



INTEGRATED APPROACH FOR RESILIENT OFFICE BUILDINGS TOWARDS REDUCING FLOOD DISASTER RISKS

S U M Tobī¹, N H Zakaria², and N A M Aris³

^{1, 2} *Razak Faculty of Technology and Informatics,
UNIVERSITI TEKNOLOGI MALAYSIA (UTM), KUALA LUMPUR*

³ *UNIVERSITI TUN HUSSEIN ONN MALAYSIA (UTHM)*

Abstract

Every year, flooding affects Malaysia, especially during the northeast monsoon season. Whilst flash floods only last a few hours, monsoon floods might take a week or longer to restore to normal water flow levels. In the interest to lessen vulnerability towards natural disasters such as floods, development of resilience building is essential since this natural phenomenon can bring considerable damages to properties such as buildings. Office buildings are one of the fundamental elements of a nation's economy as they provide essential space and services for the community. Thus, any significant changes in their abilities to provide services for the public can bring impacts to the lives of people around them. Through the concepts of "living with floods," flood resilient construction has been widely acknowledged as a crucial part of the integrated approach to flood risk management. This can be accomplished by being aware of, and sensitive to any prospective disruptions caused by disasters, as well as studying previous disruptions. This paper aims to present an integrated approach for resilient office buildings towards reducing flood risks by choosing areas that are often exposed to flood hazards in Malaysia as the sampling sites namely Johor, Pahang, and Kelantan. This research commenced with a survey questionnaire to get preliminary information of the office building involved, followed by case study of selected buildings and Focus Group Discussion to get more in-depth understandings of the risks and challenges faced by building owners and managers. The findings revealed that by applying the core elements of office building resilience towards having an integrated approach for resilient office buildings can help mitigating the risks from the planning stage of land use and focus down to reduce the risks for the office building itself. This integrated approach was divided into generic and specific mitigation approaches for resilient office building towards reducing flood risk, which can be used by the building operators and related stakeholders to enhance the resilience of their office buildings.

Keywords: Flood, Disaster Risk, Office Building

¹ Corresponding author. Email: uzairiah.kl@utm.my

INTRODUCTION

Floods have been a yearly event in Malaysia, particularly in the monsoon season. The disaster is expected to occur in the month of October to March, along the northeast monsoon season in the states along the east coast of peninsular Malaysia which is most vulnerable to floods. This natural hazard could bring considerable impacts to buildings, including the office as this type of building is one of the fundamental elements of the country's economy. Office building provides imminent space for human activities whilst offering essentials services to the public. In this respect, any significant alteration to their function could affect the condition of lives for people depending on the services provided by the office building in local, regional, and even global settings [1]. Therefore, it is crucial for Malaysia to structure a coping mechanism to deal with the flood situation, that should not be used only for the people and community but also tackled the context of building resilience towards reducing disaster risks.

Most of the previous research focused on the single mitigation approach rather than developing a holistic approach in which this study will be focussing on. During flood, most of the attention were directed to the loss of properties or lives, but less emphasise was put on the losses suffered by office building such as the damage on critical documentations or assets. As for building, most studies concentrated on residential properties, whilst another study on the literature review of reducing flooding impacts to the built environment by [2] considered built environment as buildings and infrastructures in general, such as transportation, waste, water, energy, and services associated with them, including commercial properties and construction industries.

To evaluate the damages brought by flood, the buildings are categorised based on the ownership and types as each category of buildings have identical design criteria and features in terms of materials used in construction, contents, and sizes. These resemblances influenced how each building respond to flood in a similar way, in which it will represent comparable damages to their structures and capacities [3]. Therefore, this calls for research that focuses on the office building, with the enhancement through holistic approach by introducing an integrated approach as guideline. The established guideline from this study combined all the mitigation measures, involving all agencies and stakeholders in disaster management to reduce the impact of disaster, especially flood. This research encourages the requirement of creative innovation and cross-sectoral alliance, which links to practices and diversified stakeholders in supporting the evidence-based decision-making to reduce the current risk, as well as preventing future risks of disaster.

The novelty of this study lies in its contribution to disaster resilience literature by offering a localised, empirically validated guideline that integrates structural and non-structural measures within Malaysia's office building context. Through a mixed-methods approach and the development of a resilience

scorecard for office building, this study has bridged policy, practiced, and experience, providing a replicable model for urban resilience planning in Malaysia.

LITERATURE REVIEW

Floods are natural phenomenon; however, when they exceed the coping capacity and damage life and properties, then they become a major source of concern. Malaysia, a country that is very prone to flood risks, mostly by the nature of its physical (e.g., topography and drainage) as well as its human geography (e.g., settlement and land use patterns). In Malaysia, previous research concluded that flood is the most frequent calamity that affected multitude regions particularly the low areas ever since the 1920s. Previous research found out that almost 9% of the total disaster was due to the land expansion whilst approximately 22% of the total population is directly impacted by floods [4], [5], [6], [7], [8].

