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The Impacts of Floods Towards Construction Sites in Malaysia

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***Abstract*—** This research focuses on reducing flood damage in the Malaysian construction industry. It identifies the main causes of flooding at construction sites as poor drainage systems, natural factors, and human development. The key impacts include material and equipment damage, debris flow, and project delays. Based on responses from 137 industry professionals, effective mitigation methods include raising land for storage, creating drainage basins, and installing sump pumps. The study aims to support continuous construction progress by proposing practical flood management strategies.

***Keywords*—** Construction Site, Flood, Impact, Management.

I. INTRODUCTION

Flood is an aftereffect of natural event or poor drainage system. Flood is an overflow of water that happens in dry land which is mostly caused by low capacity of drainage equipment, weather condition or geography (Earth Networks, 2022). There are many types of floods which are inland floods, flash floods, river floods, coastal floods, and urban floods (Tiffany Means, 2018). As Education. National Geographic Society (n.d.) stated that floods have enormous destructive power which can damage a building foundation, causing the building to crack and tumble and even more destructive damage.

There are many types of causes to flood. The most common is heavy rain because of the water drainage system is being overwhelmed by sustained heavy rain over a period which cause the system not draining the water as quickly as it should be and lead to housing area being flooded (B-air, 2018). Beside due to heavy rain, another common cause of flood is dam failures due to poor maintenance or internal erosion which will lead to the water could not be contained and escape from the dam. In addition, mudflow is also one of the causes of flood. As Jeri Humanities (n.d.) stated mudflow is a liquid which is the combination of water and mud flowing through dry land. It will clog the water drainage system causing flood to occur. This study dedicates the focus of impacts of floods toward construction site.

II. RATIONALE OF STUDY

There were many cases of flood happens in Malaysia in recent years. There was a serious flood happen in December 2021 which led to 50 dead and evacuation of about 40,000 people (Onn, L.P, 2022). The most serious flooded area is Taman Sri Muda which was swallowed by water as deep as 4 meter which is higher than a single-story house (Imran.A and Jananey. R, 2022). As Imran.A and Jananey R (2022) stated, Taman Sri Muda had an ongoing flood before which is in December 1995 as the water reached almost up to 1 meter. In addition to that, there is a flood happen in March 2023 which is occur at Johor which lead to 4 dead, 40,000 and more people evacuated from their house (Chen. H, 2023). Due to the latest flood incident, it is worsened than before and lead to many families lost their houses or loves one in this disaster. There are some previous studies on preparing for floods on construction sites (Caroline. R, 2016; Proverbs, D.D, 2004 and Insurance. N, 2022). These studies were focused on the application method to minimize the impacts of floods towards construction industry. It is crucial to know the impacts of flood towards one or building and apply appropriate method to have precautions or minimize the damage of flood towards social or building. This research is to find out the causes of floods towards construction site and provide preventative method for construction site in Malaysia.

III. AIM & OBJECTIVE OF STUDY

The aim of this research is to minimize and manage the damage caused by flood in Malaysian construction industry. The objectives obtained in this research is to study the effects towards construction site due to continuously flooding in Malaysia and to outline the potential methods to minimise the damage effects caused by flooding towards construction sites in Malaysia.

IV. LITERATURE REVIEW

Flood is caused by an overflow of water from existing water to be risen onto the dry land and it will last for days or weeks (National Weather Service, n.d.). According to Logan (2021), one of the damage effects towards construction site due to flood is debris flow.

Dangerous pieces of debris such as broken glass, jagged pieces of metal or any debris can be washed away by flooding. These debris could damage the structural at the construction site and even causing harmful injury to the construction worker if these debris were moving several miles per hour. As stated by Logan (2021), biohazard risk could be causing damage to construction site but not the structural building. It will be causing damage to the construction workers. Other than debris flow and biohazard risks could cause damage effects to the construction site, electrocution is also one of the damage effects to the construction site as stated by Logan (2021). As stated by Apurva, Sharareh and Sanjgna (2020), damage to material and machinery at construction is one of the damage effects by flood. Raw materials which were being bought or produced at site are destroyed due to flood occur. The material being store at a warehouse which is not high enough will also be damaged due to continuous flooding. Disruption to public or utility services such as electricity, water supply, sewage, fuel and so on could be causing the project to be delayed due to lack of facilities and public infrastructures (Apurva, Sharareh and Sanjgna ,2020). Disruption and delay are one of the damage effects of flood towards construction site. If there is disruption occur due to flooding, the project will be delayed because of no public or utility services to the construction site to undergo their progress

