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Development of a Risk Assessment Mapping and Guidelines for Fire Risk Management in the Old Town: A Case Study of Chiang Mai, Thailand

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Abstract

This research focuses on the vulnerability of old towns to fire risk due to the absence of adequate prevention and response plans in densely populated areas. With Chang Moi Community, Chiang Mai, as a case study, the research aims to investigate the factors and physical relationships that influence fire risk, in addition to mapping out a risk assessment and surveying the needs of the samples to develop guidelines for managing fire risk areas in the old town. The data were collected from a physical survey using a geographic information system (GIS) and the analysis hierarchy process (AHP) by dividing the analyzed areas into 5 zones to identify risk variables. The research findings showed that land use activity and population density were the important factors in defining fire risk zones. A survey of 300 community members revealed strong needs for fire risk management, particularly in post-fire and community participation areas. The community, with a long history in the region, emphasizes emergency management, disaster relief, and post-disaster rehabilitation. The study underscores the importance of risk mapping and comprehensive management plans to reduce a fire risk and damage in old towns. Understanding the community's needs and preferences is crucial for creating prevention measures and enhancing safety sustainably.

Keywords: *Vulnerability of the Area, Risk Assessment, Fire Risk Area Management.*

Introduction

Chiang Mai is a major economic and social metropolis in northern Thailand, with an international reputation, distinct culture, and local wisdom (Chiang Mai Provincial Office, 2017). Various tourism resources are exquisite, including ancient sites, unique art and culture, and stunning natural tourist attractions. The structure of Chiang Mai shows its specialty in a grouping of small neighbourhoods. Each area is often related to history, culture, and political dynamics. Also, urban development has been unique (Pranom Tansukanan & Wittaya Duangthima, 2018). However, Chiang Mai evolves into a vital economic metropolis with an international orientation (Urban Planner Network, 2010). The expansion of urban area and population leads to a large latent population coming to live in Chiang Mai for both the short and long term. This event causes issues in a variety of areas, including population density,

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housing density, building structure, social activities, and a lack of suitable development planning (Amphika & Nawit, 2018). Historically, numerous town activity areas become slum communities, resulting in social, environmental, and cultural transformations induced by diverse activities, including the chaotic development trend as the key factor that may facilitate a "fire risk area."

Fire or fire-related damage is a potential public disaster. This fire may be the result of human negligence, ignorance, or an accident, and it can have serious consequences for the community and society in terms of life, property, society, the economy, and the environment (Department of Disaster Prevention and Mitigation, 2015). High population density is commonly associated with fire-risk locations and other potential factors, such as the susceptibility of the building structure, the risk history of the area, and factors influencing the incidence of catastrophes in that area. A calamity is likely to affect individuals or groups of people differently. Unplanned developments in fire response and prevention can lead to increased risk. A fire would spread and be difficult to control (Bhaskar, S. 2000). Thus, community areas are a key factor that creates fire-risk areas (Zhang, Y. 2013). There are limitations in area boundaries that cannot prevent danger with low safety from event conditions; therefore, it is unable to lower danger to a safe stage (Hewitt, 1997).

The objective of this research is to investigate variables and physical relationships in the old town that cause a fire risk using the Hierarchical Analysis Process (AHP) to analyze the creation of risk maps and survey the needs of the sample group, resulting in guidelines for the effective and sustainable management of fire risk areas and the reduction of the possibility of fire impacts in the community.

Objective

1. to investigate variables and physical relationships in the old town that cause a fire risk
2. to guidelines for the effective and sustainable management of fire risk areas and the reduction of the possibility of fire impacts in the community

Literature Review

Fire-risk areas are prone to frequent disasters possibly due to natural disasters, such as weather, drought, or man-made disasters that cause damage to people and property. The identification of fire-risk areas depends on preliminary and extensive research and analysis. In addition to the variables that produce risk, many indicators or risk values may be included in the study.

1.1 Area Vulnerability

Wisner et al. (2004) defined vulnerability as the result of various factors that affect a person's life, livelihood, or property, or those groups of people at risk from disasters, including natural and social factors such as materials, age, and risk history of the area, as well as other factors that affect the occurrence of disasters in that area. With a lack of capacity to handle such disasters, each person or group of people is likely to be affected differently.

Hewitt (1997) defined vulnerability as areas with various characteristics, namely areas that are easily affected by threats, the vulnerability of the building, dangerous activities, a lack of

resources and personnel, and risk management plans. This includes areas that cannot mitigate disasters or restore a state of safety.

Santos et al. (2017) described vulnerability as "old town areas or vulnerable areas at risk for fires due to several adverse factors that contribute to the spread of fire, with difficulties in managing and reducing its spread." These concerns include deterioration of ancient structures, electrical facilities, outdated wires, a lack of detection and fire extinguishing systems, fire truck access, narrow and curving roads, an obstruction on the sidewalk, and parking that makes it difficult for automobiles to pass.

Town vulnerability analysis emphasizes the importance of multiple factors in urban fire risk assessment (Zhang, Y. 2013). An increased awareness of fire risk and effective fire risk reduction measures can be produced by taking into account numerous elements, such as climatic conditions, building density, and firefighting resources.

The world recognizes that disasters can be managed without waiting for them to occur first. Disaster management (DM) includes emergency management, providing alleviation assistance to disaster victims, and rehabilitation after the disaster. As shown in Figure 1, there is a greater emphasis on disaster risk management (DRM) operations that are sustainable (Disaster Prevention and Mitigation, 2015). As a result, DRM becomes increasingly important in society since according to DRM, all disasters are caused by human behaviors, patterns, and ways of life, which result in events that may cause harm and affect society and the environment (Davis & Alexander, 2015). Vulnerability in the town and the prospect of potential unfavorable impacts or losses, such as economic activities and environmental destruction, cause damage to people's life safety, loss of property, and risks to public security (Zhang, Y. 2013). Therefore, new and appropriate disaster management must be developed in response to the changing environment and society.

