Evaluating Flood Resistance And Resilience Using Property Level Flood Risk Adaptation (PLFRA) In Melaka

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Abstract

The residents in Melaka, Malaysia frequently face flood risks over the years. However, the Melaka residents are still lack of flood safety consciousness and highly dependent on the government to take action in reducing the flood risks. The residents could take on different steps to prevent or minimise the flood risks such as by undertaking the flood resistance and resilience measures (FRRM). Therefore, this research aims to identify the factors that are influencing the residents' decisions on taking the FRRM steps. In order to examine the factors influencing the FRRM, the Property Level Flood Risk Adaptation (PLFRA) measures are used as the measurement for identifying the residents' preferences for FRRM. Seven PLFRA measures are proposed in the research framework to investigate the knowledge of flood, favourability, and opinions of the respondents in adapting their property from flood risk. An online survey was distributed randomly to residents of Melaka. The results showed that many residents are unwilling to adapt their property to flood risk. This is mostly because they cannot afford the cost not due to lack of awareness and knowledge of the flood risks. Thus, the authorities and local communities can consider encouraging the residents to implement FRRM as a prevention to flood risks.

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1.0 Introduction

Flooding is an unusual continuous increase of water level in the drains or rivers of a certain area which causes a parched region to soak in water (National Emergency Management Organisation, 2021). Flooding is a devastating natural disaster which occurs in many parts of the world. Flood hazard is expected to increase over the years as a result of climate change and unsustainable human activities (Tempest et al., 2017). Flooding usually takes a few days or even only a few hours to happen (Zakaria et.al, 2017). This may cause residents of not having enough time to reduce flood risk, especially when they have not made any flood preparations. Often, flood affected residents and the government need to bear some losses after a flood occurs. Evans et al. (2004) emphasize the need for a philosophical change in which flood risk management can depend lesser on government involvement and more on individual responsibility acceptance.

Even though Malaysia is free from natural disasters such as earthquakes and volcanic eruptions, Malaysia is still facing the flood disaster which is affecting many regions of the country including Melaka. Floods are the most frequent natural disaster that is causing huge losses to the country (Chan, 2012). According to Shaari (2016), flooding in Malaysia may be caused by both nature and humans. The Department of Irrigation and Drainage of Malaysia (2006) states that the main cause of flooding in Malaysia may include urbanisation, poor drainage system, progressive rainfall in certain region or area, tidal backwater effect or partially blocked debris or other objects. However, Perera (2014) states that floods in Malaysia are also caused by deforestation. High rate of deforestation in Malaysia has caused floods to become worse but people did not realise that forest is protecting Malaysia from floods (Kathirgugan, 2021). Butler (2013) depicts that the Google Forest Map has shown that Malaysia is

Commented [DABS1]: Just write the surnames a country with the highest deforestation rate in the world in between 2000 to 2012.

According to Centre for Public Policy Studies (CPPS) (2017), Malaysian government has attempted to provide the latest information of flood at the information portals, build up tidal gates, SMART tunnel, water level telemetry systems, rain telemetry stations, cantilever walls, and others to improve the flood forecasting. This includes the warning systems to reduce the damage that may cause by flood. However, there are still many weaknesses in the current system such as the Flood Forecasting and Warning Systems (FFWS). This system still fails to evacuate the affected victims before the flood happens in their areas as most of the victims were trapped by the rapid rise of water level. As for the Melaka state government, they had maximized their efforts in reducing the risk of flood.

The latest estimation of flooding that happened in Melaka was during the northeast monsoon season from November 2021 to March 2022 (Bernama, 2021). The Melaka government has tried to resolve and improve the drainage and irrigation system problems to reduce the risk of upcoming floods (Murali, 2020). He also added that the agencies need to prepare emergency measures to evacuate victims in the event of flooding in low-lying areas during the heavy rainfall season. However, the Melaka state authority discovered that some residents refuse to move out from their flooded house despite advice by the authority (Koh & Raj, 2017). Thus, these reluctant residents may jeopardize their safety. In view of this problem, the state government is looking at ways in which they can minimize the flood damage cost, hence, to work towards a flood-free state by 2025 by utilizing technology (Koh & Raj, 2017). Flood hazard is a destructive disaster which could impact the economy, social and health of affected regions. Other than government support, there is a growing body of research indicating that Flood Risk Resistance and Resilience Measures (FRRM) at the property level has the potential to support property owners or residents by reducing the effect on households of flooding (Tagg, et.al., 2016).

