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The degree of housing damage model for a flood affected area

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Abstract. Floods can cause damage like slightly damaged, significantly damaged or destroyed to homes and possessions as well as disruption to communications. Inherently, victims should be given temporary or permanent houses depending on the degree of damage to their houses. Therefore, an assessment on the levels of damage must be carried out in the aftermath of a flood as a direction for recovery effort, for example housing resettlement. The fact is, in Malaysia, there is still no standardized damage assessment used by the relevant authorities in assessing the degree of housing damage after a disaster. As a result, errors in assessing the degree of housing damage and providing inaccurate type of assistance might occur. Thus, this research emphasis on the understanding the degree of house damage and recommend the significant input in developing the damage assessment model in Malaysia. To achieve the objective, this research applies a self-developed model that is derived from the literature review (framework or model of the degrees of housing damage after flood) and the observation at the case study area to see the actual conditions of the affected houses. After that, questionnaires were distributed to 50 respondents consist of engineers (n=10), architects (n=10), quantity surveyors (n=10), real estate valuers (n=10) and building surveyor (n=10) by using purposive sampling to gauge their perceptions on attributes of degree of housing damage and eventually conducting a focus group consist of ten (10) technical experts involved in MERCY Malaysia in assessing the housing damage for model validation. The findings indicate that the degree of damage can be classified as 'minor', 'major' and 'destroyed'. Research findings will give input in the form of a Housing Damage Assessment Framework for the government, NGOs, MERCY, insurers or other appropriate bodies involve in assessing or evaluating the condition of houses affected by floods.

1 Introduction

Increasing population has resulted in an increase in the number of property ownerships. Therefore, a greater percentage of the country's land area, often in areas that previously have been not fit for urban development and human settlement, have been taken up to cater for the need for accommodation (Eves, 2014). These increased numbers of properties, changes in water collection, flows and poor drainage system coupled with heavy monsoon rainfall, intense convection rainstorms and other local factors have caused seasonal floods in Malaysia (Chan, 1996; Eves, 2014). According to the Malaysian National Security Council [MNSC] (2015), flood is the most common type of disaster that occurs in Malaysia. Floods occur annually in Malaysia, causing damage to property and loss of life. The worst flood event in Malaysia was in December 2014 that rendered people helpless. The moving water had destructive powers that picked up and carried off bridges, houses, trees, and cars. The east coasts states of Kelantan, Terengganu and Pahang expose to annual recurrence of flood as these states are directly in the path of the seasonal monsoon season (Chan, 1996). The unprecedented flooding of December 2014 has been the worst flood event in the history of Kelantan.

Following such a disaster, there is often a tally of the preliminary damage assessment in respect to the injuries, loss of lives, cost of damage and destroyed properties. With these disasters attracting considerable media attention, people are more aware of the damage occurred at the affected areas. There have been a number of studies pertaining to preliminary damage assessment to buildings after the flood. There are many ways of damage assessment which have been carried out in different countries after the event of a natural disaster. There are several guidelines for assessing the degree of building damage prepared by government agencies, researchers, local authorities and non-governmental organizations (NGO). For example, Attaullah Shah, Hamid Mumtaz Khan and Ehsan U. Qazi (2009) had outlined the

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evaluation of the buildings destroyed or damaged due to flooding in Pakistan. The evaluation of damage is made on mud houses that are the most common type of building structure in Pakistan. In the USA, Federal Emergency Management Agency [FEMA] has developed an operations manual to standardize the procedures in preliminary damage assessment nationwide. There are several state authorities in the USA, like New Jersey and Florida, which reviewed this operations manual and did some modification to suit the type of disasters that occur in their states. Apart from that, there are also numerous literatures which emphasized on residential properties damaged from hurricane and floods (Hodde 2012; FEMA, 2012).