Figure 1: Disaster risk management cycle. Modified from (Aguirre-Ayerbe, I et al., 2018)

Accordingly, the risk analysis of the old town is an important tool in developing recommendations for dealing with fires proactively by providing an understanding of the true cause of the disaster, reducing damage, and resolving root cause problems after a disaster (WBI, 2009) . Risk management analysis planning is thus a process of determining the characteristic, size, or extent of risk based on the occurrence of a disaster, including assessing the state of risk exposure, vulnerabilities, and coping capacity of communities in order to predict the impact on

life, property, livelihood, and the environment. This is an analysis of the probability of impacts from a disaster in a particular area and is useful in systematic risk management planning.

1.2 Risk Management

To maintain the worth and integrity of the old town, successful risk management necessitates law, management, and technological collaboration. Furthermore, the risk areas' conditions (Jigyasu, 2016), such as densely constructed structures, result in low accessibility and a more complicated society with weaker links between management, economics, and politics. Smith (2004) proposed risk assessment guidelines, describing disasters as difficult to define specifically but with a need to consider various situations that influence disaster risk, namely the possibility of disaster, an impact, and a lack of capacity which can lead to an increased fire risk.

Zhang, Y. (2013) stated that the town's fire risk assessment requires an analytical hierarchy process (AHP) to construct an urban fire risk assessment system. AHP is a multi-criteria decision-making process that uses a wide range of criteria and alternatives to build a set of indicators for assessing urban fire risk. These variables include the risk of fire incidents in urban areas, urban fragility, and the town's fire prevention capacity.

According to Huang, H., Li, L., & Gu, Y. (2022) , the goal of fire hazard mitigation for old politics aimed to investigate complex factors to uncover problems and protect the old town with the structural capability to support emergency response. The goal also involved population growth in developing areas, assessment, planning, and emergency response techniques**.** The firefighting access system must be modified to accommodate the constraints of modifying the construction of the historic town.

Santana et al. (2007) mentioned the assessment of fire risk in the old town by identifying fire hazards, fire probability analysis, and fire consequence assessment, including the narrow road, lack of a fire protection system, the installation of a fire protection system, the removal of combustible materials, and road expansion to provide better access for firefighting vehicles. The risk analysis for the likelihood of being affected by the fire is conducted to establish appropriate steps to manage and minimize risks and the implementation is crucial for fire risk reduction (Kumpulainen, S. 2006). During the development planning phase, the relationship between catastrophe risk factors is depicted in Equation 1.

$$\text{Risk} = \frac{\text{Hazard x Vulnerability}}{} \quad (1)$$

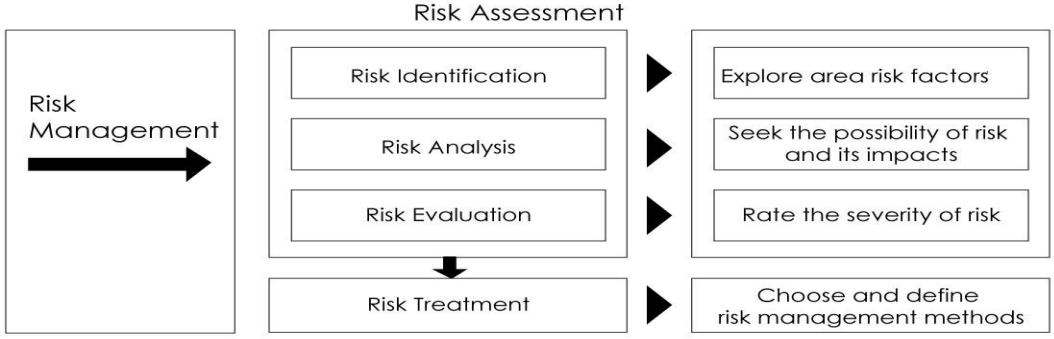
Capacity

Risk identification, risk assessment, a fire protection system, and assessing people's understanding of fire risk areas are necessary as the basis for identifying risk factors that lead to the risk assessment process in related development planning processes. Paolini et al. (2012) emphasized three key technical solutions to develop effective emergency response mechanisms for protecting the old town. Hazard assessment, emergency planning, and specific risk reduction measures are also important. Therefore, risk estimation represents the risk value from the sum analysis results above as a result of the level of disaster risk. The severity of fire consists of 5 classes: very high-risk areas (risk class greater than 3.5), high-risk areas (risk class 2.91–3.50), moderate-risk areas (risk class 2.31–2.90), relatively low-risk areas (risk class 1.81–2.30), and low-risk areas (risk class less than 1.80). A key tool that helps an emergency operation

systematically and efficiently is to prepare a risk map and a disaster prevention plan in the community area to be ready for disasters, especially at the community level (Saowalak et al., 2020). A risk map and a disaster prevention plan are utilized to display the risk area results with information related to various risks. The information involves risk factors and risk area assessment using GIS techniques with an Analysis Hierarchy Process (AHP) to create an urban fire risk assessment system. AHP is multi-criteria decision-making for the evaluation of complicated systems with multiple criteria and alternatives (Zhang,Y. 2013). Then, the weighting value of the variable is determined, and the rating value is calculated for each factor. An overlay analysis is performed, leading to results based on the conditions of the analysis. This method is commonly used to solve spatial problems. According to the study (Millet et al. 2000), fire risk assessment entails gathering data about the built environment, construction components, surrounding circumstances, and alarm and fire extinguishing capabilities. The statistical weighting is based on the importance of each item (Silva, D. et al., 2022). The application of this method contributes to building and expanding the fire risk assessment data in the center of the old town. Nur Isroatul Khusna et al. (2023) proposed disaster management strategies that include developing a comprehensive disaster management system that includes all actors and stakeholders, improving the quality and quantity of disaster data collection and analysis, strengthening disaster management institutions and organizations, strengthening community-based disaster management efforts, promoting measures to reduce and mitigate disaster risks, and organizing efforts to recover from disasters.

