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RESILIENCE OF PHYSICAL COMPONENTS IN FLOOD-PRONE AREAS IN KELANTAN

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Abstract

The functionality and ability of physical components such as energy, water and waste, transportation, telecommunication and building to sustain during floods are very crucial to communities in flood-prone areas. As known, floods in Kelantan are not only a regular occurrence but also extreme. Thus there is an urgent need to have resilient physical components. The resilience of physical components is an ability to resist, absorb, accommodate and recover from the effect of flood in a timely and efficient manner. Therefore, the objective of this paper is to determine the most important infrastructure systems for the community in flood-prone areas in Kelantan. Thus, a cross-sectional survey was conducted among one hundred and fifty-one (151) communities (government = 40; private sectors = 38; learning institution = 31; and communities = 32) in eight (8) districts which identified as flood-prone areas in Kelantan. A total 17 factors (energy = 3; water and waste = 3; transportation = 4; telecommunication = 4; and buildings = 3) for infrastructure systems were analyzed by SPSS version 22 subjected to descriptive analysis. The result obtained from the analysis found that building component is the most importance physical component for community in flood-prone areas in Kelantan.

Keywords: *disaster; flood; physical components; resilience*

1.0 INTRODUCTION

Malaysia is relatively free from any major damage of natural disasters such as earthquake, volcano eruption and typhoon (Baharuddin et al., 2015). Malaysia, however, is vulnerable to natural disasters such as floods and this has become the biggest threat for Malaysia, causing serious disruptions to livelihoods and economic losses annually (Akasah & Doraisamy, 2015). Malaysia is frequently faced with a monsoon flood. Monsoon floods triggered by heavy rainfall occur from the Northeast Monsoon during November and March. Regularly, the monsoon flood strike on the east coast of Peninsula Malaysia, the northern part of Sabah and southern part of Sarawak (Hassan, Ab. Ghani, & Abdullah, 2006). In addition, rapid growth, unplanned urbanization, global climate change and environmental degradation have increased the frequency and severity of floods. For the greater concern, report by Department of Irrigation and Drainage Malaysia (2016), about 29,000 square kilometers or 9 percent of the total land of Malaysia and more than 4.8 million people are affected by flood every year. Table 1 indicates the disasters that occurred in Malaysia for a ten year period starting from 2009 until 2019. In this ten year period, floods are the most intense and frequent occurrence in Malaysia which cause total damage USD480 million.

Table 1: Disasters occurred in Malaysia from 2009 until 2019

Year	Disaster type	Occurrence	Total deaths	Injured	Affected	Total affected	Total damage ('000 USD)
2009	Flood	2	-	-	10875	10875	-
2011	Flood	1	2	-	20000	20000	-
2011	Landslide	1	16	6	-	6	-
2013	Flood	1	4	-	75000	75000	2000

2014	Drought	1	-	-	2200000	2200000	-
2014	Flood	1	17	-	230000	230000	284000
2015	Earthquake	1	24	10	-	10	2
2015	Flood	1	1	-	3000	3000	-
2016	Flood	4	-	-	31841	31841	132000
2017	Flood	3	9	-	21981	21981	-
2017	Storm	1	-	-	426	426	-
2018	Flood	2	2	-	16900	16900	-

Source: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL)

Flood causes adverse consequences including death, injury, loss of life, degradation of physical components, disruption of economic activities and environmental damage. The damage caused by the flood is predicted to increase in the future due to climate change and global warming. As reported by Reliefweb (2016), the 2014 year end monsoon flood became the worst ever experienced by Malaysia which affected more than half million of victims in several states including Kelantan. Floods have affected more than 200,000 victims; caused thousands of houses to be damaged and damage to physical components alone was estimated at US670 million. The damaged physical components comprise of electricity supply, water supply, sewage system, road and railway network, telephone and critical facilities (i.e. hospitals and shelters). Regarding this matter, a study by Said, Gapor, Samian, & Abd Malik (2013) found that damaged physical components impacted by flood had dramatically disrupted the livelihood in the affected areas.

