ADOPTION OF INDUSTRIALISED BUILDING SYSTEM (IBS) IN BUILDING PROJECTS BASED ON DISASTER RISK MANAGEMENT CYCLE

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By

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ABSTRAK

Sistem Bangunan Industri (SBI) telah diperkenalkan dalam industri pembinaan seawal tahun 1960-an. Ia merupakan istilah yang digunakan untuk menerangkan tentang kaedah pembinaan yang menghasilkan komponen bangunan dikilang, diangkut dan dipasang ke dalam struktur menggunakan mesin dan peralatan yang sesuai tanpa memerlukan bilangan pekerja yang maksimum di tapak. Secara amnya, kitaran hayat projek ini bermula dari titik permulaan pembuatan sehingga saat ia berjaya dihantar ke tapak. Secara harfiahnya, fasa atau peringkat yang digunapakai dalam projek pembinaan adalah memulakan, merancang, melaksanakan, memantau dan mengawal serta peringkat penutup. Dalam konteks ini, pengunaan kitaran hayat projek amatlah sesuai dengan tujuan sebenar kerana kajian ini mengunapakai kitaran pengurusan risiko bencana untuk mengetahui penggunaan Sistem Bangunan Industri (SBI) dapat diterima pakai ataupun tidak berdasarkan kitaran risiko pengurusan bencana yang terdiri daripada pencegahan, kesediaan, tindakbalas atau maklumbalas dan pemulihan. Selain itu, konsep pembinaan menggunakan SBI adalah bertujuan untuk menunjukkan bahawa ia merupakan kaedah yang melahirkan produktiviti dan kualiti terhadap aspek kemampanan yang menyumbang kepada penggunaan industri pembinaan. Walaubagaimapun, penerimaan penggunaan SBI di Malaysia masih belum diterima pakai sepenuhnya kerana kurang adanya pengetahuan secara mendalam berkaitan dengan SBI. Jadi, diharapkan penyelidikan ini dapat memberi pendapat kepada pihak berkepentingan pembinaan untuk menyedari bahawa penggunaan SBI dapat memberikan pelbagai manfaat dan dapat digunakan sebagai rujukan masa depan untuk kajian perbandingan.

ABSTRACT

The Industrial Building System (IBS) was introduced in the construction industry early in the 1960s. It is a term used to describe a construction method that produced building components manufactured in a factory, transported and assembled into a structure using appropriate machinery and equipment without requiring a maximum number of workers on site. Generally, the project life cycle starts from the starting point of manufacture until the moment it is successfully delivered to the site. The phases or stages used in a construction project are initiating, planning, executing, monitoring and controlling as well as the closing stages. In this context, the use of the project life cycle is very appropriate to the real purpose because this research is used the disaster risk management cycle to find out whether adoption of Industrial Building System (IBS) can be adopted or not based on the disaster risk management cycle consisting of prevention, preparedness, response and recovery. In addition, the concept of construction using IBS is intended to show that it is a method that produces productivity and quality in the aspects of sustainability that contribute to the use of the construction industry. However, the acceptance of adoption of IBS in Malaysia has not been fully adopted due to the lack of in-depth knowledge related to IBS. So, it is hoped that this research can provide opinions to construction stakeholders to realize that adoption of IBS can provide various benefits and can be used as a future reference for comparative studies.

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LIST OF ABBREVIATIONS

IBS	Industrialised Building System
SBI	Sistem Bangunan Industri
RII	Relative Importance Index

CHAPTER 1

INTRODUCTION

1.1 Overview

Industrialised Building System (IBS) is a building construction method which is known as prefabrication, precast, standardization, modern method construction etc. where it involves production from a component manufacturing plant off-site which is properly assembled and joined on-site to form the final units (Luo et al., 2017). IBS refers to a technique of construction whereby building components are manufactured in a controlled environment, either on-site or off-site, and then installed or erected into construction (CIDB, 2022). As an innovative method of construction, the adoption of IBS in construction projects offer a range of potential benefits to the construction industry as a whole in terms of project performance and productivity. Quality control and precision for instance can be sustained at a high level in prefabrication components (Yao et al., 2021). This is due to the condition or nature of IBS components that are manufactured in factories with controlled environment using advanced technologies.

Therefore, IBS appears to be an advantage solution to tackle major causes of waste during both design and construction stages (Seman et al., 2013). IBS also can be adopted in relation to disaster risks considerations based on various benefits that it offers (Bari et al., 2018). The compelling benefits of standardization in prefabricated components includes shortened time for actual site installation, higher level of quality assurance and safety and fewer backorders (Lu et al., 2018). This research represents a perspective to discover the adoption of IBS technology to determine its implementation in building projects for disaster management.

