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Hospital Preparedness Towards Earthquake in Malaysia: A Quantitative Approach

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ABSTRACT

Malaysia located outside the 'Pacific Ring of Fire' and considered to be safe from any seismic activities. However, tremors were felt in some areas due to far-field and near-field earthquake effects. Hospitals are important for any post-disaster event and maintain their resilience in any situation. The objective is to evaluate the level of preparedness for earthquakes in Malaysian hospitals. This cross-sectional study using purposive sampling to find the minimum sample size and snowball technique for distributing the questionnaire via Google form. A descriptive statistics and relative importance index were used for the analysis. Total of 144 respondents involve in this study among health personnel and civil servants working in hospital and healthcare facilities in Ministry of Health Malaysia. Based on the results, it is shown that the level if preparedness of hospital towards earthquake are in the modest level Mean= 3.506-3.893. There is a need to have a building and facilities safety RII=0.825 as the first rank for preparedness towards earthquake disaster compared to emergency stockpiles logistics and coordination RII=0.815, disaster training and education RII=0.814, emergency support competence RII=0.804, human resources leadership RII=0.804, stress-coping ability RII=0.779 and work continuity competence RII=0.767. This study provides the importance of a safety building as the first priorities in preparedness towards earthquake in Malaysia and the importance of having a hospital with seismic design model for facing any disasters in future.

Keywords:
Hospital; disaster preparedness;
earthquake; descriptive statistic;
relative importance index

1. Introduction

Malaysia is located outside the Pacific Ring of Fire and did not involve directly to earth moving crust however exposed to near-field and field effects from a nearby countries [1-2]. Malaysia have chances of having earthquake. Peninsular Malaysia receives seismic sources from subduction zone transform zone due to its proximity to the boundary between Eurasian plate in the north and the Australian Plate in the south while in Borneo which is Sabah and Sarawak most probably the earthquake is due to three major plate which is Eurasian, India-Australia, and Philippines Pacific Plate [2-4]. Indonesia was announced as the most country received a lot of seismic activities in the world recorded in year 2020 and as a neighbour, Malaysia are not exceptional to receive the impact from tremors due to earthquakes [5]. Table 1 shows the natural hazards in Malaysia from year 1900 till

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2020 [6]. It shows that although the seismic events are not much, but the cost affected are very high and was happens since long time ago [6,7].

Table 1
Natural hazards in Malaysia (1900-2020)[6]

Hazard	Number of events	Fatalities	Total affected	Loss (Billion US$)
Seismic activity	3	176	5,073	0.5
Epidemic	13	540	32,047	-
Extreme temperature	6	-	2,208,000	0.302
Floods	59	362	1,714,059	1.501
Mass movement wet	4	96	291	-
Storm	8	296	58,372	0.053

There are a lot if epicentres earthquake with magnitude of more than five (M>5) near Malaysia [1-4,8]. The most afraid is the aftershocks that relate to mainshock where the tremors are minor but can last for weeks, months, or year depending on the magnitude from the original earthquake [9]. Figure 1 shows the seismic hazard map by using the Peak Ground Acceleration (PGA) percentage with 10% probability of exceedance in 50 years in contour extracted from National Annex Malaysia Standard [10]. There are a lot of healthcare facilities under the states which the contour extracted.