Therefore, it is crucial to ensure the functionality of physical components during flood disaster events simultaneously reduce the impacts of disruption of livelihood of the community in flood-prone areas (Cutts, Wang, & Yu, 2015; Reiner & McElvaney, 2017). This is aligned with the expected outcome of Sendai Framework for Disaster Risk Reduction 2015 – 2030 (UNISDR, 2015) which is to reduce disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of communities. The functionality of physical components for a community can be achieved through strengthening the resilience of physical components itself. According to UNISDR (2017), resilience is defined as “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner”. Therefore, it is necessary to identify the most important physical components for flood prone areas specifically in Kelantan which would be able to to resist, absorb, accommodate, adapt to, transform and recover from the effects of flood in a timely and efficient manner. Thus, the objective of this paper is to determine the most important resilient physical components for community in flood-prone areas in Kelantan.

2.0 PHYSICAL COMPONENTS

Physical components consist of the necessary infrastructure that can help communities to support their livelihoods during disaster events. Physical components can be categorized in five (5) main categories which are energy, water and waste, transportation, telecommunication and building. Table 2 shows the list of factors for each category of physical components. The five (5) main categories and list of factors as shown in Table 2 were discovered from various resilience frameworks in different countries which faced various types of disasters such as floods, earthquakes, tsunamis, typhoons and storms.

Table 2: Five (5) main physical components

Physical components	Factors of physical components	References
Energy	Electricity	(Alshehri, Rezgui, & Li, 2015; Barkham et al., 2014; Cutter et al., 2008; Miles & Chang, 2011; NIST, 2015a, 2015b; Renschler et al., 2010; Schwind, 2009; Shaw, Razafindrabe, Gulshan, Takeuchi, & Surjan, 2009)
	Fuel	(NIST, 2015a, 2015b; Renschler et al., 2010)
	Renewable energy	(Schwind, 2009)
Water and waste	Water supply system	(Barkham et al., 2014; Khazai et al., 2015; Miles & Chang, 2011; NIST, 2015a, 2015b; Renschler et al.,

		2010; Schwind, 2009; Sempier, Swann, Emmer, Sempier, & Schneider, 2010; Shaw et al., 2009; THRIVE, 2004; UNDP, 2014a, 2014b)
	Wastewater	(Khazai et al., 2015; NIST, 2015a, 2015b; Renschler et al., 2010; Sempier et al., 2010)
	Solid waste	(Alshehri et al., 2015; Renschler et al., 2010; Shaw et al., 2009)
Transportation	Road network	(Alshehri et al., 2015; Barkham et al., 2014; Cutter et al., 2008; Cutter, Burton, & Emrich, 2010; IFRC, 2014; Khazai et al., 2015; Miles & Chang, 2011; NIST, 2015a, 2015b; Orencio & Fujii, 2013; Peacock et al., 2010; Renschler et al., 2010; Shaw et al., 2009; THRIVE, 2004; UNDP, 2014a)
	Railway system	(NIST, 2015a, 2015b; Renschler et al., 2010)
	Air transportation	(NIST, 2015a, 2015b; Renschler et al., 2010)
	Waterway system	(NIST, 2015a, 2015b; Renschler et al., 2010)
Telecommunication	Internet connection	(NIST, 2015a, 2015b; Peacock et al., 2010; Perfrement & Lloyd, 2015; Renschler et al., 2010; Silva & Morera, 2014)
	Telephone network	(NIST, 2015a, 2015b; Peacock et al., 2010; Renschler et al., 2010; Silva & Morera, 2014)
	Radio network	(NIST, 2015a, 2015b; Peacock et al., 2010; Renschler et al., 2010; Silva & Morera, 2014)
	Television broadcast	(NIST, 2015a, 2015b; Peacock et al., 2010; Renschler et al., 2010)
Building	Critical facilities (healthcare facilities, police and fire stations)	(Cutter et al., 2010; IFRC, 2014; Khazai et al., 2015; NIST, 2015a, 2015b; Orencio & Fujii, 2013; Peacock et al., 2010; Perfrement & Lloyd, 2015; Sempier et al., 2010)
	Residential (housing, shelters)	(Alshehri et al., 2015; Barkham et al., 2014; C3LD, 2015; Cutter et al., 2008, 2010; IFRC, 2014; Khazai et al., 2015; Miles & Chang, 2011; NIST, 2015a, 2015b; Orencio & Fujii, 2013; Peacock et al., 2010; Perfrement & Lloyd, 2015; Renschler et al., 2010; Sempier et al., 2010; Shaw et al., 2009; Silva & Morera, 2014; THRIVE, 2004; Yoon, Kang, & Brody, 2015)
	Commercial (retail stores, bank or financial institution and petrol stations)	(NIST, 2015a, 2015b; Peacock et al., 2010; Renschler et al., 2010)