Monsoon Flood in Malaysia

In general, there are two types of floods occurred in Malaysia, namely the monsoon flood and flash flood. Monsoon flood usually took place in May until August (Southwest Monsoon) and November until February (Northeast Monsoon) [8]. In contrast, flash flood often hit the city, caused by unrestrained human activities such as developing infrastructures nearby the rivers and rampant littering that blocked the ditch and waterways [4], [9]. This condition has brought some concerns among the community members as it can bring adverse effects on their lives and health, as well as damaging the infrastructures, properties, and agricultures [7], [10]. Commonly, the east coast states of Pahang, Terengganu, and Kelantan were affected by the northeast monsoon floods which occurred in November to March. The floods usually took three days to a week to be fully subsided, but it also depends on the amount of rainfall received during that period. For instance, if heavy rains continued for a longer period, the flood would take a longer time to recede.

The Affected Office Building during Flood

Office buildings were among the buildings that experienced the impacts of flood. During major flood that had paralysed the town of Kota Bharu, Malaysia in 2014, one of the most affected office buildings was the Kelantan Contingent Headquarters of Royal Malaysian Police in Kota Bharu Kelantan. The damage was estimated to be around MYR15.3 million, which involved the buildings, vehicles, along with the Information and Communication Technology (ICT) devices. The losses also covered 19 other police stations in five other territories,

namely Kota Baharu, Pasir Mas, Tumpat, Kuala Krai, and Gua Musang that had been also hit by flood [11].

Office buildings required distinguished necessities which differentiate them from the other types of buildings. As this type of building deals with large populations, it requires specific design such as the heavier floor loadings and particular free stretch over between the structural columns and open plan floors that allows occupation flexibility, advanced EP (Mechanical, Electrical and Plumbing) system, along with the central system air conditioning, that involves special care for energy efficiency and infrastructure [12]. According to [13] Purpose-Built Office (PBO) signifies the buildings that were constructed to be used primarily as an office, which means that it should be more than 75% of the net capable area to be rented is used as office. The net lettable floor area is calculated to match the Uniform Method of Measurement of Buildings from the Royal Institution of Surveyors Malaysia (RISM). Office building contains various spaces, not only limited to the working, but also for storing up documents and other. As a workplace, an office will reflect what kind of works that have been carried out in the building.

According to the photos uploaded by Pasir Mas District Council on their official webpage on 29th November 2017, the office was hit by flood as continuous heavy rains had caused the overflow of Sungai Golok. The office and other buildings around Lubok Jong, Pasir Mas was submerged in water for a few days. Another office building that was affected by flood in Batu Pahat on 5th April 2021 was The Batu Pahat Magistrate's Court [14]. The flood was triggered by heavy rains, coupled with the high tide phenomenon.

Throughout the years, the development of flood resilient constructions has become a crucial element of the integrated measures to manage the risks of flood, and it is currently acknowledged by promoting the concept of living with floods and creating space for water. Resilient constructions have been accessible for centuries, but only in recent years have they been acknowledged as one of the components of further strategy in flood risk management. Buildings and the larger man-made environment are known to be the fundamental elements in flood risk management, and when buildings are developed on or nearby flood prone areas, there is an apparent requirement of protecting those aspects [15].

Core elements of Disaster Resilience

According to [16], coping capacity is defined as “the ability of people, organisations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters”. In this paper, coping capacity is defined as “the ability of the building owners to control the impacts of natural hazards using available resources and capabilities to reduce the impacts of flood.” To better understand how the appropriate coping strategies can be built in facing disaster situation, the core elements of disaster resilience were used to

understand the context, disturbance, capacity to respond, and reaction to disaster. Therefore, after the concept of disaster and resilience has been understood, then only the risks that might occur can be identified. Risks are the probability that a community's structure or geographic area to be damaged or disrupted by the impact of a particular hazard (flood in the context of this study) on account of their nature, construction, and proximity to a hazardous area. A framework of resilience in a DRR and (climate change adaptation) CCA context is simplified in Figure 1 below:

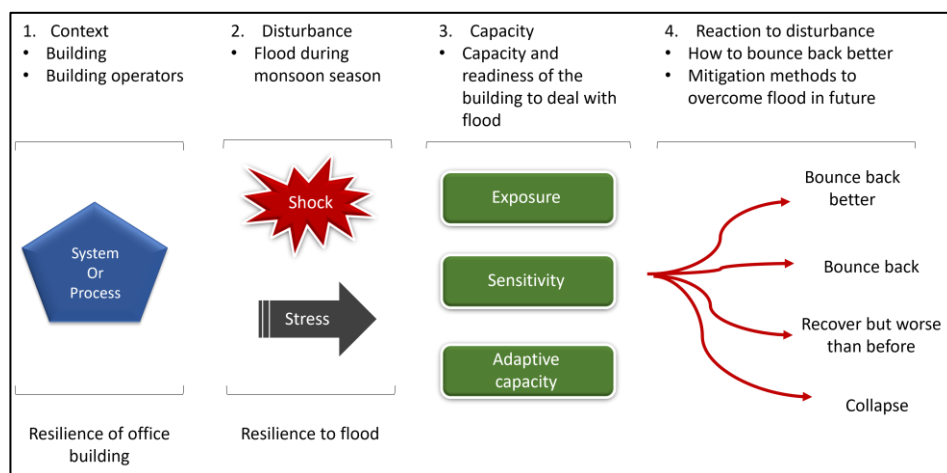


Figure 1. The Four Elements of Resilience Framework [17]

Core Elements of Office Buildings Resilience towards flood

In general, resilience is described as the capacity of a society, system, or area to respond, assimilate, and adjust to the current situation, and finally bounce back from the disturbing incidents quickly and effectively [16]. Meanwhile, Infrastructure Resilience (IR) refers to the capability of restoration across the system after disaster strikes, when the infrastructure systems were damaged due to the severe natural or human-made disruptive incidents [18]. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event. This definition is widely used to describe the resilience of any infrastructure, including the buildings.