The risk assessment is very valuable and can be used as a guideline for evaluating risk areas, lowering a fire risk, and developing risk area planning. Key principles in incorporating disaster risk reduction into development are risk identification, risk analysis, and risk estimation, all of which lead to measures to manage and reduce proper risks by people or communities before, during, and after disasters (Totsapon et al., 2020). The measures include knowledge enhancement on fires; the risk and safe areas in the community; the use of area and zoning; control of the use of space; the management of people's ability to cope with disasters; the preparation of a plan before the disaster; a follow-up on the situation; and understanding of practices before, during, and after the disaster**.** Ultimately, the measures would make that community safe. As shown in Figure 2, these processes are part of the entire risk management process, which includes risk assessment and risk management (Xin, J., & Huang, C., 2013).

Figure 2: Fire Risk Management Steps Modified from Xin, J., & Huang, C. (2013)



Risk management processes for determining risk areas and managing fire risk areas are critical with the adoption of indicators and related information for fire risk area analysis and assessment. Therefore, the effectiveness of community fire prevention and mitigation can be improved by identifying and analyzing risks and vulnerabilities to deal with fire in diverse areas

with efficiency and sustainability. Additionally, understanding of the significance of activities before, during, and after the disaster; management to enhance future safety; and awareness of fast and reliable management are crucial.

Materials and Methods

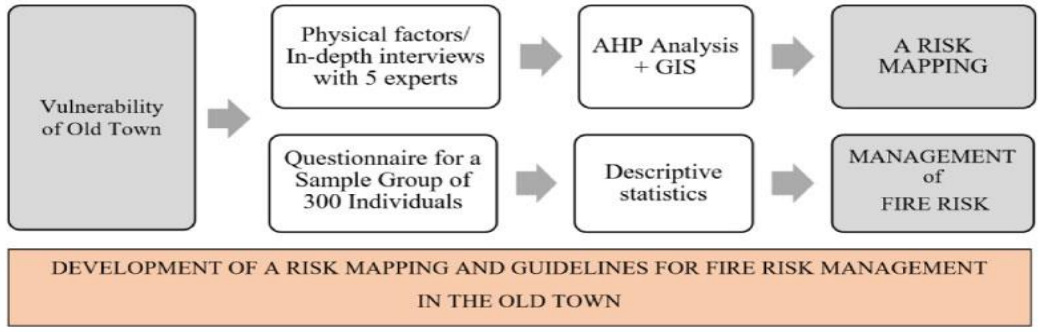
The present study was a mixed-methods study that used both qualitative research methods in the risk assessment phase and quantitative methods in the risk management process to generate precise and succinct research results. The target population was in the Chang Moi Community, Chiang Mai, with a total population of 1,087 people (Population Statistics, 2022). The two methods were used as follows:

1. The Analytical Hierarchy Process (AHP), in-depth interviews, and physical surveys were used by fire protection experts to gather information in order to determine the weighting value of the factors related to fire risk area management in the community. The AHP was used to categorize these factors and apply a weighted value to each factor. A pairwise comparison was then performed. The AHP data were examined using GIS and overlay analysis to highlight fire risk zones in the neighbourhood with 5 classes of the fire severity in order to identify areas with a high fire risk. Then, maps were created.

2. The descriptive statistics analysis was conducted with data from a random survey of 300 participants in Chang Moi village. Taro Yamane's formula (Yamane, 1967) was used to calculate the sample. This analysis includes data on demographic factors and the requirement for management of fire-risk regions in the community in terms of management before, during, and after the fire. The personal and general data reflected the needs of the population and stakeholders for fire risk area management. The analysis was performed in terms of frequency distribution, percentage, mean, and standard deviation.

Both methods foster an understanding of the elements influencing fire risk and community needs, as well as systematic and reasonable decision-making and management planning of fire risk areas. The adjustment of plans based on the analytical data could enhance fire risk area management plans in the community, as shown in Figure 3. Data analysis and the use of descriptive statistical methods could propose risk management guidelines based on the research framework.