In concordance with the variety of the degree of housing damage, different countries are likely to have different construction methods, materials used and the nature of the flood disaster. Thus, a general assessment from other countries that determines the extent of flood hit houses seems irrelevant for Malaysia context. Moreover, in Malaysia, there is no standardized damage assessment used by the authorities or relevant agencies in assessing the degree of housing damage after disasters. As a result, errors in assessing the degree of housing damage and providing inaccurate type of assistance may occur. Thus, this research emphasis on the understanding the degree of houses damage and recommends significant input in developing the damage assessment framework in Malaysia.

2 Literature review

2.1 Flood Disaster Socioeconomic Impacts

2.1.1 Flood Damage

According to MNSC (2015), flood disaster is defined as an incident caused by natural calamities and human factors that happen to cause devastation, not only to the environment and to property, but also may cause death and injury to humans. Consequently, flood damage is a direct consequence, or expressed as a physical attribute that can be directly measured in terms of a level of degradation, spoil, removal or destruction (Friedland, 2009). Meanwhile, Grigg and Helweg (1974) defined flood damage as the amount of money to restore the area to its original condition before the disaster. Thus, to understand the damage of flood, it would be useful to categorize them.

2.1.2 Category of Damage (Socioeconomic Impacts)

According to the South Asian Tsunami Damage Assessment Report (2004), damage is categorised as a physical description of the degree of housing damage; no damage, light damage, moderate damage, heavy damage or collapse. Daungthima & Kazuori (2012) underlined the category of damage in three groups. The first group is Environmental Damage, which consists of areas at risk from flood, ground cracks, landscape damages, and pit on ground or subsidence, surface water flow paths, vulnerable communities and critical infrastructure. The second group is the External Damage, which is light damage such as wall, decorative aspects and structural damage. Lastly is Internal Damage, which includes interior of the affected building such as wall, decoration and ceiling. According to the Collaborative Research on Flood Resilience in Urban Areas [CORFU] (2014), flood damage can be distinguished as tangible and intangible damage. A tangible damage is damage that is capable of being assessed in monetary terms (Smith & Ward, 1998). Messner et al (2007) stated a tangible damage is the damage which can be easily specified in monetary terms. Therefore, intangible damage is defined as damage that cannot be easily specified in monetary terms. These distinctions are clearly made to define flood damage. In spite of that, Messner et al (2007) & Jonkman et al (2008) explained that damage is categorized into direct and indirect damage (refer to Table 1).

2.1.3 Structural Type of Building

For masonry buildings, Coburn (1989) has classified structural damage to unreinforced masonry building as illustrated in Figure 1, viewing the collapse of walls and roofs that support vertical loads. Next, in Figure 2 will illustrate the typical damage to wood frame building structures. When it comes to reinforced concrete type of buildings, the typical damage is illustrated in Figure 3. Damages to mud house are shown in Figure 4 according to the damage assessment of flood affected mud houses in Pakistan conducted by (Shah, Khan, & Qazi, 2013).

