A Model of Flooding Surveillance in Sena District, Phra Nakhon Si Ayutthaya Province, Thailand

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Abstract

This research aimed to establish a surveillance model to prevent flooding in Sena District, Phra Nakhon Si Ayutthaya Province. A quantitative method was adopted involving Structural Equation Modelling (SEM). The sample size was 210 people in the Sena District. Three factors were focused on: disaster leadership, participation of citizens, as well as disaster surveillance system. The results show that the model of flooding surveillance in Sena District, Phra Nakhon Si Ayutthaya Province, was consistent with the empirical evidence. The regression weight of the model indicated that disaster leadership was highly related to the participation of citizens, while the disaster surveillance system variable was negatively related. Ultimately, citizens' participation had a strong effect on the disaster surveillance system. Overall, the model of flooding surveillance in Sena District, Phra Nakhon Si Ayutthaya Province, should adopt collaborative approaches between local government leaders and people within an area, in order to create a flood disaster plan collaboratively.

Keywords: Collaboration, Disaster Leadership, Disaster Surveillance System, Participation of Citizens

Introduction

Natural disasters are becoming increasingly dangerous, as a consequence of climate change effects linked to global warming, which has resulted from such factors as air pollution, garbage and big industry. This is troubling for both earth and humans. During rainfall it is common that the water cannot be stored or infiltrate the ground, meaning water flows to the sea. Furthermore, arctic ice is melting each year, leading to the phenomenon of rising sea levels. Thailand, has suffered continuously from annual flooding. The major effects of flooding in Thailand are highly pervasive, resulting in tremendous damage to the country's economy generally, including horticulture, agriculture and the transportation system.

Particularly in Phra Nakhon Si Ayutthaya Province, there has always been an annual flooding problem. Specifically, Sena District, with a population of over 9,000 households and more than 31,000 people (Official Statistics Registration Systems, Department of Provincial Administration, Ministry of Interior, n.d.), has seen flooding directly affect the people, economic system, trade, agriculture and transportation systems. The significant issue with flooding is pestilence, which The Phra Nakhon Si Ayutthaya Provincial Disaster Relief Agency has continuously prepared for with a preventive plan to provide support during flooding emergencies. The plan for flooding preparation suffers from insufficient collaboration between the local government and people. Nevertheless, the model of flooding surveillance should improve local community engagement. The United Nations (UN) survey results (2006, p. 2) presented the concept of early warning in relation to four key components: risk knowledge; monitoring and warning services; dissemination and communication, as well as response capability. Numerous countries internationally have adopted such a deployment approach. Furthermore, Shrestha et al. (2014, p. XI) researched into flood early warning systems in Nepal using the UN surveillance system concept. They established that key components of the surveillance system are legal provisions as well as coordination mechanisms within the community. Consequently, Nepal's flood surveillance model has been underpinned by collaboration mechanisms between government agencies and communities. Lopez (2013, p. 39) researched into enhanced flood early warning and response capacity through community participation, based on the cases of Barangay Mangin, Dagupan city, Barangay Banaba and San Mateo in the Philippines. Lopez determined that an improved flooding plan should incorporate surveillance leadership variables, a determination of whether the community possesses robust leadership in terms of flood surveillance, alongside whether the community will have strong flood management.

The research team concentrated on the flooding situation in the Sena District, Phra Nakhon Si Ayutthaya suffers from problems annually. Therefore, this research has focused on establishing a flood surveillance model in Sena District, Phra Nakhon Si Ayutthaya Province, in accordance with the UN surveillance concept and the prominence of leadership in relation to flood surveillance, underpinned by the principle of community participation. Lastly, this researcher anticipates that the study results will enhance flood surveillance systems for Ayutthaya Province, with local people also deriving advantage from this research.

Objective

To formulate a model of surveillance to prevent flooding in Sena District, Phra Nakhon Si Ayutthaya province.