The National Institute of Building Science (NIBS), United States had determined that resilience can be characterised by four key features: robustness, resourcefulness, rapid recovery, and redundancy (the 4R). There is a fundamental difference between asset resilience and community resilience in which asset

resilience is the resilience of a sole asset such as an individual building. There are multiple forms of feasible assets such as bridges, mass transit stations, transmission towers, or tunnels. Asset resilience can be characterised through the definition of resilience above, by using the 4Rs. Within an asset, its resilience is controlled by contrasting parameters (sometimes regarded as considerations). These parameters can be categorised as components from one or more of the 4Rs. Table 1 below shows a simplified example of building components and categorisations in an asset resilience setting.

Table 1. Resilience Example of Individual Building as an Asset [18]

RESILIENCE COMPONENTS	BUILDING PARAMETERS (CONSIDERATIONS)
R1: Robustness	Structural connections
R2: Resourcefulness	Maintenance of building Memorandum of Understandings (MOUs) between different organisations
R3: Recovery	Roadways leading to building Training of all kinds
R4: Redundancy	Main water pipes into building Electric and/or power lines

Assimilating resilience into new building designs, actual retrofits, and continuous building activities will imply considerable expanses. Thus, it is necessary to evaluate the investments in building resilience to assess the benefits of such expenditure throughout the life cycle of the facility. Meanwhile, the enhancement of resilience should be assessed as it is crucial to identify performance (or for security and protection) levels and their impacts on reducing the risks and increasing resilience. The four (4) core elements of resilience framework and four (4) resilience components of the buildings were used as a foundation in designing the integrated approach. By building the capacity for disaster resilience of office building, it will lead to another phase in the process of managing and mitigating disaster known as Disaster Risk Reduction.

METHODS

This study adopted mixed method approach with sequential explanatory design which commenced with the needs of quantitative data collection, followed by qualitative data collection. The quantitative data were required to represent the affected population based on the samples selected. This helped the researchers to get the big picture from the respondents based on what they have been through and the challenges they faced during flood in monsoon season. Then, data

collection continued with qualitative data using selected case study. It was carried out by identifying several buildings to get an in-depth understanding on the risks and challenges faced by the building operators, along with proposing coping strategies. Figure 2 below illustrates the mixed method approach with sequential explanatory design used in this study.

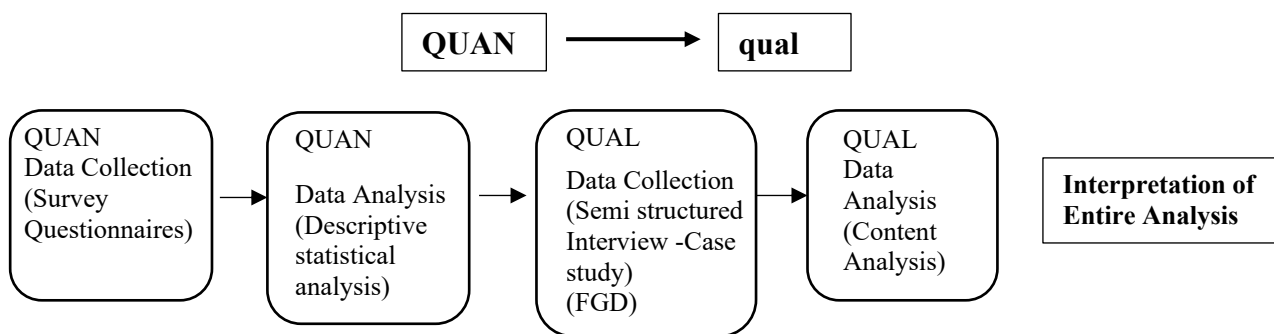


Figure 2. Sequential Explanatory Design [19]

Accordingly, the focus of this study is to investigate office buildings which had been affected by floods during monsoon season. This comprehensive data collection was conducted in three (3) phases.

Phase 1: Survey Questionnaires were distributed to 120 office building owners/managers from the states affected by the floods, namely Pahang, Johor & Kelantan, (purposeful sampling). This sample size was selected to ensure proportional representation from the three states, capturing regional diversity relevant to the objectives of this study. Participants of this study was determined using available literatures to identify the office buildings involved in 2014 monsoon flood and used them as the marking point for each state. Subsequently, the nearby office buildings that could have been also hit by flood were identified using Google Earth. The total number of the samples from each state can be summarised in Table 2 below:

Table 2. The Total Number of Office Buildings Affected by Flood in Kelantan, Pahang, and Johor

State	Total no. of Office Building
Kelantan	40
Pahang	40
Johor	40
TOTAL	120

Throughout the survey, eighty (80) from the total of 120 buildings have responded to the questionnaire. This was due to the limitations of the building owners or managers. Some of the buildings refused to answer the questionnaire as it was out of their position. For the buildings that participated in the survey, most of the building owners or managers agreed that the essentials put in the questionnaire are important in enhancing the resilience of office buildings. Meanwhile, Figure 3 below shows the map of Peninsular Malaysia, and the highlighted states are the sampling sites for this study.

