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Exploring awareness and application of disaster risk management cycle (DRMC) from stakeholder's perspective

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Abstract

Purpose – The disaster risk management cycle (DRMC) is a part of the important efforts designed to handle disaster risk. DRMC contains the following four phases: response, recovery, mitigation and preparedness. This paper aims to determine the awareness of stakeholder on DRMC and to explore the application of DRMC from stakeholder's perspective.

Design/methodology/approach – Disaster is an extreme event that causes heavy loss of life, properties and livelihood. Every year, Malaysia has been affected by disasters, whether natural or manmade. DRM is the management of resources and the responsibility for dealing with all aspects of an emergency. An effective DRM requires a combination of knowledge and skills. Questionnaires were distributed to the construction industry players and flood victims.

Findings – Results obtained on the basis of the survey revealed that a majority of respondents are unaware of DRMC. In addition, combination of professional and non-professional respondent's perspectives in each phase of DRMC and effects of disaster are presented by the hierarchy.

Originality/value – The study of DRMC is commonly about the explanation or comparison of the concept but infrequently in the application of the DRMC. This study will fill the gap between theory and application of DRMC. The study aimed to determine whether the construction industry player and community aware of DRMC and to explore DRMC of flood event from perspective of industry players and flood victims. From this comparison, the management can create a better cycle of disaster management to handle various type disaster and to anticipate disaster risks.

Keywords Risk management, Disaster response, Construction management, Disaster mitigation, Disaster prevention, Disaster Risk Management Cycle

Paper type Research paper

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Introduction

Disaster is a serious disruption of the functioning of a community or a society (Kelman and Gaillard, 2010). The United Nations indicates that disasters involve widespread human, material, economic or environmental impacts, which exceed the ability of the affected community or society to cope using its resources. Cumulative evidence revealed that disasters caused by natural hazards are increasingly becoming frequent and severe (Guha-Sapir *et al.*, 2012). The most frequent extreme natural events that occurs in Malaysia is flood (Razi *et al.*, 2010). The government must provide numerous amounts of money almost every year to restore the damage caused by floods (Chan, 2015). Flood is a common natural hazard that prominently damages properties, human lives and the environment. Flooding contributed to approximately 39.26% of worldwide extreme natural events and caused US $397.3bn worth of damage between 2000 and 2014 (Ran and Nedovic-Budic, 2016). Flood commonly occurs through a combination of events (Dawson *et al.*, 2011). For example, rainfall fills rivers, streams and ditches beyond their capacity. Floodwater then overflows riverbanks and flood defences. Rainfall can be so intense that it is unable to soaked into the ground or enter drainage systems. Instead, the water flows overland and down hills and slopes. Properties at the bottom of hills or in low spots may be vulnerable. Floodwater in urban areas may become contaminated with domestic sewage. Moreover, prolonged, heavy rainfall soaks into the ground, which leads to ground saturation. This phenomenon raises groundwater levels, which lead to flooding above the ground. Floodwater may also enter properties through basements or at ground floor level. Groundwater flooding may take weeks or months to dissipate (Jha *et al.*, 2012). Merz *et al.* (2010) revealed that the effects of floods can substantially damage materials, structures and services. At construction sites, floodwater will follow the path with the least resistance to enter a building, particularly through masonry and construction joints and any gaps or voids. Current buildings and traditional construction do not use materials and design details that can withstand long-term immersion in floodwater (Escarameia *et al.*, 2012). Floodwater mostly contains various contaminants, such as silt, sewage and chemical and biological substances. These contaminants can affect the performance of buildings and the health of the construction workers (Taylor *et al.*, 2011). Buildings may also require further cleaning or extended drying times following a flood, thereby leading to increased costs and delays in construction works. Physical health may suffer if floodwater is contaminated or the building is re-occupied before it is effectively dried. Stress caused by the disruption to lifestyle and livelihood during and after a flood is probably one of its main consequences (Few, 2013).

The study of disaster risk management cycle (DRMC) is commonly about the explanation or comparison of the concept (Khan *et al.*, 2008; Coetzee and Van Niekerk, 2012; Sawalha, 2020) but infrequently in the application of the DRMC. This study will fill the gap between theory and application of DRMC. The study aimed to determine whether the construction industry player and community aware of DRMC and to explore DRMC of flood event from perspective of industry players and flood victims.