According to Richard, Brad, Simon, Alessandro, Matia and Raik (2012), potential method to minimize the damage effect is by excavating a site drainage basin where water accumulates in a safe area within the construction site which will also not affect the progress of the construction work. This is to ensure the water will not be overflow at the construction site to prevent damage to the structural work and injuries to the construction workers at the construction site. As stated by Richard, Brad, Simon, Alessandro, Matia and Raik (2012), another potential method to minimize the damage effect is by adding additional sump pumps at the construction site in order to drain out the excavation or draw water out to another sewerage system in order to prevent the site to be overflow or flood to occur. Another potential method to minimize the damage is by raising up the land to temporarily located at another location in a rain or flood event (Richard, Brad, Simon, Alessandro, Matia & Raik, 2012). According to Shahanas (2020), considering the level of the site with the road by maintaining the site at a higher level expecting the elevated road after repair and maintenance. This is to prevent the backflow of water to the site during heavy monsoons. Increasing the drainage level so that the flood will be less occur to the construction site when heavy monsoons.

V. RESEARCH METHODOLOGY

Research Design

The research method that applied on this research is quantitative research. According to Indeed Editorial Team (2022), quantitative research is commonly used to collect, test, and measure numerical data from a large sample of participants.

Sampling Method and Size

In this research, non-probability sampling technique will be selected as this research tends to focus on small samples and are intended to explore a real-life phenomenon. This sampling technique will be adopted by way of convenience sampling and purposive. This is by choosing the contractor and consultant in the construction industry rather than another type of industry. This is by choosing the contractor and consultant in the construction industry rather than another type of industry. Therefore, the formula to calculate the sample size is by using Cochran formula. This formula provides the estimated optimal sample size required for the level of precision and the required degree of confidence with the expected proportion of the respondents. In conclusion, a sampling size of 137 respondents was required in this research study.

Data Analysis Method

There are a few tests which are to test the reliability of the data collected from the respondents. Besides testing reliability, the frequency distribution test is also being used for the data collection. The data analysis which are used in this research are frequency distribution analysis and Kruskal Wallis.

VI. RESULTS AND DISCUSSION

Table 1. *Profession of Respondents*

General Information	Categories	Frequency	Percentage
Type of organisation	Contractor firm	77	56.2%
	Consultant firm	60	43.8%

Table above shows most of the respondents are from contractor firm which is 77 respondents with the percentage of 56.2% of the total respondents. Next the rest of the percentage which is 43.8% of the respondents are in consultant firm (N=60).

Table 2: Mean Ranking on Damage Effects Towards Construction Site Due to Flood in Malaysia

Years of Working experience		Debris Flow	Biohazard Risks	Electrocution	Damage to Material and Equipment	Disruption and Delay
Less than 5 years	Mean	4.15	3.85	3.85	4.12	4.15
	N	26	26	26	26	26
	Std. Deviation	0.732	0.732	0.834	0.653	0.675
6 – 10 years	Mean	4.14	3.86	3.84	4.20	3.93
	N	44	44	44	44	44
	Std. Deviation	0.702	0.765	0.776	0.734	0.728
11 – 15 years	Mean	4.11	4.07	4.07	4.40	4.04
	N	45	45	45	45	45
	Std. Deviation	0.745	0.751	0.780	0.751	0.852
More than 15 years	Mean	4.23	4.09	3.64	4.41	4.00
	N	22	22	22	22	22
	Std. Deviation	0.685	0.684	1.049	0.666	0.617
Total	Mean	4.15	3.96	**3.88***	**4.28***	4.00
	N	137	137	137	137	137
	Std. Deviation	0.713	0.742	0.841	0.717	0.742
	Mean ranking	2	4	5	1	3

Table 2 displays the mean ranking on damage effects towards construction site due to flood in Malaysia among different years of occupation in the construction industry.