Figure 3: Research Framework



Site Study

Chang Moi Community is an old urban community in Chiang Mai Municipality. It is an important old city area located in Chiang Mai Municipality in the east between Chiang Mai's old town and Kamphaeng Din along the Mae Kha Canal as a major urban landscape in the municipal plan and as a case study. The overall study area is around 0.205 square kilometers. Land usage is a mix of relatively dense residential districts, such as commercial buildings, hotels, and commercial business areas, which have long served as the commercial heart of Chiang Mai (from 1965 to the present). This research area was divided into five zones (as shown in Figure 6):

Figure 4: Scope of Study Area

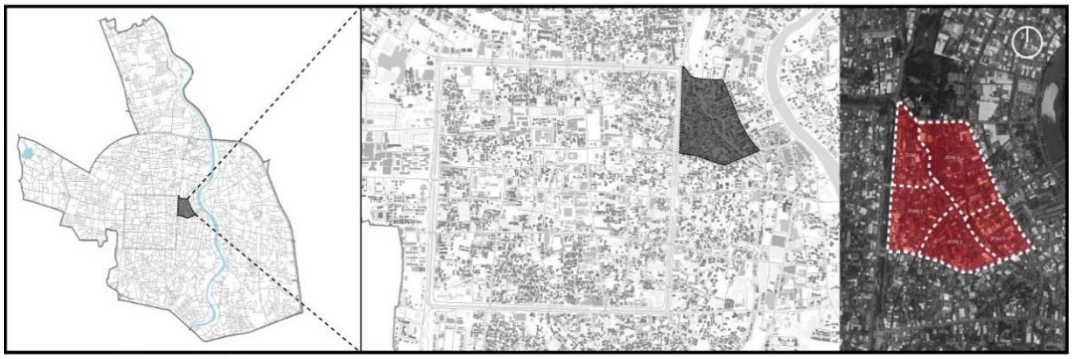


Figure 5: Chang Moi Community Conditions in Chiang Mai

Zone 1 is a significant historical area in the community centered around Wat Chai Sri Phum in the northwest corner. There is a line of the Jang Si Phum earthen wall separating the inner moat and the outer moat. The community is in the form of a village divided into alleys connected by footpaths along with a canal, or Mae Kha canal. The town's earthen wall is a key landscape.

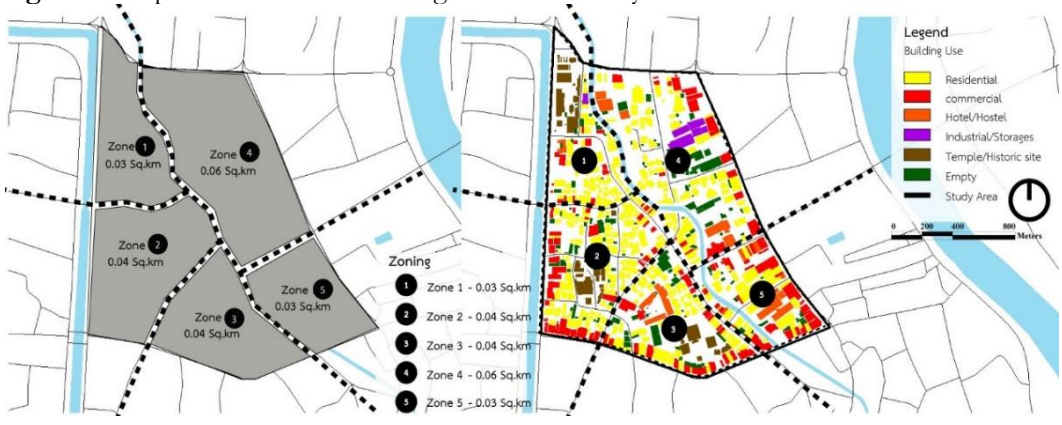
Zone 2 is the community area on the west side with old temples such as Wat Chomphu. Land use consists of residential areas, including single-family homes, shophouses, wooden buildings, commercial buildings, cafes, restaurants, guesthouses, and hostels. As a result, the Chang Moi neighborhood features a mix of residential and commercial structures. The alleys are relatively tiny and have one-way traffic.

Zone 3 is the community area in the south, with Wat Nong Kham as an old temple. Land use consists of old buildings, including both wooden buildings and local wooden shophouses, which retain the uniqueness of the original building construction with the story of the past to the present. The shophouses in Chiang Mai with a blend of building construction techniques and current components, commercial structures of contemporary architecture were also located on the roadside.

Zone 4 is the community area in the northeast part. Land use includes residential villages along the Mae Kha Canal, each with a one-story wooden residential building, as well as the region adjacent to the road to Warorot Market and Mueang Mai Market. An old commercial building has been converted into a new sort of business in the town.

Zone 5 is in the community area in the southeastern part. Land use consists of commercial buildings that have been developed from old buildings to new business ones in the community, including a warehouse, furniture and electrical appliance stores, motorcycle shops, and accommodation.

Figure 6: Map of Five Zones in Chang Moi Community



Data of the Factors

Analysis of Chang Moi community's physical area survey data in Chiang Mai Province It's a crowded neighborhood. One significant factor that could result in a high risk is the old city's vulnerability. In terms of the composition of the community Density of population and surroundings on three main factors: the possibility of fire, the impact on the population in the area, and the lack of potential for area protection and management. These three factors were used to analyze seven sub-factors, including activities and land use, building material, number of building floors, population density in the area, fire station service radius, road network, and fire hydrants. The geometric mean, score weights of the alternative models, and data consistency were then analyzed to determine whether the comparison results of the factors used in the study were reasonable or consistent with the ratings (Table 6) by calculating the consistency ratio (CR) using Equations (1) and (2) (Saaty, 1980). It is regarded as acceptable if the CR is less than 0.10. Equations (1) and (2) are shown as follows:

$$CR = \frac{CI}{RI} \qquad (1)$$

Where CR refers to Consistency Ratio

CI refers to Consistency Index

RI refers to Random Consistency Index

$$CR = \frac{\lambda \max - n}{n-1} \quad (2)$$

n is equal to a number of variables. The Random Consistency Index (RI) is based on Saaty's matrix (Saaty, 1980). The findings were presented as the danger level from the incident location in the Moi Chang community, resulting in five risk classes: extremely high-risk areas, high-risk areas, moderate-risk areas, very low-risk areas, and low-risk areas.

