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# Hazard Identification in Total Demolition Work

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**Abstract:** Demolition activities is one of the most important sector in demolished the building before going to construct a new building and it is growing extremely and progressive and profitable. However, demolition activities are still not well known among Malaysian and initiatives to identify and overcome the hazards in working activities are still lack. The objectives of this study was to classifying the hazards and risk control measure accordance to the phases and proposes safe work procedure in total demolition work involved. The study methods used are by site visit and an interview with the stakeholders. Implementation method will be focusing in achieve the objectives of this study. Therefore, the data collected will be referred to the HIRARC form from the company research conducted as an overview of the total demolition work by phases which starting from the first phase that is an early stages, second phase, middle process of work and third phase which is last stages of working activities. It can conclude, this study conducted is to give a look about how the process and work activities in total demolition involved. The entire of guidelines in total demolition work has been discovered through this research by implemented the safe work procedure according to the right standard of guidelines among the workers and employer. Hence, the findings provide additional knowledge on classifying hazards in total demolition work in Malaysia.

**Keywords:** Total Demolition Work, HIRARC Form, Hazards Identification

## 1. Introduction

Demolition are one of the challenge management that faces with the risk whether safety or environmental which usually clarified with the hazards occur by the activity involved among the workers. Total demolition is one of the demolition works that facing a lot of hazardous on site and it is one of the risky works where it consist of the re-tearing down of the entire structure that need to supervise and monitored by the competency workers and engineer to prevent from any unsafe condition happen on site [1].

There are lot of hazard will appear during the demolished of the structured that will lead into a major or minor injuries towards the workers depending on the process of the total demolition take apart [1].

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The demolition work need to overcome or get improved is by implement the appropriated safe work method through the hazard identification analysis that is more effective based on the step on how it can resolve and decrease the hazard in each method of demolition that need to be comply with the guidelines [1]. The process of hazard identification can be acknowledge based on the process hazard analysis (PHA), where the entire safety considerations is begin from understanding the possible hazard occur [1].

Process hazard analysis, PHA is a risk control and risk management which is basic step towards the technical system and the process based on the operations much learn by trial and error of the design process in risk control process which can be shows and implementing in identifying the hazard in an appropriate and productive way [1].

Based on the data from International Labour Organization, there are more than 60,000 fatalities and nonfatal injuries were reported around the globe from the construction and demolition workplaces [2].

However, Bureau of Labor Statistics, Department of Labor, and OSHA's Area Offices research examines all 653 OSHA demolition accident data from 1984 to 2012 [3]. The descriptions of 20 of the 653 demolition accident reports are included in Figure 1.

No	Event Date	Fatality	Event Description
1	11/7/2014	X	Water Tank Crushes Employee
2	10/19/2011		Employee Fractures Ankle by Falling Off an Elevated Platform
3	10/18/2011	X	Employee Dies After Wall Collapses
4	10/15/2011	X	Employee Is Killed in Wall Collapse
5	09/27/2011	X	Drywall Installer Is Electrocuted
6	09/15/2011	X	Employee Is Killed When Impaled on Rebar
7	09/14/2011		Multiple Employees Are Injured in Scaffold Collapse
8	08/30/2011		Two Employees Injured in Amusement Ride Removal
9	06/23/2011	X	Employees Fall as Trusses Collapse
10	06/20/2011	X	Employee Is Electrocuted
11	04/26/2011	X	One Employee Crushed, One Employee Injures Leg in Collapse
12	04/08/2011	X	Employee Is Killed by Fall Through Skylight
13	03/01/2011		Employee's Foot Is Amputated When Struck by Steel Beam
14	02/13/2011		Employee Is Injured When Hit by Falling Hull
15	01/04/2011	X	Employee Is Killed When Crushed Under Collapsed Wall
16	12/28/2010		Employee Fractures Back While Falling from Ladder
17	12/27/2011		Employees Are Injured Falling from Roof
18	12/14/2010	X	Employee Is Killed When Struck by Refrigerator
19	12/08/2010		Four Employees Are Injured in Explosion in Confined Space
20	12/07/2010		Employee Is Injured in Partial House Collapse

**Figure 1: OSHA Demolition accident search results**

The summarization took place for the two reasons listed in Figure 2. The first is that the 11 types of work procedures shown in Figure 2 cause 95 percent of all accidents. The other reason is that accidents that occur as a result of the "other" work procedures are already present in the 11 work procedures. One of the work procedures, for example, "General demolition procedure," has the hazard of "falling from heights." Working at heights, on the other hand, is already a sub-procedure of the "General demolition procedure." [3].