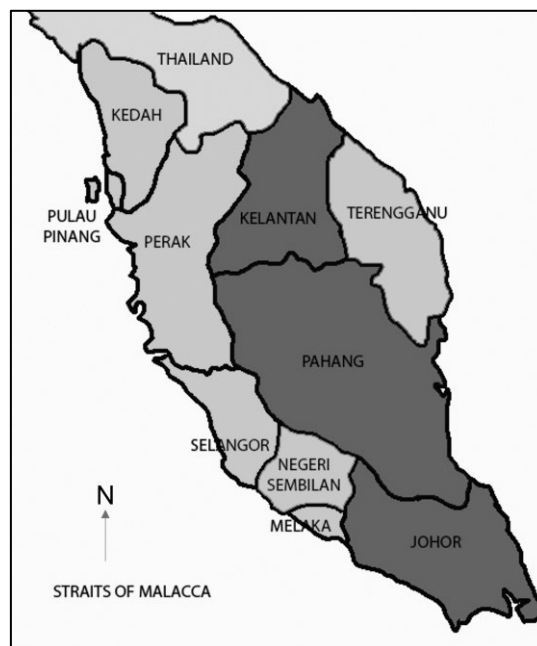


Figure 3. Sampling Sites

Whilst the districts chosen for the case study were depicted in the figures below, according to their respective states.



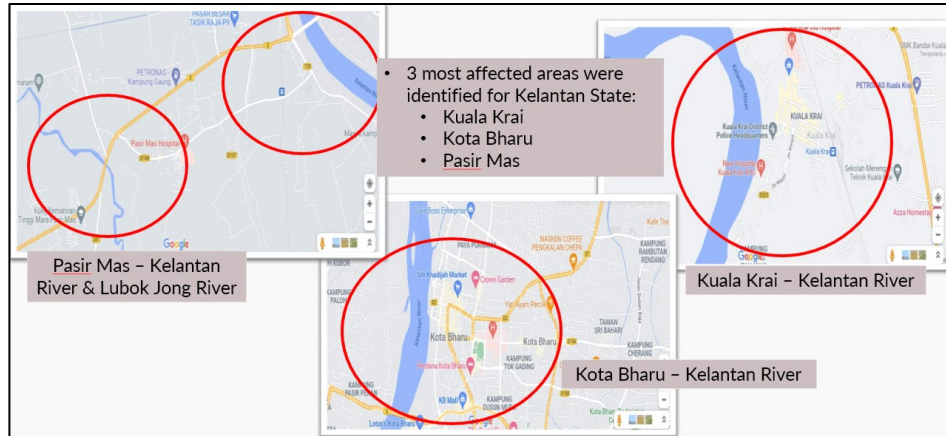


Figure 4. Study Sites for Kelantan State (Source: Google Earth)



Figure 5. Study Sites for Pahang State (Source: Google Earth)



Figure 6. Study Sites for Johor State (Source: Google Earth)

Before commencing with the survey, Cronbach's Alpha was used to measure the internal consistency and reliability of the essentials in the questionnaire. The result of the Cronbach's Alpha for each Essential in the questionnaire is listed in Table 3 below:

Table 3. The result of the Cronbach's Alpha for each essential in the questionnaire

No.	Essential	Cronbach's Alpha value
1	Developing and Maintaining the Office Building Resilience in General	0.967
2	Identifying, Understanding, and utilizing the current and future risk scenarios	0.977
3	Enhancing Financial Capability for Resilience	0.838
4	Pursuing the Development of Resilient City to Achieve of Exceed the Resilience Requirements	0.950
5	Empowering Institution's Capacity for Resilience	0.938
6	Enhancing Infrastructures' Resilience	0.950
7	Ensuring Effective Response Towards Disaster	0.949

From the result, all the essentials were categorised as good and excellent. Hence, all the essentials were accepted to be put in the questionnaire.

Phase 2: In depth investigation via interview sessions with the selected case studies involved eight (8) buildings; two (2) from Pahang, three (3) from Johor, and three (3) from Kelantan. These buildings were chosen based on three most affected districts during flood from the respective states. In depth investigation via interview comprised the building management/facilities management team for the respective buildings. The findings of the interview were used to develop the questions for the next stage of the study, which is Focus Group Discussion.

Phase 3: Focus Group Discussion (FGD) was conducted with the relevant stakeholders such as government agencies involved in disaster management, academicians, and insurance company to gain more information on the mitigation measures that can be adopted in reducing the risk of disaster for office buildings. FGD was conducted face to face with all the stakeholders, and the findings were used to develop the final guidelines for this study.

Prior notice was given to the participants on the purpose of the study, and their permission were asked before the interviews commenced. It was stated in the official letter, that all particulars of the participants and/or organisation details would remain confidential and the contents of the interview would be used solely for the research purposes. The interview process was then conducted after the participants gave their consent, based on their convenience through agreement on the date, location and time. Thus, this study has adhered to the ethical research standards.