Results

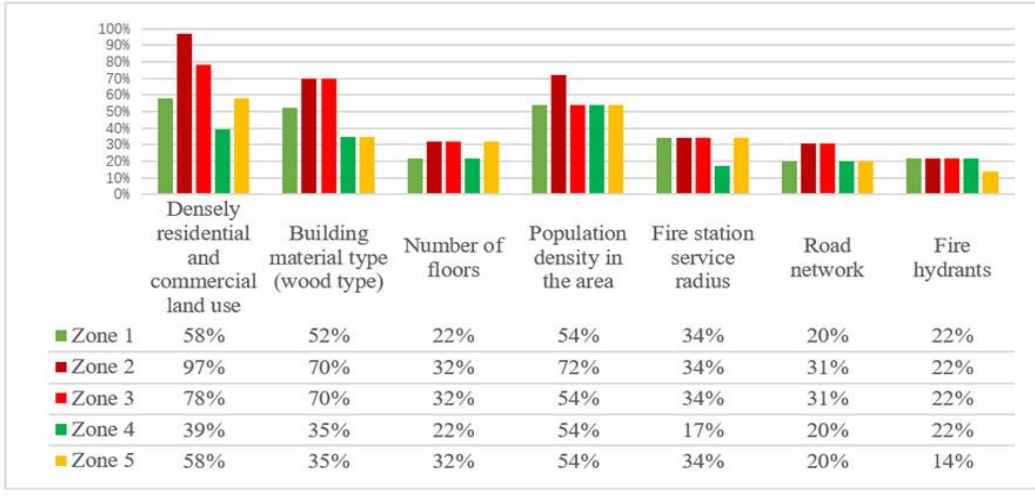
Table1: Data on Factors/Sub-factors and Weighted Values for the Impacts of Fire Risk Assessment Areas

Data of the factors/sub-factors	**Class**	**Rank**	**AHP Weighting (CR = 0.027)**	**Risk Classes**
1. Fire Risk Chance				
1.1 Densely residential and commercial land use	> 80%	4	0.19	Very high
	80 - 70	3		high
	70 - 60	2		Moderate
	< 60%	1		Low
1.2 Building material type (wood type)	> 30%	3	0.17	high
	30 - 20	2		Moderate
	20 - 10	1		Low
1.3 Number of floors	> 3 floors	3	0.11	high
	2-3 floors	2		Moderate
	1 floor	1		Low
2. Impact on the Population in the Area				
2.1 Population density in the area	> 25 people/Rai	3	0.18	high
	12 – 25 people/Rai	2		Moderate
	< 12 people/Rai	1		Low
3. Lack of Potential for Area Protection and Management				
3.1 Fire station service radius	> 1.2 kilometres	4	0.17	Very high
	1.2 – 0.8 kilometres	3		high
	0.8 – 0.5 kilometres	2		Moderate
	< 0.5 kilometres	1		Low
3.2 Road network	> 6 Meters	1	0.10	Low
	3 – 6 Meters	2		Moderate
	< 3 Meters	3		high

3.3 Fire hydrants	> 1 Fire extinguisher /1000 Sq.m	1	0.08	Low
	1 Fire extinguisher /1000 Sq.m	2		Moderate
	< 1 Fire extinguisher /1000 Sq.m	3		high

According to Table 1, seven factors influenced the risk index in the Chang Moi community: activities and land use (index value of 0.19), building material type (index value of 0.17), building number of floors (index value of 0.11), population density in the area (index value of 0.18), fire station service radius (index value of 0.17), road network (index value of 0.10), and fire hydrants (index value of 0.08). These variables were obtained through an in-depth interview with a group of professionals and a physical survey of fire risk areas in the Chang Moi community for risk management by identifying risks, risk analysis, and risk assessment of the study areas in all five community zones. The details of the assessment are as follows:

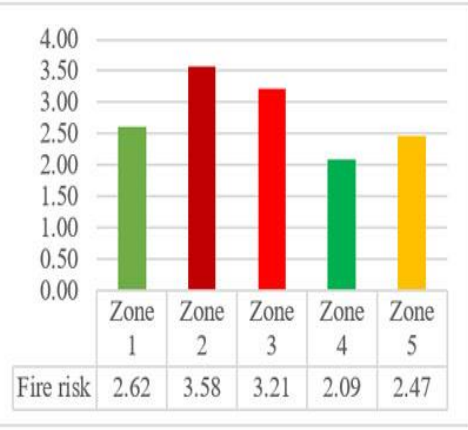
Chart 1: The Chang Moi Community Study Area's Risk Factors



According to the assessment results of the fire risk areas in the Chang Moi community under Objective 1, areas in the community were different in terms of types of activities and characteristics of land use. Based on characteristics on the vulnerability of the Chang Moi community, risk estimation was divided into five classes of severity. Table 2 shows the risk order to assess the results of the Chang Moi community's fire danger zones. The data can be summarized as follows:

Table 2: Results of Fire Risk Assessments in Chang Moi Community

Zoning	Area (Sq.km)	Tota l	Total (%)	Assessment Level
1	0.03	2.62	19.0	Moderate
2	0.04	3.58	25.9	Higher
3	0.04	3.21	23.2	High
4	0.06	2.09	15.1	Low
5	0.03	2.47	16.7	Low



Zone 1: The fire risk was moderate, with a rating of 2.62 (19 percent). As a result, immediate action should be taken to increase strength and preparedness for a fire. Risk factors arose from land use activities with the largest risk value (58 percent) due to land use activities. Other factors include population density with a risk value of 54%; building material type with a risk value of 52%; fire station service radius with a risk value of 34%; number of floors with a risk value of 22%; road network with a risk value of 20%; and fire hydrants with a risk value of 22%. The community land use is a hamlet separated into alleys linked by pathways with the Mae Kha canal, and the town's earthen wall is a crucial landscape with a road next to the town's main road. The accessibility of fire trucks is moderate.