1.2 Background of the Study

IBS adoption has been identified as a solution to promote sustainable construction. For instance, the use of IBS is more productive because it has sustainability features that benefit the user compared to conventional methods where there are factors that lead to the improvements of non-engineered building by adopting IBS which complies with established standards (Musa et al., 2016). IBS is already known in the Malaysian construction industry, but its usage is still very low compared to conventional methods (Nawi et al., 2017). Therefore, the main purpose of this research is to obtain empirical data on the adoption of IBS for building construction based on disaster risk management.

According to Auwal et al. (2022), IBS is a solution for a speedy recovery of building and construction projects. The introduction of IBS as a new construction method to be used in post-disaster building reconstruction is considered as an optimistic choice (Hou et al., 2020). Thus, it is vital to adopt and develop IBS as an innovative constructive method for post-disaster reconstruction (Waheeb and Andersen, 2022). Moreover, increased adoption of IBS is one of the rapid encouragement efforts made by the Malaysian government to enhance the productivity and performance of the construction industry. Benefits of IBS in construction has been well-documented such as improved quality of workmanship and material precision, but despite various high-profile projects that use IBS components, the uptake of IBS adoption in the Malaysian construction industry has been slower than expected (Akmam Syed Zakaria et al., 2018).

In Malaysia, there are various disaster occurrences that often occur every year such as floods, storms, landslides, and fires. Based on the annual report statistics released by NADMA in 2018, there were 110 disaster incidents that occurred and 2018 has the highest number of disasters compared to the previous year. Table 1.1 below shows the statistics of NADMA's annual report for disasters types in Malaysia.

Table 1.1: Comparison of Disaster Incidents in Malaysia 2015-2018 (Annual Report Statistic of NADMA MALAYSIA, 2018)

Year	**Type of disaster/Number of cases**				
	Flood	**Storms**	**Landslide**	**Fires**	**Earthquakes**
2015	46	4	11	1	1
2016	95	3	4	6	-
2017	81	2	2	1	-
2018	66	26	3	9	6

According to the disaster cases above, flood is an annual event that occurs on a yearly basis in Malaysia. Therefore, almost every year there will be damaged buildings and houses that caused by flood disasters. In this case, it is discovered that there are many situations where some houses or buildings were washed away by flood water and collapsed due to these buildings were constructed by not following the standard requirements of building construction (Gautam and Chaulagain, 2016). According to Usman Kaoje et al. (2021), IBS can be an innovative solution to building construction with the anticipation of disaster occurrences. Moreover, with the existence of a disaster risk management cycle, all risk conditions and impacts that occur due to disasters can be resolved in relation to building construction.

Generally, disaster risk management is a reactive strategy post-disaster, however a resilient-built environment can ensure that the built assets abilities are maximised and it will be a more robust version from its original (Malalgoda, 2015). Thus, a more holistic shift of disaster resilience is essential where greater pro-active and preparedness are required rather than just traditional reactive strategies in relation to building projects. One of the ways to ensure built environment resilience is through structural mitigation. As explained by Bosher (2014), structural mitigation is the strengthening of buildings and infrastructure exposed to hazards via building codes, engineering design and construction practices.

The design criteria are vital for any project and are considered as the back bone for any construction projects and the design for each structural component will determine the strength of an infrastructure (Iacovidou and Purnell, 2016). For example, appropriate selection of materials, the configuration and capacity of, such a frame is vital for the short- and long-term performance of a building. Even in the construction industry, stakeholders are trying to exercise quality testing in order to develop strategies that create passionate attachments to a particular building design (Arashpour et al., 2015).

It is well known that most high value construction projects prefer to use IBS products because it produces higher quality of components through its careful selection of materials, use of advanced technologies and strict quality assurance (Zakaria, 2020). Accordingly, (Garay et al. 2017) discovered that designers often consider precast concrete to provide a low-maintenance, durable and high-performance solution as requirements for thermal performance, air leakage and rain penetration control in modern buildings.

Precast concrete wall systems are acknowledged to provide increased security during disasters as they provide protection from projectiles (wind borne, thrown, shot, explosion) and require little repair after the disaster (Knyziak, 2019). It is also discovered that IBS quality is also influenced by the technical innovations of IBS technology in terms of standardisation, durability and method, particularly of IBS components (Luo et al., 2015). Therefore, the adoption of IBS specifically modular construction approach can be explored further for the development of building and construction with the consideration or anticipation of disaster risks (Ghannad et al., 2020).

