

# IMPACT OF DISASTER TO PRIVATE CONSTRUCTION ORGANISATIONS IN MALAYSIA

## Article history

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## Graphical abstract

vulnerable factors	Respondent							Total
	R1	R2	R3	R4	R5	R6	R7	
1. Physical Vulnerability	✓	✓	✓	✓	✓	✓	✓	6
2. Social Vulnerability	✓	✓	✓	✓	✓	✓	✓	7
3. Economic Vulnerability		✓	✓	✓	✓	✓	✓	5
4. Environmental Vulnerability	✓	✓	✓	✓	✓	✓	✓	7

## Abstract

Disaster events tend to affect construction organisations in the entire community. In the recent years, with the intensity and frequency of disaster occurrences in Malaysia, the impact of disaster could destruct construction organisational business, assets and properties. For instance, flood occurrence in 2011, has affected the double track construction project in Malaysia resulting time overrun for a period of 18 months and financial loss of ringgit Malaysia 150 million to private construction organisations. Based on the 11th Malaysian Plan (Strategy Paper 11: Climate Resilient Development), construction organisations are recommended to identify the disaster impacts to prepare for disaster occurrences. Hence, the objective are: to investigate vulnerable factors of disaster (pre-event) and to distinguish the key areas of disaster impacts (post-event) for private construction organisations in Malaysia. The initial research starts with literature review from various scholars on key areas of disaster impact and disaster impact model. The next stage is conducting preliminary data survey among seven private construction organisations involved in disasters. The findings revealed that in Malaysia, social and environmental vulnerabilities are prominent elements in the pre-event phase of disaster impact. Subsequently, the Malaysian private construction organisations selected four (4) key areas of disaster impact to be the utmost critical at the post-event phase. These are people: reputation; information and communication; and finance. The outcomes of the research would provide valuable insight to the private construction organisations in Malaysia in reducing impacts to any kind of disaster and to sustain the business efficacy in the long run.

Keywords: Disaster impacts key areas; Malaysia; Private construction organisations, Vulnerable factors

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## 1.0 INTRODUCTION

More than half a million Malaysians were affected by disasters in the past 10 years[1]. This represented a five-fold increase from 103,168 people (1994-2003) to 532,851 people (2004-2013). Major emergencies, disasters and other crisis are no respecters of national borders and never occur at convenient times[2]. The magnitude of human suffering caused by disaster is huge, and many aspects of people's live such health, security, housing, access to food, water and other life commodities are affected[2]. Disasters are unpredictable events that kill and affect people, demolish construction organisational business

properties and disrupt environment [3]. It brings vulnerable community onto physical, social, economic and environment aspects if the disaster hit in places that are heavily populated areas. For private construction organisations, it is inevitable to identify key areas to protect their business, employees and customers from disasters. For instance, flood occurrence in 2011, has affected the double track construction project in Malaysia resulting time overrun for a period of 18 months and financial loss of ringgit Malaysia 150 million to private construction organisations[4]. Evidently, a study found out that only 37 per cent [5] Malaysian construction organisations are implementing business continuity plan. This is to

minimise disruptions to their business operations which could affect the monetary losses as well as their image and reputation[5]. According to Wedawatta and Ingirige [6], only 20 per cent of construction organisations are prepared to deal with any supply chain interruption during disaster occurrences compared to the other sectors such as manufacturing, retail, business/financial services, transport, and land based[6]. Meanwhile, disaster events create system deficiencies in information, communication and technology capacity for construction organisation[7]. Similarly, disaster such as flooding happened in 2007 had caused construction organisations ran out of business for the first six months [8]. Consequently, Wedawatta and Ingirige [8] claimed that the affected organisations lost their end-user trusts and the businesses never managed to reach the pre-flood status[8]. From year 1980 to 2014, 64 disaster events were reported in Malaysia [1] and have caused significant loss of life, property and infrastructure damage and environmental destruction[9]. Hence, the objectives of this paper are two-fold: to investigate vulnerable factors of disaster (pre-event) and to distinguish the key areas of disaster impacts (post-event) for private construction organisations in Malaysia to sustain the business efficacy in the long run.

## 2.0 DISASTER IMPACT MODEL

Figure 1 shows disaster impact model adapted from Lindell, Prater and Perry [10]. The model describes three important phases; vulnerability factors of disaster; emergency response and key areas of disaster impact. For the purpose of this paper, vulnerable factors and key areas of disaster impact are reported

while emergency response will be reported in the next paper.