Methods and Materials

This research has adopted a quantitative method, with the target area for the research being Sena District, Phra Nakhon Si Ayutthaya Province. The quantitative approach comprised of the following steps:

Determining the Sample Sizes: The researchers applied Kline's (2016, p. 16) concept, who recommended that the Structural Equation Model (SEM) should use a sample size of over 200 participants. Even so, Schumacker and Lomax (2010, p. 42) stated that the rules of thumb of the sample size should have between 10 and 20 subjects per variable. Accordingly, this research considered 21 variables, meaning the sample size was calculated as 10 x 21 = 210. This is over 200, meaning the sample size was suitable for this research.

Certification of Human Research Ethics: The researcher submitted this research project through the application process for the certification of human research ethics. The project was approved on June 21, 2020, by the Regional Human Research Ethics Committee, Naresuan University, Thailand. The certified project code is COA NO. 018/2020 RREC NO. 009/63.

Validation of Instruments: The researcher tested 30 questionnaires with a sample from the Muang Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya Province. Reliability testing was undertaken using Cronbach's alpha criteria. The results are presented in Table 1.

Table 1 The Reliability Test Results

Latent Variables (Code)	Cronbach's Alpha
Leadership of Surveillance Flooding (X1)	0.92
Participation in Flood Disaster Surveillance (X2)	0.93
Surveillance Flooding System (Y)	0.93
Total	**0.96**

Data Analysis: The researcher carried out two steps of analysis, which were as follows:

Step 1 – The fundamental data analysis stage, using descriptive statistics, percentages, standard deviation and the mean.

Step 2 – The SEM analysis, with this strategy requiring that the effects of variables on the model are sufficiently understood. The model fit criteria (Kline, 2016, pp. 240-277; Harrington, 2009, pp. 52-53) are presented in Table 2.

Table 2 The Model Fit Criteria

Index	Standard Criteria
Chi-Square Index	> 0.05
Chi-Square Index / Degree of Freedom	< 2.00
Standardized Root Mean Square Residual Index	< 0.05
Index the Root Mean Square Error of Approximation (RMSEA)	< 0.05
Tucker-Lewis Index (TLI)	> 0.95
Comparative Fit Index (CFI)	> 0.95

Results

The researcher divided the results into three sections: 1) Fundamental data; and 2) SEM. The findings were as follows:

1. Fundamental Data. This data is separated into three parts, namely gender, age and employment.

Table 3 The Fundamental Data (N = 210)

Data	Quantity	Percentage
Gender		
Male	138	65.70
Female	72	34.30
Age		
20-36 Years	95	45.20
37-52 Years	83	39.50
Over 53 Years	32	15.20
Employment		
Farmer	25	11.90
Merchant	57	27.10
General Contractor	54	25.70
Civil Servant	12	5.70
Company Employee	14	6.70
Freelance	30	14.30
Other	18	8.60
Total	**210**	**100**

As the basic data analysis in Table 3 shows, the respondents' gender comprised of 138 males (65.70%) and 72 females (34.30%). The age of 95 respondents was 20-36 years (45.20%), 83 were 37-52 years old (39.50%), while 32 were over 53 years old (15.20%). In terms of the respondents' employment, the highest percentage (27.10% or 57 people) were merchants. 54 people were general contractors (25.70%), 30 people were freelancers (14.30%), while 12 people were civil servants (5.70%).

Table 4 Skewness and Kurtosis Tests

Variables	$\overline{X}$	S.D.	SKEW	KUR
L1	4.24	0.74	-0.46	-1.01
L2	4.29	0.65	-0.40	-0.97
L3	4.30	0.65	-0.48	-0.53
L4	4.30	0.66	-0.51	-0.71
L5	4.30	0.67	-0.74	0.52
L6	4.28	0.65	-0.71	0.23
L7	4.30	0.65	-0.58	-0.34
L8	4.30	0.63	-0.55	0.01
L9	4.30	0.61	-0.22	-1.29
P1	4.32	0.63	-0.55	-0.29
P2	4.30	0.60	-0.21	-1.27
P3	4.31	0.62	-0.53	-0.28
P4	4.29	0.63	-0.42	-0.80
P5	4.34	0.60	-0.80	0.89
W1	4.45	0.54	-0.80	0.81
W2	4.49	0.51	-0.62	-0.41
W3	4.49	0.49	-0.60	-0.24
W4	4.44	0.53	-0.84	1.60