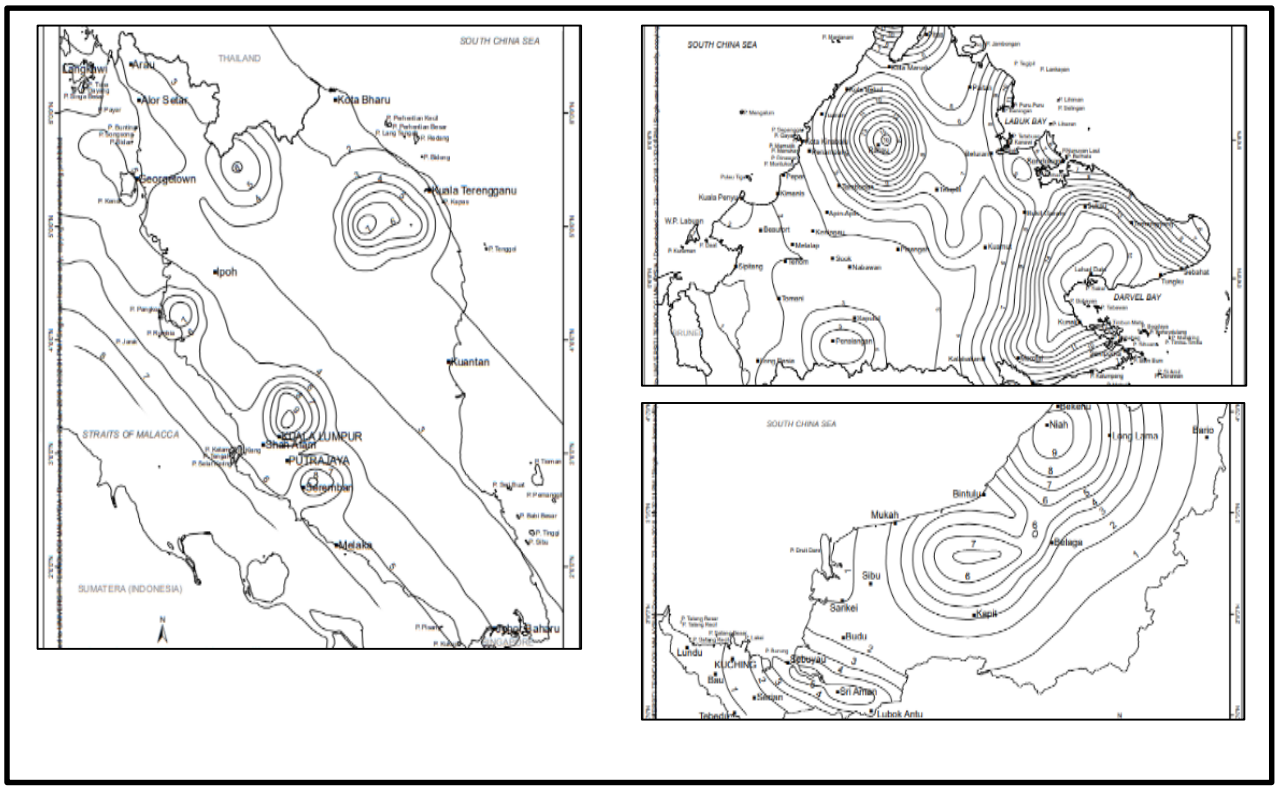

Fig. 1. The Seismic Hazard Map in Malaysia [10]

Hospital are an important place for health communities. Therefore, it is crucial to be ready and well prepared to face any disaster [11]. We cannot predict the future so preparedness must be done before response to any situations [12]. Unpreparedness may lead to disruption and unable to serve

important services due to limited resource, and difficult to coordinate during a chaotic post-disaster situation [13]. Disaster could occur anytime in any place and location. Pandemics, natural disasters, and infrastructure failures can happen without notice. In providing such a multiplicity of victims with emergency medical treatment of disasters, health facilities play an essential role. Many hospitals have been damaged or destroyed because of an earthquake [14]. The impact on recovery and resiliency in hospitals greatly affects the community's ability to respond and recover from disasters. Thus, enhancing healthcare facilities' resilience to disaster is of utmost priority [14].

Hospitals are critical if located in disaster affected areas. The resilient of hospitals will continues to deliver critical services and able to reduce the risk of injuries although the catastrophes resulted in damage buildings and clinical procedures interrupted [15]. The objective of this study is to evaluate the level of preparedness towards earthquake in Malaysia. It will look on the perception of staff that works in the healthcare facilities under the Ministry of Health Malaysia (MOH) the prevalence, knowledge, building safety, readiness to response during earthquake, and information which related to preparedness. The main focus of the study focused more to Klang Valley which is Selangor, Kuala Lumpur and Putrajaya in Peninsular Malaysia and extended to Penang, Sabah and other states based on the literature review and previous episodes of tremors in Malaysian history of earthquakes [1-4,16]. The methodology used was descriptive statistics to see the current situation reflections of subject towards the healthcare facilities preparedness management and relative importance index (RII) for choosing the priority rank of preparedness towards earthquake to determine the importance levels [11,14,17]. The factor component parameters involved are building and facilities safety, emergency stockpiles logistics and coordination, disaster training and education, emergency support competence, human resources leadership, stress-coping ability, and work continuity competence [14,17].

2. Methodology

This is a cross-sectional study. Collecting data was done through online questionnaire using Google Form and spread using a snowball technique through emails and WhatsApp among healthcare personnel and staffs who working in health sectors. The questionnaire of preparedness level for hospitals and clinics was adopted and adapted from previous study and was tested before distributed [14][17]. It consists of experience, knowledge, the building safety index with personal competency and readiness. The setting of this study conducted are Penang, Sabah, Selangor, Kuala Lumpur, Putrajaya, and other state in Malaysia. The chosen state based on previous episode of near-field and far-field effect due to nearby earthquake epicenter and literature review [2-4,6-7].