### 2.1 Vulnerability Factors of Disaster

According to the model, the first phase (pre-event) addressed four vulnerable factors of disaster: physical, social, economy and environmental vulnerability. *Physical vulnerability* for private construction organisations can be determined with the density of population; the construction site; design and materials used for critical infrastructure or housing [11].

Meanwhile, *social vulnerability* however, is the complex set of characteristics that includes: *initial well-being* (nutritional status, physical and mental health, morale); *livelihood and resilience* (asset pattern and capitals, income and exchange options, qualifications); *self-protection* (the degree of protection afforded by capability and willingness to build safe home, use safe site); *social protection* (forms of hazard preparedness provided by society, e.g. building codes, mitigation measures, shelters, preparedness); and *social and political networks and institutions*[8]. On the other hand, *economic vulnerability* highly dependent on the status of the individuals, communities or nations economic reserves; level of debts; and the access degree of credit, loans and insurance[12]. As for *environmental vulnerability*, climate change increase hazard risk; loss of natural defence increases and environmental degradation weakens resilience[13]. Disaster events are rooted in these four vulnerability factors that need to be assessed and manage appropriately by the private construction organisations. This is to minimise exposure to post-disaster events in ensuring to withstand further loss or damage[12].

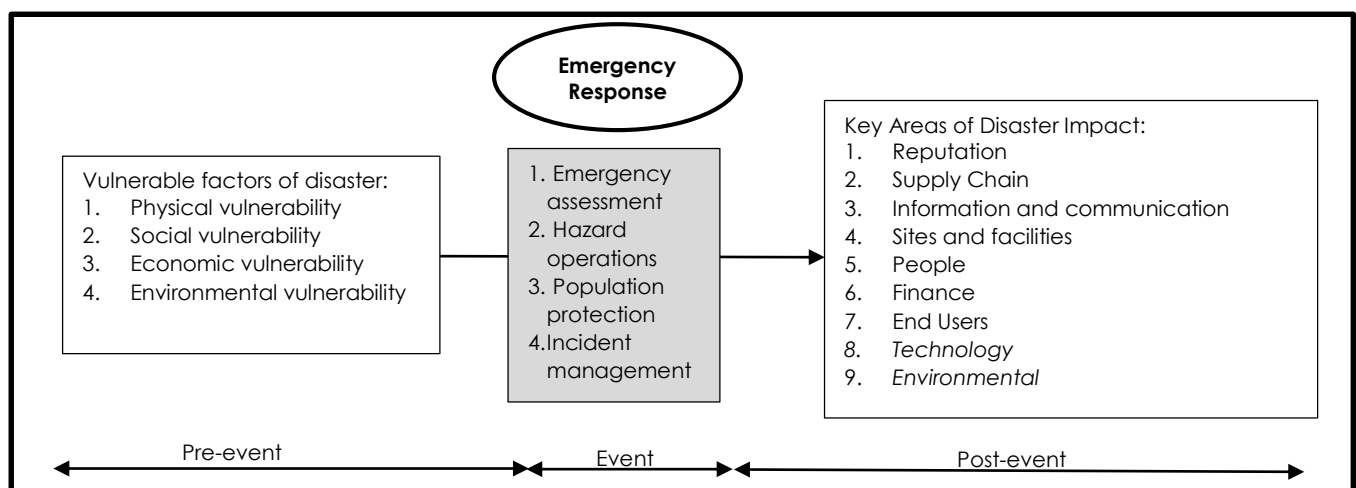


Figure 1 Disaster impact model [10]

The next important phase to be addressed is the post-event components consisting of key areas of disaster impact. These are: reputation; supply chain; information and communication; site and facilities;

people; finance; end-users; technology and environment.

## 2.2 Key Areas of Disaster Impact

Disaster impact in terms of human, structural and economic loss has been reported increasing every year [14]. Table 1 presents key areas of disaster impact towards private construction organisations from various scholars [6], [8], [15]–[22]. It has been identified seven disaster impact elements in business and operating of an organisation: reputation, supply chain, information and communication; sites and facilities; people; finance and end users [15]. Furthermore, a comprehensive study investigating disaster impacts and found out that environment [8], [19], [20] and technology [17], [18], [22] can be considered as another two additional elements.