Investing in flood resistance and resilience measures have both financial and non-financial benefits (Joseph et al., 2015). The financial benefit is the damage cost that will be saved when floods occur and some of the non-financial benefits include reducing or eliminating some of the intangible impacts of flooding. Some intangible impacts of flooding include worsening physical and mental health, worrying about potential strains of flooding between families, lossing group spirit and time spent in alternative housing; are other non-financial benefits for households. However, the emphasis on the adaptation of flood risk resistance and resilience by residents in flood prone areas is low in Malaysia. Therefore, this research is worth undertaking as flood resistance and resilience are a field of study that has not been studied in depth, especially in developing countries such as Malaysia.

This research is carried out to examine the perception of FRRM initiatives by homeowners. The study therefore sought to address the research question 'what variables could influence the decisions of flood affected residents on FRRM steps'.

2.0 Literature Review

2.1 Flood Resistance and Resilience

A significant factor in understanding the goal of evolving flood risk management strategies in the UK is to involve floodplain residents in the flood risk management process (Joseph et al., 2015). Flood plain residents should be encouraged to take steps from flood warning registration by installing their own protection and alarm systems (Pitt, 2008). Malaysia is not alone in this situation as the adoption of flood mitigation measures in many countries is also low (Bubeck et al., 2012). Joseph et al. (2015) hypothesise that this low take-up is attributable in part to the fact that homeowners are not aware of the intangible benefits of investing in flood resistance and resilience measures (FRRM) initiatives or do not support them. Understanding intangible benefits is particularly important because a homeowner is completely insured and their insurers can cover much of the monetary expenses, thus leaving homeowners to be contented with the intangibles.

Flood resistance can be explained as the change in response variable generated by interference (Fritz & Dodds, 2004). According to Tagg et.al., (2016), flood resistance is the protection steps taken to protect the properties or buildings from floodwater. This gives the residents more time to move out and even take some time to prepare for their valuable things (Bowker, 2007). The measures taken may include flood resistant materials (Tagg et.al., 2016). This study also reveals that taking flood resistance steps can minimize the damage towards the buildings as floodwater is prevented to enter the buildings.

The concept of resilience was studied by Holling (1973), which distinguished the resilience into engineering resilience and ecological resilience. Engineering resilience refers to the ability to return to a steady state after a disturbance and the ability to maintain functional efficiency while ecological resilience is about accepting and resisting different equilibrium possibilities, in which the ability to absorb changes to return or maintain its original structure (Holling, 1973). Flood resilience is a type of condition and it is also a process at the same time (Magali et. al., 2012). Furthermore, the research also mentioned that flood resilience needs to include both types of components which are stability and adaptability in order to perform well in a flood resilience system. Unlike flood resistance, flood resilience is a concept that accepts that floods will occur, but reduces the risk of floods on the basis of consideration of corporate, government, social and economic factors (Batica & Gourbesville, 2016). In short, the communities with flood resilience systems should be able to accept, change, withstand and also recuperate from the floods. Another study by Zevenbergen, Gersonius & Radhakrishan (2020) also mentioned that the community needs to accept the fact that flood exists and unavoidable. Therefore, the community need to learn and take action to reduce and mitigate the damages it may cause. The flood resilience can include preparation, protection and also prevention activities in order to minimise the flood risk and the loss (Zevenbergen, Gersonius & Radhakrishan, 2020). A study by Batica and Gourbesville (2016) has concluded that a flood resilience system is suitable and effective to reduce flood damage and destruction.

