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Guidelines for Industrial Business Management During a Flood Disaster

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Abstract

Floods continually impact the industrial economy in Thailand almost every year, making flood response crucial for preventing harm to employees and the organization's property, as well as ensuring continuous business operations. This research aims to study the management practices of industrial business organizations during flooding and develop a structural equation model, combining qualitative and quantitative research methods. Qualitative research involved 9 experts and a group discussion with 11 participants, while quantitative data was gathered from questionnaires distributed to 500 executives in the industrial business sector who had experienced flooding. Descriptive statistics, inferential statistics, and multiple statistics were used for analysis.

The research findings indicate that guidelines for managing industrial business organizations during flooding prioritize four elements in the following order of importance: 1) Risk management components ($\bar{X}$ = 4.35): Most important items: Following announcements from the Meteorological Department regarding the continuous rain situation. 2) Organizational management components ($\bar{X}$ = 4.32): Most important items: Preparing a list of emergency telephone numbers to contact various agencies for assistance during floods. 3) Cooperative management components ($\bar{X}$ = 4.24): Most important items: Collaborating with personnel in the organization to prevent flooding, such as working together to fill sandbags and build waterproof embankments. 4) Resource management components ($\bar{X}$ = 4.20): Most important items: Establishing a gathering point for emergency employee evacuation. Regarding the hypothesis test results, it was found that industrial businesses located within industrial estates and industrial businesses located outside industrial estates giving importance to the management practices of industrial business organizations during flooding is not significantly different at the 0.05 level for industrial businesses located outside industrial estates. The results of the analysis of the developed structural equation model revealed that it met the evaluation criteria and was consistent with the empirical data. It obtained a chi-square probability level value of 0.058, a relative chi-square value of 1.160, a concordance index value of 0.959, and a root mean square error of approximation index value of 0.018.

Guidelines for Industrial Business Management During a Flood Disaster encompass four key aspects: Risk Management, Collaboration Management, Organizational Management, and Resources Management, each of which holds significant importance.

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The results of the hypothesis testing revealed that the Risk Management component significantly influences the Collaboration Management segment, with the highest weight value (Standardized Regression Weight) at 0.83. This empirical data emphasizes the necessity for organizational risk management to garner support and participation from all levels within the organization.

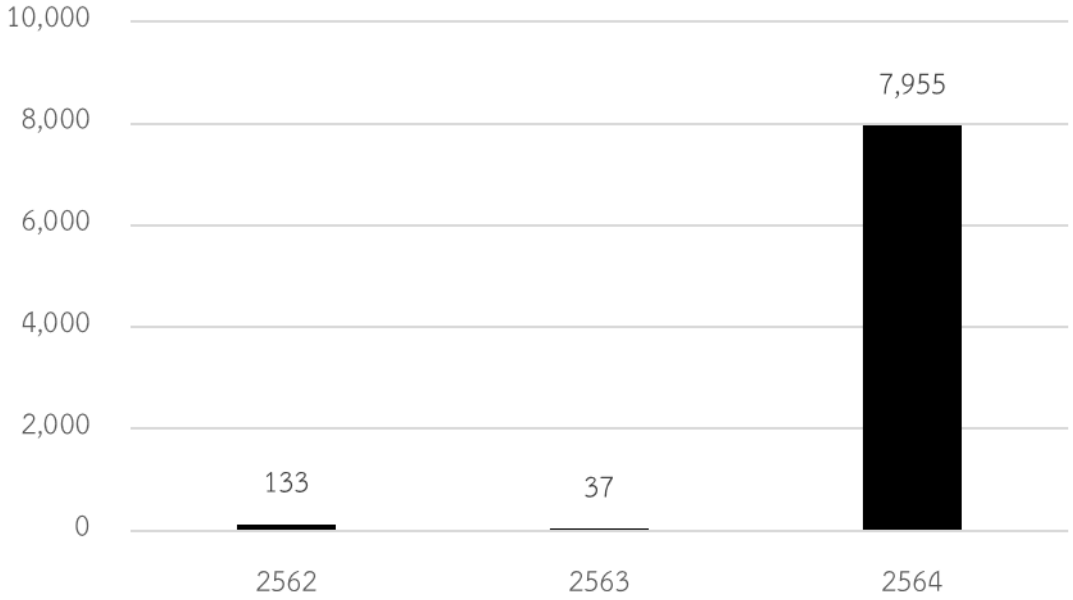
Keywords: *Flood, Risk Management, Collaboration, Organizational Management, Resources Management.*