Disaster management

Kapucu (2012) argued that disaster management is the organisation and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, particularly preparedness, response and recovery, to lessen the impact of disasters (Field, 2012). The management of disasters and flood events is achieved in the form of disaster operations management and emergency planning (Hoyos *et al.*, 2015). Disaster operations represent the set of activities performed before, during and after a sudden, devastating incidence that seriously disturbs the functioning of a population and causes human, material, economic or environmental damages beyond the coping capacity of the affected population using its resources (Powell *et al.*, 2016). Risk management is defined as the process of identifying and assessing risks and applying methods to reduce these risks to an acceptable extent (Haimes, 2015). Project risk management mainly aims to identify, evaluate and control the risk for project success (Serpella *et al.*, 2014). Risk management is important in construction projects to handle and plan how to overcome the disaster risk at sites. However, disaster risk is expressed as the likelihood of loss of life, injury or destruction and damage from a disaster in each period. Therefore, disaster risk is considered to be a combination of the severity and frequency of a hazard, the numbers of people and assets exposed to the hazard and their vulnerability to damage (United Nation Office for Disaster Reduction, 2016).

Resilience is seen as ability of a community to recover by its own resources and capable to response and change after disaster happen (Cutter *et al.*, 2010). Disaster resilience is important to create a better planning to reduce impact in economy, social and environment (Manyena *et al.*, 2011). DRMC is one of the plans to increase resilience for the industry and community to "bounce back" to its pre-disaster conditions or, ideally, "bounce forward" for a better condition. According to Manyena *et al.* (2011), "resilience should be viewed as the ability to "bounce forward" and "move on" following a disaster". This statement show that disaster resilience should be a new plan of reform process to achieve better solution of DRM.

Understanding disaster risk management cycle

Baas *et al.* (2008) indicated that disaster risk reduction (DRR) refers to the conceptual framework of elements considered with the possibilities to minimise vulnerabilities and disaster risks throughout society and avoid (prevention) or limit (mitigation and preparedness) the adverse impacts of hazards within the broad context of sustainable development. Fekete *et al.* (2014) reported that DRM includes but exceeds DRR by adding a management perspective that combines prevention, mitigation and preparedness with a response. Moreover, DRM includes the sum of all activities, measures and programmes that should be taken before, during and after a disaster to avoid such a phenomenon, reduce its impact or recover from its losses (Heazle *et al.*, 2013). The concept of disaster management can generally be defined as the correct set of actions and activities taken during each phase of the disaster, extending between preventing the disaster from happening to overcome its effects (Blaikie *et al.*, 2014). Disaster management has four phases of disaster risk: prevention, preparedness, response and recovery (Vasilescu *et al.*, 2008). These phases will contribute to the existence of the DRMC.

The four phases of DRMC are presented as follows.

(1) Prevention/Mitigation

The term "mitigation" can be included in the term "prevention". Mitigation means reducing the severity of the human and material damage caused by the disaster (Berke *et al.*, 2012). Meanwhile, prevention ensures that human action or natural phenomena do not result in disaster or emergency (Cutter *et al.*, 2008). The mitigation phase occurs during the preparation of disaster management improvements in anticipation of disaster events (Hristidis *et al.*, 2010). This phase aims to prevent hazards from developing into disasters or reduce the effects of disasters. The prevention phase focuses on long-term measures to eliminate or reduce the risk (Keim, 2011). Personal mitigation mainly emphasises knowing and avoiding unnecessary risks.

(2) Preparedness

(2) The development of action plans before a disaster occurs in this phase. Masten and Obradović (2008) indicated that disaster preparedness refers to measures taken to prepare for and reduce the effects of disasters. Simpson (2008) revealed the following common preparedness measures.

- The communication plans with easily understood terminology and chain of command.
- Development and practice of multi-agency coordination and incident command.
- Proper maintenance and training of emergency services.
- Development and exercise of emergency population warning methods combined with emergency shelters and evacuation plans.
- Stockpiling, inventory and maintenance of supplies and equipment.
- Response.
- The response phase of an emergency may commence with a search and rescue phase. Kapucu *et al.* (2009) stated that the response phase includes providing immediate assistance, assessing damage, continuing assistance and immediately restoring infrastructure. This phase will plan the activities and measures taken in advance to ensure an effective response. The response phase also includes the necessary emergency services in disaster areas and contains the mobilisation of necessary emergency services and first responders in the disaster area (Goodchild and Glennon, 2010). This phase may include the first wave of core emergency services, such as firefighters, police and ambulance crews. This wave may be supported by several secondary emergency services, such as specialist rescue teams (Sylves, 2014).