The Mean of the Variables

L1	refers to communication skills.	P1	refers to perception participation.
L2	refers to planning and organizing skills.	P2	refers to planning participation.
L3	refers to personal management skills.	P3	refers to implementation participation.
L4	refers to thinking and learning skills.	P4	refers to evaluative participation.
L5	refers to decision-making skills.	P5	refers to benefit participation.
L6	refers to motivation skills.	W1	refers to risk knowledge.
L7	refers to delegating skills.	W2	refers to monitoring and warning service.
L8	refers to responsibility skills.	W3	refers to announcement and communication.
L9	refers to flexibility skills.	W4	refers to response capability of disaster management.
X1	refers to disaster leadership.	Y	refers to disaster surveillance system.
X2	refers to participation of citizens.		

As Table 4 presents, the skewness and kurtosis tests evidence that the skewness ranged between -0.84 and -0.21, exceeding no more than 3.00. This means that the variables were highly amenable to statistical analysis. Kurtosis ranged between -1.29 to 1.60, exceeding no more than 10.00. This means that their variables were better. Overall, this index shows that the data passed the standard criteria.

Table 5 The Correlation Coefficient Tests

Variables	L1	L2	L3	L4	L5	L6	L7	L8	L9	P1	P2	P3	P4	P5	W1	W2	W3	W4
L1	-																	
L2	.84	-																
L3	.79	.85	-															
L4	.79	.89	.85	-														
L5	.78	.80	.83	.88	-													
L6	.73	.70	.76	.76	.79	-												
L7	.73	.70	.73	.73	.72	.83	-											
L8	.75	.75	.74	.75	.74	.71	.80	-										
L9	.75	.73	.74	.76	.79	.76	.78	.83	-									
P1	.74	.76	.68	.74	.68	.66	.74	.82	.79	-								
P2	.70	.71	.68	.69	.70	.68	.76	.81	.80	.83	-							
P3	.66	.65	.62	.63	.68	.65	.73	.80	.78	.78	.83	-						
P4	.68	.68	.66	.66	.70	.69	.72	.75	.76	.74	.78	.86	-					
P5	.42	.46	.44	.46	.49	.48	.50	.55	.52	.50	.56	.56	.56	-				
W1	.42	.42	.43	.39	.41	.39	.41	.50	.41	.47	.50	.51	.47	.74	-			
W2	.44	.44	.47	.47	.46	.42	.45	.49	.48	.46	.50	.46	.49	.59	.73	-		
W3	.45	.44	.48	.44	.45	.44	.51	.48	.51	.52	.53	.50	.50	.57	.67	.76	-	
W4	.51	.53	.48	.58	.54	.48	.53	.57	.55	.59	.56	.53	.52	.46	.51	.57	.71	-

All variables were statistically significant at the level of 0.01.