According to a study of 653 accident reports of hazards causing death, injury, or any kind of health problems, falling from great heights and falling objects are the most common accident types [3].

Work Procedures	1	2	3	4	5	6	7	8	9	10	11	12	
Work Procedures / Hazards	1. General Demolition Procedure	2. Demolition Machines	3. Demolition of Steel Constructions	4. Working with Stairs	5. Manual Operation	6. Active Services in the Area	7. Fire	8. Mobile Scaffolding	9. Working at Heights	10. Demolition-Falling Materials	11. Asbestos	12. Others	Total
1. Collapse of Buildings	165	0	15	0	0	0	0	3	0	0	0	1	184
2. Falling from Heights	119	5	9	0	1	0	0	8	27	0	0	0	169
3. Struck by Falling Objects	65	29	14	0	5	0	0	1	1	10	0	5	130
4. Falling /Slipping /Stumbling	2	0	1	28	1	0	0	0	0	0	0	7	39
5. Asbestos Exposure	0	0	0	0	0	0	0	0	0	0	3	0	3
6. Electric Shock	1	1	0	0	0	16	0	0	0	0	0	0	18
7. Fire	0	0	0	0	0	0	16	0	0	0	0	0	16
8. Machine Accidents	0	54	0	0	0	0	0	2	3	0	0	3	62
9. Traffic Accidents	0	1	0	0	0	0	0	0	0	0	0	1	2
10. Cuts /Scratches	0	0	0	0	13	0	0	0	0	0	0	0	13
11. Others	4	0	0	0	0	0	0	0	0	0	0	13	17
<b>Total</b>	<b>356</b>	<b>90</b>	<b>39</b>	<b>28</b>	<b>20</b>	<b>16</b>	<b>16</b>	<b>14</b>	<b>31</b>	<b>10</b>	<b>3</b>	<b>30</b>	<b>653</b>

**Figure 2: Accident types in terms of work procedures**

## Literature Review

### 2.1 Definition

There is several definition of total demolition work based on the research studies. Demolition plan is to undertake a demolition work without creating risks, and to execute it in a safe and orderly manner, requires careful planning of each stage of the demolition [4].

According to Haile & Men, economic dropping were reported as one of the issue that can menace the sustainability and the profitability of construction and demolition commerce that also affected the harm and pain that had suffer among the workers and their loved ones[4].

### 2.2 Occupational Safety and Health Malaysia

Department of Occupational Safety and Health (DOSH), is one of the department under the Ministry of Human Resource that in charge to make sure the safety, health, and welfare of the workers on site is protected and also keep save other people life from the injuries arising at site based from the work activities [5]. An Act to make further provisions for securing the safety, health and welfare of persons at work, for protecting others against risks to safety or health in connection with the activities of persons at work, to establish the National Council for Occupational Safety and Health, and for matters connected therewith [6].

### 2.3 Demolition Buildings - Code of Practice

The intention of this standard is to give guidelines in a safe method statement procedure of any types of demolition methods for buildings and then to give information based on the requirements of the regulations involved [7].

### 2.4 Hazard

The majority of an unplanned collapse of the structure is related based on the demolition activities involved that need to be taken into action into the safety and health risks that includes the inappropriate use of demolition tool and unsafe work activity which can give cause to injuries [8].

The fatality is more likely on demolition accidents than any other construction work and this statement has been supported by the earliest JAC Report that despite the fact of rates in accident cases related to demolition works in Malaysia seems comparatively small, and this must be taking into an account to prevent these issues from any disaster would happening in the future [8].

