POLITEKNIK UNGKU OMAR

HAZARD IDENTIFICATION, RISK ASSESSMENT AND RISK CONTROL (HIRARC) AT THE CONSTRUCTION SITE

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01BCT20F3023

CIVIL ENGINEERING DEPARTMENT

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(01BCT20F3023)

A project report/thesis submitted in partial fulfillment of the requirement for the award of the Bachelor of Civil Engineering Technology with Honours

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STATEMENT OF AUTHENTICITY AND PROPRIETARY RIGHTS

HAZARD IDENTIFICATION, RISK ASSESSMENT AND RISK CONTROL (HIRARC) AT THE CONSTRUCTION SITE.

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ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to all those who have contributed to the successful completion of this research project. While it is not possible to mention everyone individually, I am deeply grateful for their efforts and support. First and foremost, I would like to extend my heartfelt thanks to my parents for their unwavering moral support throughout the entire duration of this project. Their encouragement and belief in me have been invaluable. I am also immensely grateful to my project supervisor, Ts. Dr. Azuin Binti Ramli, for her guidance and mentorship throughout the study. Her continuous support and regular check-ins have played a crucial role in helping me complete this research. Without her guidance, I would not have been able to accomplish this study. I would also like to acknowledge the support and encouragement from my friends and family, who have been a constant source of motivation. Additionally, I am grateful to my friends who assisted me in collecting data from their respective industries. Special thanks go to my WBL industry mentor, supervisors, and co-workers at CLCE Construction Sdn. Bhd. for providing me with the opportunity to conduct my research at their organization. Their support and cooperation have been instrumental in the successful execution of this study. Lastly, I would like to express my gratitude to all individuals and organizations who directly or indirectly contributed to the completion of my thesis. Thank you all for your invaluable contributions.

ABSTRACT

Poor construction site safety is the real reason for chances of the construction site fatalities or accidents happening to the workers or the stakeholders. This was due to the employer's and employees' inadequate self-awareness of the hazard that happens on construction site. Therefore, this research aims the safety of workers at construction sites through assessing Hazard Identification, Risk Assessment and Risk Control (HIRARC) for the safety and health risks at construction sites; from the observation and empathy study, improper construction waste or material collection or disposal can lead to some hazards occur and would happen near misses, accidents, or deaths among workers, employers, or people around the on-going construction project area. From the earliest phases of this study, the methodological procedure consisted of gathering information from numerous sources, including primary and secondary sources. A quantitative risk assessment has been conducted in conjunction with hazard identification to prioritize risk control management. The research found several dangers from improper construction waste collection and how its dispose or handled on the site such as the waste and materials that include biological, chemical, physical, mechanical, and ergonomic wastes are of risk which 40% of 7 dangers were high-risk, and 60% were a medium risk. To control this situation, mitigation measures have been improved according to the hierarchy control of The National Institute for Occupational Safety and Health (NIOSH). This assessment shows its effectiveness by preventing that potential harm from happening at the construction site.

ABSTRAK

Keselamatan tapak pembinaan yang lemah adalah punca sebenar kemungkinan kematian atau kemalangan tapak pembinaan berlaku kepada pekerja atau pihak berkepentingan. Ini disebabkan oleh kesedaran diri majikan dan pekerja yang tidak mencukupi tentang bahaya yang berlaku di tapak pembinaan. Oleh itu, penyelidikan ini mensasarkan keselamatan pekerja di tapak pembinaan melalui penilaian *'Hazard Identification, Risk Assessment and Risk Control (HIRARC)'* untuk risiko keselamatan dan kesihatan di tapak pembinaan; daripada kajian pemerhatian dan empati, sisa pembinaan atau pengumpulan atau pelupusan bahan yang tidak betul boleh menyebabkan pelbagai bahaya berlaku dan akan berlaku nyaris, kemalangan atau kematian di kalangan pekerja, majikan atau orang di sekitar kawasan projek pembinaan yang sedang dijalankan. Dari fasa terawal kajian ini, prosedur metodologi terdiri daripada mengumpul maklumat daripada pelbagai sumber, termasuk sumber primer dan sekunder. Penilaian risiko kuantitatif telah dijalankan bersama-sama dengan pengenalpastian bahaya untuk mengutamakan pengurusan kawalan risiko. Penyelidikan mendapati beberapa bahaya daripada pengumpulan sisa pembinaan yang tidak betul dan bagaimana ia dilupuskan atau dikendalikan di tapak seperti sisa dan bahan yang termasuk sisa biologi, kimia, fizikal, mekanikal dan ergonomik berisiko yang mana 40% daripada 7 bahaya adalah tinggi- risiko, dan 60% adalah risiko sederhana. Untuk mengawal keadaan ini, langkah-langkah mitigasi telah dipertingkatkan mengikut kawalan hierarki *'The National Institute for Occupational Safety and Health (NIOSH)'*. Penilaian ini menunjukkan keberkesanannya dengan menghalang potensi bahaya itu daripada berlaku di tapak pembinaan.