According to Flood Risk, Flood Resilience and Resistance (2021), the main difference between flood resistance and resilience is the action taken to face the floods. Flood resistance is steps adopted to avoid the water from entering the properties. Flood resilience is accepting the fact that the water will enter the properties by taking the steps to reduce the damage and loss caused by the floods and the ability to recover from the flood Flood Risk, Flood Resilience and Resistance (2021). In short, the flood resistance is preventing flood damage while flood resilience is minimizing the flood damage and faster recovery from flood.

2.2 Property Level Flood Risk Adaptation (PLFRA)

Property Level Flood Risk Adaptation (PLFRA) measures are used to decrease or stop the flood damage that could bring towards the property (Joseph, 2014). According to Wires (2019), PLFRA measures are usually expensive and it is an action on voluntary basis. Therefore, it depends on the individual to decide on whether they need to implement the PLFRA measures on their property according to their own personal experience. Although PLFRA measures bring a lot of benefits to protect the properties, many individuals still do not implement it (Davids & Thaler, 2021). This may happen because the individuals are still clueless about PLFRA measures and the ways to implement it to their property (Attems et al., 2020).

As far as insured households are concerned, the benefits of participating in PLFRA interventions can be divided into two main areas: financial benefits for insurance firms and intangible benefits for households (Joseph et al., 2011). Studies have shown that the financial benefits outweigh the upfront expenditure by a factor of between 5 and 10 for assets that flood more than once every 10 years (Drabek, 2001). The monetary benefits for engaging in FRRM are less insurance premium and reduce flood damage cost. Non-financial benefits for households include reducing or removing some of the intangible impacts of flooding, such as physical and mental health deterioration, potential family flood pressures, loss of group spirit and time spent in alternative accommodation (Joseph et al., 2015).

The Melaka flood prone area residents' influencing factors for adopting FRRM measured using Joseph et al. (2015) Property Level Flood Risk Adaptation (PLFRA) measures. PLFRA measures indicate eight factors that can influence FRRM preference. The eight factors are as stated in the Table 1.

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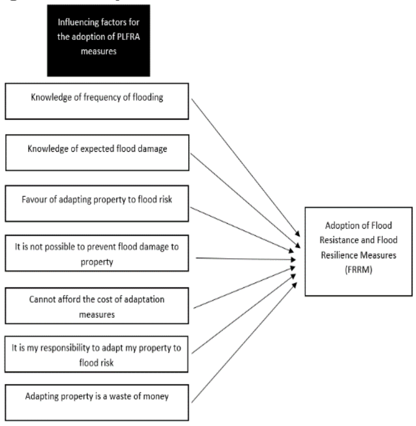
Table 1: Property Level Flood Risk Adaptation (PLFRA)

	Influencing factors for the adoption of PLFRA measures
1	Knowledge of frequency of flooding can encourage adapting property
2	Knowledge of expected flood damage can encourage adapting property
3	Favour of adapting property to flood risk
4	It is not possible to prevent flood damage to property
5	I cannot afford the cost of adaptation measures.
6	It is my responsibility to adapt my property to flood risk
7	Adapting property is a waste of money
8	Responsibility of insurer to adapt my property because I am fully insured

2.3 Research Framework

This research adapts the PLFRA measures by Joseph et al. (2015) to find out the influencing factors for adopting FRRM measures. There are eight measures suggested in PLFRA measures but this research only adapted seven of them to identify the factors that are influencing the residents in Melaka to adopt FRRM measures. The excluded measures from PLFRA is "Responsibility of insurer to adapt my property because I am fully insured". This measure is excluded in this research since it is less relevant in influencing the residents in Melaka to adopt the FRRM measures. The research framework of this research is shown in Figure 1.