At the top of the mean ranking shows that most of the respondents agreed on the factors that caused flood. E4 = 'damage to material and equipment' with a mean of 4.28 takes the leads among the other effects. This reveals that majority of the targeted respondents strongly agreed that the damage to material and equipment is one of the damage effects towards construction site.

Materials such as concrete or metal may be damaged by flood which will lead to being rust or flow away to the drainage while for the equipment will be damaged due to exposed to water from flood. Water conducts electricity when the flood water gets into the equipment, it will create a short circuit and damage some components of the equipment (Coombes. R, 2022)

Lastly, the lowest mean rank is E3 = 'electrocution' with the mean value of 3.88. This shows that most of the respondents slightly agree that electrocution is one of the effects due to the workers at the site will stop the power when heavy rain is happened so that they would not get electrocuted by the exposed wire and so on.

As stated by Safe Electricity (2013), there will be a danger of electrocution when electrical equipment comes into contact with flood water.

Other than that, Safe Electricity also mention there are a few possibilities of electrocution from water damaged appliances during the clean-up process when the flood waters had dispersed.

Table 3: Mean Ranking on Potential Method to Minimize the Damage Effect Caused by Flood Towards Construction Site in Malaysia

Years of Working experience		Excavate A Site Drainage Basin	Additional Sump Pumps	Raise Up Land to Put Materials and Plants	Drainage Level
Less than 5 years	Mean	4.15	3.85	3.85	4.12
	N	26	26	26	26
	Std. Deviation	0.732	0.732	0.834	0.653
6 – 10 years	Mean	4.14	3.86	3.84	4.20
	N	44	44	44	44
	Std. Deviation	0.702	0.765	0.776	0.734
11 – 15 years	Mean	4.11	4.07	4.07	4.40
	N	45	45	45	45
	Std. Deviation	0.745	0.751	0.780	0.751
More than 15 years	Mean	4.23	4.09	3.64	4.41
	N	22	22	22	22
	Std. Deviation	0.685	0.684	1.049	0.666
Total	Mean	4.14	4.03	**4.20***	**3.94***
	N	137	137	137	137
	Std. Deviation	0.719	0.706	0.759	0.811
	Mean ranking	2	3	1	4

Table 3 displays the mean ranking on potential method to minimize the damage effects caused by flood towards construction site in Malaysia among different years of occupation in the construction industry.

The highest mean ranking is M3 = 'raise up land to put materials and plants' with a mean of 4.20 takes the leads among the other potential method.

This reveals that majority of the targeted respondents agreed on raising up the land to put the materials and plants to prevent the flood to damage the materials and plants which will lead to delay of construction work.

Safe Electricity (2013) stated that all tools and equipment are needed to keep at least 10 feet away or above from flood or wet surfaces.

Lastly, the lowest mean rank is M4 = 'drainage level' with the mean value of 3.94.

This shows that most of the respondents slightly agree that extending the previous drainage level is one of the methods to minimize the flood due to it can be done by excavating a new drainage basin with deeper depth without influencing the drawing set by the architect.

According to Chang, Tan, Lai and et al (2012), improvement of drainage capacity such as extending the drainage depth to between 1 meter and 2 meter or deeper.

This means the carrying capacity of water will increase and lower the chances of flood occurring.

Table 4: Kruskal – Wallis H Test on Damage Effects Towards Construction Site in Malaysia due to Flood

Code	Damage Effects	Kruskal – Wallis H	df	Asymp. Sig
E1	Debris Flow	2.775	3	0.428
E2	Biohazard Risks	1.814	3	0.612
E3	Electrocution	2.109	3	0.550
E4	Damage to Material and Equipment	0.660	3	0.882
E5	Disruption and Delay	3.442	3	0.328

Table 5: Kruskal – Wallis H Test on Potential Method to Minimize the Damage Effect Caused by Flood Towards Construction Site in Malaysia

Code	Potential Method	Kruskal – Wallis H	df	Asymp. Sig
M1	Excavate A Site Drainage Basin	2.765	3	0.429
M2	Additional Sump Pumps	2.950	3	0.399
M3	Raise Up Land to Put Materials and Plants	2.276	3	0.517
M4	Drainage Level	0.332	3	0.954

All the damage effects and potential methods have no significance difference among all the respondents because all the respondents have the knowledge handling the flood happens in the construction site as flood is an issue happen in Malaysia for many of years and current years. However, their years of working experience might effect on the agreement of different factors, damage effects and potential methods. Besides that, all of them had experience of floods happen to the site which led them to have no significant difference among their rates to the questionnaire.

