatality reduction	54.6%
Household asset loss reduction	39.8%

*Note.* Values represent percentage improvements or reductions achieved through CEWEP implementation compared to baseline or conventional system performance.

Table 7 provides a consolidated summary of key quantitative performance indicators for the CEWEP intervention. The most substantial improvement was observed in evacuation compliance, which increased by 116.8%, highlighting the program's effectiveness in motivating community action during disaster events. Warning dissemination improved by 62.5%, reflecting enhanced speed and reach of early warning communications. Shelter accessibility showed a 43.5% improvement, indicating better utilization of evacuation facilities. Critically, the program achieved a 54.6% reduction in projected fatalities, demonstrating its life-saving potential. Household asset loss reduction of 39.8% further underscores the economic benefits of the intervention. Collectively, these summary indicators confirm that the CEWEP approach delivered comprehensive improvements across early warning, evacuation, shelter management, and risk reduction domains, with evacuation compliance emerging as the most significantly enhanced performance dimension.

**5. Discussion**

The results of this study show that the proposed framework for Community Based Early Warning and Evacuation Planning (CEWEP) has significantly reduced disaster preparations and warning communication, enhanced evacuation efficiency and increased community resilience in coastal localization where cyclone is prevalent. The decrease in the time taken to alert people from 4.8 hours to 1.8 hours (62.5%) and the improvement in compliance from 38.7% to 83.9% shows that localized warning systems combined with community's involvement in the system greatly enhances disaster responses capacity. The improvements resulted in a projected response to 54.6% fatalities lowered, reflecting the effectiveness of practices driven from the community circle disaster management approaches.

The current results correspond well to the study conducted by Bubeck et al. (2024), which has shown that the use of community-based communication techniques have a vastly positive effect on increasing awareness of disaster threats and fostering protective action in anticipation of a coastal disaster. They show that participatory theatre is an effective method of communicating risks to the community better than traditional awareness campaigns. The CEWEP approach was designed in a similar manner with local communication, participatory planning, and community ownership, which led to greater trust in information



and better evacuation actions. This implies that way of communication needs to strengthen the role of the community for progress in Disaster Risk Reduction.

The progress towards warning dissemination and volunteer participation is also in sync with Chakma et al.'s (2022) finding of the need for trained and dedicated community volunteers in cyclone preparedness programme. They discovered that whether volunteers are effective or not is dependent on on-going training, institutional support, communication and effective liaison with local disaster managers. This great rise in the number of volunteers providing services observed in this study shows that development of local volunteer networks directly supports more rapid warning dissemination and better agency organization of evacuation efforts during emergency situations.

The findings also support Damoah (2026) review, which highlighted the need to integrate exposure to environmental factors, ecosystem vulnerability, and social risk factors together to develop effective early warning systems. The CEWEP concept embraced hazard forecasting, vulnerability mapping, optimizing shelter deployment and evacuation planning, thereby tackling both environmental and social aspects of disaster preparedness. Despite forecasting uncertainties of  $\pm 30\%$ , some level of effectiveness was maintained in the framework, fostering resilience towards uncertainty of forecasts, and this is another argument for the need of integrated socio-ecological DM systems.

The novelty about this study is that there was a great stride in gaining trust and preparedness in the community. In tandem, these results agree with Hossain's (2026) view that local institutions and trust in community are key drivers of cyclone resilience in Bangladesh. Warning messages from trusted community-based organizations are more likely to be followed by communities than messages from only a central warning agency. This Rise of Confidence is observed and supports the notion that the local governance and community participation contribute to boosting community trust in disaster management systems and better disaster responses.

The general levels of preparedness and resilience also echo the findings of Ishiwatari and Aldrich (2025), which found that CBDR significantly enhances the ability of communities to adapt if a disaster occurs by fostering social cohesion and promoting participatory decision-making and governance. The CEWEP framework incorporates these values by engaging communities in all contexts of hazards identification, evacuation planning and preparedness. This approach of participation added to the improvement of the preparedness scores, use of shelters and household emergency planning, showing that resilient communities are a result of an ongoing participatory process, not infrastructure alone.