From the information gathered (Table 1), among others, four essential key areas of disaster impact are inevitable such as supply chain; sites and facilities; people and finance. Disaster impact on supply chain can be determined with disruption to delivery and utility supplies through supply chain; ambiguous contractual clauses in supplier agreements; and improper selection, monitor and management of suppliers [6], [17]. Meanwhile, disaster impact often create construction site and facilities disorganised,

chaotic and ruin the equipment on construction site. It is essential to have appropriate controls and alternatives like efficient facilities management team; Uninterruptible Power Supply (UPS) systems; backup generators and portable clean water to keep on-site activities operate continuously [17], [22]. Additionally, disaster impact on people in private construction organisations can be ascertained with safety knowledge and training; workers' wellbeing and attitude; staff morale and job satisfaction [17]. As for impact on finance, the disrupted construction activities and damaged facilities on site could create hindrance on overall construction project time and planning [20]. For example, damage to infrastructure, machineries and equipment; loss of stock materials; costs of demolition; debris removal and workers turnover [19]. Hence, private construction organisations' decision makers and planners must consciously consider the risks from initial stage to minimise economic loss [21], [22]. Therefore, in order to minimise disaster impact, these four key areas must be well aware by the management team of private construction organisations.

**Table 1** Key Areas of Disaster Impact

Disaster Impacts Key Areas	BCI (2010)	Child Fund Alliance (2015)	Bartlett (2013)	Dickson (2013)	Laugé et al. (2013)	Wedawatta, Ingirige (2012)	Lindell (2011)	Wedawatta (2011)	ISDR (2009)	Sans Institute (2003)	Total
Reputation	✓		✓							✓	30%
Supply Chain	✓		✓			✓	✓	✓		✓	60%
Information & Communication	✓		✓	✓						✓	40%
Sites & Facilities	✓		✓	✓✓	✓		✓		✓	✓	70%
People	✓	✓	✓	✓	✓		✓		✓	✓	80%
Finance	✓		✓		✓	✓	✓	✓	✓	✓	80%
End Users	✓		✓			✓				✓	40%
Technology	✓		✓	✓						✓	40%
Environment					✓	✓	✓				30%

Nevertheless, literature search recorded that merely 30 per cent researches agreed reputation and environmental key areas are vital in disaster impact towards private construction organisations. Disaster impact on reputation can be described as in negative publicity and wide scale impact and disruption [17]. Meanwhile, environmental impacts to private construction organisations could include air, water or soil contaminations; soil movements (i.e., earthwork and soil erosion); and natural resources (i.e., minerals, forests, fertile land) degradation or rehabilitation [19], [20]. Despite the two areas are important, more empirical research are needed to illustrate the importance.

On the other hand, the remaining three key elements, namely information and communication; end users and technology aspects were expressed by four different scholars each. Disaster impact for information and communication is crucial to have

necessary controls for secure storage and data retrieval [17]. Alike, once disaster strike, end users perception normally turned into negative where the organisation lost its customer base and trust [8] due to interruption of service quality and reliability; insecure expectation and uncertainty on business agreement [17]. Compatibly, technology contingency planning and management in private construction organisations must be well organised to avoid negative interference [22]. This in turn is important for the private construction organisation to increase level of awareness and preparedness towards any disastrous events.

Given the above, most of disaster impact above, if not all; focus on *supply chain; sites and facilities, people and finance* are basic key areas to encounter in private construction organisations' plan to sustain its business for the long run.

### 3.0 PRELIMINARY DATA COLLECTION

For the preliminary data collection, a face-to-face semi-structured interviews have been conducted to seven respondents from private construction organisations in Malaysia that involved in disaster events. The purposes are to collect preliminary data on a) vulnerable factors and b) key areas of disaster impacts to private construction organisations in Malaysia.

Based on the designation, it is rational to infer that they have reasonable knowledge pertaining to disaster events within their organisations. The respondents' experience in construction industry is between 4-30 years with an overall average of approximately 15.43 years; which gives a reliable extent of experience in the sample. Table 2 shows the sample of respondents involved in the interview. The interview were recorded and transcribed verbatim for content analysis.

**Table 2** Sample of Interview Respondents from Private Construction Organisations

Interview Respondents (Private Construction Organisation)	Designation	Experience in Construction Industry (years)	Experience on Disaster Events
R1	Project Engineer	23	<b>Flash flood</b> (chaotic); building structure collapsed; basement flood; tower crane collapsed; workers fell into bore pile hole
R2	Safety Manager	6	<b>Fire outbreak</b> in workers' quarters; falling objects from height; tower crane rigging breakage; mobile crane collapsed; haze
R3	Project Manager	30	Falling debris from height; workers fell from height (injury, no fatality); haze; and heavy-dusty air surround site area.
R4	Operation Manager	20	<b>Hillslope eroded</b> (negative publicity to the organisation); Internal formwork of lift core fell from height of 12 <sup>th</sup> floor
R5	QA/QC Manager	6	Heavy rain leads to rainwater down pipe burst due to high water pressure; rainwater seeped through the roof; damaged materials during mobilization
R6	Safety Manager	19	Flood; five fatality experiences from different sites due to workers' mishap
R7	Environmental Manager	4	<b>Contaminated underground water</b> from basement; oil-spilled from jetty construction affecting tourist-attraction island.