Introduction

The great flood of B.E. 2554 caused widespread flooding in the northern, central, and northeastern regions, affecting a total of 64 provinces. It was the worst flood in Thailand's history in the past 100 years, resulting in extensive damage to people's property, agriculture, industries, and homes. More than 13 million people, including over 4 million households, suffered from the consequences. The situation progressively worsened, reaching its peak in October with the "Industrial Estate Flooding" event. For the first time in history, seven locations in Ayutthaya and Pathum Thani provinces experienced flooding, causing an estimated 240 billion baht in damages to factories in industrial estates and an equivalent amount for factories outside industrial estates (Nation TV, 2564 B.E.). Over the past 10 years since the great flood of B.E. 2554, it has become evident that the preparedness for dealing with such events has not kept pace with the situation in B.E. 2564. Thailand continues to face repeated flood situations as a result of the influence of the monsoon trough and various storms, leading to intense and heavy rainfall, acute flooding in many areas, including people's homes, agricultural areas, and some industrial factories. This recurring flooding problem has had a significant impact on the country's economy. Despite the damage not reaching the levels of the great flood in B.E. 2554 and the implementation of flood response plans in many areas within the industrial sector, significant damage continues to occur. Moreover, heavy rainfall in four districts of Samut Prakan Province for three consecutive days from August 27 to 29, 2564 B.E., resulted in an excess of 2 million cubic meters of water in the area, leading to the flooding of all surrounding canals. As a result, there was a flood of water flowing into the Bang Pu Industrial Estate area. Furthermore, it coincided with a period of high sea levels, causing the Bang Pu Industrial Estate to be flooded to a height of over 1 meter, resulting in damage to a total of 374 factories. The Industrial Estate Authority of Thailand has summarized the initial impacts on the production sector into four parts: 1) impacts on production lines, 2) impacts on warehouses, 3) impacts on product transportation and delivery to customers, and 4) effects on equipment exposed to water (Krungthep Business, 2564 B.E.).

According to the report from the Ministry of Industry and the Fiscal Policy Office, the value of damages to the industrial sector from the flood situation was 133 million baht in B.E. 2562, 37 million baht in B.E. 2563, and 7,955 million baht in B.E. 2564, as shown in

Figure 1. Million (THB)



Buddhist Era

Figure 1: Value of damages from flood situations in the industrial business sector since B.E.2562 -2564 (Ministry of Industry, B.E. 2563; Fiscal Policy Office, B.E.2564)