1.3 Problem Statement

Although Malaysia is not a disaster-prone country in terms of earthquakes and tropical cyclones, it is still exposed to other kinds of disasters such as floods, landslides, and wind (Taib et al., 2016). There is an increasing trend that disasters are caused by natural hazards and becoming more frequent and more severe (Kelman, 2020). IBS technology adoption can also be influenced by cost factors, but client-related elements other than prices such as timing and quality assurance are becoming increasingly significant (Rumane, 2016).

The acceptance of the IBS system for building construction with the consideration of disaster risks is still uncertain, thus requiring further research in this area. The consideration of disaster risks in the adoption of IBS which offers a fast or speed system of the construction process in order to provide or restore housing needs is important as the risk of natural disasters increases around the world (Demirkesen, 2020). Therefore, the construction industry should introduce the IBS to be applied for building construction to manage disaster risks and to overcome the difficulties of conventional or traditional construction which involve high wattage, low quality of the products, and project delays (Ghannad et al., 2020). These difficulties may be caused by environmental factors such as climate factors such as rains and windy which cause the delay of construction work.

In order to handle the negative impact of disasters related to construction activities and building projects, this research intends to identify construction problems related to disasters occurrences in building projects. As IBS is becoming an important and innovative construction technology in Malaysia, based on its advantages and benefits, IBS should be expanded and diversified into the area of disaster management. Moreover, from the observation of IBS adoption, there are many positive impacts in terms of quality and sustainability to conduct this study because the implementation of IBS technology will lead to positive environmental, economic and social impacts on building construction practices.

1.4 Aim and Objectives

This study aims to determine the adoption of industrial building systems in building projects based on the disaster risk management cycle which consists of prevention, preparedness, response, and recovery. Specifically, the research objectives are as follows:

i) To identify the productivity and quality-related factors that contribute towards IBS adoption with the consideration of disaster risks in building projects.

ii) To examine the sustainability aspects of Industrialised Building System (IBS) adoption that influence building projects in relation to disaster risks.

iii) To evaluate Industrialised Building System (IBS) adoption in building projects based on the Disaster Risk Management Cycle.

1.5 Research Question

Based on the above research objective, this research attempts to answer the following research question:

- How the adoption of Industrialised Building System (IBS) in building projects can be implemented based on disaster risk management cycle?

1.6 Scope and Limitation

The scope area of this research is focusing on the adoption of IBS technology in building projects based on the disaster risk management cycle. The study is limited to the perception of a sample of local respondents who are stakeholders in the construction industry. This group of respondents vary from professionals amongst construction industry members who are involved or work with IBS technology and building projects.

The choice of respondents involved in this research were limited to the construction stakeholders only. Then, by selecting the target respondent, a combination of extensive literature reviews and quantitative research will help to obtain reliable answers for the research question. In this study, a questionnaire survey was performed to the respondents within the research area in Malaysia. Data collected from the survey was analysed, interpreted and discussed as part of the findings of the study.

1.7 The Importance and Benefits of Project

This research was conducted to determine the appropriateness of whether the industrial building system (IBS) can be effectively adopted in the area of disaster management based on the disaster risk management cycle by utilising the advantages of IBS in terms of productivity, sustainability and quality aspects in building projects.

Specifically, the significance of this research is based on the characteristics of IBS technology that can be used to overcome disaster risks and their related issues while accelerating the adoption of IBS to achieve:

i) A clearer understanding of the adoption of IBS in terms of its contributions in managing disaster for building project developments.
ii) A better project development of sustainability aspect through IBS adoption in terms of economy, environment and society benefits with the anticipation and consideration of disaster risks.
iii) An evaluation tool to determine the distinctive features of IBS adoption that are dominant to be implemented throughput the disaster risk management cycle.

Consequently, this study also fills the research gap in Malaysia for IBS adoption in the area of disaster management. Through the quantitative data collection method, the ranking of sustainability aspects related to IBS adoption throughout the disaster risk management cycle can assist in the development of sustainable infrastructure in Malaysia.

1.8 Dissertation Outline

This dissertation consists five main chapters that explain in detail about the research project that been conducted. Chapter 1 describes the introduction to the overall research, background of the study, problem statement, aim and objective as well as scope and limitation. Chapter 2 is related to the literature review where descriptions from previous studies are used to examine the benefits of using IBS in the construction industry in Malaysia and current studies can be applied related to natural disasters that occur to apply the adoption of IBS based on disaster risk management cycle. Chapter 3 presents the methodology in all the relevant materials and flows in this research. Furthermore, this chapter will provide procedures to collect data and obtain on analyse data. Chapter 4 explain in details about results and discussion of the objective research. Chapter 5 conclude the research and recommendations to implement this research to the construction industry. Finally, reference and appendix are included at the last part of the dissertation.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of Industrialized Building System (IBS)