(3) Recovery

Disaster recovery is a reconstruction stage that aims to make improvements from the effects of significant negative events (Aldrich, 2012). This phase presents the actions that must be taken after a disaster to restore infrastructure and services. The recovery phase also aims to restore the affected area into its original state and focuses on issues and decisions that should be made after identifying the immediate needs (Phillips, 2015). Recovery efforts focus on re-employment, rebuilding the destroyed property and repair of the infrastructure.

Application of disaster risk management cycle

DRM aims to determine the underlying factors of risk and prepare for and initiate an immediate response in case of disasters to reduce and handle disaster risks. Mercer *et al.* (2010) revealed that the DRM framework (DRMF), which has been improvised accordingly, is a framework used to simplify the DRMC. The DRMC in this study is illustrated in Figure 1. DRMF actions aim to strengthen the capacity and resilience of households and communities to protect their lives and livelihoods through measures to avoid (prevention) or limit (mitigation) adverse effects of hazards and provide timely and reliable hazard forecasts. Communities and relief agencies focus on saving lives and properties during emergency response. The focus in post-disaster situations is on recovery and rehabilitation, including the concept of “building back better”. This condition implies the initiation of DRR activities during recovery and rehabilitation. Conclusively, a DRMC is used as a foundation and a guideline in managing disaster.

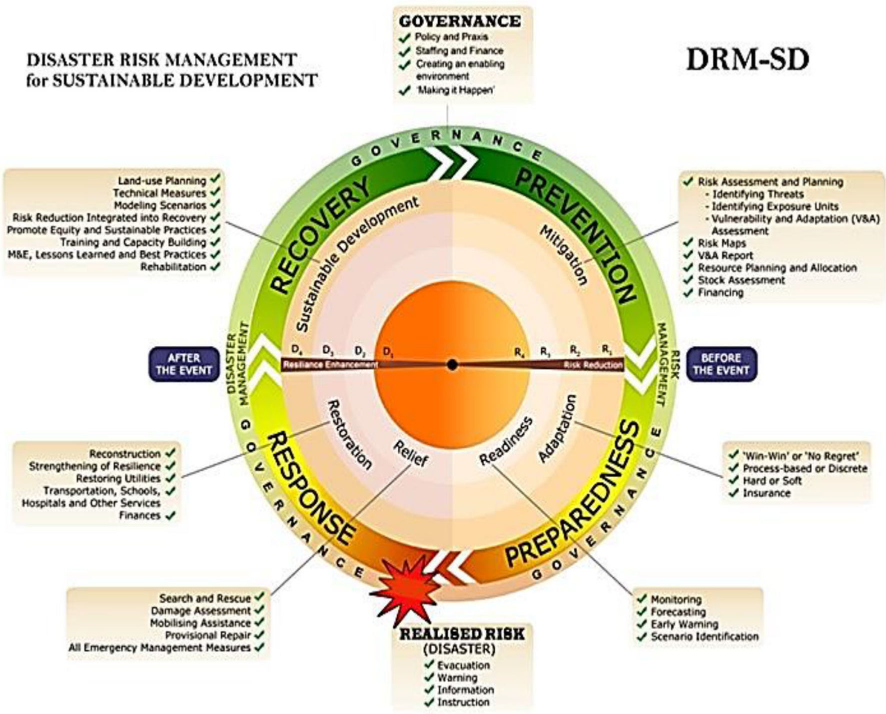

Figure 1.
Disaster risk management framework (DRMF) for sustainable development

Source: Centre for Global Sustainability Studies, Universiti Sains Malaysia

McNeil *et al.* (2015) claimed that systematic risk management has already been widely appreciated and applied in the industrial, engineering and financial sectors. Systematic processes and procedures have been well organised and introduced in risk management to examine risks and make decisions. The innovative application of the generic methodology of the risk management process to disaster management presents a new approach to understanding the nature of disasters, preventing their harmful effects and seeking opportunities from their occurrences. DRM is defined as a series of actions (programmes, projects and/or measures) and measures that specifically aim to reduce disaster risks of endangered regions and mitigate the extent of disasters (Prabhakar *et al.*, 2009). DRM strengthens prevention/mitigation and preparedness in the pre-disaster stage to reduce the frequency of disasters, proposes effective control measures to unavoidable disasters and conducts full preparation to deal with the disasters and reduce the damage.