### 3.1 Vulnerable Factors of Disaster

Table 3 shows lists of vulnerable factors in the pre-event phase. From the interviews, among others in Malaysia it can be deduced that *social* and *environmental* vulnerabilities are the most favourable factors grasped by the private construction organisations (100% -7 out of 7). In Malaysia, social vulnerability such as livelihood (assets, incomes and qualifications); housing (staff accommodation, shelters and welfare); security (safety procedure and staff protection plan) and gender are crucial aspects to encounter in the private construction organisations as suggested by Tapsell et.al [23]. Similarly goes to environmental vulnerability (i.e., ecosystem services, environmental management and environmental information) which it alleviates opportunities to reduce disaster impact onto private construction organisations as supported by United Nations Environment Programme [13].

**Table 3** Vulnerable Factors in the Pre-event Phase

	Respondent	R1	R2	R3	R4	R5	R6	R7	Total
Vulnerable factors									
1. Physical Vulnerability		✓	✓		✓	✓	✓	✓	6
2. Social Vulnerability		✓	✓	✓	✓	✓	✓	✓	7
3. Economic Vulnerability			✓		✓	✓	✓	✓	5
4. Environmental Vulnerability		✓	✓	✓	✓	✓	✓	✓	7

Meanwhile, six out of seven respondents focusing vulnerable factors in the form of physical vulnerability (i.e., labours on-site temporary settlements; infrastructure and people's belongings). This implies that apart from social, physical vulnerability is another important factors to attend. Neglecting it might cause further post-event disruption towards the organisations. However, the economic vulnerability seems to be the least favourable among the Malaysian respondents.

This is due to the fact that to a certain extent, construction organisations in Malaysia are able to absorb the loss and damage incurred due to disaster. As mentioned by Respondent 1 (R1), "Our Company policy is not emphasising on financial

losses during disaster. The most important is to complete and deliver the project successfully. As such all the cost incurred will be absorbed and adjusted accordingly".

### 3.2 Key Areas of Disaster Impact

Table 4 shows there are four crucial key areas of disaster impact towards private construction organisation such as *people; reputation; information and communication and finance*. The respondents indicated that the most vital disaster impact is toward people. R1 mentioned that the management of construction organisations play essential role in protecting their staff and workers on site. This coincide with the experiences of R2 (i.e., fire outbreak) and R3 (i.e., workers fell from height). They agreed that post disaster events had exposed the people in the construction organisations to be distressed in physical or psychological; fatalities and injuries. R5 and R6 added that their organisations engaged professional psychiatrists to aid in boosting negative morale among staff and workers on site.

Secondly, reputation is the next choice to be the important key areas of disaster impact. Feedback from R2, R3 and R4 mentioned that organisations' reputation is valuable to secure future potential projects and maintain good image in the construction industry. For example, experience from R4 indicated that nearby hillslope soil erosion has created negative publicity to the company. Nevertheless, the results are contradicted with literature review in which literature search revealed that reputation is less important. The reason for the contradiction is that in Malaysia, reputation is more emphasized by private organisation in order to sustain construction business, in particular during the economic hick-up.

**Table 4** Key Areas of Disaster Impact

Organisation Post-event	LR Result	Pilot Interview							Total
		R 1	R 2	R 3	R 4	R 5	R 6	R 7	
1. People	80%	✓	✓	✓	✓	✓	✓	✓	86%
2. Reputation	30%		✓	✓	✓	✓		✓	71%
3. Information and communication	40%	✓		✓	✓	✓			57%
4. Finance	80%		✓			✓	✓	✓	57%
5. Supply chain	60%		✓		✓				29%
6. Sites and facilities	70%					✓	✓		29%
7. End Users	40%						✓	✓	29%
8. Technology	40%						✓	✓	29%
9. Environmental	30%				✓			✓	29%

The third utmost important key areas of disaster in Malaysia is the information and communication. R1, R3 and R4 are synchronised as their construction organisations required data backup and alternative

systems whenever any disaster occurred. For example, R1 said the construction site became a huge mess and chaotic due to flash flood occurred. Nonetheless, literature search reported as somewhat importance with a-40 per cent response rate. Once again the data is contradicted with the Malaysian scenario that revealed a 57% of respondent agreed that information and communication is essential during disaster. The probable reason for this predicament is that as mentioned by R3,

"To date many private construction organisations in Malaysia is still implementing conventional system to store project data. As such when disaster occurred it is hard for us to retrieve information".