Adoption of Industrialized Building System (IBS) technology brings various benefits to the implementation phase of construction project, by exploiting the advantages of the manufacturing process (Hong et al., 2018), including improved control of the building project (Lessing et al., 2015; Tam et al., 2015) and improved quality (Akmam Syed Zakaria and Amtered El-Abidi, 2021). IBS technology is adopted to achieve the goal of achieving greater productivity and better performance of building projects in the construction sector as an innovative technique of construction. It also has several advantages, including the reduction of project duration, reducing the reliance on a large number of laborers particularly the dependency on foreign labours, and reducing construction waste which lead to cleaner construction sites. Even though various building projects in Malaysia have shown the advantages of adopting IBS in building and construction projects, the adoption and acceptance level of IBS in Malaysia is still considered as very low (El-Abidi et al., 2019)

Moreover, IBS is currently regarded as a very methodical and appropriate technology to be adopted to improve the building industry's existing performance. Adopting IBS technology is the common choice of building method in various building-project contexts such as fast-track projects, changeable weather conditions, and congested sites, particularly in the Malaysian environment (Zakaria, Majid and Nazri, 2017). In the context of construction projects, IBS technology adoption is accepted as an alternative to traditional building methods (Zairul, 2021).

2.2 IBS Development in Malaysia

In the early 1960s, IBS was first introduced in Malaysia when the Public Works Department (PWD) and the Ministry of Housing and Local Government (MHLG) of Malaysia visited numerous European nations to evaluate their housing building development programs. IBS technology was implemented in Malaysia in 1964 when the government started its first IBS project, Pekeliling Flats in Kuala Lumpur and Taman Tun Sardon, Gelugor, Penang in 1965 to speed up delivery times and construct inexpensive and high-quality housing as stipulated under the 2nd Malayan Plan 1960-1965 and the 1st Malaysian Plan 1966–1970. Figure 2.1 below shows the evolution of IBS implementation in the Malaysian construction industry from the year 1960 to 2015.

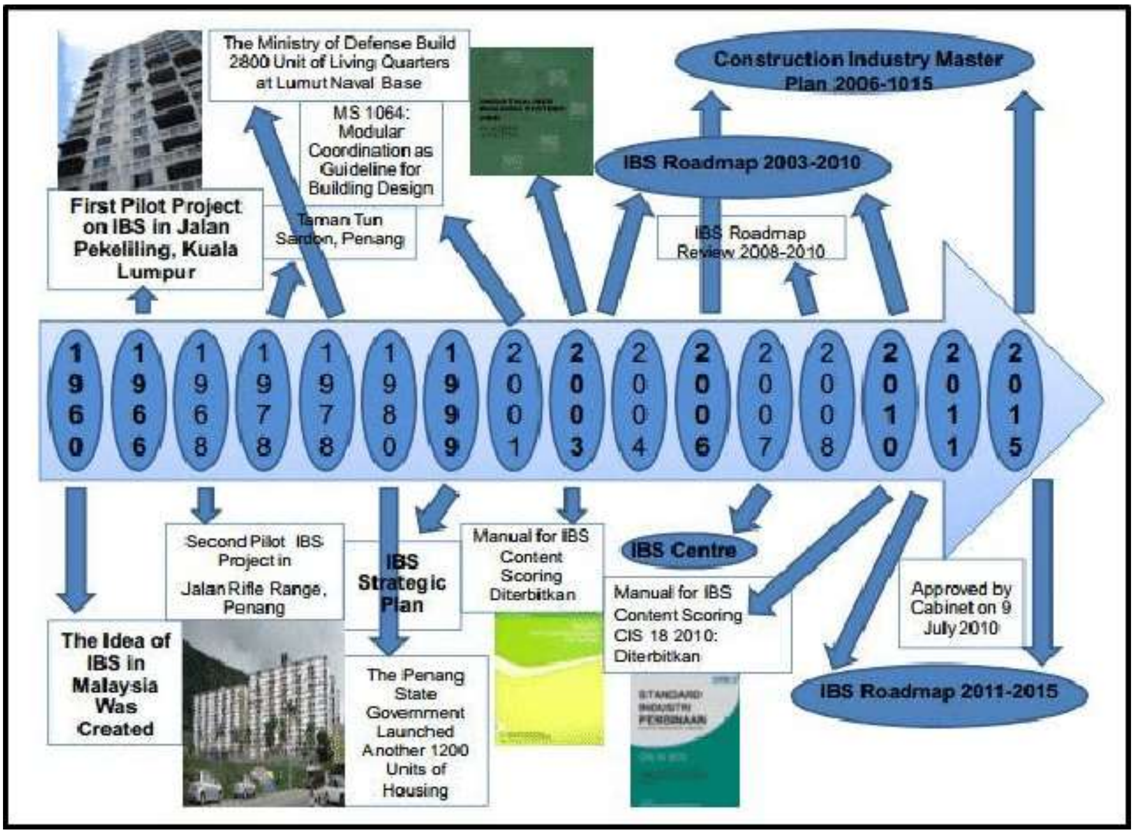

Figure 2.1: IBS Development in Malaysia (Abedi et al., 2011)