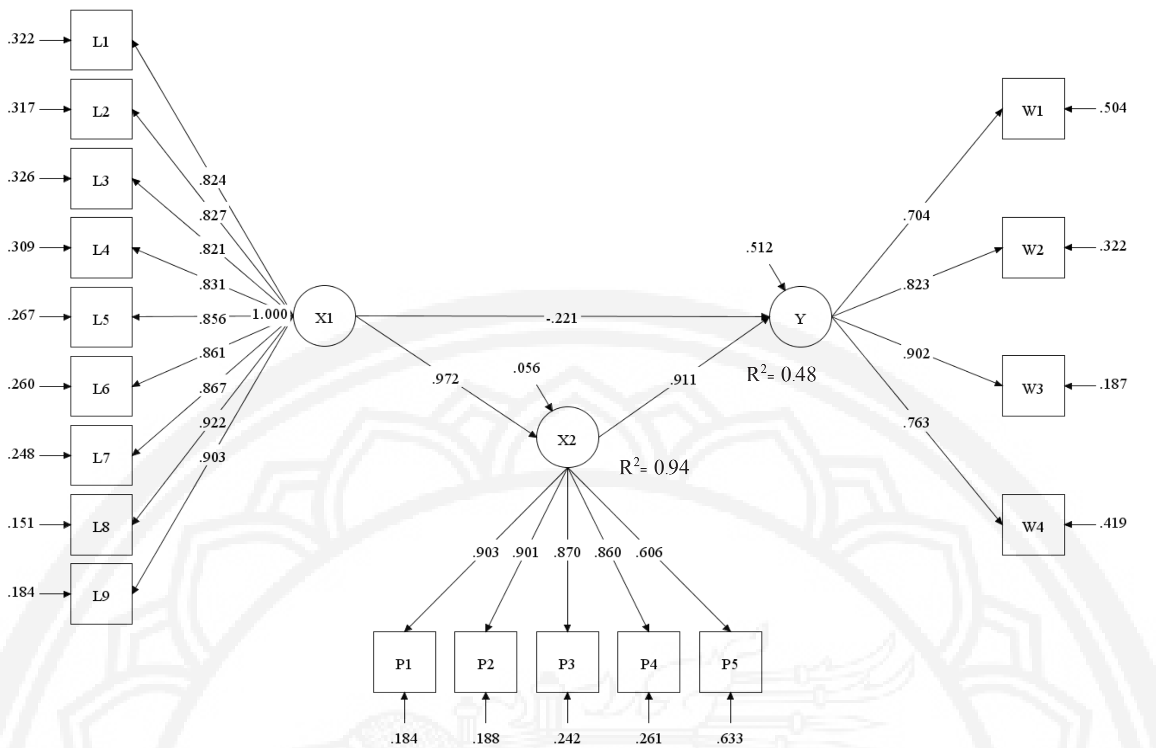
According to Table 5, the correlation coefficient tests established that the Pearson correlation coefficient was between 0.39-0.88, with statistical significance at the level of 0.01.

2. The Structural Model of Preventive Surveillance for Flooded Areas of Sena District, Phra Nakhon Si Ayutthaya Province. This analytical method comprised of three causal latent variables: disaster leadership; participation of citizens, as well as the disaster surveillance system. Furthermore, the research established that the SEM results are in accordance with the extant empirical data.

Table 6 The Criterion for the Model Fit

Model-Fit Criterion	Acceptable Level	Result	Interpretation
X^2	> 0.05	0.06	Passed
X^2/df	< 2.00	1.23	Passed
SRMR	< 0.10	0.04	Passed
RMSEA	< 0.05	0.03	Passed
CFI	> 0.95	0.99	Passed
TLI	> 0.95	0.99	Passed

Table 6 presents the criteria pertaining to the model fit, with the Chi-Square index being 0.06, the Chi-Square index / Degree of freedom being 1.23, the standardised root mean square residual index being 0.04, the Index of the root mean square error of approximation being 0.03, the Tucker-Lewis index being 0.99, with the Comparative fit index being 0.99. All of the results passed the standard criteria successfully. These results are presented in Figure 1.



Chi-Square = 116.07; Chi-Square/df = 1.23; df = 94; *p*-value = 0.06; RMSEA = 0.03; SRMR = 0.04; CFI = 0.99; TLI = 0.99

Figure 1 Diagram of the Structural Model of Preventive Surveillance in Flooded Areas of Sena District, Phra Nakhon Si Ayutthaya Province.