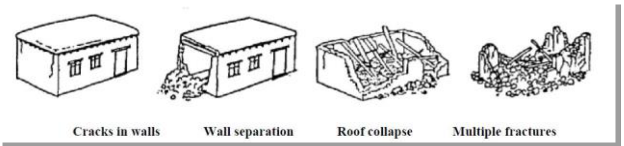

Figure 1: Typical damage to masonry type of buildings

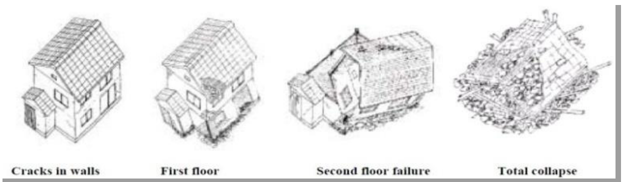

Figure 2: Typical damage to wood frame type of buildings

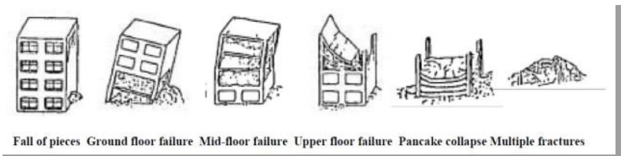

Figure 3: Typical damage to RC buildings


Figure 4: Typical damage to mud houses

2.2 The Existing Degree of Building Damage Assessment Models

There are many ways of damage assessment which have been carried out in different countries after the event of natural disasters. There are several guidelines for assessing the degree of building damage prepared by government agencies, researchers, local authorities and non-governmental organizations (NGO). In concordance with the variety of the degrees of housing damages, different countries are likely to have different construction methods, materials used and the nature of the flood disaster. The attributes models from a synthesis of existing eight degrees of housing damage are as follows.

2.2.1European Macro-seismic scale 1998 (EMS-98)

The EMS-98 is the basis for evaluation of seismic intensity in European countries and is also used in a number of countries outside Europe. The first scale has 12 divisions for seismic loads, but for flood disaster, the damage classification scale is only classified into six divisions namely' Grade 0, Grade1, Grade 2, Grade 3, Grade 4 and Grade 5. The grade takes into consideration structural and non-structural elements. Structural elements are the main structures such as foundation, beams, columns, roofs, floors and load-bearing walls. Whereas non-structural elements are gutters, chimneys, plaster ceilings, siding et cetera.

2.2.2 Green Alert Damage Assessment Manual

Damage assessment Manual by www.GreenAlert.net is based on the Windshield Survey in 2004 that provides information to determine the severity of the disaster and type of disaster assistance that may be required. In this manual, the person responsible will assess the affected house into damage categories representing a range of damage percentage wise.

2.2.3 State of Florida Division Emergency Management

In Florida, as it is vulnerable to a host of natural and man-made disasters, local governments may contact the Florida Department of Community Affairs, Division of Emergency Management to initiate assistance for damage assessment. Immediately following a disaster, an initial damage assessment must be carried out by them to estimate the type and extent of damages. The model is influenced by the FEMA, with some improvements on the structure damage attributes.

2.2.4 Earthquake Engineering Field Investigation Team of Japan (EEFIT) Model

EEFIT was formed as joint venture between industries and universities. EEFIT has its own mission team typically to visit affected regions for data collection to improve the understanding of structural behavior of natural disasters especially seismic loads. In Japan, EEFIT mission team made some modifications to the damage assessment model from the European Macroseismic Scale 1998 or also known as EMS-98.

2.2.5 National Disaster Management Agency of Indonesia (BNBP)

In the event of a natural disaster in Indonesia, especially earthquakes before flooding, The National Disaster Management Agency (BNPB) will lead in coordinating and facilitating the recovery, reconstruction and rehabilitation of the flood affected areas. Preliminary damage and needs assessment are necessary in the delivery of assistance addressing the specific needs for particular vulnerable groups of affected victims. In assessing the damage, BNPB use a model that distinguishes three degrees of property damage; Light Damage, Moderate Damage and Heavy Damage.

2.2.6 New Jersey State Police Office Emergency Management

The New Jersey State Police Office of Emergency Management produced a preliminary damage assessment in any event of natural disasters, especially in the event of hurricanes. Based on FEMA Preliminary Damage Assessment, they did some modifications on damage scale and categorized it into 4 degrees; Affected, Minor, Major and Destroyed.

2.2.7 Henry B. Hodde III Damage Assessment Model

Although FEMA has prescribed specific guidelines for the damage assessment procedure, Henry (2012) stressed that most communities or state organizations use slightly different protocols and methods in assessing property damage caused by natural disasters. In his research, he laid out several damage assessment models from thirteen local governments and provided with an improvised degree of damage assessment. He further categorized the damage into four degrees, Category 1, Category 2, Category 3 and Category 4. However, this category of damage only described the structured damage and did not explain the details in the structured damage attributes.