3.0 RESEARCH METHODOLOGY

The questionnaire survey method was utilized for this research based on physical components (i.e. energy, water and waste, transportation, telecommunication, building) as discussed in the section above. Consequently, the 7-point Likert-scales (i.e. ranging from 1 “strongly disagree” to 7 “strongly agree”) were adapted to measure the extent of importance of resilience physical components. Moreover, respondents were asked to indicate the level of agreement on the importance of those factors. For the purpose of this research, the purposive sampling used based on respondents’ experience towards floods disaster events. However, the selection was mainly focused on communities in flood-prone areas in Kelantan. Based on the studies by Pour & Hashim (2016) and Syed Hussain & Ismail (2013), the flood-prone areas in Kelantan involved several district such as Kota Bharu, Pasir Mas, Tumpat, Tanah Merah, Machang, Kuala Krai, Jeli and Gua Musang. All of these districts were located at several main rivers including Sungai Kelantan, Sungai Lebir, Sungai Galas and Sungai Pergau. Hence, the survey was distributed to these several districts which recognized as flood-prone areas in Kelantan. In addition, by referring to MERCY (2016), in term of disaster, communities can be categorized into four (4) main groups: government, private sectors, learning institutions and communities. Thus, the survey was distributed to these several districts among these four most important target groups. Then, the outcomes of the questionnaires were analyzed by using IBM SPSS Statistics Version 22 for descriptive analysis.

4.0 FINDING

Table 3 represents the descriptive analysis of physical components based on category while Table 4 represents the descriptive analysis of physical components based on factors which are embedded in each category for community in flood-prone areas in Kelantan. In this section, the analysis deals with ranking based on the mean values to determine the level of importance for both categories and factors of physical components.

Based on Table 3, the results revealed that *'building'* is the most important category of physical components where the overall mean is 4.7682. Access to well-functioned critical facilities (i.e healthcare facilities, police and fire stations) (mean=5.1258), residential building (i.e. housing and shelter) (mean=4.7881) and commercial building (retail stores, bank or financial institution and petrol stations) (mean=4.3907) during flood events were contributed to this result. Meanwhile, based on Table 4, it revealed that access to well-functioned critical facilities (i.e. healthcare facilities, police station and fire station) are agreed by the respondents as the most important factors of physical components for community in flood-prone areas in Kelantan.

In terms of critical facilities, it can be categorised as government-owned buildings which consist of healthcare facilities and emergency operation centres such as police stations and fire stations. The well-functioning of these buildings are crucial as they provide essential services to the community during and after flood disaster events. The healthcare facilities such as hospitals for example, even the entire facilities may not need to be fully operational, but essential functions such as operation theatre, emergency room and life support systems should be operational as other services are restored (Chacowry, 2014; Mcdaniels, Chang, Cole, Mikawoz, & Longstaff, 2008). Likewise, police and fire stations, these buildings are critical as it provides critical equipment and support services during the response phase (Hamdan, 2015).