### 2.4.1 Hazard in Total Demolition Work

Any hazards that appear in construction and demolition site activities are notable. Some of the working activities involved at workplace can turn into a death, if the safety etiquette is not complied. For example in get a proper setting of trusses in the buildings are one of the dangerous working condition because trusses are the heaviest part in tearing down the trusses or during in installation [9].

Based on the database from the Occupational Health and Safety, (OSHA), there were 211 incidents was found from the single fatalities, one accident was occur involving with the number of three fatalities, and the other incident is contribute into four fatalities. Most of the incidents that contribute into fatalities are come from the installation in truss work because there is evidence show from the OSHA database that the collapsed of the 34 trusses in 21m length has bringing into the four fatality incidents and it can be conclude that the heavy materials need to be considered and taking into serious action [10].

### 2.5 Safe Work Method

SWM is come from the work activities that are separated into the series job or task and hazards in controlling the risk that were identified for each step [11]. Job Hazard Analysis, JHA is defined as 'technique' in identifying the hazards which are focused more on relation between the workers, tools, and work environment in order to reduce the risk to an acceptable level accordance to the US Occupation Safety and Health Administration [11].

### 2.6 Risk

A demolition risk can be defined as the term of any exposure to possible loss. It is because every demolition works of project facing to different of risk. Specific hazardous occurred is come from the combination of the consequences and likelihood which is as defined in the risk term [12]. However, risk can be identify based on the method in controlling the hazards in order to evaluate the risk potential involved according to the hierarchy of control by working activities of total demolition.

## 2. Method of Study

The methods section known as methodology, describes all the necessary information regarding to the hazard identification that is required to obtain the results of the study. The data collected are based on the site visit and an interview with the stakeholder which is safety supervisor that handling the process of total demolition work involved.

However, the methods in classifying the hazards are conducted based on three (3) phases. The first phase cover an early stage of work, second phase that is middle process of working activities and third phase which is last stage of hazards occur by total demolition work.

### 3.1 Selection of Site Visit for Demolition Work

The selection location shown in Figure 3 for this study is at Pasir Gudang, Johor. This project was handling by company of Jing Sheng Construction & Engineering Sdn.Bhd. This type of project is conduct demolition work at YTL Power Plant.



**Figure 3: Location of site visit project for demolition work**

### 3.2 Collection Data of Hazard

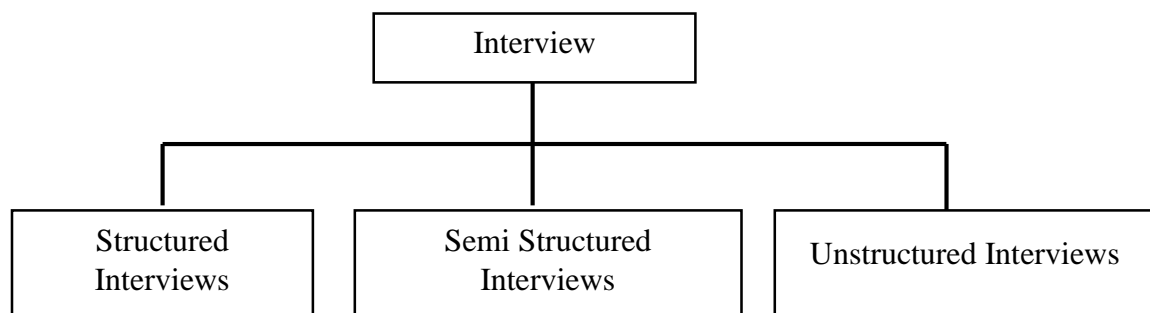
Hazard identification at the workplaces during the working activity is most likely exposed to the hazard that will bring an injury towards the workers. Based on the working condition during the demolition process, the data collection in classifying the hazard will help in order to reduce the number of likelihood and severity of hazard become worse. The collection data in recognizing the hazard will listed into the HIRARC form which is will give more easily for the researcher obtain the result.