ANALYSIS RESULT

Survey questionnaire results

There were seven (7) essentials in the questionnaire that were used to develop the Office Building Resilient Scorecard in Malaysian context. Within the essentials, there were several components that can be used to determine the status of the office building resilience. The level of importance for each component and the current practice of the components in the management of buildings under investigation were summarised in Table 4 below:

Table 4. Survey Questionnaire Results for Disaster Resilience
Scorecard for Office Building

Essential	Level of importance	Current practise
Essential 1 - Developing and Maintaining Office Building Resilience in General	>70%	<70%
Essential 2 - Identifying, Understanding, and utilising the current and future risk scenarios	>70%	<25%
Essential 3 - Enhancing Financial Capability for Resilience	>70%	>70%
Essential 4 - Pursuing the Development of Resilient City to Achieve or Exceed the Resilience Requirements	>70%	<70%
Essential 5 - Empowering Institution's Capacity for Resilience	>70%	<70%
Essential 6 – Enhancing Building' Resilience	>70%	<70%
Essential 7 - Ensuring Effective Response Towards Disaster	>70%	>70%

In conclusion, the survey questionnaire has reflected the importance of all the components in the proposed essentials towards developing the Disaster Resilience Scorecard for Office Building in Malaysia. The scorecard can be used to assess the current state of the office buildings in Malaysia and the level of awareness in managing the building towards reducing disaster risks, specifically for flood. As part of the integrated approach, this scorecard will help the building managers and operators to evaluate the current state of their buildings and constructing the mitigation methods that can be adopted in facing the disaster of flood in future.

The score will be used to evaluate the status of the building management, according to the score in each component within the essentials. The measurement can be interpreted as the percentage of involvement among managers and staff of the building in the components stated in the scorecard or how far have the components have been adopted in the management of the building towards reducing the current and future risks of flood. Each score indicated that 1 signifies zero or no preparation at all whilst 5 signifies perfection, or resilience has been achieved in that element. The exhibitive assessment scales can be categorised as follows:

- 5 – Single point of coordination exists with agreed roles and responsibilities
- 4 – Single point exists but with some minor exceptions
- 3 – Single points exists in principle, but with some major exclusions, or lack of agreement on some major areas
- 2 – Initial steps taken to create a single point of coordination
- 1 – No single point but plans exist to create one

All the scores will be added up and the total scores could be determined. The measurement of the scorecard is summarised as in Table 5 below.

Table 5. The indication of the score from the Disaster Resilience Scorecard for Office Building

	Red Zone	Caution Zone	Going Well Zone
Overall score	25% (55-56)	26-75% (57-167)	76-100% (168-220)
Building resilience	25% (6-7)	26-75% (7-18)	76-100% (19-25)
Current & future risks	25% (7-8)	26-75% (8-22)	76-100% (23-30)
Financial Capacity	25% (7-8)	26-75% (8-22)	76-100% (23-30)
Resilient city	25% (6-7)	26-75% (7-18)	76-100% (19-25)
Empowering institutional capacity	25% (9-10)	26-75% (11-30)	76-100% (31 -40)
Enhancing building resilience	25% (7-8)	26-75% (8-22)	76-100% (23-30)
Effective response	25% (10-11)	26-75% (11-30)	76-100% (31 -40)

Focus Group Discussion Result

Analysis done was run through Nvivo R1 software analysis. The findings were divided into three themes:

1. Theme 1 - Building
2. Theme 2 - Surrounding and location
3. Theme 3 - 'Others'

The main findings of theme 1 are illustrated in Figure 7 below:

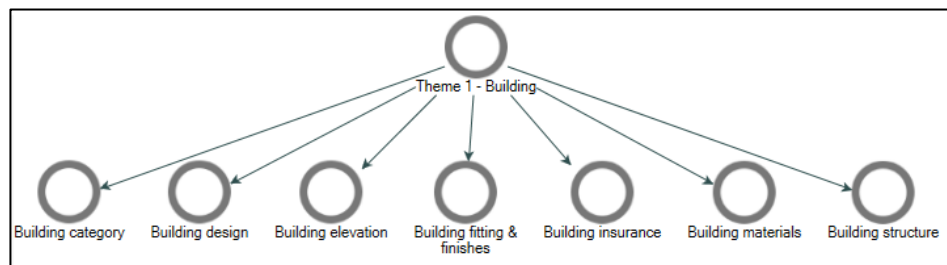


Figure 7. Main findings of theme 1 - Building

As seen in the figure above, there were seven (7) subthemes under building, which are:

- i) Building category
- ii) Building design
- iii) Building elevation
- iv) Building fitting and finishes
- v) Building insurance
- vi) Building materials
- vii) Building structure

The following table (Table 6) shows part of the content analysis result from the interview.

Table 6. Data display of content analysis process – Sub Theme 1

Ground floor and open space concept.	Finishes such as carpet, vinyl & curtains.	Using waterproof doors such as steel door.
The areas involved might be gazetted. So, we don't have to use the ground floor or basement. The operation should start at the next floor. Ground floor should be left empty as the flood mitigation method. The ground floor should be exposed. So, the damages can be minimised during flood.	These finishes are considered as moveable assets which are not part of the building.	The are some offices that change their doors into steel doors as the existing doors were damaged during flood.
Choosing waterproof finishes is crucial	Damaged doors and cabinets	New building should be insured
Choosing the right types of building finishes is fundamental. Building finishes such as floor, wallpaper, ceiling, and door and window are always expensive and should be insured if it is a new building. Selecting the high resilient building finishes is very important in reducing the risks of flood for any buildings or office buildings.	Involving specific components only. Properties such as cabinets and doors will be destroyed.	Might be applicable to the high-risk buildings, the buildings aged less than two years, or the newly built buildings.