Research methodology

This research is a quantitative study. Thus, the development of a questionnaire and distribution of questionnaires to the respondent are major steps in implementing the research.

Research methodology framework

The seven phases shown in Figure 2 provide information regarding the methodology framework used in this research. This framework described all steps taken to achieve the research objectives.

The questionnaires were distributed to the stakeholders in the construction industry and the flood victims. The target respondents comprise the main construction players in the construction industry, which include architects, engineers, contractors and construction managers. The questionnaires were distributed through email and by hand to the construction companies. All the chosen construction companies were registered with the board of architect, board of engineer and the Construction Industry and Development Board. Meanwhile, the questionnaires were distributed by hand to the flood victims.

Questionnaire development

A set of questionnaires was developed in this study to obtain data, perform data analysis and interpret the research results. The questions of the survey were based on previous literature reviews to ensure the objectives of the research can be achieved. The items of the questionnaire comprise multiple-choice answers to ease the respondents during the answering process. The questionnaire comprises three major variables with a total of 24 research items to measure risk factors relevant to the four major phases of DRMC, namely preparedness, response, recovery and mitigation.

The survey comprises four sections of questions according to the variables as shown in Table 1. The questions for the first variable focused on the general information of the respondents, such as gender and designation. The second section of the questions pertained to the awareness of the respondent towards the DRMC. The next section covered the importance of different DRM items in DRMC. The DRMC contains the following four phases: preparedness, response, recovery and mitigation. The questions for each of these phases are related to the important aspects of disaster risks as perceived by the respondents

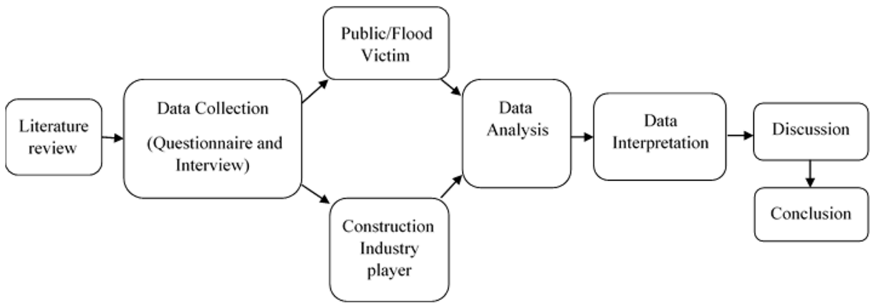

Figure 2. Research methodology framework

Item and contents of questionnaire	Description
Personal Background	Items regarding background information of the respondents such as gender and designation
Awareness of DRMC (DRMC)	Items regarding the awareness of the construction industry stakeholders towards the DRMC
Technical and Non-Technical Factors in DRMC	Items regarding steps to be taken before, during and after a disaster that are relevant to technical and non-technical factors of disaster risks
Effect of Disaster	Items regarding the opinion of respondents towards the significant effect of disaster

Table 1. Items and contents of questionnaire

according to each DRMC phase. This was intended to determine the most significant risk factors that must be considered by the construction stakeholders. The last section focused on the effect of the disaster. This section seeks to determine the opinion of respondents towards the significant effect of disaster risks.

The Likert scale method was used in this study for the questions in Sections 3 and 4. The range of answers was scaled from 1 to 5 as shown in Tables 2 for Sections 3 and Table 3 for Section 4.

The Likert scale method was used in this research because the rationale of a Likert item is as follows: attitude or opinion will vary on a bi-polar continuum (scale stem), from negative (e.g. "strongly disagree" or "no importance") to positive (e.g. "strongly agree" or "very important") (Johns, 2010). A Likert item holds optimum psychometric properties between four and seven response categories (Leung, 2011). Likert items incorporating five response categories are typical (Jamieson, 2004) such that the "middle" category represents neither a negative nor positive response. However, even-numbered scales can be used to help avoid (e.g. acquiescence) bias or ambivalence (no mid- or neutral-response category) and to "force" either a negative or positive response attitude (Johns, 2010).

Data analysis

The analysis of data was performed in accordance with the research objectives. The research data were analysed using SPSS version 22 and Microsoft Excel. The two approaches were used for data analysis.