However, in collecting the data through this method, it will reveal degrees of viewpoint that could make a real difference in understanding the result from the HIRARC form while the other data collection provided are through an interview with the safety supervisor.

#### 3.2.1 Interview Method

Interviews are also defined as two-way conversations with the goal of gathering research data. The interviewer's based on face-to-face interaction with the respondent aims to obtain information from the respondent through orally. In this study, interviews were conducted between researchers to obtain relevant information about study subjects.

Data obtained from observations can then be reinforced and supplemented through interviews. Interviews are used to validate the data or information that has been collected. A survey study is one in which interviews or questionnaires are used as instruments. Interviews are possible in orally or conversation, and answer based on interview can be recorded in writing, via tape recordings, radio, video and other electronic media.



**Figure 4: Type of Interview**

Structured interviews conducted in a formal way. It's well-organized and meticulously planned. However, a semi-structured interview is a two-way conversation intentional to gather research data

where in involve face-to-face interaction between interviewer and respondents is required while unstructured interviews are the opposite of structured interviews.

Based on this research, structured and unstructured interview has been conducting among the respondent selected which is safety supervisor from JSCE Company.

### 3.3 HIRARC Form

HIRARC form are one of the way in organize any potential hazard by list down all the hazard occurred at workplaces during demolition works. It consist three elements which is hazard identification, risk analysis and followed by risk control. The risk obtained by the working activity in total demolition work been rated through risk matrix table as shown in Table 1.

**Table 1: Risk Matrix (HIRARC)**

Likelihood (L)	Severity (S)				
	1	2	3	4	5
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

Legend:-

High	
Medium	
Low	

The risk evaluation of hazards also refers to the likelihood and severity of hazards appears during the working activity as shown in Table 2 and Table 3. The rating of risk hazards will be determined accordance to the working activity among the workers that evaluated from the professional judgment by safety supervisor or data.

**Table 2: Likelihood (HIRARC)**

Likelihood (L)	Example	Rating
Most Likely	The most likely result of the hazard / event being realized	5
Possible	Has a good chance of occurring and is not unusual	4
Conceivable	Might be occur at some time in future	3
Remote	Has not been known to occur after many years	2
Inconceivable	Is practically impossible and has never occurred	1

**Table 3: Severity (HIRARC)**

Severity (S)	Example	Rating
Catastrophic	Numerous fatalities , irrecoverable property damage and productivity	5
Fatal	Approximately one single fatality major property damage if hazard is realized	4
Serious	Non - fatal injury, permanent disability	3
Minor	Disabling but not permanent injury	2
Negligible	Minor abrasions, bruises, cuts, first aid type injury	1

### 3.4 Hazards listed by Phase

The hazards in total demolition work are separated as shown in Table 4 based on the three (3) phases conducted as an overview in classifying the hazards based on the potential of risk among workers activities.

**Table 4: Hazards listed by Phases**

No	Phase 1: Early stage of activity	Activity of Hazards
1	Soft Stripping	Slip and Trip Exposed to sharp edge
2	Dismantling pipeline by manual cutting with oxy cutters	Hot work
3	Transfer dismantle pipeline at the dumping area using forklift.	Over capacity load Blocking vision
No	Phase 2: Middle stage of activity	Activity of Hazards
1	Dismantle roof and structure using sky lift and mobile crane.	Falling from height Exposed to direct sun heat Falling object due to lifting gear failure
2	Dismantle roof and structure using sky lift and mobile crane.	Crane topple Exposed to noise
3	Crushing and Hacking Building Structure.	Exposed to dust Hit by moving object
No	Phase 3: Final stage of activity	Activity of Hazards
1	Excavation work and backfilling	Uneven surface Opening Underground flow water
2	Site Clearing	Hit by moving object Vehicle collision