2.2.8 Federal Emergency Management Agency (FEMA) Revised Model of Damage Assessment Operations Manual (2012)

This operations manual was developed by FEMA to standardize the procedures in preliminary damage assessments nationwide. This manual was prepared and reviewed by FEMA regional officers with vast experience in performing damage assessment through many types of disasters. The models, this manual use to distinguish degree of damage are categorized into Destroyed, Major, Minor, Affected and Inaccessible.

2.3 The Degree of House Damage Frequency Table

From the review on eight (8) models of house damage assessment, the attributes are laid out in Table 1. The attributes were sorted according to its degree of damage and the frequencies of each attributes were recorded to provide frequency data for the development of the suggested degree of the damage model.

Table 1: The frequency table of the degree of house damage attributes

Degree of Damage	Author	EMS 98	Green Alert	Florida State	EEFIT	BNBP	New Jersey State	Henry B. Hodde III	FEMA	Frequency
	Year of Publication	**‘98**	**‘04**	**‘04**	**‘05**	**‘10**	**‘12**	**‘12**	**‘12**	
	Country/ Region of Study	**EUR**	**UK**	**USA**	**JPN**	**INA**	**USA**	**USA**	**USA**	
	Domain/ Attributes									
No Damage/ DM0/ Grade 0/ N/A (Not Available)										
	No visible damage				√				√	**2**
Grade 1										
	Minor cracking in partitions, infills and ceilings	√								**1**
	Minor damage to non-structural elements	√				√	√		√	**4**
Affected/ Affected but Habitable/ DM1/ Grade 2/ Category 1										
	Hairline cracks in beams/columns near the joints	√								**1**
	Chipping on plaster walls	√		√	√					**3**
	Minor cracks on walls	√		√	√			√	√	**5**
	Minor damage to door/ windows			√	√			√	√	**4**
	Damage to shutters, gutters, roof shingles or siding		√	√						**2**
	Minor cracks on facade	√								**1**
Minor/ Minor 5%/ DM2/ Grade 3/ Category 2/ Light Damage										
	Partial failure of walls, floors, foundation			√		√	√	√		**4**
	Fracture at the roof line	√								**1**
	Failure of partition walls	√								**1**
	Failure of gable walls	√								**1**
	Large and visible cracks in most walls	√	√		√					**3**
	Roof tiles detached	√	√							**2**
	Cracks in most beams/columns	√								**1**
	Collapsed of parts of masonry walls				√					**1**
	Scouring at corners of structures leaving partly exposed foundation				√					**1**
	Exposing sheathings		√							**1**
	Windows and/or doors blown in								√	**1**
	One foot or more of water in basement								√	**1**
	Furnace or water heater damage								√	**1**
Major/ Major 30%/ DM3/ Grade 4/ Category 3/ Moderate Damage										
	Utilities damaged		√							**1**
	One or more rooms collapsed		√							**1**
	One exterior walls collapsed		√							**1**
	Exterior building frame damaged		√							**1**
	Foundation damaged		√							**1**
	Collapse of a	√								**1**

	few columns/beams									
	Substantial failure of walls, floors and roof	√	√	√	√	√	√	√	√	**8**
	Substantial failure of foundation			√						**1**
	One foot or more of water on the first floor (home with basements)								√	**1**
	Collapsed of masonry walls panels				√					**1**
	Excessive foundation settlement and tilting				√					**1**
Destroyed/ Destroyed 80%/ Grade 5/ Category 4/ Heavy Damage										
	Complete or impending building collapse	√	√	√		√	√	√	√	**7**
	Two exterior walls collapsed		√							**1**
	Two or more basement walls collapsed		√							**1**
	Second floor is gone		√							**1**
	House pushed off from the foundation		√						√	**2**
	Exposed floor slabs				√					**1**
	Visible and heavy damage to foundation				√					**1**
	Heavy scouring that leads to collapse of large sections of foundation				√					**1**
Inaccessible										
	Road or/and bridge damaged		√	√						**2**
	House is flooded or submerged		√							**1**
	Road covered by water			√						**1**

[Source: Researchers' Study, 2015]

3 Research Methodology

3.1 Research design

Purpose of this research is to develop Housing Damage Assessment Model. In other to achieve the objective, this research applies the triangulation research design in order to gauge an understanding on the degree of housing damage. Further, it recommends significant input in developing a damage assessment framework in Malaysia. This design encompasses both descriptive and exploratory research methods.