Index average and relative important index

Relative important index (RII) is a type of relative important analysis. The RII was used because it fits well with the research objective to determine the perspective of construction industry players and flood victims towards the DRMC and rank it in a hierarchical way. The formula used in the calculation of RII is shown below.

Table 2.
Range of Scale for Section 3

Scale	Range
1	Strongly disagree
2	Disagree
3	Neither agree or disagree
4	Agree
5	Strongly agree

Table 3.
Range of Scale for Section 4

Scale	Range
1	Not significant
2	Less significant
3	Significant
4	Very significant
5	Highly significant

$$\text{Index Average} = \frac{\Sigma ai \times xi}{\Sigma xi} \quad (1)$$

where ai = constant (weighing factor)xi = variables representing the response frequency of respondents

The factors with the highest RII value are the most important.

Frequency analysis

The frequency analysis was used to describe the information or data of the study, such as distribution of responses and frequency, and summarise the responses to each question. The frequency of various variables is tabulated accordingly.

Result and discussion

The questionnaires were distributed into two types of respondents: professional and non-professional. The perspectives of professional and non-professional respondents are combined to obtain the overall representation of the construction stakeholders considering their perception towards DRMC. The analysed data in Figure 3 show the frequency of awareness on DRMC for professional and non-professional respondents.

The total number of professional and non-professional respondents is 45. More than half of respondents, which is 73% (33 respondents), perceived non-awareness of the existence of DRMC, whilst the remaining 27% (12) of respondents perceived awareness of DRMC. Therefore, the majority of the respondents demonstrated awareness of DRMC (particularly, if not on the cycle, then awareness could be on the elements of DRMC) despite their background. Accordingly, 27% (12) of respondents who are aware of DRMC have different levels of knowledge regarding DRMC. Only one of the respondents had expert knowledge of DRMC. Four of the respondents had fair knowledge, followed by four respondents who had minimal knowledge of DRMC. Three respondents had substantially limited knowledge of DRMC as shown in Figure 4.

Figure 4 shows that the sample of construction stakeholders in this study has at least minimal knowledge of DRMC. Thus, the information or data provided by the respondents can be considered reliable based on their knowledge of DRMC. In addition, their feedback is necessary to verify the existing DRMC framework.

Consequently, Table 4 shows the overall results obtained from the analysed questionnaires and the index average calculated using equation (1) for professional and non-professional respondents. The total number of respondents was 45. Each element in each factor was ranked on the basis of the calculated index average value. The perception of respondents is shown by RII rank according to the element in the DRMC phases.

In the preparedness phase, the highest RII rank score is "takes steps to prepare for disaster" (mean = 4.66), followed by "risk assessment of building structure" (mean = 4.45) and "provide training to understand and handle disaster risk" (mean = 4.43). The next score

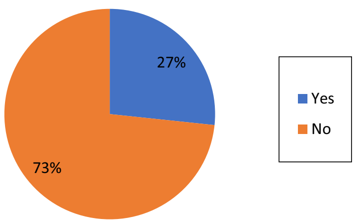

Figure 3. Frequency of awareness of the DRMC for professional and non-professional respondent

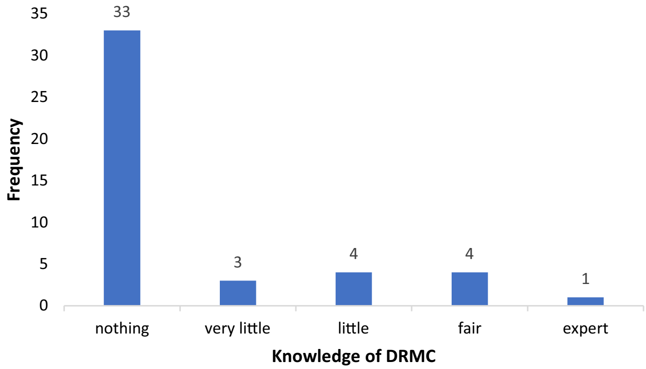

Figure 4.
Knowledge level of DRMC for professional and non-professional respondent

Table 4.
Ranking of element in DRMC phase (professional and Non-Professional respondent)