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INTRODUCTION

1.1 Background of the study

Malaysia has experienced quick infrastructure development over the last decade. Construction and Demolition waste constitutes around 20% to 30% of the total waste in landfills. The amount of demolition waste is double the amount of construction waste. Construction waste management has become a high concern issue in many developing countries because it hurts the economy, environment, and social aspects (Kupusamy *et al*.,2019).

The construction sector is an essential aspect of every country's economy. This industry has been critical to the success of the Malaysian economy. Nowadays, the construction industry was rapidly expanding because of modernization in lifestyle, infrastructure project demands, changes in purchasing preferences, and population growth. The building sector is frequently harmful to the environment. Construction waste and demolition waste are generated during the construction, refurbishment, and destruction of buildings and structures. Construction waste were defined as everything created during construction and afterwards abandoned, regardless of whether it has been treated or hoarded. It comprises leftover materials from site clearance, excavation, building, remodelling, demolition, and road work (Kupusamy *et al*.,2019).

Construction and Demolition waste account for a significant share of total solid waste generated worldwide. This industry contributes significantly to the environmental problem regarding natural resources exploration, the irreversible transformation of the natural environment, and the accumulation of pollutants in the atmosphere. Construction waste is produced throughout construction, during site clearance, material damage, material use, material non-use, excess procurement, and human errors. Moreover, statistical data confirm that 10-30% of total waste is originated from construction and demolition works. The main types of waste from construction activities are wood, metals, concrete debris, plastics, paper and cardboard, glass, and hazardous wastes (such as paints and glues) (Kupusamy *et al*.,2019).

Construction waste is generated throughout the project, including the pre-construction, rough construction, and finishing stages. Various causes might contribute to the generation of building debris. Identifying and appreciating those reasons to limit waste creation at its source is essential. The following are the causes of construction waste generation on-site such as a lack of skills and experience among construction workers, a lack of skills and expertise among demolition contractors, wasteful use of materials in construction activities, inappropriate methods for loading and shipping building materials from suppliers to sites, improper methods for handling building materials on-site, frequent demolitions due to reworks and changes in orders, traditional methods of construction, ineptitude, and incompetence (Mah Chooi Mei,2017).

In Malaysia, there currently needs to be more statistics on building waste creation. In Malaysia, field measurement studies on building waste production are maximum. Construction waste is a significant global issue that may be produced in many ways. It can harm the environment of the construction site, the community, and a project's overall performance. Some of the research tends to focus more on municipal solid waste (MSW) rather than construction and demolition waste (CDW), although CDW accounts for approximately 36% of global solid waste generation by weight (Cook et al, 2022).

Health, Safety, and Environment (HSE) is important because it, directly and indirectly, impacts the company's productivity. HSE discusses the relationship of workers with equipment, machinery, and the environment that have potential risks to occupational health and safety. The company is responsible for implementing a safety strategy; it uses it as the first precaution, even if it is simple (Prabaswari *et al*., 2020).

Using this principle, workers' safety is increased since they are no longer concerned about occupational injuries or possible accidents. Hazards are prevalent in the workplace and pose a threat to the safety and health of personnel. Dangers may result in accidents, but this is avoidable if appropriate risk assessment and management are adopted. Hazard Identification and Risk Assessment (HIRA) is one way of identifying workplace accidents, with risk level assessment as one of the critical aspects in implementing the Occupational Health and Safety Management System (OSHA) (Prabaswari *et al*., 2020).

As a result, the HIRARC approach was developed to detect possible risks in processing construction debris to estimate the likelihood of an accident or loss. Hazard identification, risk assessment, and risk management must occur throughout construction site operations, regardless of whether the job is performed by direct workers or contract employees, suppliers, contractors, or buildings or personal activities entering the workplace. In general, risk control has been identified by the Hierarchy of Controls is used to establish how to carry out control by applying practical and effective methods. The National Institute for Occupational Safety and Health (NIOSH) is a division of the Department of Occupational Safety and Health (DOSH) that is creating the Hierarchy of Controls Research Method, which have eventually become the Hierarchy of Hazard Controls (Atyanti *et al*., 2020).