3.2 Data Collection

This research applies a self-developed model that is derived from the literature review (framework or model of the degrees of housing damage after flood) and the observation at the case study area to see the actual conditions of the affected houses. After that, questionnaires were distributed to 50 respondents consist of engineers (n=10), architects (n=10), quantity surveyors (n=10), real estate valuers (n=10) and building surveyor (n=10) by using purposive sampling to gauge their perceptions on attributes of degree of housing damage and eventually conducting a focus group consist of ten (10) technical experts involved in MERCY Malaysia in assessing the housing damage for model validation.

3.3 Data Analysis

In analysing and evaluating the results of this research, quantitative approaches were used. These approaches involved the analysis of data and information through the perception survey method. Quantitative data which was obtained through questions involving likert scale type contained in a structured questionnaire form were analysed by using the Statistical Package for the Social Sciences (SPSS) software. In order to achieve research objective, the data were analysed using Confirmatory Factor Analysis (CFA). CFA is a statistical technique used to verify the factor structure of a set of observed variables. CFA allows the researcher to test the hypothesis that a relationship between observed variables and their underlying latent constructs exists. The researcher uses knowledge of the theory, empirical research, or both to postulate the relationship pattern a priori and then tests the hypothesis statistically (Harrington, 2009). Initially, the factorability of the eight (8) attributes of degrees' of housing damage was examined using Kaiser-Meyer-Olkin (KMO) and Bartlett's test.

3.4 Pilot Study

The reliability of these constructs measurement was evaluated by examining the internal consistency reliability. Thus, a pilot study was carried out on 25 respondents: engineers, architects, building surveyors, quantity surveyors and real estate valuers. An analysis using the reliability test- Cronbach's Alpha (α) was conducted to ensure the reliability of the constructs. As Table 2 shows, the Cronbach's Alpha of inaccessible attributes that are ground zero, flooded houses and, roads and bridges is out is higher than 0.60. Similarly, for the 'minor' attributes (minor damage in partitions, infills and ceilings partition, infills and ceiling, minor damage to door and windows, large and visible cracks in most walls and roof tiles detached) and major attributes (substantial failure of walls, floors, foundation or roof and utilities damaged) also destroyed attributes that is total loss are higher than 0.60. This indicates that all the attributes have a good reliability. For minor attributes, the researchers found that if the attributes large and visible cracks in most walls and roof tiles detached was deleted, the Cronbach's Alpha would rise to 0.747 and 0.678 respectively. As a result we removed both attributes, the Cronbach's Alpha of whole attributes rose to 0.915 (see Table 3) and Cronbach's Alpha for every attribute is more than 0.90 (refer Table 4). Finally, the researchers decided eight (8) attributes as an input to housing model damages. This indicates that the reliability of all attributes of housing damages model was at a high value of Cronbach's Alpha.

Table 2: Cronbach's alpha if item is deleted in the pilot study

Suggested Degree of Damage	Suggested Description of Damage	Suggested Attributes of Damage	Cronbach's Alpha if item deleted
Inaccessible	The residence is inaccessible by normal means	The house is flooded or submerged	0.628
		Roads and bridges are out	0.628
		Ground zero	0.628
Minor	Slight damage to building structure, can be occupied within a short period of time after minor repairs.	Minor damage in partitions, infills and ceilings	0.637
		Minor damage to doors and windows	0.637
		Large and visible cracks in most walls	0.747
		Roof tiles detached	0.678
Major	The building has sustained structural or significant damages, uninhabitable and requires extensive repairs.	Substantial failure of walls, floors, foundation or roof.	0.628
		Utilities damaged (Electrical, Surface water drainage, Sewerage reticulation system, Water reticulation)	0.638
Destroyed	Total loss	Total loss	0.631