Accordingly, there are three (3) subthemes under theme 2 (surrounding and location), which are:

- i.) Drainage
- ii.) Information sharing between agencies on development area
- iii.) Location for development

The example of data display of analysis conducted through Nvivo software using content analysis technique for the sub-themes under theme 2 is listed in Table 7 below.

Table 7. Data display of content analysis process – Sub Theme 2

Drainage system for flash flood is still functioning and can be improved.	Monsoon flood _ existing drainage design will often fail.	Types of soil trench under JPS
Firstly, need to look at the flood category – flash flood or monsoon flood. Drainage and landscape system, such as the ‘Manual saliran mesra alam’ each development will control its own water flow before releasing it to the river. Every candidate should follow the manual.	During monsoon flood, most of the designs will oftentimes fail.	In terms of trench, to put it simple, if it is soil trench, then it is under JPS.
Complying with the drainage design by Local Council	The buildings were developed in the flood prone areas	Risk Assessment in the new development areas
The issue is whether the developers followed the plan or not as it is under the jurisdiction of Local Council.	The location has been fixed. So, need to think of other ways to handle the problems in the area.	The existing flood risk map can be used to develop a flood mitigation map for the specific areas. Assessing the risks of flood in the areas according to the maps provided – either urbanisation or agricultural areas.

Meanwhile, the final theme which is categorised under ‘others’ can be classified into six (6) subthemes as the following:

- i.) Coordination between agencies
- ii.) Digitalised document
- iii.) Educate and raise awareness
- iv.) Flood risk mapping and risk evaluation
- v.) Living with flood concept
- vi.) Strict rules and regulation enforcement

The content analysis result from is shown in Table 8 below, which listed the codes list under theme 3.

Table 8. Data display of content analysis process – Sub Themes 3

Digitalising existing documents	Confidential Documents & damaged tenders	New development, risk assessment on the environment should be conducted
Proposed only for the crucial documents Need to be justified – but can be printed whenever needed. Need to have the digitalised data to ease the process of storing the documents especially for drawings. This is because the risks of redrawing the documents often lead to problems such as the consultants closed their business or dead, hence the documents should not be stored in hardcopy only. The cost of redrawing measured drawing is very high.	The confidential and tenders were destroyed during the flood as they were stored at ground level.	Should consider and look at the surroundings before increasing the level of development in any areas. As in one area where NADMA is involved – should assess the surrounding. Once forecasted if the surrounding become worse, new methods should be implemented.
Risk evaluation in the new development areas	In development cannot be avoided - educate the concept of living with flood	Requirement to re-establish floodplain areas
Flood Risk Map which is readily available can be used to develop a flood mitigation map. Assessing the risks of flood in the areas according to the map – whether the urbanisation or agricultural areas.	Office building owners can be aware of the condition and mitigation approaches taken in their areas and can lend their help. need to be supported with the insurance coverage and flood proofing, The resilient building towards disaster, by following the concept of living with flood as it cannot be avoided anymore.	Farmers will get the insurance coverage for their crops NAFAS dan FAMA will be involved. Suggesting the re-establishment of flood plain areas, to make room for water in the existing strategic plan.

From the data display above, all the elements mentioned in the previous part of the themes and subthemes are listed in the table such as the requirement of digitalising important documents, assessment and evaluation of the new development areas, educating the concept of living with flood, and the requirement of re-establishing the flood plain areas to reduce the risks of disaster, especially flood. All these elements are crucial in minimising the impact of disaster in constructing the final guidelines of this study. The results from this FGD have helped the researchers to validate the initial guidelines outlined for this study. All the comments and suggestions are put into consideration regarding improving the guidelines so that it can benefit the stakeholders involved.

FINDINGS AND DISCUSSION

The integrated approach developed is centred around the core elements of disaster reliance framework and the core elements of resilient buildings. The core elements from both inputs were then combined to establish the core elements of office building resilience for this study. The seven (7) essentials in the scorecard reflected the capacity to deal with reaction in the core elements of office building resilience, which is summarised in Table 9 below:

Table 9. The core elements of office building resilience (Adapted from [17], [18])

Context	Disturbance	Capacity to deal with disaster	Reaction to disturbance
Office Building	Monsoon Flood Disaster	Exposure Robustness Redundancy Resourcefulness Recovery Sensitivity	Bounce back better

Accordingly, the specific components of the integrated approach related to the office building were built upon the core elements of building resilience. It is translated into the Disaster Resilience Scorecard for Office Building which can be used by the building managers and operators. All the seven essentials were embedded under the capacity to deal with disturbance. Table 10 below summarised the specific components of disaster mitigation approach related to office building, in terms of the non-structural measures.