A purposive sampling technique conducted to capture respondents from health sites. Table 2 shows the latest population of registered healthcare profession by five state (Penang, Sabah, Selangor, Kuala Lumpur, and Putrajaya) in MOH [18]. Participants from others state are welcome to join this study since there might be a chance the participant who are experienced have change different workplace in their service with MOH [18]. The minimal sample size predicted with 78,753 of registered healthcare personnel based on Raosoft sample size calculator, 95% confidence interval, 10% margin of error and 50% response distribution was 96 samples. To obtain some of the sample information, proposed study was submitted earlier to National Medical Research Register NMRR and get the Medical Research and Ethics Committee (MREC) approval. All participants are provided consent regarding the study's objectives and were guaranteed of the confidentiality of personal data protected.

Table 2
Registered profession in public sector in study population [18].

Profession	State				
	Penang	Sabah	Selangor	Kuala Lumpur	Putrajaya
Medical Doctor	2519	4054	7373	4168	5103
Assistant Medical Officer	797	1748	1733	1146	251
Nurse	3555	7063	8811	5613	1671
Pharmacist	679	603	1824	513	201
Assistant Pharmacist	535	183	492	196	128
Community Nurse	941	3636	1414	700	360
Dentist	399	368	711	345	109
Dental Therapist	195	364	230	90	88
Dental Technologist	49	102	96	34	32
Dental Surgery Assistant	280	360	428	169	128
Optometrist	17	21	49	22	15
Environment Health Officer	10	22	21	9	43
Assistant Environmental Health Officer	235	152	489	152	126
Medical Laboratory Technologist	294	760	970	431	89
Radiographer	164	305	336	238	134
Occupational Therapist	82	151	117	73	37
Physiotherapist	83	162	153	116	88
Total by state	10834	20054	25247	14015	8603

Among 145 respondents, a total of 144 participants only accepted to involve in this study during a period of survey of 3-month from June until Augusts 2021. All the raw data collected in the government healthcare facilities was compiled using Microsoft Excel for data cleaning purposed and then the data analyzed using latest version of Statistical Program for Social Science (SPSS). The results interpreted demographic and statistics using descriptive statistics and RII. To obtain the statistical results, a five-point Likert scale were used for respondents to answer components of hospital preparedness towards earthquakes [11,14]. The respondents mostly are expertise in their field and had encountered any disasters during their work services, so it is reasonable of using RII to look the importance level on the research [11]. Equation 1 shows the formula for RII [11].

$$RII = \frac{\sum W}{A*N} \quad (1)$$

where the weight, W given to each factor by respondents within the range of 1 to 5 using the same Likert scale, A and N is the total number of respondents.

3. Results

3.1 Demographic Information

Table 3 shows the demographic of questionnaire's respondent. Majority are male (73.6%), hospitals workers (73%), diploma's holders (60.4%), assistant medical officer (75%), have experience of more than five years (87.5%) and postings in Emergency Department (34.7%). Among the respondent, 29 (20.1%) have experiencing earthquake in their life and 8 (5.6%) have experienced the 2015 Ranau earthquake in Sabah. Meanwhile 49 (34%) have knowledge regarding the earthquake disaster preparedness and total of 56 (38.9%) knows to get access to latest information regarding earthquake disaster in Malaysia.