[Source: Researchers' Study, 2015]

Table 3: Reliability statistics

Cronbach's Alpha	No of item
0.915	8

[Source: Researchers' Study, 2015]

Table 4: Reliability statistics of pilot attributes

Suggested Degree of Damage	Suggested Description of Damage	Suggested Attributes of Damage	Cronbach's Alpha
Inaccessible	The residence is inaccessible by normal means	The house is flooded or submerged	0.902
		Roads and bridges are out	0.902
		Ground zero	0.899
Minor	Slight damage to building structure, can be occupied within a short period of time after minor repairs.	Minor damage in partitions, infills and ceilings	0.911
		Minor damage to door and windows	0.911
Major	The building has sustained structural or significant damages, inhabitable and requires extensive repairs.	Substantial failure of walls, floors, foundation or roof.	0.900
		Utilities damaged (Electrical, Surface water drainage, Sewerage reticulation system, Water reticulation)	0.905
Destroyed	Total loss	Total loss	0.906

[Source: Researchers' Study, 2015]

3.5 Model Validation

In order to obtain validation of the proposed model of degree of housing damages, the researchers have conducted a 'model validation' by forming focus groups among selected panels to evaluate and provide personal views on the proposed model. These focus groups consist of ten (10) technical experts involved in MERCY Malaysia to assess the housing damage post flooding.

4 Results and Discussion

From the review of eight (8) attribute models of damage assessment from several countries, with a comprehensive summary based on the frequency of the degree of housing damage attributes and the suitability of flood disaster and building structure in the Malaysian context, the suggested degree of housing damages is shown in Table 5.

Table 5: Suggested degree of housing damages for flood affected area

Suggested Degree of Damage	Suggested Description of Damage	Suggested Attributes of Damage
Inaccessible	The residence is inaccessible by normal means	The house is flooded or submerged
		Roads and bridges are out
		Ground zero
Minor	Slight damage to building structure, can be occupied within a short period of time after minor repairs.	Minor damage in partitions, infills and ceilings
		Minor damage to doors and windows
Major	The building has sustained structural or significant damages, inhabitable and requires extensive repairs.	Substantial failure of walls, floors, foundation or roof.
		Utilities damaged (Electrical, Surface water drainage, Sewerage reticulation system, Water reticulation)
Destroyed	Total loss	Total loss

[Source: Researchers' Study, 2015]

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From Table 5, the suggested degree of housing damage is categorized into four (4) degree of damage; 1) Inaccessible, 2) Minor, 3) Major and 4) Destroyed.

In the event of 'inaccessible' degree of damage, the affected house is inaccessible by normal means due to road closures, roads covered by water; the roads are impassible because of landslides or bridge collapse. The flood affected area might be inaccessible due to ground zero situations or submerged situation.

For 'minor', the damage is described as slight damage to building structure; the building can still be occupied within a short period of time after some minor repairs. The length of time for minor reparation is less than two (2) weeks. The attributes of damage are minor damage to partitions, infills, ceilings, doors and windows.

'Major' is the third degree of damage. The building has sustained structural or significant damage that made it unsuitable for occupation. However, the building can be occupied after extensive repairs. The attributes of damage are substantial failure of walls, floors, foundation or roof and utilities damaged (electrical, surface water drainage, sewerage reticulation system, water reticulation).The recommendation is that the affected building with a major degree of damage is to undergo extensive repair and could be occupied after 30 days.

The last degree of damage is 'destroyed'. The description for this degree of damage is that a particular building experienced total loss or has been completely destroyed.