Figure 1: Conceptual Framework



Methodology

3.1 Study Area

The study area of this research focused on a state in Malaysia, which is Melaka. The estimated population in Melaka in 2021 is 0.94 million (Department of Statistic Malaysia, 2021). Out of the 0.94 million of populations, there are an estimated 18,000 populations in Melaka that are affected by floods and it covers the areas in about 80.9 square kilometers (Water Governance, 2011). However, the flood prone areas are believed to change from year to year. For example, the latest data showed that there were 124 flood prone areas in Melaka that is affected by the upcoming north-east monsoon period (Bernama, 2021). Melaka is a state in Malaysia that is frequently affected by floods (Mohamad et.al., 2021).

The questionnaire for this research was mainly distributed to five areas which include Alor Gajah, Batu Berendam, Durian Tunggal, Melaka Baru and Sungai Putat since these five areas were highly affected by floods before. However, other respondents from other parts of Melaka were also encouraged to participate in the questionnaire since there are still many flood prone areas in Melaka.

3.2 Data Collection

This research utilises quantitative method where survey in the form of questionnaires were distributed to targeted respondents. The survey method is suitable for this research as it can help to reach out to larger respondents in different areas in Melaka. It is more convenient and efficient to get a large amount of data in a shorter time frame. This research aimed to collect at least 100 responses from 100 respondents. Therefore, the distribution of questionnaires was carried out via electronic methods to collect the data. The questionnaire was prepared using Google Form and it was distributed broadly by sending the Google Form link to different types of social media which include Facebook, WhatsApp, email, Telegrams, WeChat and Twitter. In order to reach out to the residents in Melaka, the link was mainly distributed to the group chat that are mainly for Melaka residents. Both English and Bahasa Melayu languages were included in the questionnaire so that the respondents can answer it according to their preferred language and understand the question more clearly. The data collection of this research undergone three stages which are pre-test, pilot test and field study.

Section A of the questionnaire contains questions in order to collect the demographic data of the respondents. Only basic demographic data such as gender, age, area of region, household income

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and type of houses were collected. The respondents answered the questionnaire anonymously. For Section B, the questions focused on the factors influencing the adoption of PLFRA measures that influence the FRRM preferences. There were five questions for each statement of PLFRA measures as mentioned in the research framework. Therefore, a total of 35 questions were included in Section B. The questions in this section used Likert scale which contain ratings from 1 to 5. 1 is 'strongly disagree', 2- 'disagree', 3- 'neutral', 4- 'agree' and 5- 'strongly agree'.

3.3 Data Analysis

Firstly, a pre-test was carried out to test the questions in section B to find out which questions were suitable to be included in the questionnaire. Then, a pilot test was conducted by distributing the questionnaire to 30 respondents to figure out whether the data is reliable, and to obtain feedback from the respondents to find out possible problems occurring during their answering process.

After collecting more than 100 responses, the descriptive analysis was carried out using IBM SPSS version 26 to find out the mean, median, mode, standard deviation, standard error, maximum and minimum number for Section B. The results and analysis of the results are discussed in the next section. In addition, another analysis which is Intraclass Correlation Coefficient (ICC) was undertaken to figure out the reliability of the data collected. The relationship between the questions for each statement were analysed through ICC, and the overall reliability between all of the statements was also examined.

4.0 Results and Discussion

4.1 Descriptive Analysis

Table 2: Descriptive Statistics

Statements	N	Min	Max	Mean		Std. Deviation		
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Mode	Median
Knowledge of frequency of flooding	128	1	5	3.8953	0.07263	0.82174	4	4
Knowledge of expected flood damage	128	1	5	4.2063	0.06765	0.76537	5	4.2
Favour of adapting property to flood risk	128	1	5	3.3062	0.08823	0.99825	3	4.3
It is not possible to prevent flood damage to property	128	1	5	3.5785	0.07529	0.85179	4	3.6
I cannot afford the cost of adaptation measures.	128	1	5	3.8953	0.07188	0.81326	4	4
It is my responsibility to adapt my property to flood risk	128	1	5	3.8359	0.069	0.78065	4	4
Adapting property is a waste of money	128	1	5	3.5578	0.08519	0.9638	4	3.8
Valid N (listwise)	128							

The Table 2 shows the descriptive statistics for each PLFRA measure. The statistics shows total number of responses, minimum and maximum rating, mean, standard error, standard deviation, mode and median. The total number of responses collected is 128 which shows on the table that each measure gained the same number of responses as respondents are required to answer all of the questions given in the questionnaire before they can submit the form. All of the PLFRA measures gained the same minimum and maximum rate which are 1 and 5 respectively. This shows that in each of the measures, there are respondents that strongly disagree and strongly agree with the statements given.