	Frequency of respondent score 1	2	3	4	5	Mean	Average index	RII rank
Preparedness								
Takes step to prepare for disaster	0	0	1	18	26	4.66	4.43	1
Provide training	0	0	3	24	18	4.43		3
Strengthening financial and non-financial resources	0	0	5	25	15	4.32		6
Risk assessment of building structure	0	0	4	21	20	4.45		2
Damage of structure	0	0	3	26	16	4.39		4
Performance of engineered buildings	0	0	6	22	17	4.34		5
Response								
Real time information	0	0	2	19	24	4.59	4.50	2
Focus on response activities	0	1	6	13	25	4.48		3
Involvement of NGO	0	0	5	23	17	4.36		4
Aware early warning	0	0	2	18	25	4.61		1
Collective efforts to repair on damages	0	0	5	18	22	4.48		3
Obtain building design information	0	0	5	18	22	4.48		3
Recovery								
Programs focus on health and safety	0	1	5	17	22	4.43	4.41	2
Displaced tenants are housed	0	0	7	17	21	4.41		3
Restore disturbed communication system	0	1	7	17	20	4.34		5
Flow of transport mobilization	0	0	5	17	23	4.50		1
Conduct the assessment of disaster	0	0	7	17	21	4.41		3
Debris removal and demolition of unsafe structures	0	1	7	16	21	4.36		4
Mitigation								
Highlight disaster prone areas	0	0	5	17	23	4.50	4.46	2
Evacuation plans	0	1	4	20	20	4.41		4
Conduct public awareness and education program	1	0	7	17	20	4.32		5
Conduct disaster rehabilitation	0	0	5	13	27	4.59		1
Perform technical measures	0	0	5	17	23	4.50		2
Avoid high risk land	0	0	7	15	23	4.45		3

is "damage of structure" (mean = 4.39), followed by "performance of engineered buildings" (mean = 4.34), and the lowest score is "strengthening financial and non-financial resources" (mean = 4.32).

Meanwhile, "aware of early warning" in the response phase has the highest RII rank score (mean = 4.61), followed by "obtain real-time information" (mean = 4.59). The third-highest RII rank scores are "collective effort to repair on damages", "obtain building design information" and "focus on response activities" (mean = 4.48), which have the same rank scores, and the least score is "involvement of NGOs" (mean = 4.36).

In the recovery phase, the highest RII rank score is "restore the flow of transport mobilisation" (mean = 4.50), followed by "programme focus on health and safety" (mean = 4.43). The next score is "displaced tenants are housed", which has the same score as "conduct the assessment of damage" (mean = 4.41), followed by "debris removal and reconstruction of building" (mean = 4.36). The least score is "restore disturbed communication system" (mean = 4.34).

Finally, in the mitigation phase, "conduct disaster rehabilitation based on engineering design" has the highest RII rank score (mean = 4.59), followed by "highlight disaster-prone areas for land use policy after a disaster" and "perform technical measures", which have the same score (mean = 4.50). The next rank is followed by the RII rank score of "build critical facilities outside evacuation areas" and "avoid high-risk land use" (mean = 4.45), followed by "development of practical emergency management and evacuation plans" (mean = 4.41). The least score is "conducting public awareness and education programme to handle a disaster" (mean = 4.32).

Considering the effects of disasters, Table 5 shows the RII rank for the significant effect of disaster as perceived by the professional and non-professional respondents. This table indicates that the most significant effect of disaster is safety (AI = 4.70), followed by cost of reconstruction (AI = 4.50), reconstruction and maintenance of building structure (AI = 4.45) and defect of building (AI = 4.36). The least effect from RII rank score is social life (AI = 3.91).

Conceptual model

This study investigated the significant factors for each phase in DRMC. The factors can assist in the decision making and policy development of disaster management. This study uses a quantitative method. The opinions from all respondents for phases in DRMC are placed hierarchically in Figure 5. The overall result shows that the response phase is the most important in DRMC followed by mitigation, preparedness and recovery.

The study found that the respondents believe that awareness and monitoring, an early sign or disaster warning in the response phase are the most significant steps to be taken in the response phase in disaster management. The early signs of disasters will provide real-time information for people to take proper action during disaster periods. The safety of people must also be prioritised

	Frequency of respondent score						Average	RII
	1	2	3	4	5	Mean	index	rank
Safety	0	0	4	10	31	4.70	4.39	1
Cost of reconstruction	0	1	4	16	24	4.50		2
Reconstruction and maintenance of building structure	0	0	5	19	21	4.45		3
Defect of the building	0	0	8	17	20	4.36		4
Social life	1	3	10	20	11	3.91		5

Table 5. Effect of disaster (professional and non-professional respondent)

during a disaster. Thus, risk management must focus on response activities for the evacuation and rescue of victims. In the construction aspect, starting the repair and reconstruction work on damages requires collective efforts. Moreover, obtaining the building design information for emergency response procedures is necessary during disasters.