Table 7 The Results of the SEM

Model	β (Standardisation)		*B* (Unstandardisation)		SE	R^2
	X1	X2	X1	X2		
Direct						
X2	0.97	-	0.90	-	0.02	0.94
Y	-0.22	0.91	-0.13	0.59	0.06	0.48
Indirect						
X2	-	-	-	-		
Y	0.88	-	0.54	-		
Total						
X2	0.97	-	0.90	-		
Y	0.66	0.91	0.40	0.59		

Table 7 presents the results that disaster leadership (X1) was strongly correlated with citizens' participation (X2) (0.97), while disaster leadership (X1) was negatively correlated with disaster surveillance system (Y) (-0.22). Citizens' participation (X2) was highly correlated with disaster surveillance system (Y) (0.91). Resultantly, the new model of preventive surveillance for flooded areas of Sena District, Phra Nakhon Si Ayutthaya Province, is presented below:

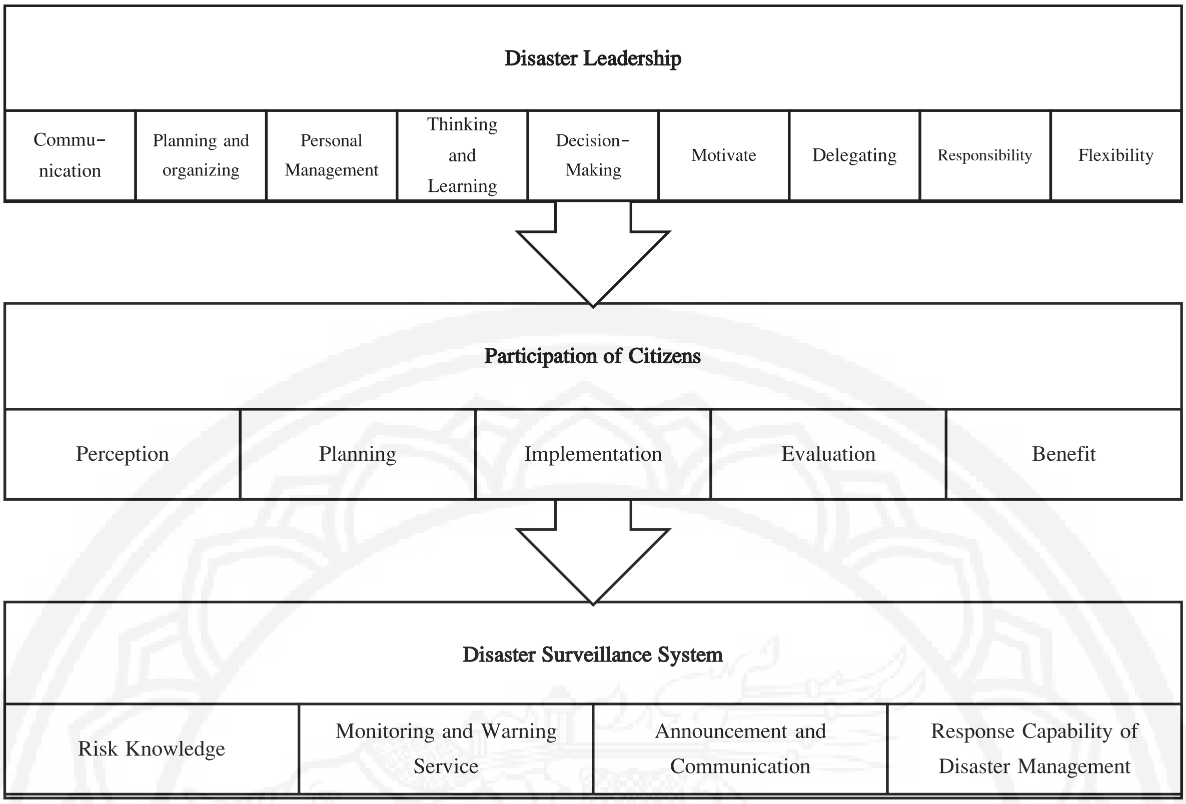


Figure 2 The Model of Preventive Surveillance for Flooded Areas in Sena District, Phra Nakhon Si Ayutthaya Province.