Nevertheless, the construction industry in Malaysia has begun to accept the method of IBS to achieve better construction quality and productivity, reduce risks to safety and health, construction site cleanliness, reduce the issue of skilled workers, and achieve the ultimate goal of reducing costs for the whole construction. Therefore, with the development of IBS technology, the Malaysian government has been mandating all public projects to attain no less than 70% of IBS component to build up momentum and establish demand for IBS technology adoption, thus bringing the cost down (Kamar et al., 2012). According to the building system classification by CIDB, the six main groups of IBS that are used in the Malaysian construction industry are as shown in Table 2.1.

Table 2.1: Classification of IBS component Malaysia (Adapted from CIDB, 2003 & 2011)

Classification	**Types**
Precast Concrete Framing, Panel and Box Systems	Precast concrete columns, beams, slabs, walls, “3-D” components, lightweight precast concrete and permanent concrete formworks
Steel Formwork System	Tunnel forms, tilt-up systems, beams and columns moulding forms and permanent steel formworks (metal decks)
Steel Framing Systems	Lights steel trusses (cold-formed channels) and steel portal frame systems

Prefabricated Timber Framing System	Timber building frames and timber roof trusses
Blockwork Systems	Interlocking concrete masonry units (CMU) and lightweight concrete blocks
Innovative product systems	Solid drywall system and sandwich panel system

2.3 Benefits of IBS Adoption

Industrialised Building System (IBS) is described as a construction method whose parts are produced in a controlled environment setting (on or off-site) (CIDB, 2022). They are moved, placed, and assembled into a structure all at once without requiring a lot of additional site labour. Prefabrication, offshore production, mass production, standardised components, and design employing modular coordination are the five standard characteristics of IBS (Alawag et al., 2021). The qualities and distinctive features of IBS technology have the potential to improve the building's sustainability performance. However, coping with IBS technology adoption in building projects requires careful planning and tactics to avoid additional unnecessary costs, unpleasant community disruptions, and degradation of the environment's performance. Therefore, environmental, economic, social, and institutional requirements should all be met for sustainable development to take place (Fernando et al, 2019).

IBS may be viewed as an alternative strategy in the construction industry for preserving sustainability in buildings projects as it can improve cost and human resource management, speed up construction, raise building quality, and improve workplace health and safety (Kamaruddi et al., 2018). Additionally, IBS is the foundation for the best way to reduce construction waste. Considering these benefits, IBS can therefore be considered as one of the best approaches to support sustainable building initiatives compare with conventional buildings (Luo et al., 2015).

Accordingly, IBS adoption can be implemented to promote sustainable development and to increase the performance of construction projects in the built environment. The benefits of IBS technology adoption are not limited to projects in remote areas, as many domestic projects located near major populations are being constructed, with significant cost- and time savings (Ismail et al., 2018). The features of IBS benefits are based on the economic, social, environmental, and institutional sustainability performance criteria as listed in Table 2.2.

Table 2.2: Benefits of Industrialised Building System

Environment	Economic	Social
Optimum material usage	Reduce overall cost of construction work	Reduced risk related to occupational
Increase site safety and neatness	Shorter construction time	Reducing unskilled labour
Lower weather impact to construction progress	Better finished product quality	Easy and speedy installation
Pollution control	Reduced manpower cost	Less relied on labour
Factory controlled environment	Quality and productivity of construction	Minimize rework

2.3.1 Environmental Benefits

The ability to move construction processes from the site to a much better-controlled factory environment is one of the key environmental advantages of IBS (Wong and Lau, 2015). Accordingly, one of the inherent characteristics of traditional on-site work is the intense activities that constantly interrupt its surroundings through noise, air pollution, a disordered environment, and traffic chaos. It is also discovered that IBS produced less waste than conventional method (Muhaidin and Chan, 2018). In addition, (Saleh and Alalouch, 2020) discovered that the key important legislations relating to, not only public health and safety in the usage of IBS components, but also to quality and productivity, workplace safety and environmental sustainability.

Materials are one of the important factors that contribute to the performance for the structures of building projects. According to Mohammad et al. (2016), the usage of IBS in building construction can results in overall reduction of material usage. This can be observed in the adoption of prefabrication and interlocking block systems where structural framing can be eliminated and this can reduce construction material usage such as cement, sand, steel and timber (Bari et al., 2018).