Table 3
Demographics of questionnaire respondents

	Respondents by state						Total
	Penang	Sabah	Selangor	Kuala Lumpur	Putrajaya	Others	
Gender							
Male	1.4% (2)	11.8% (17)	17.4% (25)	2.1% (3)	4.9% (7)	36.1% (52)	73.6% (106)
Female	0.7% (1)	6.3% (9)	12.5% (18)	0.7% (1)	0.7% (1)	5.6% (8)	26.4% (38)
Current Workplace							
Hospital	2.1% (3)	15.3% (22)	25% (36)	2.1% (3)	2.8% (4)	25.7% (37)	73% (105)
Clinics	-	1.4% (2)	4.2% (6)	-	0.7% (1)	11.1% (16)	17.4% (25)
Other health facilities	-	1.4% (2)	0.7% (1)	0.7% (1)	1.4% (2)	5.6% (8)	9.7% (14)
Education level							
Certificates	-	-	0.7% (1)	-	-	0.7% (1)	1.4% (2)
Diploma	0.7% (1)	12.5% (18)	21.5% (31)	1.4% (2)	2.8% (4)	21.5% (31)	60.4% (87)
Bachelor's degree	0.7% (1)	4.2% (6)	5.6% (8)	1.4% (2)	2.1% (3)	16.0% (23)	29.9% (43)
Post-graduate studies	0.7% (1)	1.4% (2)	2.1% (3)	-	-	4.2% (6)	8.3% (12)
Occupation							
Specialist/Medical Officer	-	-	1.4% (2)	-	-	0.7% (1)	2.1% (3)
Assistant Medical Officer	1.4% (2)	15.3% (22)	17.4% (25)	2.8% (4)	3.5% (5)	34.7% (50)	75% (108)
Nurses	-	2.1% (3)	6.3% (9)	-	0.7% (1)	3.5% (5)	12.5% (18)
Other staff	0.7% (1)	0.7% (1)	4.9% (7)	-	0.7% (1)	3.5% (5)	10.4% (15)
Field of Practice							
Emergency and trauma	0.7% (1)	6.9% (10)	11.1% (16)	2.1% (3)	2.8% (4)	11.1% (16)	34.7% (50)
Surgery	-	1.4% (2)	1.4% (2)	-	-	2.8% (4)	5.6% (8)
Anesthesiology	-	1.4% (2)	2.8% (4)	-	-	2.8% (4)	6.9% (10)
Orthopedics	0.7% (1)	-	0.7% (1)	-	-	0.7% (1)	2.1% (3)
Others Department	0.7% (1)	8.3% (12)	13.9% (20)	0.7% (1)	2.1% (3)	25.0% (36)	50.7% (73)
Working experience							
<1 year	-	0.7% (1)	0.7% (1)	-	-	-	1.4% (2)
1-3 years	-	4.2% (6)	1.4% (2)	-	0.7% (1)	1.4% (2)	7.6% (11)

4-5 years	-	1.4% (2)	0.7% (1)	-	-	1.4% (2)	3.5% (5)
>5years	2.1% (3)	11.8% (17)	27.1% (39)	2.8% (4)	4.2% (6)	39.6% (57)	87.5% (126)
Experienced facing earthquakes	0.7% (1)	9.7% (14)	3.5% (5)	0.7% (1)	1.4% (2)	4.2% (6)	20.1% (29)
Experienced working in 2015 Ranau Earthquake Sabah	-	2.8% (4)	0.7% (1)	0.7% (1)	0.7% (1)	0.7% (1)	5.6% (8)
Knowledge to earthquake disaster preparedness	0.7% (1)	6.3% (9)	12.5% (18)	1.4% (2)	1.4% (2)	11.8% (17)	34.0% (49)
Knows where to get latest earthquake information	0.7% (1)	5.6% (8)	11.1% (16)	1.4% (2)	2.1% (3)	18.1% (26)	38.9% (56)
Total respondents	2.1% (3)	18.1% (26)	29.9% (43)	2.8% (4)	4.9% (7)	42.4% (61)	

3.2 Descriptive Statistic

Table 4 shows the descriptive statistics for components related to hospital preparedness towards earthquake. Generally, most the result shows a mean between 3.618 up to 3.893 statistics with highest standard deviation at the building safety index. The data skewness is skew to the left and the Z-kurtosis lies symmetrically between -3.00 and 3.00.

Table 4

Descriptive Statistics of Component is Hospital Earthquake Preparedness

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Building Safety Index	143	3.893	1.023	-.960	.203	.472	.403
Emergency Stockpiles	141	3.792	.962	-.377	.204	-.803	.406
Logistics Coordination	141	3.704	.930	-.276	.204	-.603	.406
Human Resources	140	3.862	.872	-.328	.205	-.625	.407
Response Readiness (Clinical Competence)	131	3.581	.807	-.467	.212	.114	.420
Response Readiness (Emergency Support Competence	141	3.536	.816	-.508	.204	.333	.406
Response Readiness (Working Progress Competence)	143	3.506	.790	-.446	.203	.579	.403
Response Readiness (Stress-coping ability)	126	3.618	.687	-.173	.216	.762	.428

3.3. The Relative Importance Index of Hospital Earthquake Preparedness

To rank a number for hospital preparedness during pandemic situation, the RII was used to calculate the factors that affect the preparedness together with its priorities. The RII were calculated from Eq. 1 and the components factors influencing the hospital earthquake preparedness based on Likert scale are summarized in Table 5.