Discussion and Conclusion

The discussion is based on the research findings, with the research target being to formulate a model of surveillance to prevent flooding in Sena District, Phra Nakhon Si Ayutthaya Province. Disaster leadership has not proven effective as part of the disaster surveillance system, given that one person cannot drive the flood surveillance system alone. Furthermore, citizens' participation significantly affects the flood surveillance system, meaning that sometimes the leader is unable to avert disaster singlehandedly. Ultimately, the leader can decentralise power to citizens to increase their participation in avoiding flooding disasters, for example planning, implementing, evaluating and perceiving data pertaining to flooding in local areas. Meanwhile, disaster surveillance systems require monitoring and warning services, with announcements and communication pertaining to dangerous situations. This will enable an effective response and intervention for Thai people suffering flooding events, who wish to gain knowledge about the disaster circumstances and have a warning service in place in their community.

Nevertheless, the communication of leaders with people in communities is highly crucial, given that the information must be distributed swiftly to people in order to protect those facing dangerous situations. Moreover, it diminishes the damage incurred, in terms of the economy, transportation and waterborne diseases. HR Wallingford et al. (2008, p. 75) showed the distribution of costs and benefits with regards to flood protection planning; the property price slightly declined in the flooded area, with the industry saving repair costs following flooding, while the government has reduced the budget for transportation system repair in the flooded area.

Regardless, the OECD (2016, p. 9) has stated that the government is unable to evade financing the provision of assistance to citizens and repairing flood-damaged infrastructure, meaning that flood surveillance systems can strongly facilitate the regulation of budgetary spending in relation to flooding disasters. Therefore, the Thai government has adopted these approaches to integrate with their flooding protection plan, as a means of reducing the budget for spending on damage stemming from a disaster situation in Sena District. A surveillance plan to prevent flooding involving participation of citizens has been developed, with the results determining that collaboration between the local government leader and communities will result in strong improvements to the flood surveillance system model. This is because Thai people facing flooding situations believe local government leaders, meaning the development of the flooding plan requires collaboration. Therefore, people's participation is dependent on information provided by the local government, for example the perception of the disaster situation, flood planning, implementation of the plan in response to the disaster situation, monitoring of the situation, as well as people receiving benefit from the surveillance plan implemented to prevent flooding. People's perceptions of disaster situations should be informed by government agencies, as a means of averting misinformation issues. This is because individuals receiving erroneous information will undermine knowledge in the area of the country overall, perhaps exacerbating the problems faced. Lin et al. (2017) suggested different components of community leaders' actions, namely: identification of project objectives and relevant stakeholders; stakeholder engagement management, alongside a sound comprehension of the socio-cultural context, which is an approach learnt from Japan's experience. Lin et al.'s conceptualisation is consistent with our results relating to leadership during the Thai flooding disaster situation, in that leaders must possess numerous skills to manage situations, including the ability to take responsibility even in the worst scenarios.

Finally, this research concentrated on three factors: disaster leadership; participation of citizens, as well as the disaster surveillance system. The research findings identified that disaster leadership is highly correlated with citizens' participation, while the disaster surveillance system variable was negatively correlated. The participation of citizens strongly affects the disaster surveillance system. Resultantly, the model of flooding surveillance in Sena District, Phra Nakhon Si Ayutthaya Province, should pursue collaborative approaches between local government leaders and individuals in an area, when flood disaster plans are being established.

Research Suggestions

1. The government should formulate the policy of developing a modern technology-based flood disaster surveillance system to reduce risks and monitor disasters in the future.
2. The government should create a cooperation policy framework on the exchange of disaster information between countries for use in assessing the flood situation.

Future Study

The next research should study the determination of the variables or factors affecting the disaster or factors affecting the disaster surveillance model in other areas, such as the wildflower surveillance model in the north, the PM2.5 pollution surveillance model in Bangkok, the Surveillance model for the COVID-19 in Thailand.

Acknowledgments

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