Similarly, 57% of respondents agreed that financial aspect is one of the key areas of disaster impact in private construction organisations in Malaysia. For example, experience from R7 revealed that treating contaminated underground water had caused substantial financial lost for the company. However, according to R1, R5, R6 and R7, in Malaysia most construction projects and organisations are covered with respective insurances. As such all cost pertaining to safety matters are included in the contractual agreement.

For supply chain, R2 mentioned, "When disaster hit, all supply chain network related to the construction projects including material deliveries and utilities supplies on site had caused delay. Hence, it drags overall targeted completion time". Nevertheless, R1, R3, R5, R6 and R7 failed to address this variable as critical for their organisations. By right the impact of disaster could create supply chain disruption and will continue to get leaner and more complex. The reason could be the two contractors have well established networking throughout Malaysia. However, R5 and R6 mentioned that if disaster event occurs on site, the overall project schedule would not much affected by supply chain factor as most of their materials are imported from overseas. Therefore, suppliers from none affected areas could assist reconstruction stages due to the 'decentralised' supply chain network.

On the other hand, the remaining key areas of disaster impact such as sites and facilities; end users; technology and environmental are required for further and extensive data collection among the private construction organisations. This is due the fact that it is initial data and the sample size collected are too small.

## 4.0 DISCUSSION

Based on the literature and findings from the interviews, a relationship between main vulnerability factors (pre-event) and key areas of disaster impact (post-event) is developed as shown in Table 5. The relationship shows that the highly affected vulnerable factors (i.e., social and environmental) could cause



greater disaster impact (i.e., people; reputation; information & communication; and finance) towards private construction organisations in Malaysia.

According to respective respondents as tabulated in Table 4, social vulnerability criteria such as initial well-being and livelihood & resilience are most likely to influence the people disturbances; tarnish reputation and financial status in the private construction organisations. Likewise, self-protection and social protection criteria could affect disruption of information & communication within the construction organisations.

Congruently, environmental vulnerability follows the lead. The more exposure of this factor towards

disaster occurrences, the more immense disaster impact to private construction organisations in Malaysia. Neglecting environmental vulnerability in the construction organisations such as environmental management and information will leads to interruption among their workers (people); reputation and information & communication. Relatedly, third criteria of environmental vulnerability is ecosystem services. Respondent 2 stated, "Construction site surroundings and ecosystems are usually studied and assessed thoroughly before commencing any sub-structure activities. This is to avoid severe impacts if disaster struck nearby or on the construction site".

**Table 5** Relationship between Main Vulnerability Factors and Key Areas of Disaster Impact

Pre-event Vulnerability Factors	Post-event Key Areas			
	People	Reputation	Information & Communication	Finance
<b>1. Social Vulnerability</b>				
a. Initial well-being	R2	R2, R4		R5, R6, R7
b. Livelihood & resilience	R1,R5	R3		R2,R5,R6,R7
c. Self-protection	R1,R3,R4,R6	R5	R1, R3, R5	
d. Social protection			R4, R5	
<b>2. Environmental Vulnerability</b>				
a. Environmental management	R4	R7		
b. Environmental information	R5	R3, R5, R7	R3, R4, R5	
c. Ecosystem services		R4, R7	R1, R4, R5	R2, R5, R6, R7

From Table 5, it can be deduced that if disaster preparedness and precautions measures are taken into account, it could alleviate and reduce disaster impacts onto Malaysian private construction organisations.

## 5.0 CONCLUSION

This paper has presented the findings on vulnerability factors and key areas of disaster impacts to private construction organisations in Malaysia. From the findings above, it can be deduced that *social* and *environmental* vulnerability factors are compulsory elements in the organisations' sustainable planning. By having these elements allow them to prepare their capacity and capability to combat and minimise disaster impact afterwards.

Subsequently, among the nine key areas of disaster impacts, the Malaysian private construction organisations selected four key areas to be the utmost critical. These are: *people*; *reputation*; *information and communication* and *finance*. Since the sampling size is small, an extensive data collection is planned to be carried out to more respective companies that involved in disasters based on the data retrieved from Malaysian Construction Industry Development Board and SME Corp. Malaysia.

The research presented in the paper is part of ongoing PhD research to develop a framework of Business Continuity and Disaster Recovery Management (BCDRM) for construction organisations in Malaysia. The result of the study could provide awareness and preparedness for Malaysian construction industry pertaining to disaster events.

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