Table 5

Components factors influencing Hospital Earthquake Preparedness

Factors	Mean	Std. Deviation	RII	Rank

1. Building and facilities safety	4.125	1.379	0.825	1
2. Emergency stockpiles logistics and coordination	4.105	1.331	0.815	2
3. Disaster training and education	4.069	1.382	0.814	3
4. Emergency support competence	4.077	1.389	0.804	4
5. Human resources leadership	4.021	1.298	0.804	5
6. Stress-coping ability	3.896	1.326	0.779	6
7. Work continuity competence	3.846	1.380	0.767	7

Likert scale, 5=Very Important; 4=Important; 3=Fair; 2= Less important;1=Very less important

Based on the result shown in Table 5, the building and facility safety is chosen as the top priority for preparedness towards earthquake in Malaysia followed by emergency stockpiles, training, and response readiness.

4. Discussions

The worst hit in Kelantan 2014 flood disaster in Malaysia was hospital [17]. So, it is impossible to stop the earthquakes and tsunamis to hit hospitals too. Some previous study mentioned there are negative impacts affecting public hospitals in Malaysia are due to insufficient preparedness of hospitals towards disaster resilience [19]. Most of the country have high toll of death from are due to unpreparedness to disasters [1,14,20]. Based on the results and analysis, overall shows the level of preparedness is in the modest level. More research needs to be conducted to see the relationship of leadership, group integration and management of hospital towards the preparedness of earthquakes and multi-disaster in Malaysia.

Although not causing some death in hospital, but the effects were expected to be very high in terms of structural and infrastructures damages which later could lead to economic losses and fatalities as shown in table 1 which causes 0.5 billion US Dollar [21]. Figure 2 shows the probability level of an earthquakes in Malaysia. Based on the figure, most respondent believes the impacts are in minimal, but the cost of the effects are more expensive. That is why most of the respondent choose the building safety as the priority in terms of earthquake preparedness in RII. It suggested to follow the basic structural design that have special code for seismic design which is Eurocode 8 (EC8) in the National Annex [10,22].

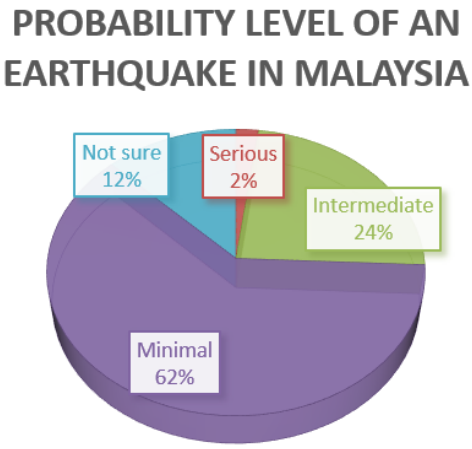

Fig. 2. Probability level of an earthquake in Malaysia

Awareness need to be developed among health workers communities. Based on the results (Table 3), only 49 participants have knowledge about the earthquake disaster preparedness. Which means 34% of respondents have awareness about the danger related with seismicity instead of primary hazard in Malaysia which are floods associated with landslides and pandemics [6,12,23-24].

Usually, the person who response towards disasters in hospital was under the responsibility of doctors, assistance medical officer, nurses, and hospitals attendants [25]. They are the healthcare officers act as the frontlines for the external disaster in pre-hospital care level and experts in field triage to identifying critically ill patients during disaster happens [25-27]. At the early preparation phase, all profession in hospital should support the efforts for hospital preparedness [24]. The management and financial institution should lead the hospital by providing training, education and disaster drills not only primary disaster in Malaysia but also includes earthquakes by following the latest disaster action plan which standardized the standard operating procedures and disaster guidelines from National Security Councils (MKN) and the National Disaster Management Agency of the Prime Minister Office Department (NADMA) [24,28-29]. This should include the role of supporting staff and non-clinical to take role in the preparation level to increase the knowledge of disaster preparedness level with transdisciplinary approach with multiple agencies and multiple disciplines [30]. Lack of exercise, amenities and good management systems will affect the capability of providing the necessary response and treatment during critical situations of post-disasters event [14].

By increasing the significant improvement in hospital infrastructure, technology, disaster risk reduction and knowledge, it is hope that it will reduce the death toll if earthquake hits Malaysia as many countries have succeeded before and also gives some ideas of how to deal with sick patients in new norms [23,30-31].

5. Conclusions

The evaluation of hospital preparedness towards earthquake in Malaysia is presented here. The level of preparedness was moderate although currently most hospitals are handling pandemic cases with multi-disaster events in Malaysia such as landslide, flash flood, fire tragedy and motor vehicle accidents. More experiments are needed to study the relationship between the impact of health, human resources, political and economy towards earthquake disaster management in hospitals.

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