2.3.2 Economic Benefits

Quality, speed of construction, and cost reductions are the three key economic advantages of IBS (Yunus et al., 2016). Costs associated with maintenance and operation can be decreased due to the IBS's high-quality features and with the adoption of IBS, labour and material costs have also decreased dramatically (Ismail et al., 2016). Accordingly, IBS technology adoption offers a healthy profit margin rather than an overall cost reduction from the perspective of individual costs (Shamsuddin et al., 2018).

IBS adoption in building projects demonstrated that it is possible to save labour costs on-site and overall construction time (Amin et al., 2017). Adopting IBS in a building can save time since it standardises the manufacturing process, which reduces lead time, enhances quality control, and uses less material (Bari et al., 2018). If all construction stakeholders are aware and have a better grasp on how IBS might improve sustainability aspects, IBS can be used as a construction method that promotes sustainability practices in the construction industry with a wide range of economic benefits.

2.3.3 Social Benefits

By enhancing human lives and providing skill development, IBS adoption has its ability to contribute to social aspects. Abd Rashid et al. (2019) stated that IBS adoption is a strategy for reducing the frequency of transportation and on-site labour during the construction phase. It is clear that adopting IBS as a sustainable construction method is beneficial in terms of labour aspects especially in Malaysia where the construction industry is obliged to import a large number of inexperienced foreign employees due to a labour shortage, which may unfortunately lead to issues like incompetence, delays in the completion of the projects other social issues (Akmam Syed Zakaria and Amtered El-Abidi, 2021). Therefore, based on the advantages of IBS benefits from Table 2.2, it is reasonable to claim that IBS adoption in terms of social aspects is one of the key techniques to resolve the majority of issues in building projects, thus contributing towards the advancement of sustainable development in the construction industry.

2.4 Overview of Disaster Incidents in Malaysia

Environmental problems can be regarded as universal issues. Meanwhile, natural disasters are threats to the physical environment that is primarily brought on by human activity, such as the overuse of natural resources and unsustainable development that causes illness and the death of living things (Singh and Singh, 2017). Technical accidents, human error, mechanical or technological failure, or carelessness can all lead to environmental disasters. However, the main cause of the disaster was human meddling in the environment (Ali et al, 2020). Thus, the combination of the environment, social structure, and human behaviour result in long-lasting environmental changes like deforestation, soil erosion, and drought.

In general, environmental disaster frequency and severity have increased in Malaysia (Chan et al., 2015). Environmental disasters that have affected this country include landslides, floods, and tsunamis. According to Du et al. (2016), the unpredictable nature and intensity of a calamity like a tsunami have made the preparation and defence of disaster occurrences very challenging. These disasters occurrences have increased rapidly due to human activities which have also affected our physical environment.

In addition, Malaysia is a country that experiencing equatorial climate change where it is hot and humid throughout the year. In fact, Malaysia receives heavy rainfall with an average of 2400 mm per year (Hashim et al., 2016). Therefore, when unpredictable weather changes are combined with human activities with less control mechanism, it leads to a high tendency or risks of natural disasters such as floods and landslides.

2.4.1 Type of Disaster in Malaysia

Generally, disasters can typically be divided into three categories which are natural disasters, man-made disasters, and subsequent disasters (Zheng et al., 2021). Natural disasters are catastrophic occurrences brought on by uncontrollable natural forces such as floods, landslides, mudslides, earthquakes, and others. In contrast, man-made disasters can be divided into four categories which are technology disasters, transportation accidents, failures in public spaces, and production failures. The subsequent tragedy, which included displaced individuals and haze, was caused by a man-made disaster. Malaysia's population and economic resources are becoming more concentrated in disaster-prone locations, as seen by the rise in human mortality and economic losses brought on by natural disasters in recent years.

Malaysia is a country that frequently experiences flooding and it is the most common natural disaster that occurs in Malaysia. The most severe natural calamity that ever hit Malaysia, including Sabah and Sarawak, is flood. Nearly 4.82 million people, or about 22% of the nation's population, live in the estimated 29,800 km2 of the entire area of Malaysia that is vulnerable to a flood disaster (Taib et al., 2016). Floods happen when water overflows from riverbanks to the nearby plain area. This overflow typically occurs when heavy rain falls continuously for several days in some places. In this scenario, water will overflow into generally dry places, perhaps causing floods. Water flows will cause property damage during the flood season.

Besides, Malaysia also has landslides other than floods. All around Malaysia, landslides have caused a number of concerns. Landslides were caused in part by farming practices such as careless clearing of soil and persistent downpours. These landslides may occur close to commercial and residential areas and may destroy or damage infrastructure which are schools, hospitals, clinics, police stations and etc.