Table 3: Overall mean score for physical components

Physical components	Variables	N	Mean	Std. Deviation	Overall mean	Rank
Energy	Electricity	151	4.5828	1.07924	4.1280	5
	Fuel	151	4.5762	.94824		
	Renewable energy	151	3.2252	1.11458		
Water and waste	Water supply system	151	4.7881	1.03027	4.2472	4
	Wastewater	151	4.0397	1.01902		
	Solid waste	151	3.9139	.91608		
Transportation	Road network	151	4.1987	1.07095	4.4421	3
	Railway system	151	4.0728	1.07765		
	Air transportation	151	4.8411	1.12008		
	Waterway system	151	4.6556	.86446		
Telecommunication	Internet connection	151	4.5033	1.08243	4.7036	2
	Telephone network	151	4.5563	1.08711		
	Radio network	151	4.8940	.98761		
	Television broadcast	151	4.8609	.99358		
Building	Critical facilities (healthcare facilities, police and fire stations)	151	5.1258	1.10938	4.7682	1
	Residential (housing, shelters)	151	4.7881	.90634		
	Commercial (retail stores, bank or financial institution and petrol stations)	151	4.3907	1.14876		

Table 4: Mean scores for the factors of physical components

Ranking	Variables	N	Min	Max	Mean	Std. Deviation
1	Critical facilities (healthcare facilities, police and fire stations)	151	3.00	7.00	5.1258	1.10938

2	Radio network	151	3.00	7.00	4.8940	.98761
3	Television broadcast	151	3.00	7.00	4.8609	.99358
4	Air transportation	151	2.00	7.00	4.8411	1.12008
5	Water supply system	151	3.00	7.00	4.7881	1.03027
6	Residential (housing, shelters)	151	3.00	7.00	4.7881	.90634
7	Waterway system	151	3.00	6.00	4.6556	.86446
8	Electricity	151	2.00	7.00	4.5828	1.07924
9	Fuel	151	3.00	7.00	4.5762	.94824
10	Telephone network	151	2.00	7.00	4.5563	1.08711
11	Internet connection	151	2.00	7.00	4.5033	1.08243
12	Commercial (retail stores, bank or financial institution and petrol stations)	151	2.00	7.00	4.3907	1.14876
13	Road network	151	2.00	7.00	4.1987	1.07095
14	Railway system	151	1.00	7.00	4.0728	1.07765
15	Wastewater	151	2.00	6.00	4.0397	1.01902
16	Solid waste	151	2.00	6.00	3.9139	.91608
17	Renewable energy	151	1.00	5.00	3.2252	1.11458
	Valid N (listwise)	151				

5.0 CONCLUSIONS

Kelantan has been prone to flood in recent years. The flood has negatively impacted the community which had been caused by devastation of physical components. Though, this adverse impact can be significantly reduced by focusing on the resilience of physical components. Physical components are crucial in the face of expected increase of the frequency and intensity of flood in the future. Thus, access to well-functioned critical facilities such as healthcare facilities, police stations and fire stations need to be concerned as they are the most important physical components for communities in flood-prone areas in Kelantan. However, other components and factors should not be overlooked because they also contribute to reduce the severe impact of flood towards the community.

Finally, the finding presented in this paper is a part of an on-going PhD research study which mainly aims to develop a framework of resilient infrastructure systems for communities in flood-prone areas in Kelantan. Furthermore, the authors believe this study can serve as a platform for other researchers to launch into this field and find a way to enhance the resilience of physical components towards flood in other flood-prone areas.

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Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

Setuju.

"BERKHIDMAT UNTUK NEGARA"

27.1.2023

Saya yang menjalankan amanah,

PROF. MADYA DR. NUR HISHAM IBRAHIM
REKTOR
UNIVERSITI TEKNOLOGI MARA
CAWANGAN PERAK
KAMPUS SERI ISKANDAR

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

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