VII. CONCLUSION

Construction industry is one of the most contributors or key drivers to Malaysia's economy during this era as the industry will continue to enhance due to the country is developing. However, the event of flood has kept on increasing which lead the construction to be affected by flood and caused more damage effects to the construction site. This is affecting the progress of the construction site and lead to many delays and lost money to repair of the defects.The aim of this study is to minimize the damage caused by flood in Malaysian construction industry with the objectives (1) to study the effects that will happen to construction site due to continuously flooding in Malaysia and (2) to outline the potential methods to minimize the damage effects caused by flooding towards construction site in Malaysia. Literature review is complete on all the objectives to collect the evidence and facts on the topic. In addition to that, questionnaire was designed based on the findings in literature review to conduct questionnaire survey. The target respondents for the questionnaire are consultants and contractors in construction industry which total up to 137 respondents. The data collected were analyzed with different methods. The objectives established were accomplished in this study and summarized as below:

Objectives 1:

There are 5 damage effects towards construction site due to flood in Malaysia which are also rated by the targeted respondents. The result shown that (1) Debris Flow, (4) Damage to Material and Equipment and (5) Disruption and Delay. However, for the damage effects that ranked last is (3) Electrocution. For the debris flow, during the event of flood, there will be lots of scrap metals or other types of materials will be flow along the flood. If the flood is flowing through rapidly across the constructions site, small debris like concrete, nails, metals and so on

will be washed away along with the flood which will cause damage to the construction site. In addition to that, when there is flooding occurred in the construction site, material such as cement, rebar and other types of materials will be damaged when being soaked for a long period of time during the flood. Equipment with electronics will also be damaged when flood occurred or contact with wet surfaces. Besides these, flooding will also cause delays and disruption to the construction site which leads to late start of construction works. However, for the electrocution is seldom happen due to when there is event of raining some of the electrical will be close and isolated from wet surfaces to prevent the construction workers to be electrocuted when in touch with the equipment.

Objective 2:

There are 4 numbers of potential method to minimize the damage effect caused by flood towards construction site which are rated by the respondents which the top 2 potential method are (1) Excavate a Site Drainage Basin and (2) Raise Up Land to Put Materials and Plants. It can be said that if the contractor and consultant used these 2 potential methods to minimize the damage effect caused by flood, it can help them to continue their construction progress and help to save some unnecessary cost in repairing plants and buying new materials to replace the defect materials which are damaged by flood. By applying these 2 potential methods is can help to ensure the continuation of the construction work rather than delaying the time of completion due to the defects of materials and works caused by flood. Other than that, it could also help contractor to save costs on repairing the defect due to flood and replacing the damaged materials. However, not all the potential method to minimize the damage effects is suitable for all projects due to all projects have their own unique and characteristic to their own way.

Research Implications

This study explored the potential method on minimizing the damage effect caused by flood towards construction site to allow the construction industry to have a better understanding of the damage effects towards construction site. It is believed that this implementation may help to provide some sustainable ways for the construction industry to continue their progress on construction work when there is flood occur. This study may also provide some ways for the construction site to not delay their works and reduce the potential of damage happens when there is flood occurring at the site.

Research Limitations

There are a few limitations that had faced in this study. One of the limitations is there is limited information and previous research studies regarding on potential method to reduce damage effects towards construction flood cause by flood and damage effects of floods towards construction site. Other than that, the time for collecting data from respondents is limited due to more data can be collected to achieve a more substantial data from the target respondents. In addition, not all the potential method to minimize the damage effects is suitable for all projects due to all projects have their own unique and characteristics.

Research Recommendations

It is recommended to the future researchers to obtain the survey data from more working years of respondents to be able to determine the difference of each factor, effects, or potential method more effectively and get better quality of data. Besides that, it is also advisable for future researchers to make a site visit to projects sites to see the damage effects of flood towards construction site to get a better understating and make comparison and obtain obvious evidence for future research. A qualitative method and a bigger pool of respondents based on multiple locations should be carried out in the future.

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