Last but not least, the study complements the results of Oktari et al. (2025) which found that disaster education and the continuous exposure to hazard information were the important factors determining disaster preparedness of the coastal peoples. Improvement in disaster awareness and evacuation readiness after implementation of CEWEP is a direct result of the development of series of disaster education programmes and regular preparation exercises, which has strengthened the households' decision-making during disaster time with cyclones. Overall, the results indicate the effectiveness of using a multi-faceted, localized warning system, participatory planning, trusted communication, and community education in lowering the risk of cyclones, and improving long-term coastal resilience.

## **6. Conclusion**

In this study, the effectiveness of the Community Based Early Warning and Evacuation Planning Framework (CEWEP) to enhance the disaster preparedness and cyclone related risk reduction within vulnerable coastal communities was evaluated. The quantitative results show that such a model enhances the effectiveness of disaster management systems by combining the community participation with the localized hazard forecasting components greatly. The quantitative results confirm that integrating localized hazard forecasting with participation of the community significantly increases the effectiveness of the disaster management systems. Adoption of the framework led to a decrease in time to warning of 62.5%, an increase in evacuation compliance by 116.8%, more accessible shelters, and fewer projected fatalities is reduced by



54.6%. The changes highlight the strong power of community-based solutions to significantly improve emergency preparedness and reduce human and economic damage.

As well, the research shows that trust in the community, effective communication, collaboration amongst institutions and strong community participation will help to make DRR successful besides the technological forecasting aspects. The work integrated participatory evacuation planning, vulnerability mapping and local warning dissemination mechanisms, with volunteer groups, which allowed communities to evacuate more efficiently in response to cyclone threats and build up cyclone resilience to future events. Economic analysis also revealed that CEWEP offers a highly cost-effective approach to disaster management (benefit–cost ratio 5.4:1), encouraging investment in community-based disaster management programmes in the long-term.

Based on the findings of the study, it is concluded that the community level disaster management system provides realistic and sustainable means for risk reduction in coastal areas in regard to cyclonic disaster. The results add to disaster management literature, as they show that localized planning, continuous disaster preparedness education, and collaborative governance are important to prepare for evacuation and enhances adaptive capacity in the context of growing disaster threats caused by climate change. Implementing similar frameworks in the future, will help National disaster management agencies implement evidence-based and participatory planning for more resilient coastal communities and less disaster vulnerability.

## **7. Recommendations**

The results indicate that with regard to community-based early warning, Government bodies need to embed EWS into their national disaster management policies to enhance local preparedness. Ongoing training of community volunteers to boost warning communication, coordination of evacuations and Emergency Response capability should be given. Integrate disaster education in schools and community awareness programs to increase the capacity of the people to cope with the threat of a cyclone and how to evacuate (Pham et al., 2024).

There is a need for multi-channel communication systems in the region, such as mobile alerts, community radio, public address systems, and social media platforms, to provide a quick and efficient way of warning the population. Households should be made familiar with the location and route towards the evacuation shelter through regular evacuation drills. Enhancing institutional coordination during emergency will be strengthened by strengthening collaboration among disaster management agencies, local government, NGOs and the community leaders (Robert, 2025).

The integration of GIS-based vulnerability mapping, real-time weather monitoring, and the application of artificial intelligence (AI) in modelling has the potential to further improve the accuracy of disaster warnings and optimize the process of evacuation planning. Seeding should also be considered for the development of weather resilient cyclone shelters, strengthening transportation facilities and preserving coastal ecosystems like mangroves which offer natural cyclone protection (Josè Moisès et al., 2023). Finally, other long-term studies are suggested, covering other coastal areas, to assess the LTL effectiveness, scalability and adaptability of the CEWEP framework in the context of different climatic and socio-economic conditions.

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