Zone 2: The fire risk was extremely high, with a rating of 3.58 (25.9%). This zone posed the highest fire risk. Land use activities posed the greatest risk (97%) and had the largest population density (72%). As a result, this zone requires emergency actions, followed by elements related to building material type with a risk value of 70% and fire station distance with a risk value of 34%. In addition, risk indicators include the number of floors in a building with a danger value of 32%; the road network with a risk value of 31%; and fire hydrants with a risk value of 22%. The location was crowded because the area was commercial and residential. This indicates a significant danger from land use activities. Due to a dense population and a latent population, most building materials were made of wood. Residential areas include detached houses, shophouses, wooden structures, commercial structures, cafes, restaurants, guesthouses, and hostels. The west side of the community was densely populated with traders. The buildings were extremely crowded. The alleyways were relatively narrow, with only one lane going in each direction. Access for fire trucks was difficult and far from the fire hydrants.

Zone 3: The fire risk was in the high category, with a risk rating of 3.21 (23.2 percent), since several variables should be focused on strengthening fire protection and management. The largest risk factor is land use activities with a risk value of 78%, followed by building material types with a danger value of 70%, and population density with a risk value of 54%. It was also required to consider road networks with a danger value of 31%, and fire hydrants, which have a risk value of 22%. This zone was distinguished by a high population density and a wide range of land-use activities. As a result, fire preparedness and management should be prioritized throughout the area.

Zone 4: The fire risk caused by a variety of low-risk variables was relatively low, with a risk rating of 2.09 (15.1 percent). The characteristics with the highest risk classes include population density (54% risk value) and land use activities (39% risk value), followed by building material

kinds (35% risk value) and the number of building floors (22% risk value). However, Zone 4 remains a key consideration in preparedness, with a fire station service radius (17%), a road network (20%), and water hydrants (22%). Zone 4 remains an important component in readiness.

Zone 5: The fire risk was relatively low, with a risk rating of 2.47 (16.7%). Land use activities (58%) are a factor, as are population density (54%), building material types (35%), a fire station service radius (34%), the number of building floors (32%), the road network (20%), and fire hydrants (14%). In spite of the minimal risk, vigilance and readiness are crucial in the event of a fire. The areas in this zone are situated along the Mae Kha Canal and have wooden houses and one-story homes. These communities are connected to various thoroughfares that go to Warorot Market and Muang Mai Market. Only 800 meters separate the location from the fire station to the east.

Based on the statistical data analysis, the management of the fire risk areas from physical surveys and the need for fire risk area management in the Chang Moi community led to the level of needs for fire risk area management in all 4 areas, namely management before, during, and after fire, and management and participation. The data were obtained from a random sample questionnaire from 300 people in the Chang Moi community as shown in the Table below.

Table 3: Percentages of Personal Characteristics of the Sample (n=300)

Personal Characteristics			Number (People)	Percentage
1.	Gender	Male Female LGBTQ+	123 169 8	41.0 56.3 2.7
2.	Age	Below 30 Years 31-40 Years 41-50 Years 51-60 Years 60 Years Above	29 48 52 69 102	9.7 16.0 17.3 23.0 34.0
3.	Status	Single Married Divorced/Widowed	96 139 65	32.0 46.3 21.7
4.	Educational Background	Secondary school or below High School/Vocational Certificate Associate Degree/High Vocational Certificate Bachelor's degree Postgraduate	117 68 35 71 9	39.0 22.7 11.7 23.6 3.0
5.	Career	Merchant Government service/state enterprise Contractor Housekeeper Student Other	74 29 101 66 15 15	24.7 9.7 33.6 22.0 5.0 5.0

According to Table 3 of 300 samples, females accounted for 56.3 percent of the sample, while males accounted for 41.0 percent. In terms of age, the majority of them were aged over 60 years (34%), with those aged 51–60 (23%). Most of the sample (46.3%) was married. Educational background was mostly high school or below (39%). For career, most of them were contractors (33.6%), followed by merchants (24.7%). It could be concluded that the sample posed a diverse distribution of population characteristics, with a significant share of gender, age, and differences in marital status, educational background, and career.

The descriptive analysis of average demands for fire risk area management in the Chang Moi community provided an overview of the data and the link between the data. The following is a summary of the results of the management before, during, and after the fire, and management and participation:

The Needs for Management Before Fire

The results of the needs assessments for fire risk area management prior to the fire in the Chang Moi neighborhood showed a "high" priority level with an average score of 3.58 and a standard deviation of 0.924. These scores demonstrate the significance of fire preparedness and management in the Chang Moi community in order to reduce risk and deal with fires effectively. Fire prevention and management prior to the fire are critical in ensuring the Chang Moi community's safety and readiness in the face of future fire risk events (Table 4).

Table 4 Results of the Needs Assessments for Management Before Fire in the Chang Moi Community

Fire Management	Results of the needs assessments for fire risk area management		
	$\bar{X}$	S.D.	Level of Needs
1. Management before fire			
1) To conduct area risk assessment	3.35	0.969	Moderate
2) To conduct a response plan and trainings to provide knowledge to teams in the community	3.67	0.879	High
3) To develop an alarm system and to spread news and reports	3.61	0.881	High
4) To set a team to monitor the safety and the area	3.63	0.908	High
5) To check fire extinguishing equipment's availability	3.55	0.959	High
6) To encourage community participation and awareness of fire prevention	3.80	0.777	High
Total	3.58	0.924	High

The Needs for Management During Fire

The results of the needs assessments for fire risk area management revealed a high mean score of 3.70 and a standard deviation of 0.828. The results indicate the importance of planning for and dealing with fire. It is vital to enhance communities' and agencies' preparedness to deal with future fire hazards efficiently and safely (Table 5).