Table 10. Specific components of disaster mitigation approach related to office building (Non-structural measures)

Capacity to deal with disturbance	Office Building Disaster Resilient Scorecard (7 Essentials)
Robustness	<u>Essential 1</u> Developing and maintaining office building resilience
Exposure	<u>Essential 2</u> Identifying, understanding, and utilizing the current and future risk scenarios
Resourcefulness	<u>Essential 3</u> Enhancing financial capability for resilience
Sensitivity	<u>Essential 4</u> Pursuing to achieve or exceed the resilience requirements
Resourcefulness	<u>Essential 5</u> Empowering capacity for resilience
Recovery	<u>Essential 6</u>

	Enhancing building structure/infrastructure resilience
Robustness Redundancy	<u>Essential 7</u> Ensuring effective response towards disaster
Reaction to disturbance – ‘Bounce Back Better’	
Location selection	• New development on the flood free area • Flood Risk Mapping and assessment
Insurance	• Educate and raise awareness of building owners (i.e government buildings) • Group insurance for building within the same areas under one owner/building manager
Document Digitization	• Create digital backups of all essential documents, such as financial statements, leases, agreements, contracts, design etc. • Using inexpensive/free software applications OR Specialised Optical Character Recognition software (OCR)
Information sharing on new development area	• The proposed new development area can be reviewed by referring to the ‘Integrated Land use Planning Information System (I-Plan) PLANMalaysia and cross evaluated with flood risk mapping in the area. • This information on risk evaluation report should be shared with the respective agencies and information of data confidentiality should be considered.
Educate building owner and users	• To raise awareness and educate business owners on the capacity building requirements to manage the building better • To ensure business continuity or uninterrupted/ less effected business activities on post-disaster event
Raise awareness on concept living with flood	• To have resilience strategies for flood risk management within flood prone area • Flood mitigation measures can significantly reduce flood damage and, as a result, help to reduce risk.

Referring to the table above, for the non-structural measures which represented the Essentials in the Disaster Resilience Scorecard for Office Buildings, specifically Essential 1 and 7 are related to the core element of robustness. It refers to the capability to continue the critical operations and functions amid critical situation in which the building and its crucial support systems can be constructed to minimise interruption. Meanwhile, Essential 2 is related to exposure in which the building is exposed to the current and future risk scenarios whilst Essentials 3 and 5 can be associated with resourcefulness. Resourcefulness can be referred as the capacity to get ready for, react to, and conduct any ongoing catastrophe or interruption through effective mitigation measures.

Whilst sensitivity can be related to Essential 4 as all the building users will be accounted in the mitigation approaches, including those who are disabled. The recovery elements can be seen in Essential 6 as it refers to the ability to bounce back to normal operations as soon and as efficiently as possible after a disaster by enhancing the resilience of building structure and infrastructures. Another core elements that can be related with the mitigation approach for office building is redundancy, which is reflected in Essential 7.

To complement the non-structural measures listed in Table 10 above, building owners and operators can refer to Table 11 below which specified the structural measures that can be adopted towards reducing flood risks for their office buildings.

Table 11. Specific components of disaster mitigation approach related to office building (Structural measures)

Reaction to disturbance – ‘Bounce Back Better’	
Construction Materials / foundation Material absorbency categorized by Class	• Class A - minimal damage under most circumstances • Class B - susceptible to physical damage when wet, otherwise no long-term damage • Class C - C subject to damage after prolonged immersion, but will recover when effectively dried • Class D - subject to permanent damage if subjected to relatively short periods of wetness • Building built on less permeable soil should add 6 inches of topsoil
Building elevation (from the ground level)	• 1 or 2 feet from the ground level • Not more than 2 meters from the ground level • Building elevation standard from UN not exceeding 2 meter
Requirement for flood proofing measures in the building (basement car park) - Dept. of Town and Country Planning (Peninsular Malaysia) JPBD (PlanMalaysia) 7/2003 source Planning Standards & Guideline – Multi-storey Carparks of New Buildings - JKR (PWD)source 2nd Edition of Garis Panduan Reka bentuk Parkiran (Tempat Letak Kereta) Bawah Tanah Kalis Banjir - JPS (DID)source	All basement carpark of new building should be equipped with flood gates to obtain construction approval by Authorities <u>Part 1</u> • Planning Criteria • Space • Location • Arrangement • Traffic • Instrument <u>Part 2</u> • Guideline on the design of flood proofing • Flood record analysis • Flood warning system • Security & Access • Flood emergency plan • Inspection and maintenance plan • Flood risk assessment • Hydraulic computation • Flood surveillance & warning system • Emergency plan action

Reaction to disturbance – ‘Bounce Back Better’	
<i>Guideline of Flood Prevention for Basement Carpark (2006)</i>	Flood proofing designs and methods application technique <i>*Note: All indicators listed under each part is adapted from related government agencies (PlanMalaysia, PWD, DID)</i>
Building design to reduce flood risk	- Pillared buildings reduce losses - The ground floor is open concept
Building fittings and finishes materials	- Class A and Class B absorbent materials - Flood resilient flooring (i.e., solid concrete floors or floor laminates) - Flood resistance door (i.e., steel doors)
Guideline according to building category <i>-JKR sources:</i> <i>i) Manual Panduan JKR Standard</i> <i>ii) Garis Panduan BIM JKR</i>	- New develop building - Less than 10 years - More than 10years - Exceeding 20 years - Heritage building - Prestige building
Drainage systems within the surroundings <i>-DID sources:</i> <i>Manual Saliran Mesra Alam</i>	- Enforcement and compliance with drainage design under local government - Schedule and preventive maintenance

The integrated approach for Resilient Office Buildings Towards Reducing Flood Disaster Risks can be seen through a comprehensive measure that it offers. It is a combination of an assessment of the office building status through the disaster resilience scorecard for office buildings, followed by the list of mitigation measures that can be taken by the office building towards enhancing their resilience to reduce the risks of disaster, specifically for flood.