The mean is the average number of ratings given by the respondents on each statement of the PLFRA measures. It shows that many respondents agreed with the statement of measure when the number of means is higher. Among the 7 PLFRA measures, "Knowledge of expected flood damage can encourage adapting property" gained the highest number of mean which is 4.2063. It shows that most of the respondents have agreed that they know or they know what the damages may cause by the floods. At the same time, the mean number for the statement of measures of "Knowledge of frequency of flooding can encourage adapting property" is relatively large in number compared to other measures. The mean number for this statement of PLFRA measure is 3.8953, which indicates more respondents agree that they know the frequency of flooding. Other than that, "It is my responsibility to adapt my property to flood risk" gained 3.8359 mean number. This also shows more respondents are agreeing that adapting their property from flood risk is their own responsibility instead of others.

On the other hand, the mean number for "Adapting property is a waste of money" and "It is not possible to prevent flood damage to property" is low, which is 3.5578 and 3.5785 respectively. This signals that not many of the respondents agree that adapting their property from flood is a waste of money and they think it is possible to reduce the flood risk. However, the data analysed shown on the Table 2 also signifies that many respondents are not willing to adapt their properties from floods. This can be explained by looking at the mean number for "I cannot afford the cost of adaptation measures" and "Favour of adapting property to flood risk". The mean numbers are 3.8953 and 3.3062 respectively. These analysed data shows many of the respondents agree that they cannot afford to adapt their properties from floods due to lack of financial ability. Moreover, their willingness to adapt their property to flood risk is also relatively low since this statement gained the lowest mean number among all of the statements of PLFRA measures. Majority of the respondents do not prefer to make any changes to their property.

The data analysed shown in Table 2 also proved that more data are clustered around the mean. This is because the standard deviation for all seven of the statement measures are less than 1. For example, the mean for "It is my responsibility to adapt my property to flood risk" is 3.8359 with standard deviation of 0.78065. According to the standard interpretation method of standard deviation, 68% of the data is between (3.8359-0.78065=3.05525) and (3.8359+0.78065=4.61655). Since the standard deviation is quite low in number, more data is in a smaller range. This helps to prove that the data gained is more reliable as the data gained does not spread out of the range.

This research also refers to the mode of the data collected. Apparently, the number of modes is the rating chosen by most of the respondents. Therefore, the majority choices can be known by looking at the mode. The mode for statement of "Knowledge of expected flood damage" is the highest which is 5. Majority of the respondents have chosen 5 which strongly agree to show that they reach a consensus that they know what kind of damage caused by floods. On the other hand, the mode for "Favour of adapting property to flood risk" is 3. Majority of the respondents are not sure whether they want to adapt their property to avoid or reduce the flood risk. For the rest of the statements, the modes are the same, which is 4. The analyses of mode show the majority of the respondents still agree with the rest of the statement.

4.2 Intraclass Correlation Coefficient

Table 3: Intraclass Correlation Coefficient

Intraclass Correlation Coefficient									
Statements		Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0				
			Lower Bound	Upper Bound	Value	df1	df2	Sig	
Knowledge of frequency of flooding	Average Measures	.851[c]	0.805	0.888	6.869	127	508	0	
Knowledge of frequency of flooding can encourage adapting property	Average Measures	.889[c]	0.855	0.917	9.188	127	508	0	
Favour of adapting property to flood risk	Average Measures	.841[c]	0.783	0.885	7.183	127	508	0	
It is not possible to prevent flood damage to property	Average Measures	.870[c]	0.831	0.903	7.741	126	504	0	
I cannot afford the cost of adaptation measures.	Average Measures	.870[c]	0.829	0.903	8.023	127	508	0	
It is my responsibility to adapt my property to flood risk	Average Measures	.834[c]	0.783	0.876	6.317	127	508	0	
Adapting property is a waste of money	Average Measures	.897[c]	0.865	0.923	10.139	127	508	0	
Overall	Average Measures	.833[c]	0.775	0.878	7.024	127	762	0	