2.5 Overview of Disaster Risk Management Cycle

Disaster management aims to minimize or eliminate possible losses from risks, provide immediate and appropriate assistance to disaster victims, and ensure a quick and effective recovery. The disaster management cycle illustrates the continual process by which governments, businesses, and civil society plan for and mitigate the effects of disasters, respond during and immediately after a disaster, and recover after a disaster. In the next cycle iteration, appropriate actions at all points in the cycle result in enhanced preparedness, better warnings, reduced susceptibility, or disaster prevention. The entire disaster management cycle entails the creation of public policies and initiatives that either mitigate disaster consequences on people, property, and infrastructure or modify disaster causes.

As disaster management is strengthened in advance of a disaster, the mitigation and readiness phases take place. Concerns about development are crucial in assisting a community in preparing for and responding to a disaster. Disaster management actors, particularly humanitarian groups, become involved in the immediate response and long-term recovery phases as soon as a disaster happens. The four phases of crisis management depicted above are not always, or even typically, followed in this order. Depending on the severity of the disaster, the length of each step of the cycle varies significantly.

Other than that, all components of the disaster management cycle are influenced by developmental considerations. One of the primary goals of disaster management, as well as one of its greatest linkages with development, is the promotion of sustainable livelihoods, as well as their preservation and recovery during disasters and emergencies. When this goal is achieved, people have a greater capacity to deal with disasters, and recovery is more rapid and long-lasting. Reducing hazards, preventing disasters, and preparing for emergencies are the goals of a development-oriented disaster management method. As a result, developmental challenges are significant in the prevention and readiness phases of the disaster management cycle. Inadequate development methods might raise disaster susceptibility and leave you unprepared for an emergency.

2.5.1 Components of Disaster Risk Management Cycle

Figure 2.1 below shows the disaster risk management cycle, which is divided into four stages likes prevention, preparedness, response, and recovery. Efforts are done in the "Prevention" phase to prevent or mitigate damage, such as the construction of flood dikes and dams. "Preparedness" refers to activities and procedures that ensure an effective reaction to the impact of risks, such as emergency drills and public awareness, but are not intended to prevent disasters from occurring. Rescue efforts, first assistance, firefighting, and evacuation are all examples of "response." All activities in the "Recovery" phase should be based on disaster risk reduction factors.