Before this model undergoes the validation process by the technical expertise, a pilot study was conducted for the instrument validity and reliability purposes. To establish this model for expertise perception, a survey was conducted by using purposive sampling among fifty (50) respondents who possessed minimum 5 years industrial working experience. The respondents consist of ten (10) engineers, ten (10) architects, ten (10) quantity surveyors, ten (10) building surveyors and ten (10) real estate valuers. Data collected were analysed using SPSS software for Confirmatory Factor Analysis (CFA).

4.1 Survey Results

The model had undergone CFA, a tool for investigating variable relationships or observing patterns of responses. By using Kaiser-Meyer-Olkin (KMO) and Bartlett's test, the results of the factor analysis are as follows:

Table 6: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.800
Significant value	.000

[Source: Researchers' Study, 2015]

A model is deemed fit when the KMO value is more than 0.6 and the p value (significant) is less than 0.05 (AA Afifi, 1990: Dillon & Goldstein, 1984). From Table 6, the KMO value is 0.800 which indicates that the model is fit and is significant with value at 0.000 value.

Table 7: Anti Image Correlation (a. Measures of Sampling Adequacy [MSA])

		GROUND ZERO	FLOODED HOUSE	ROADS AND BRIDGES ARE OUT	PARTITION, INFILLS AND CEILINGS	DOORS, WINDOWS	SUBSTANTIAL FAILURE	UTILITIES DAMAGED	TOTAL LOSS
Anti-image Correlation	GROUND ZERO	**.874[a]**	-.437	-.119	.164	.011	-.044	-.116	-.008
	FLOODED HOUSE	-.437	**.702[a]**	-.773	-.096	-.126	-.071	.188	-.303
	ROADS AND BRIDGES ARE OUT	-.119	-.773	**.692[a]**	-.022	.041	.102	-.133	.385
	PARTITION, INFILLS AND CEILINGS	.164	-.096	-.022	**.821[a]**	-.487	-.212	-.490	-.138
	DOORS, WINDOWS	.011	-.126	.041	-.487	**.866[a]**	-.291	.121	-.001
	SUBSTANTIAL FAILURE OF WALLS, FLOORS, FOUNDATION, ROOF	-.044	-.071	.102	-.212	-.291	**.916[a]**	-.193	.071
	UTILITIES DAMAGED	-.116	.188	-.133	-.490	.121	-.193	**.797[a]**	-.457
	TOTAL LOSS	-.008	-.303	.385	-.138	-.001	.071	-.457	**.776[a]**

[Source: Researchers' Study, 2015]

The Anti-Image correlation shows (refer to Table 7) that all attributes are correlated with each other, 0.874 (Ground zero), 0.702 (The house is flooded or submerged), 0.692 (Roads and bridges are out), 0.821 (Minor damage in partition, infills and ceilings), 0.866 (Minor damage to door and windows), 0.916 (Substantial failure of walls, floors, foundation, roof), 0.797 (Utilities damaged) and 0.776 (Total loss). Given these overall indicators, it indicates that all eight (8) attributes are significant and well represented the construct (model).

4.2 Model Validation Results

The suggested model was later reviewed by ten (10) technical experts (n=10) for model validation purpose. These technical experts were directly involved in assessing housing damage after flood disasters.

From the experts validation, it was found that all respondents agreed not to include 'inaccessible' as a part of the degree of damage attributes model.

"…Inaccessible is a not part of housing damage attributes." (n1; n2; n3; n6; n9; n10)

"…Beneficiaries need to be assessed although it is not accessible, assessment must be carried out." (n4; n5; n7)

"…by hook or by crook, assessment need to be carried out as inaccessible is not damage." (n8)

These findings are actually in line with the correlation matrix from the survey analysis by the definition if p.value is less than 0.05, the relationship between variables is strong (refer to Table 8).