Therefore, as a summary of this part, this industry's construction sites utilize hazardous machinery, equipment, and environments that provide a risk of occupational sickness and workplace accidents. One of the reasons is a lack of knowledge and inadequate monitoring and execution of hazard identification on waste materials consumed at the sites. Efforts must thus be made to limit the likelihood of accidents and occupational diseases. The goal of this study was undertaken by assessing the possible risks of occupational hazards and workplace accidents at active building sites. The findings of this study contribute to the solution of the issue and provide sites with risk management options. The execution of HIRARC in this study intends to identify all factors that could put employees at risk for an accident, take into account potential risks that might arise under any situation, and empower workers to plan, introduce, and manage prevention strategies against the risks of occupational injury.

1.2 Problem statement

Numerous relevant studies have highlighted the need of creating a safe workplace because of the inherent hazards and risk factors that emphasize every work environment and their detrimental influence on a company's overall performance. While risk refers to the possibility or likelihood that a person has been harmed or suffered an adverse health effect as a result of being exposed to a hazard, hazard refers to the situation or source which could be biological, chemical, physical, or ergonomic of potential damage to someone, property, or equipment. Some industries are seen to be more dangerous than others. However, the construction industry is regarded as one of the most dangerous in the world (Samuel, 2014). This is because, construction activity results in substantial bodily injury in the form of material waste, including metal trash, crumbled concrete remnants, and more. According to studies, waste material has a major effect on project costs, and safety and has a detrimental effect on the environment (Mohammed et al.,2020).

Although a construction job or work environment is thought to be very unsafe and dangerous, it does not imply that its susceptibility to an accident is uncontrollable; this mostly relies on the "work situation," which is changeable by humans. This has been shown by safety records in the same building sector in the most developed nations. In many nations, the improper disposal of building waste on construction sites has become a serious safety and health concern. Since the late 1990s, it has been a major problem in our nation owing to the inappropriate waste management of building sites and the enormous volume of garbage created (Samuel, 2014).

The construction sector consumes substantial resources, ranging from the most basic material, sand, to important natural assets, such as lumber. If the life cycle of the material on-site, from its transportation and delivery to its final disposition, is thoroughly investigated, it is widely accepted that a significant number of materials are lost on construction sites due to inadequate material management. There are two primary types of hazardous building construction waste: structural waste and finishing waste. During the course of building, shards of concrete, reinforcing bars, abandoned wood plates, and other debris are formed as structural waste (Samuel, 2014).

According to this study, improper construction waste disposal causes many hazards and risks to the workers and stakeholders at construction sites. This issue also was identified in the WBL industries where the construction waste was not collected and distributed properly at construction sites. The construction waste was scattered around the surroundings of construction sites. This would make happen many hazards that cause any kind of fatalities and near misses to the workers and stakeholders at construction sites. Handling construction waste improperly poses significant risks. If the organization is unaware of the dangers and fails to recognize them, it might result in a big fatality while engaged in construction waste collection, and disposal. Employees, employers, and the economy may suffer from damage to facilities and the environment.

Consequently, several dangers remain undetected, and no mitigating measures are currently in place. This might result in significant future health and safety issues for workers at sites. Hazard identification and risk assessment are essential parts of a safety management system. Construction waste collection on the job site poses several risks with severe consequences. The present research focused on identifying existing and prospective risks before doing a quantitative risk assessment to prioritize the threats.

The present study aims to investigate Hazard Identification, Risk Assessment, and Risk Control for on-site construction waste collection and disposal at the chosen anticipated site from the WBL industry. It suggests appropriate methods for reducing hazards and controlling residual effects to promote the safety of construction waste. Studies were done to detect hazards and assess the risk caused by on-site construction waste collection and disposal. (Refer Appendix 1)

1.3 Objectives

This study aims to develop Hazard Identification, Risk Assessment and Risk Control studies at the construction site that can overcome the existing hazard that occurred because of improper construction waste material collection at the construction site. The objectives of this research are:

- To identify the potential risks associated with improper construction waste at a site.
- To perform hazard analysis with the severity of an issue to categorize the risks.
- To access the current risk control practices by making suggestions for improvement to reduce the related risk.