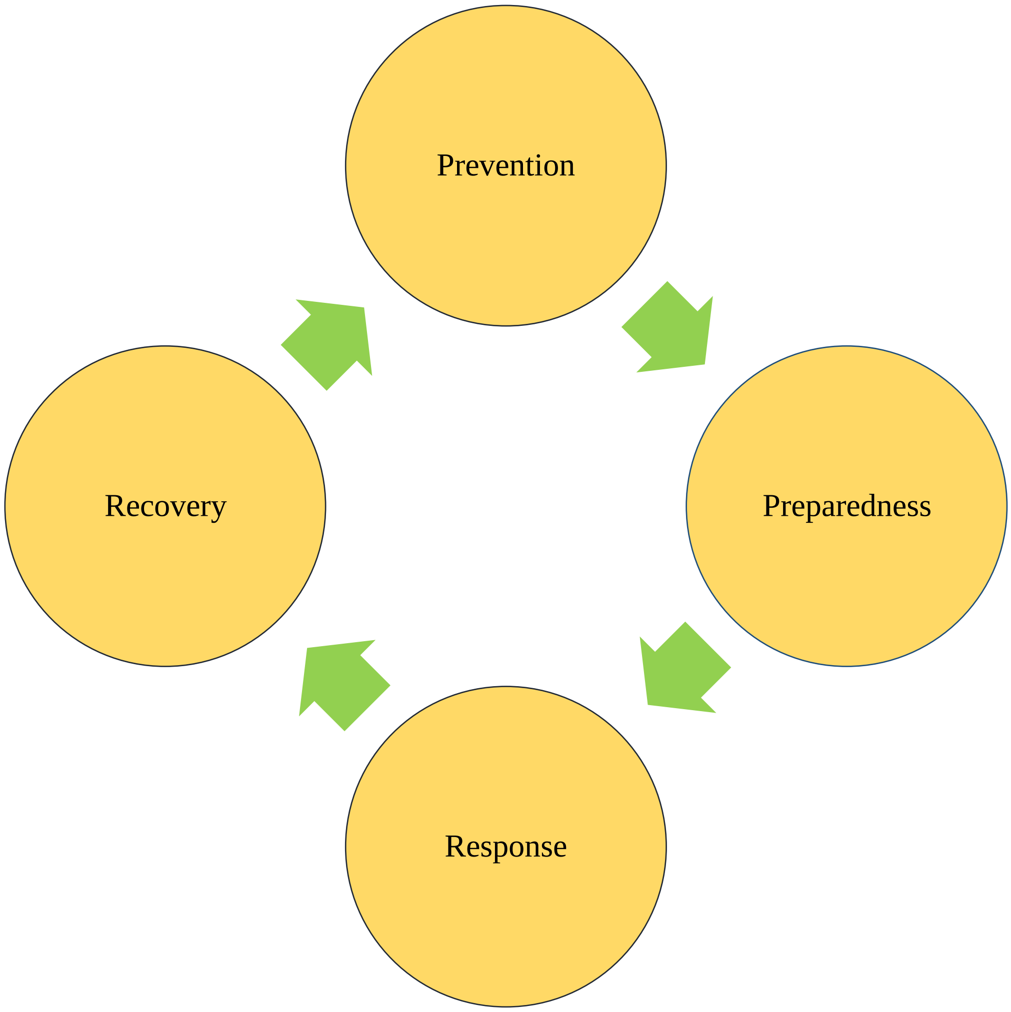

Figure 2.2: Disaster Risk Management Cycle

Figure 2.2 shows the examples of measurements taken in each step for the type of disaster. The overall disaster risk can be reduced by taking appropriate steps based on the disaster risk management concept in each phase of the disaster risk management cycle.

Table 2.3: Examples of measurements taken in each step for the type of disaster

Phase	Details
Prevention	• Tying down homes or barns with ground anchors to withstand wind damage. • Dig water channels to redirect water and plant vegetation to absorb water. • Constructing levees or permanent barriers to control flooding. • Buying insurance policies.
Preparedness	• Developing disaster preparedness plans for what to do, where to go, or who to call for help in a disaster. • Exercising plans through drills, tabletop exercises, and full-scale exercises. • Creating a supply list of items that are useful in a disaster.
Response	• Implementing disaster response plans. • Conducting search and rescue missions. • Taking actions to protect yourself, your family, your animals, and others. • Addressing public perceptions about food safety.
Recovery	• Preventing or reducing stress-related illnesses and excessive financial burdens. • Rebuilding damaged structures based on advanced knowledge obtained from the preceding disaster. • Reducing vulnerability to future disasters.

2.5.2 Benefits of Disaster Risk Management Cycle

All phases of the disaster management cycle take developmental factors into account. The promotion of sustainable livelihoods and their preservation and recovery during emergencies and disasters is one of the key objectives of disaster management and one of its strongest ties with development. Where this objective is met, people are better equipped to deal with calamities, and their recovery is faster and more sustained. The goals of a development-oriented approach to disaster management are to lessen risks, avert catastrophes, and get ready for emergencies. As a result, the disaster management cycle's mitigation and readiness phases heavily weigh developmental factors. A lack of readiness for emergencies and greater vulnerability to disasters can result from improper development practices.

In this context, the benefits or advantages that can be attributed when disaster risk management is carried out or practised are as follows:

i) Can minimize a disaster's impact
ii) Have better planning in response when a disaster occurs
iii) Reduce the hazard created by a disaster
iv) Restoring normalcy to the community

2.6 IBS Adoption of Building Projects and Disaster Risk

The consideration of disaster risks in the adoption of IBS which offers a fast or speed system of the construction process to provide or restore housing needs is important as the risk of natural disasters increases around the world (Demirkesen, 2020). In this term, building construction using IBS technology has proven to be a quick construction technique, especially in a foreign country. IBS is one of the developments in building technologies that have had a significant impact on project performance in terms of speed, time, and quality (Cennamo et al., 2012). IBS technology can be a dependable construction technology that also serves as a means of achieving improved levels of productivity and quality when sustainability considerations are taken into account during implementation. The environment, economy, technology, and society are the four sustainability variables that are related to IBS. Every element offers benefits that encourage the use of IBS technology. Building technologies, like the adoption of IBS technology, are becoming the focus of project development, where sustainable issues are seen as universal concerns.

Furthermore, IBS emphasized standardization which is a crucial component in the process of planning and overseeing construction projects (Shukor et al., 2011). So, the adoption of IBS for disaster management has been impacted by these standardisation concerns regarding quality tests. Implementing standardisation of IBS technology requirements and incorporating this role as a component of its policy on IBS technology adoption in building-project settings are two effective ways to prevent conflicts between organisations in the construction industry.

IBS adoption with new building concepts, materials, manufacturing process and construction techniques would mean that every building project could be different in terms of disaster resilience, with the entities of building projects effectively able to design and construct a customised building project. During the testing process of building components, project members are concerned with new materials and innovation to improve project efficiency.