Table 8: Significant table (1-tailed)

		GROUND ZERO	FLOODED HOUSE	ROADS AND BRIDGES ARE OUT	PARTITION, INFILLS AND CEILINGS	DOORS, WINDOWS	SUBSTANTIAL FAILURE	UTILITIES DAMAGED	TOTAL LOSS
Sig. (1-tailed)	**GROUND ZERO**		.000	.000	.000	**.007**	**.030**	**.069**	**.170**
	FLOODED HOUSE	.000		.000	.002	**.000**	**.005**	**.023**	**.063**
	ROADS AND BRIDGES ARE OUT	.000	.000		.001	**.007**	**.053**	**.134**	**.433**
	PARTITION, INFILLS AND CEILINGS	**.032**	**.002**	**.031**		.000	.000	.000	.000
	DOORS, WINDOW	**.007**	**.007**	**.007**	.000		.000	.000	.000
	SUBSTANTIAL FAILURE OF WALLS, FLOORS, FOUNDATION, ROOF	**.030**	**.005**	**.053**	.000	.000		.000	.000
	UTILITIES DAMAGED	**.069**	**.023**	**.134**	.000	.000	.000		.000
	TOTAL LOSS	**.170**	**.063**	**.433**	.000	.000	.000	.000	

[Source: Researchers' Study, 2015]

From Table 8, the p.value for 'inaccessible' attributes variables (Ground zero, Flooded house and Roads and bridges are out) is more than 0.05. It indicates that the relationship between 'inaccessible' attributes with other attributes is less significant.

In addition, six (6) respondents stated that in 'destroyed', the attributes of damage must also describe that the affected house is not fit for occupancy.

"…For destroyed, the attributes should include it is unsafe structure or building for occupancy." (n2; n3; n5; n6; n7; n9).

Whereas, two (2) respondents stated that the attribute for 'destroyed' must include that the house need to be anew and also agreed to include that the house is not suitable for occupancy.

"…destroyed should describe that the house is unfit for occupancy and recommended to require a new house." (n8; n10).

Thus, based on the eight (8) reviews of the attributes model, and with a comprehensive summary based on the feedback from experts, the frequency of the degree of housing damage attributes and building structure in the Malaysian context, the model of degree of housing damage for flood affected area is as follows:

Table 9: The degree of housing damage for flood affected areas after model validation.

Degree of Damage	**Description of Damage**	**Attributes of Damage**
Minor	Slight damage to building structure, can be occupied within a short period of time after minor repairs.	Minor damage in partitions, infills and ceilings
		Minor damage to doors and windows
Major	The building has sustained structural or significant damages, inhabitable after extensive repairs.	Substantial failure of walls, floors, foundation or roof.
		Utilities damaged (Electrical, Surface water drainage, Sewerage reticulation system, Water reticulation)
Destroyed	The building structure is permanently uninhabitable and requires demolition.	The building structure is a total loss.

[Source: Researchers' Study, 2015]

5 Conclusion

This research presents a model to determine the degree of housing damage for flood affected area. This model helps for estimation of degree of damages due to flood event across the countries in Malaysia. The framework assures that no type of damage is counted more than once. The attributes developed in the research is synthesis from the existing eight (8) models of assessment that had been carried out in different countries with a comprehensive summary based on the frequency of the degree of housing damage attributes and the suitability of flood disaster and building structure in Malaysian context, observation at the study area to see the actual condition of the affected house and survey analysis from experts consist of engineers, architects, quantity surveyors, building surveyors and real estate valuers. On the basis of surveys and review with the technical experts, significant feedback in the design and construction of this model have been considered in assessing the degree of housing damage after a flood in the Malaysian context. On top of that, the information that can be obtained from this model can be used for the process of re-location, resettlement and the planning and organization of the recovery process.

The Housing Damage Assessment Model will provide an edge to the government, local authorities, NGOs, MERCY, insurers or other appropriate bodies involved in assessing or evaluating the condition of houses affected by floods. By using this model, the process of assessing the degree of housing damages after floods can be more accurate, transparent, and efficient. Besides, the form provides an easier and quicker method of recording damage.

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