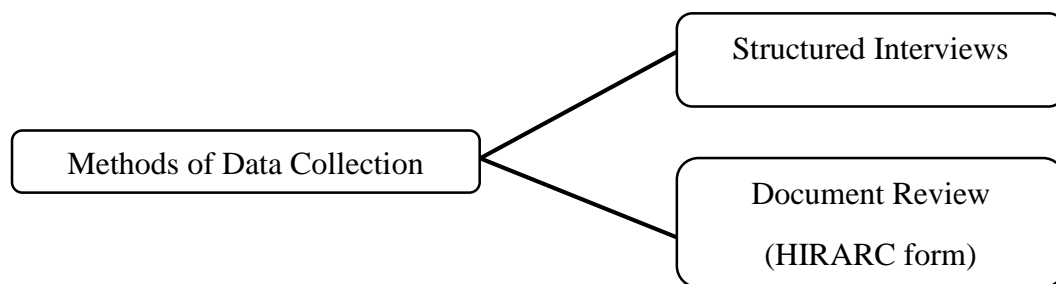
### 3. Results and Discussion

The results and discussion of the data collected based on the results obtained through the site visit and an interview occurs based on demolition activities. The hazards involved through the total demolition work are summarized into the HIRARC form based on the elements in HIRARC that cover for hazard identification, risk analysis and risk control.

#### 4.1 Data Collected

Method of interviews, observation and document review which is HIRARC form was used in this study based on the classification of hazard shown by activities of total demolition work among workers through the respondent from Jing Sheng Construction & Engineering Company.

The collections of HIRARC form were taken to analyze the study describing in general how the interviews, observation and document review of HIRARC form were made as shown in Figure 5.



**Figure 5: Structure of data collection to classify the hazards and risk control measure and propose safe work procedure accordance to the phases involved**

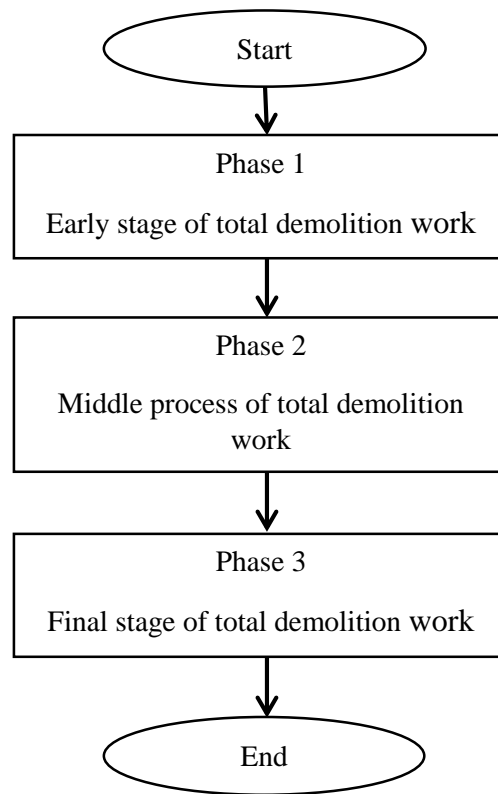
This data collected were separated into three (3) phases. First phase is review about the early stages of the total demolition work and followed by the second phases which are in the middle process of demolition work. Lastly, the final phases which are shown in the total demolition work in project demolition site.

In this result, the data collected are demonstrated in Figure 6, as a step to determining the classification process involved during the total demolition work activities. This phase of activities come out with three phases which represents as a step to classify the hazards exposure by the most hazards whether low to high risk level based on the activities conducted by each workers. The first phase come out with the early stage process of activities which cover the early work of total demolition work which exposed to the low risk of hazards.

However, activities of total demolition work in the middle phase demonstrate based on the type of activities in total demolition work occur. During this second phase, the level of risk and hazards occur towards the workers are medium or high where in this middle phase they exposed to dismantling the structure by a machine equipment. Most of the hazards exposed are due to the handling with machine equipment in the middle process of total demolition work activity.

Regarding to the final stage of total demolition work which known as a third phase demonstrate that the process of total demolition work involved in this phase exposed to the lesser hazards where the used machine equipment are less compared to the middle phase. The process took place in this final phase only related to the final work demolition which is excavation works and site clearing work that involved lesser workers in a certain area.