In B.E. 2565, due to heavy rainfall, areas at repeated risk of flooding included the central zone, such as Phra Nakhon Si Ayutthaya, Saraburi, Pathum Thani, and Samut Sakhon provinces, as well as the eastern zone, comprising Samut Prakan, Chonburi, Rayong, and Chachoengsao provinces. Although these areas did not experience heavy flooding, they still faced frequent occurrences of flooding. This situation may impact industrial plants, and if flooding occurs around industrial estates, it can also affect the transportation sector, thus impacting exports. Industrial estate areas at risk include the Bang Pa-in Industrial Estate, Ban Wa Industrial Estate (Hi-Tech), and Nakhon Luang Industrial Estate, all located in the Phra Nakhon Si Ayutthaya Province. These areas are low-lying and situated adjacent to the Chao Phraya River, posing a risk of flash floods. Additionally, the Bang Pu Industrial Estate in Samut Prakan Province is in close proximity to the sea and communities that may experience sea surges at certain times (Daily News Online, 2565 B.E.). In October 2565 B.E., it was found that there were accumulated flooding areas in 44 provinces, affecting over 260 districts and impacting 16,472 factories. An estimated 14,995 factories, accounting for 22% of all factories in the country, were affected. Additionally, in the flooded areas in the central region within the Chao Phraya River Basin, where 14,055 factories are located, approximately 7,287 factories were estimated to be affected. Phra Nakhon Si Ayutthaya Province is a significant industrial area in the central region, with an estimated 1,560 affected factories. The Economic Forecasting Center of the University of the Chamber of Commerce has estimated industrial damage worth 6,000-12,000 million baht in B.E. 2565 (Federation of Thai Industries, 2565 B.E.). In summary, despite the industrial sector having a plan to deal with emergency situations in the event of flooding according to environmental management system standards, for some industrial plants, it has not yet been implemented in a concrete way. This has resulted in a significant amount of damage to property, affecting warehouses and production lines. The researcher is interested in studying factories with environmental management system standards that do not have an efficient and effective emergency contingency plan in place for flooding. Therefore, the researcher has embarked on a study on "Guidelines for Industrial Business Management During a Flood Disaster," hoping

that the findings will support the industrial business sector by providing effective management guidelines for organizations in flood situations.

Literature review

From past management concepts and theories for industrial business organizations during flooding, the researcher synthesized guidelines for managing industrial business organizations into four components:

1. The risk management component encompasses strategies to identify, analyze, evaluate, manage, monitor, and communicate risks associated with an agency or department's activities or operational processes. The goal is to minimize losses and maximize organizational opportunities. Omer Ekmekcioglu, et al. (2021) highlighted flood risk mapping as a crucial method for implementing flood risk management practices. Effective flood risk management involves preventive measures, backup plans, water management improvements, early warning systems, and evacuation simulations. Nopporn (2021) emphasized the importance of risk management plans for business crises, enabling organizations to respond promptly and continue operations while maintaining competitiveness.

2. The cooperative management component refers to working together to achieve common organizational goals. Noralfishah Sulaiman, et al. (2019) elaborated on the importance of coordinating work within and between groups for consistency and efficiency.

3. Organizational management components refer to organizing work and systems of people or positions to efficiently utilize administrative resources by dividing work into groups, defining authority, duties, and responsibilities, and systematically coordinating and controlling these aspects. These actions aim to help the organization achieve success in line with its objectives and goals. According to Lars Andreas Roald (2021*: 1-801), many industries are situated near major rivers in urban areas. When flooding occurs, organizations must evacuate valuable machinery to safe locations and remove raw materials and finished products from the water. Failure to implement flood prevention measures may halt production, leading to damaged production, potential worker layoffs, and income loss during production interruptions or evacuations. From the study by Sunee Wattanakomola and Thanin Silpcharub (2023: 1359–1368), it was observed that as the global business environment evolves and competition intensifies, organizations face increasing complexity. This necessitates adaptation by all entities, including small and medium-sized enterprises, which are considered particularly vulnerable. In light of the recent COVID-19 epidemic, organizational leaders, as entrepreneurs, must adjust management practices to be more flexible. There should be a shift from controlling employees to trusting and empowering them to leverage their strengths. Moreover, organizations need to acknowledge the diversity and capabilities of their personnel, aligning assignments with their expertise to drive sustainable organizational success.

4. Resource management components (Resources Management) refer to the process of planning resource utilization and work allocation to meet expectations, aiming for maximum efficiency. Resources include employees, equipment, etc. According to a study by Takahiro et al. (2020: 1-32), while natural disasters may not directly damage the buildings and facilities of business organizations, they can disrupt businesses through infrastructure disruptions such as electricity, gas, and transportation, or by impacting suppliers or customers. Business impact analysis and risk assessment should identify risks to both internal and external resources, including the potential financial impact under expected circumstances. Companies with adequate preventive measures, such as recurrence prevention and damage prevention, have a lower likelihood of experiencing

physical damage. Effective resource management can help reduce the risk of business interruption.