Table 5 Results of the Needs Assessments for Management During Fire in the Chang Moi Community

Fire Management	Results of the needs assessments for fire risk area management		
	$\bar{X}$	S.D.	Level of Needs
2. Management during fire			
1) To send an alarm signal immediately	3.69	0.904	High
2) To support basic public services, such as toilets, electricity, and lighting	3.79	1.001	High

3) To enable fire prevention team leaders to give orders and report to relevant agencies in a timely manner.	3.67	0.872	High
4) To report evacuation routes and set meeting points for safe places	3.55	0.807	High
5) To notify the first aid units	3.71	0.805	High
6) To enable traffic control unit to facilitate people and the work of officials and fire trucks	3.77	0.787	High
Total	3.70	0.828	High

The Needs for Management After Fire

The results of the needs assessments for fire risk area management in terms of post-fire management revealed a mean of 3.70 and a standard deviation of 0.828. The results showed that this was influential with a high level of demand, particularly in continuous relief and care for disaster victims and communities with a high average of 3.91 and a high level of demand. Management after the fire is a critical step in restoring the devastated community or area to normalcy (Table 6).

Table 6 Results of the Needs Assessments for Management After Fire in the Chang Moi Community

Fire Management	**Results of the needs assessments for fire risk area management**		
	$\bar{X}$	**S.D.**	**Level of Needs**
	1. Management after fire		
1) To provide a barrier around the incident area	3.68	0.830	High
2) To survey the cause of the damage with repetition before people come back to the area	3.79	1.001	High
3) To survey the needs of people in risk areas	3.67	0.872	High
4) To plan for recovery and repair of areas after a fire to return to normal conditions	3.66	0.818	High
5) To provide continuous relief and care for victims and communities	3.91	0.867	High
6) To introduce measures to reduce potential risks	3.89	0.738	High

7) To perform lessons learned for the application in other areas	3.72	0.743	High
Total	3.76	0.565	High

The Needs for Management and Participation

The results of the needs assessments for fire risk area management regarding management and participation showed a high level of demand with a mean of 3.76 and a standard deviation of 0.753. The public sector's support was at a high level of 3.88, with a high demand level. The public sector is crucial in planning for and managing a post-incident. They might provide appropriate preparedness and resources to assist towns or areas in responding to the situation efficiently and rapidly (Table 7).

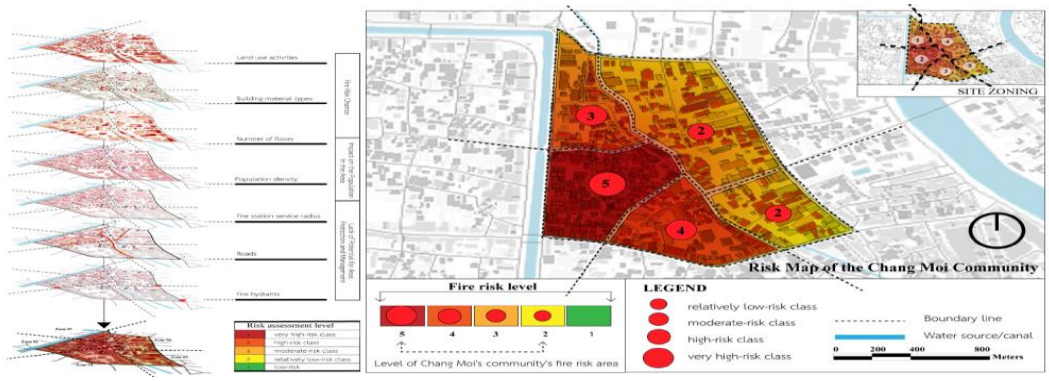
Table 7 Results of the Needs Assessments for Management and Participation in the Chang Moi Community

Fire Management	Results of the needs assessments for fire risk area management		
	$\bar{X}$	S.D.	Level of Needs
1. Management and Participation			
1) Administration of the community committee	3.80	0.777	High
2) Community activities	3.74	0.755	High
3) Public relations	3.71	0.771	High
4) Restrictions and community laws	3.67	0.798	High
5) Community's attitude	3.75	0.753	High
6) Support from the public sector and communities	3.88	0.794	High
Total	3.76	0.753	High

Discussion

The results of the assessment of fire risk areas in the Chang Moi community under Objective 1 provide a fire risk map from the overlay analysis method. The map is divided into 5 zones based on the vulnerability of the community structure and risk estimation through 5 classes of severity. The details are shown in Figure 8.

Figure 7: Overlay of Risk Factors and a Risk Map of the Chang Moi Community



According to the findings of the assessments of fire risk areas in the Chang Moi community, the community is divided into five zones based on fire risk and land use, with an emphasis on fire awareness and readiness as follows:

Zone 1 (moderate risk class): An emphasis should be placed on strengthening prevention and readiness in the event of a fire through drills and training in preventing and resolving emergency situations, such as training in the use of fire hoses, alarm broadcasting, and evacuation plans. To deal with emergency travel, places with high traffic to the city's main roadways, traffic management, and fire truck access should be investigated. Integration of community groups and significant places, such as the Mae Kha Canal as key water sources for firefighting, including cleanliness and safety, should be considered.