However, mitigation, preparedness and recovery phase are also crucial in DRMC during disasters. This study found that the factors in each phase of DRMC can be ranked differently based on the respondent's perspective. Slightly difference in average indexes with simple comparison of means, show that all the phases are important. According to Khan *et al.* (2008), these four phases of DRMC does not always occur in precise order. The phases often overlap depends on severity of disaster.

Figure 6 shows the summary of the conceptual framework or model of DRMC developed from the results of this study. It shows that three major management factors were established from each phase of DRMC hierarchically. These factors can be used in the future for analysing the best approach that serves as a foundation in the decision and policy making of disaster management. The factors can also be utilised in anticipating and managing potential risks towards a sustainable future. In most developing countries, conventional disaster management is limited to events-based reactions, whilst proactive disaster management calls for strong preparedness and response measures [Centre for Global Sustainable Studies (CGSS), 2013].

Conclusion

This research found that the production of DRMC is important in each type of disaster. Public awareness of DRMC is very well concern to help people to plan their movement before, during and after disaster occur. Community has more practical knowledge of the event while construction industry player has knowledge for identification and implementation of effective and sustainable management measure. The combination of stakeholder's perspective about DRMC and effect of disaster will bring out the best result to deal with disaster (Anderson and Holcombe, 2013).

This research discovers that majority of the respondents did not aware about DRMC. Based on data collected, only 12 (27%) out of 45 respondents were aware of DRMC. This might be due to the lack of information dissemination about DRMC. However, from response of respondents, they believe that DRMC) is a best approach of management to deal with disaster. From this result, it can be concluded that the awareness and knowledge of the stakeholders pertaining disaster risks management need to be improved. This is vital to ensure that they do not only understand DRMC as a conceptual framework, but also to anticipate and consider disaster risks in order to handle them accordingly.

There was slightly difference in average index of DRMC from the study conducted. A simple comparison of means generated the difference in rank. The small difference in

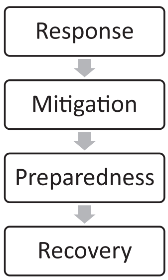

Figure 5.
Hierarchy of DRMC phase based on RII index

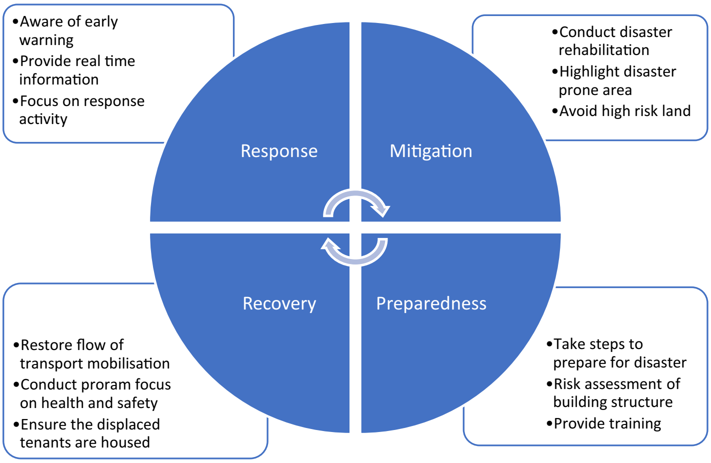

Figure 6.
Conceptual framework of DRMC

average index between each phase indicates that all phases are significant, but the minor difference is required to understand the phase hierarchy. Response phase is in the first rank followed by mitigation, preparedness and recovery phase. In effect of disaster, first effect accordance to RII rank is safety, followed by cost of reconstruction, reconstruction and maintenance of building structure, defect of building and lastly social life.

Based on this study, the risk management of disasters will become easier to conduct. People will have early information to solve the problem related to disasters. The studied factors can also be considered in future disaster planning. This study cannot solve overall disaster problems. However, the study serves as a foundation, which can contribute towards effective future planning considering understanding, anticipating and handling disaster risks, particularly floods.

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