Table 3 shows the results of the data analysed through Intraclass Correlation Coefficient (ICC). This ICC is carried out to identify the inter-rater reliability as this is a quantitative research. According to a study by Koo and Li (2016), ICC indicates the degree of correlation and consistency between the values. ICC that is closer to 1 is better as it shows higher resembility between values from the same group (Glen, 2016). ICC is very important as the researchers use this to examine and determine the value of the measurement (Koo & Li, 2016).

Since this research is targeting Melaka, the population data is gathered. Other than that, the raters and ratees are consistent. Therefore, this Intraclass Correlation Coefficient (ICC) used a two-way mixed method to carry out. In case of referring to single measures or average measures, average measures is used as the data used to carry out the ICC is mean instead of single individual. This ICC is carried out to determine the reliability of each statement and scores. Thus, ICC is assessed absolute agreement instead of consistency.

Referring to Table 3, it is clear that all of the statements of PLFRA measures including the overall ICC are good in reliability. This is because the ICC of all statements are in between 0.8 to 0.9. The ICC between 0.75 to 0.90 is good in reliability, lower than this range will be poor and moderate in reliability, only ICC with 0.90 or above is considered as excellent in reliability (Koo & Li, 2016). “Adapting property is a waste of money” statement has the highest ICC while “It is my responsibility to adapt my property to flood risk” statement has the lowest ICC among the 7 statements of PLFRA measurements. It is 0.897 and 0.834 respectively.

Despite this, the difference of ICC between all of the statements is not large. Even the overall ICC that included all statements in analysis also in between 0.75 and 0.90, which is 0.833. Hence, it can be concluded that the data collected for this research is very reliable.

5.0 Conclusion

It can be concluded that the Melaka residents may have sufficient knowledge about flood damage and flood frequency. Majority of the respondents agree that by adapting the property from flood is possible to reduce the flood risk and it is not a waste of money. In comparison with all statements, the results showed that fewer respondents were willing to adapt their property from flood risk and to bear the cost associated to it. Although many respondents know the benefits of adapting property from flood risk, they still opt not choose to adapt the steps. The possibility is due to the results of another statement of measures in which the respondents expressed their concern with regards to the cost to adapt their property from flood risks. However, there could be other reasons, for example, they might reluctant to think much further into the possibility of flood occurrences in their area.

In conclusion, this research showed the factors influencing the flood resistance and resilience measures can be determined by referring to the PLFRA measures. Since flood resistance and resilience are more focused on adapting the property to prevent and reduce the flood risk and damage, the Melaka flood prone area residents’ influencing factors for adopting FRRM can be directly reflected through PLFRA measures. The more the respondents are willing to adapt their property from flood risk, the more the respondents are considered taking flood resistance and resilience to prevent and avoid the flood risks and damages. Finally, the findings in this research can be a reference for local communities and even the government to identify the improvement that can be done in order to encourage and increase the willingness of Melaka residents to adapt their property from flood risks.

6.0 Recommendation

This research is conducted to examine factors that influencing Melaka residents to implement flood resistance and resilience measures to their property. In order to gain more accurate results, it is recommended that future research to examine how many residents have already implemented the flood resistance and resilience measures and how many of them are ready to implement it in a short time. This is to obtain more information about how they are going to do or what they have done instead of just their thoughts without action. Future research could also investigate the reasons and factors of residents choosing not to implement the FRRM measures despite knowing the importance of implementing it and the flood damage that may damage their property. Another suggestion for future researchers is to carry out the analysis for residents who have experienced in floods and for residents who have no flood experience in order to identify the difference in their views and attitude towards FRRM.

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