Research objectives

The objective of the research is to study the factors affecting the management practices of industrial business organizations during flooding as follows.

1. To study the structure and operating characteristics of industrial businesses with organizational management during flooding.

2. To study the elements of management guidelines for industrial business organizations in times of flooding.

3. To study the structural equation model for management of industrial business organizations in times of flooding.

Research Methodology

This research focuses on generating new knowledge (Inductive Research) using mixed methods research. The Mixed-Methodology Research consists of three parts:

1. Qualitative Research involves in-depth interview techniques. The research population included 9 experts selected through Purposive Sampling, adhering to the qualification criteria set by the Executive Committee of the Doctor of Business Administration Program, Industrial Business Administration Major, Faculty of Business Administration, King Mongkut's University of Technology North Bangkok. The research pertains to "Guidelines for Industrial Business Management During a Flood Disaster" and involves three groups of experts: 3 business executives, 3 government organization representatives, and 3 education experts.

2. Quantitative Research utilized a population of 3,502 industrial business operators who had experienced flooding and received ISO 14001 or ISO 45001 certification. The sample size was determined to be 500, deemed at a high level through factor analysis or structural equation models, utilized a Multi-Stage Sampling method. This involved Cluster Sampling for industrial businesses within industrial estates and Probability Sampling using the Lottery Method for those outside industrial estates, as outlined by Silpcharu (2021).

3. Qualitative Research incorporated group discussion techniques, to certify that the population model used in this research consisted of 11 experts, the method of selecting a specific sample (Purposive Sampling) was used.

Results

Table 1.

Level of importance: Guidelines for Industrial Business Management During a Flood Disaster, classified by industrial business location

Guidelines for Industrial Business Management During a Flood Disaster.	Inside the industrial estate			Outside the industrial estate		
	$\bar{X}$	SD.	Level importance	$\bar{X}$	SD.	Level importance
Overall level of importance of components	4.28	0.48	High	4.28	0.45	High

1	Risk Management	4.34	0.45	High	4.35	0.49	High
2	Collaboration Management	4.21	0.55	High	4.27	0.55	High
3	Organization Management	4.34	0.54	High	4.30	0.48	High
4	Resources Management	4.21	0.56	High	4.20	0.46	High

1. Overall research results found that industrial businesses are located within industrial estates. Overall management guidelines for industrial business organizations in flood situations It is important at a high level. has an average of 4.28, and when analyzing the level of importance in each aspect, it was found that Every aspect is important at a high level. Arranged in order of importance from highest to lowest as follows:

1) Risk Management component has an average of 4.34, 2) Organizational Management has an average of 4.34, 3) Cooperation Management has an average of 4.21, and 4) Resource Management has an average of 4.21, respectively.

Industrial businesses are generally located outside the industrial estate. It is important at a high level. The average value was 4.28 and when analyzing the level of importance in each aspect, it was found that every aspect was important at a high level. Arranged in order of importance from highest to lowest as follows:

1) Risk Management component has an average of 4.35.

2) Organizational Management has an average of 4.30.

3) Collaboration Management has an average of 4.27 and

4) Resources Management has an average of 4.20, respectively.

2. Results of research on statistics used to compare differences in the level of importance of management approaches for industrial business organizations in the event of flooding as a whole. Classified according to the location of the industrial business, there is no statistically significant difference at the 0.05 level.

3. Statistics evaluating the consistency of the structural equation model after model adjustment found that the chi-square probability value (CMIN-ρ) was equal to 0.058, greater than 0.05, the chi-square correlation value (CMIN/DF) is equal to 1.160, is less than 2.00. The consistency level index (GFI) is equal to 0.959, is greater than 0.90, and the root mean square error approximation (RMSEA) index value of 0.018 was less than 0.08.