The specific components which comprise specific elements of resilient office building also adopted the multi approach criteria through the proposed structural and non-structural approaches. The combination of these two approaches have shown the robustness of the guideline as it provides comprehensive mitigation approaches that can be adopted by the office buildings towards enhancing their resilience and reducing the risks of disaster.

CONCLUSIONS

It can be concluded that this integrated approach can be used by the building owners, managers, operators, and other relevant stakeholders. This guideline

provides a scientific approach in the non-structural and structural measures that can be used to enhance the resilience of office buildings towards reducing the risks of water related disaster, specifically flood in Malaysia. From the three stages of data collection adopted in this study, the risks of flood on the office buildings were identified and mitigation approaches were structured to develop a guideline for resilient office buildings in the context of Malaysia. It can be utilised to enhance the resilience of the office building and simultaneously reduce the risks of future disaster by implementing the measures outlined in the guidelines into the management of office buildings that are vulnerable to floods.

ACKNOWLEDGMENT

This research is funded by National Real Property Research Coordinator (NAPREC), National Institute of Valuation (INSPEN), Valuation & Property Services Department (JPPH Malaysia) and Ministry of Finance, Malaysia.

REFERENCES

- Aliagha, G. U., Mar Iman, A. H., Ali, H. M., Kamaruddin, N., & Ali, K. N. (2015). Discriminant factors of flood insurance demand for flood-hit residential properties: A case for Malaysia. *Journal of Flood Risk Management*, 8(1), 39–51.
- Bernama. (2015). Zahid: Kerosakan aset PDRM di K'tan RM15.3j. *MalaysiaKini*. <https://www.malaysiakini.com/news/285712>
- Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research*. SAGE Publications.
- Department for International Development (DFID). (2011). *Defining disaster resilience: A DFID approach paper*. Department for International Development.
- Hammond, M. J., Chen, A. S., Djordjević, S., Butler, D., & Mark, O. (2015). Urban flood impact assessment: A state-of-the-art review. *Urban Water Journal*, 12(1), 14–29.
- Jabatan Penilaian dan Perkhidmatan Harta Malaysia. (2019). *Indeks sewaan pejabat binaan khas Lembah Klang, Johor Bahru & George Town purpose-built office rental index (PBO-RI) Klang Valley, Johor Bahru & George Town*. Pusat Maklumat Harta Tanah Negara (NAPIC).
- Khalid, M. S., & Shafiai, S. (2015). Flood disaster management in Malaysia: An evaluation of the effectiveness flood delivery system. *International Journal of Social Science and Humanity*, 5(4), 398–402.
- Liu, A., & Melhado, S. (2010). *Office building design conception guidelines*. 18th CIB World Building Congress.
- Marvi, M. T. (2020). A review of flood damage analysis for a building structure and contents. *Natural Hazards*, 102, 967–995. <https://doi.org/10.1007/s11069-020-03941-w>
- Mohammed, N., Rodger, E., & Mohd Nordin, R. (2019). Reducing flooding impacts to the built environment: A literature review. *MATEC Web of Conferences*.
- National Institute of Building Science. (2018). *NIBS 2018 annual report*. National Institute of Building Science.

- Othman, M., Ahmad, M. N., Suliman, A., Arshad, N. H., & Maidin, S. S. (2014). COBIT principles to govern flood management. *International Journal of Disaster Risk Reduction*, 9, 212–223.
- Proverbs, D., & Lamond, J. (2017). Flood resilient construction and adaptation of buildings. In *Oxford research encyclopaedia of natural hazard science*. <https://oxfordre.com/naturalhazardscience/view/10.1093/acrefore/9780199389407.001.0001/acrefore-9780199389407-c-111>
- Salleh, N. A., Mustaffa, C. S., & Ariffin, M. T. (2013). Proposing instrument to measure impression management among flood victims. *International Journal of Social Science and Humanity*, 3(6), 538–542.
- Sipon, S., Sakdan, M. F., Mustaffa, C. S., Marzuki, N. A., Khalid, M. S., Ariffin, M. T., Nazli, N., & Abdullah, S. (2015). Spirituality among flood victims: A comparison between two states. *Procedia - Social and Behavioral Sciences*, 185(1), 357–360.
- Tan, M. L., Ibrahim, A. L., Duan, Z., Cracknell, A. P., & Chaplot, V. (2015). Evaluation of six high-resolution satellite and ground-based precipitation products over Malaysia. *Remote Sensing*, 7, 1504–1528.
- Tavanaie Marvi, M. (2020). A review of flood damage analysis for a building structure and contents. *Natural Hazards*, 102.
- UN International Strategy for Disaster Reduction. (2009). *UNISDR terminology on DRR*. United Nations.
- Yamin, E. A. (2021). Batu Pahat dilanda banjir kilat. *BHOnline*. https://www.bharian.com.my/berita/wilayah/2021/04/803821/batu-pahat-dilanda-banjir-kilat#google_vignette

Received: 7th May 2025. Accepted: 1st October 2025