Zone 2 (the highest risk class): Risk management should be a high priority. A systematic and clear emergency plan is essential, such as an evacuation plan, a firefighting plan, and a coordination plan with emergency services, so that the population can receive information and gather in the event of an emergency. Residential buildings should be fire-resistant by employing safer building materials, such as fire-resistant materials, and creating structures with safety in mind. In the event of a catastrophe, inspection and maintenance of fire extinguishing equipment, such as hose systems and fire extinguishers, were critical to preserving building safety.

Zone 3 (high-risk class): This zone has a large population density and a variety of land use activities, including commercial and residential land use. To increase community prevention and readiness for fire, risk management should focus on boosting fire prevention and management, including designating areas for fire departments and informing the public of suitable fire management plans, such as drills and training. Risk management elements, such as utilities and emergency communications need to be reviewed and improved.

Zone 4 and 5 (relatively low-risk class): Despite their low risk, fires can occur unexpectedly. We should be prepared to deal with any situation at any time. Training is important to prepare and raise awareness about fire. People in this zone should know how to respond and evacuate high-risk places in the event of an emergency. Preparing an emergency list involves gathering essential equipment and supplies, such as emergency food, drinking water, and medicine. A comprehensive evacuation plan, including secure exits and escape locations, should be in place so that people know how to evacuate and move safely if necessary. However, keeping awareness and responding to emergencies should be continuing activities in the future to ensure everyone's long-term safety as well as sustainable community growth and fire readiness.

A risk plan, proper management, and community participation all play a key role in decreasing risk and promoting long-term safety in the old town. Analysis and awareness of community needs are required for effective community-based management plans. These concerns can be addressed as follows:

Chart 3: The Level of Need for Fire Risk Area Management Results

According to Chart 3, the study of the sample group's demand for fire risk area management under Objective 2 shows that the sample group has significant needs in management after the fire, with an emphasis on urgent aid and victim protection. Communities and local governments can respond to fires rapidly and reduce danger during an occurrence to improve management and involvement. This is the result of the community's experience and preparedness in disaster management for those who had lived there for more than 40 years. The emphasis is placed on emergency management, relief, and assistance to disaster victims or rehabilitation after the disaster to effectively manage risks in this community. Based on the findings, the following fire risk management guidelines should be implemented:

Implementation of Management Before Fire

It is critical to identify risk areas prior to a fire in order to understand the variables and establish an adequate risk management plan. Developing an alarm system and news alerts is critical in communicating in specific circumstances to provide the community knowledge and time to cope with fires in a short period of time. Organizing area security surveillance and survey teams prove useful to detect and deal with potential problems. It is critical to inspect and maintain fire extinguishing equipment. Promoting community knowledge and engagement is critical to deal with fire situations in order to mitigate their damage. With this management plan, the Chang Moi community can efficiently be prepared for and deal with fires, protecting people and property in the community.

Implementation of Management During Fire

Fire management is critical in responding to emergencies. It includes immediate alarm signals, fire event reports, the assistance system on time, basic public services for the convenience, safety of the population in fire situations, and fire prevention team leaders with instant commands and cautions. They are critical in responding to emergencies. Planning and preparation for evacuation and navigation systems are required to allow the population to flee to secure areas. Reports on first aid units and traffic management are required to offer basic management services in the event of a fire, such as rescuing the injured and preserving traffic flow. The findings of this study stress the significance of continued emergency planning and response to ensure people's safety in all probable future fire situations.

Implementation of Management After Fire

For measures to reduce risks in the future, one of the key things is to create a barrier at the incident area to prevent access to areas and check equipment that may be at risk. The careful inspection of risk areas is essential to find the cause of the damage. Before people are allowed

to go back in a post-fire situation, the needs survey of people in risky areas is important for providing assistance and services. Understanding people's needs facilitates the operation. Lessons learned can be applied to other areas as an important step in improving management after a fire. The knowledge and experience gained from past situations can be used to prepare for and deal with potential situations. Therefore, planning for recovery and reconstruction of areas after fire is crucial in providing assistance and strengthening the community or area. A rapid and effective return to normal conditions is important to assist the population and promote the prosperity of the affected areas. This indicates the need for effective and sustainable management.

Implementation of Management and Participation

The management of the community committee is critical in coordinating community efforts following the fire in order to use resources and cooperation to handle the situation systematically and efficiently. In fire emergencies, public relations are a critical communication channel since accurate and timely information helps citizens make the right judgments and deal with issues. Community views influence community members' knowledge and accountability in fire emergencies. A constructive approach toward preparing for and coping with problems reduces danger and damage. Also, community actions are critical in establishing a response and recovery. Activities that link and encourage community members to develop communities in the long run and legal constraints on community areas are critical in management since rules and regulations are important for fire prevention management. As a result, these efforts would improve communities' preparation to deal with fires more effectively and safely.

Finally, in order to sustainably increase community safety, fire risk management in the Chang Moi community should be improved to be sustainable and modern, with a focus on risk management for fire protection and the effective response on the occurrence of fire.

Conclusion

This research clearly indicates the importance of fire risk management with a high class in the old town through appropriate management plans and community participation to reduce risk and improve safety in the long term. This also emphasizes the importance of a risk map and fire management for appropriate emergency preparedness in the short and long term by analyzing the needs of communities with potential fires and developing effective management plans that are based on the actual needs of these communities to effectively reduce the risk and damage in case of fire and create safety for the old town in the future with sustainability according to dynamic conditions in the old town.

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