Therefore, it can be concluded that all 4 statistics passed the evaluation criteria. Therefore, the structural equation model for managing industrial business organizations in flood situations after adjustment is consistent with the empirical data.

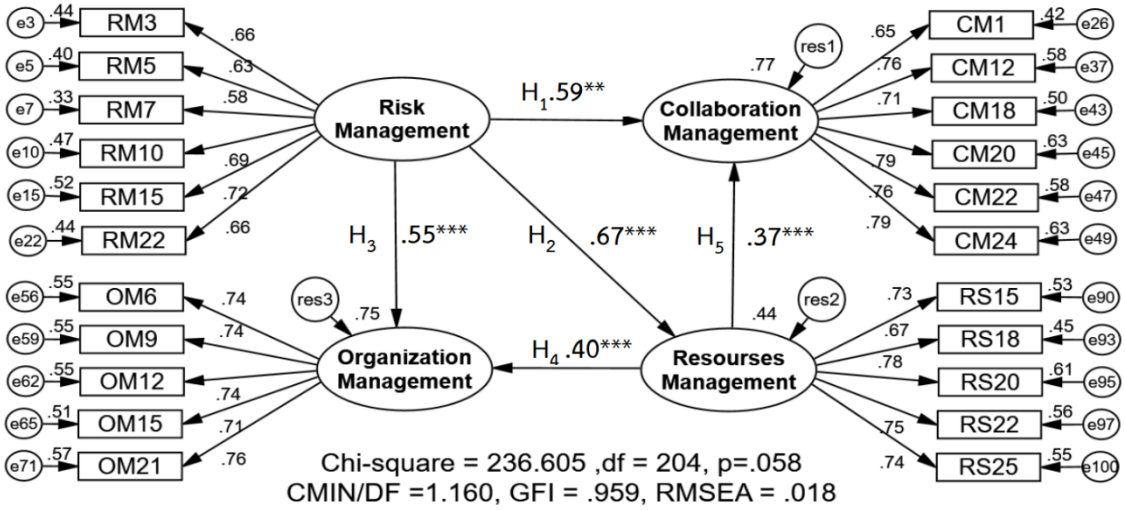


Figure 4: Structural equation model for management of industrial business organizations in the situation of flooding in Standardized Estimate Mode after model improvement.

The results of the hypothesis testing to analyze the causal influence between the latent variables in the structural equation model for the management of industrial business organizations during flooding, there are five hypotheses as follows:

H1: The Risk Management components have a direct influence on cooperation management components (Collaboration Management) with statistical significance at the 0.001 level, evident from the Standardized Regression Weight of 0.59, in accordance with the research assumptions.

H2: The Risk Management components have a direct influence on Resources Management components with statistical significance at the 0.001 level, indicated by a Standardized Regression Weight of 0.67, aligning with the research hypothesis.

H3: The Risk Management components have a direct influence on organizational management components (Organization Management) with statistical significance at the 0.001 level, as demonstrated by a Standardized Regression Weight of 0.55, in accordance with the research assumptions.

H4: The Resources Management component has a direct influence on the Organization Management component with statistical significance at the 0.001 level, supported by a Standardized Regression Weight of 0.40, in line with the research assumptions.

H5: The Resources management component has a direct influence on the collaborative management component (Collaboration Management) with statistical significance at the 0.001 level, evidenced by a Standardized Regression Weight of 0.37, aligning with the research assumptions.

Discussion of Conclusion

Guidelines for Industrial Business Management During a Flood Disaster encompass four key aspects: Risk Management, Collaboration Management, Organizational Management, and Resources Management, each of which holds significant importance.