**Figure 6: Demolition activities involve in each stage**

4.2 Risk Rating

Risk rating evaluated based on the formula format severity times likelihood which refer to the severity categories such as fatality, minor or major injuries effect towards the workers and likelihood based on categories chance such as could happen frequently, frequently and others that evaluated through the professional judgment of safety supervisor. The risk rating has been rated according to the work activities involved among the workers and the result obtained to rate the risk been discussed during an interview.

4.3 First Phase of Hazard

The risk rating obtain from the first phases of activity soft stripping are low hazard due to the activity is in the early process of activity work in total demolition and can be acceptable and resolve as shown in Table 5

**Table 5: First phase of hazard**

No	Activity/Task	Hazard	Likelihood (L)	Severity (S)	Risk Rating
1	Soft Stripping	Slip and trip	1	2	2
		Exposed to sharp edge	1	2	2
2	Dismantling pipeline by manual cutting with oxy cutters	Hot surface	1	5	5
		Spark	1	5	5
3	Transfer dismantle pipeline at the dumping	Over capacity load	1	5	5

area using forklift	Blocking vision	1	4	4
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#### 4.4 Second Phase of Hazard

The activities demonstrate in the second phase of hazard where the risk obtain from the HIRARC form by the judgment of safety supervisor with risk matrix formula is more exposed to the injuries which involved machinery and mobilization operating system based on the working activities of total demolition work by referring to the standard guideline of demolition and occupation safety and health as shown in Table 6. However, the more activities in total demolition occur in the middle phase, more hazards come out among workers. Risk rate obtained in middle phase are based on the potential of the risk happened among the workers through the evaluation from the competent safety supervisor.

**Table 6: Second phase of hazard**

No	Activity/Task	Hazard	Likelihood (L)	Severity (S)	Risk Rating
1	Dismantle roof and structure using sky lift and mobile crane.	Falling from height	1	4	4
		Exposed to direct sun heat	2	2	2
		Falling object due to lifting gear failure	1	5	5
		Crane topple	1	5	5
		Exposed to noise	1	3	3
2	Crushing and hacking building structure	Exposed to dust	1	2	2
		Exposed to flying objects	1	2	2
		Hit by moving object	1	5	5

#### 4.5 Third Phase of Hazard

The activity of excavation work and site clearing shows the risk rating in this activity is low where the activities of the final phase are only focuses on the final work demolition of the ground which is less exposure to the major hazards and fatality. According to the Demolition Code of Practice, MS 2318, hazards at final work obtain are low risk and potential of injuries among workers is less due to the work activities involved. This phase are involved the final work of total demolition where hazards obtain are low risk due to its activity that are not strictly focuses on the operational machinery system as shown in Table 7.

**Table 7: Third phase of hazard**

No	Activity/Task	Hazard	Likelihood (L)	Severity (S)	Risk Rating
1	Excavation work and backfilling	Uneven surface	1	3	3
		Opening	1	2	2
		Underground flow water	1	3	3
2	Site clearing	Hit by moving object	1	4	4
		Vehicle collision	1	4	4

#### 4. Conclusion

Total demolition work has its own characteristic towards contributing into demolition sector. Even though, demolition activities are not well-known among the locality in Malaysian society, demolition activities should be shown and exposed towards the process of dismantling took place according the guidelines and standard procedure of demolition.

The objectives of classifying the hazards through the activities of total demolition work involved as a part of the knowledge to getting additional input based on how the process of demolition took place. The collaboration with the parties of locality and authority towards the demolition sector will provide extra knowledge that beneficial subject to the society.

Regarding to this study in total demolition, the improvisation are one of the important part to achieve the good result and enlighten researcher to explore and extend the limitations research project to more widely to generate more information of hazard identification on the different types of total demolition project and delivering through the importance of knowledge regarding to the process on demolition work involved rather than focusing on construction sector only.

In a nutshell, the entire of guidelines that are related to the demolition work are one of the important element in getting the good result to overcome the hazards and prevent any undesired incident happened among the workers, public and environment.

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