The results of the hypothesis testing revealed that the Risk Management component significantly influences the Collaboration Management segment, with the highest weight value (Standardized Regression Weight) at 0.83. This empirical data emphasizes the necessity for organizational risk management to garner support and participation from all levels within the organization, echoing the findings of Matteo Rubinato, et al. (2019*: 1-

9), who conducted a comprehensive research study. This comprehensive strategy for the future includes:

1) Identifying the responsibilities of all stakeholders, encompassing institutions, organizations, government departments, and flood-affected communities, to elevate resilience against climate change.

2) Fostering the creation of sustainable and habitable cities, thereby empowering stakeholders in environmental matters.

3) Acknowledging urban flood risk management as predominantly reactive, and advocating for a proactive approach involving integrated land use planning and flood management, coupled with the implementation of early warning systems.

4) Communities need to engage and communicate their specific interests (such as economic development and environmental protection), while stakeholders play a role in providing a better understanding of the causes of water occurrence. Flooding in urban areas identifies various techniques for inclusion in urban planning, and also consistent with Junaid Rehman, et al. (2019: 1-27) stated that the use of systems thinking in sustainable flood disaster management creates an environment that supports the creation, of organization, storage, sharing, and application of knowledge related to disaster risk reduction. Managing disaster risk reduction knowledge in a way that makes the most of emerging research, and new knowledge created in the field of disaster risk reduction. Promote disaster risk reduction efforts nationwide. By coordinating with government organizations media, higher education institutions, civil society, and non-governmental organizations that aim to train, educate, and raise awareness of the general public and vulnerable communities In particular, develop the roles and responsibilities of government agencies at the district, provincial and national levels, organizations responsible for flood management, preparation, and rehabilitation based on effective coordination.

Suggestions

Guidelines for Industrial Business Management During a Flood Disaster is a guideline that shows the internal management of industrial business organizations in the event of a flood. Organizations that have appropriate flood management guidelines will enable the organization to cope with floods to reduce the impact that will occur on the business in this research the researcher has suggested principles and guidelines for managing industrial business organizations in times of flooding the details are as follows:

Suggestions obtained from policy research level

1. The Department of Industrial Works, Ministry of Industry, is tasked with developing and improving flood prevention practices in industrial plants by leveraging modern technology and innovation to provide quick and accurate flood warnings. This includes assigning provincial industries to impart knowledge on flood prevention to industrial business organizations and closely monitoring the situation to provide immediate assistance. Furthermore, the department coordinates with the Provincial Disaster Prevention and Mitigation Office, local government organizations, and other relevant agencies in flood response to assist industrial business organizations, especially in areas experiencing annual flooding.

2. The Department of Disaster Prevention and Mitigation, Ministry of Interior, aims to accelerate its participation in and strengthening of networks with the industrial business sector. This involves expediting the professional development of its personnel and industrial disaster management practitioners by collaborating with the government, private sector, and civil society to effectively manage flood disasters. Additionally, the department is accelerating the development of disaster management standards for pre-

event, during-event, and post-event scenarios, as well as enhancing and conducting training courses on disaster prevention and mitigation for industrial business organizations.

3. The Industrial Estate Authority of Thailand (IEAT) under the Ministry of Industry is actively monitoring and preparing for flash floods, particularly in industrial estates located in high-risk areas. Strict measures are being implemented to monitor the situation and preemptively prepare for flash floods to prevent flooding. The authority is also progressing with a project aimed at constructing a flood prevention system in industrial estates that are prone to recurrent flooding, including building a water barrier improving drainage channels and complete the installation of CCTV cameras and automatic rain gauges. Including, requiring every industrial estate to practice emergency plans for flooding every year.

4. National Water Resources Office (ONWR) and Meteorological Department Ministry of Digital Economy and Society The communication of flood risk area warnings in advance should be accelerated by applying the water map database to industrial businesses of all sizes. So that the industrial business sector can follow the announcement. National Water Administration regarding flash flood monitoring Flash floods as well as news about various floods via the website of the National Water Resources Office. Or following graphics showing areas at risk of heavy to very heavy rain in Thailand from the Meteorological Department during the rainy season. and should speed up the drainage efficiency of drainage channels to reduce flooding in high-risk areas every year.

Suggestions obtained from operational research level

1. The industrial business sector should place significant importance on flood risk management by monitoring announcements from the Meteorological Department regarding continuous rainfall. With these measures, the sector can promptly and appropriately determine actions to reduce flood risk. Additionally, it is essential to assess the loss of production capacity during flooding, minimizing the impact on the production line.

2. The industrial business sector should develop a Business Continuity Management Plan (Business Continuity Plan) specifically tailored to address flood situations. This plan should include the preparation of a list of emergency contact telephone numbers for various agencies that may need assistance in the event of a flood. Roles, duties, and responsibilities for dealing with flooding should be clearly defined and assigned to working groups within the organization.

3. The industrial business should be taken to ensure the safety of personnel in the event of a flood, which includes conducting situation assessments when floods occur and outlining steps before, during, and after a flood emergency to support uninterrupted business operations.

4. The industrial business sector should develop an Emergency Response Plan specifically tailored for flood scenarios and conduct annual practice drills. This plan ought to include a roster of emergency response team members, their respective responsibilities, evacuation procedures, and the identification of critical materials or equipment requiring protection from flooding, such as machinery, raw materials, and finished products. Moreover, it should outline strategies for flood prevention within factory buildings, including water pumping and drainage systems.

5. To prevent flooding, the industrial sector should establish cooperation among personnel, encouraging collaborative efforts like working together to fill sandbags and construct waterproof embankments. Fostering teamwork among employees is crucial for effectively addressing flooding challenges. Additionally, the sector should formulate plans to collaborate with the Industrial Estate Authority's disaster prevention and relief unit or other agencies responsible for flood response.

6. The industrial business sector should establish a social network to connect with potential groups or diverse agencies providing knowledge about preparing plans and offering assistance during floods. Moreover, various departments should contribute to developing the potential of the organization's employees to apply and disseminate knowledge within the organization, ensuring proper implementation. Furthermore, to significantly reduce flood risk, the sector should focus on advancing communication technology and online social networks to facilitate flexible and rapid advance warning or emergency plan coordination. Leveraging satellite imagery and aerial photography for more precise weather forecasts will provide crucial information to help the industrial sector immediately mitigate the impact of flooding.

7. Prepare flood response resources by establishing assembly points for employees in case of emergency evacuation. Ensure the availability of personal protective equipment (PPE) for flooding, including boots, raincoats, and life jackets. Additionally, provide communication equipment such as radios, hotline numbers, group lines, etc.

8. The industrial business sector should plan a budget for flood risk management, such as building a flood protection wall, preparing sandbags, and embankments, or preparing materials, equipment, and space for moving machinery to high areas so that they are above the flood level. Including, the budget for organizing training to educate employees on managing and reducing impacts from floods, etc.

Suggestions for further research

1. Research on fire prevention guidelines in the industrial business sector is crucial for preventing fires at their source and enabling industrial organizations to quickly cope with or control fire situations, thereby reducing losses in terms of both employee lives and corporate assets. This also includes preventing business interruptions.

2. Research on ways to mitigate the effects of hazardous chemicals in the industrial business sector involves studying the detailed effects of hazardous chemicals, such as their impact on the production chain, employees, organizational assets, and the environment. This includes addressing potential dangers that may arise from chemicals used in production in reducing the impact on communities. Such research will enable the business sector to properly and effectively plan to prevent these impacts.

3. Research on guidelines for reducing greenhouse gases in the industrial business sector is imperative due to current global warming leading to extreme climate change and an increase in natural disasters such as forest fires, rainstorms, and floods worldwide. Furthermore, with Thailand's announcement of the important goal to achieve Carbon Neutrality by B.E. 2050 and to attain net zero greenhouse gas emissions (Net Zero) by 2065, such research becomes even more crucial.

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