1.4 Scope of the Study

The scope of this study was conducted at one of the ongoing projects from WBL industries. The project was ongoing at Lot 51119 (Jalan Kuala Kangsar), Mukim Hulu Kinta, Daerah Kinta, Ipoh, Perak Darul Ridzuan. The building of this project is 2 storey office and 1 storey workshop Honda showroom for the stakeholder of Skyline Entity Sdn. Bhd. The construction of this project was in the process of construction of the superstructure. This research have identify the present and prospective dangers of improper construction waste collection in a specified site. The analysis for data findings have be used for the observation of hazard identification, distribution of questionnaires to the 40 samples of respondents for the first two questionnaire and 30 samples for the respondents for last questionnaire, and followed by a quantitative risk assessment to prioritize risk management measures at the workplace. Then, the highest likelihood and severity of hazards have be identified by using Pareto analysis to make recommendations for the risk control to enhance the current risk and improve the risk control by finding the mitigation measure has been identified by calculate the relationship between articles by bibliometric analysis.

Figure 1.1 The layout plan of the project area (Google MAP, 2023)

1.5 Significance of Research

In this research, the main point that is highlighted about The Hazard Identification, Risk Assessment, and Risk Control (HIRARC) study for occupational safety and health assessment on improper construction waste at a site and hazards that happen because of waste materials. This can make the safety officer to be aware of the existing hazards by achieving the objectives. Moreover, this research made an improvement and identified the mitigating measures to the current risk control and risk that doesn’t have measure to the hazard. The study's finding may be used as a guide to reduce the risk involved and improve the safety of managing construction waste and construction sites.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The HIRARC techniques have be discussed briefly in this study. In a nutshell, HIRARC is the strategic planning technique to identify and locate hazards, determine the amount of risk, prepare a risk control action plan for high-risk activities, and assess the appropriateness and efficacy of the action plan regularly.

In this research, hazard identification was a technique for identifying potential hazards that may lead to accidents. The dangers to be recognized on building sites include those linked with construction waste, classified as health and physical hazards. Because certain risks may be difficult to identify, hazard identification is carried out by examining the total work activities and verifying onsite. Dangers are then documented using hazard assessment models.

As a result, the survey has been completed by reviewing all work activities and conducting hazard identification using the brainstorming method, job safety analysis, what-if analysis, fault tree techniques, and accident investigation that have occur as a result of improper construction waste collection and disposal.

2.2 Sources of Construction Waste

According to Tam and Tam (2006), construction waste comprised destroyed concrete from foundations, slabs, columns, and beams, among other components. Other substantial waste components were bricks and masonry, wood, glass, electrical wire, pipe, excavated rock, and dirt. From the studies of Nagappan, et al. (2012), There were 30 building sites in Malaysia with six categories of waste materials, including timber (69.10%), concrete (12.32%), metals (9.62%), bricks (6.54%), plastics (0.43%), and other debris (2%). Concrete accounted for the greatest proportion of construction debris on three apartment construction sites in Korea.

Demolished concrete from foundations, slabs, columns, beams, and other structures was included in construction trash. Other substantial waste components were bricks and masonry, wood, glass, electric wire, pipe, rock, and excavated soil. (Kim *et al.*, 2019). As shown in Table 2.1, CIDB (2008) reported the construction waste composition discarded at Malaysia's landfill sites.

Table 2.1: Composition of Construction and Demolition Waste Disposed at Landfills (CIDB, 2008).

Component	Road Work Materials	Excavated Soil	Demolition Waste	Site Clearance	Renovation Waste
Soil/ sand	23	73.8	21.5	33	19.4
Rock/ Rubble	14.4	12.5	27.7	15	38.8
Concrete/ Mortar	16.9	1.2	10.8	4.6	7.4
Wood	0.6	0.9	10.5	13.3	7.1
Reinforced Concrete	14.2	0.4	5.8	0.9	7
Asphalt	24.7	0	0	0.2	0
Others (glass etc)	1.4	0.7	5.6	13.8	2.9
Bricks / tiles	0.8	0.4	12.1	1.4	9.6
Cement Contaminated	1.7	0.4	3.2	15.6	3.3
Slurry and mud	1.8	9.7	1.5	1	3.1
Ferrous metals	0.5	0	0.6	1	1.3
Non-ferrous metals	0	0	0.7	0.2	0.1
Total	100	100	100	100	100
Total quantity of C & D waste landfilled (%)	5.2	59.4	8.5	14.6	12.3

The sources of construction waste production which took up the landfill space are summarized in the pie chart in Figure 2.1. It shows that excavation waste is the primary source in landfills, whereas road work waste is the least content (Lew Kar Hui, 2021).

Figure 2.2 shows a pie chart depicting the distribution of waste items that contributed to the landfill volume. The waste components were compiled from their respective sources to provide an overview of objects discovered in landfills. The soil was the most common kind of construction waste, followed by rock and rubble, concrete and mortar, wood, bricks and tiles, slurry mud, and metals. (Lew Kar Hui,2021).

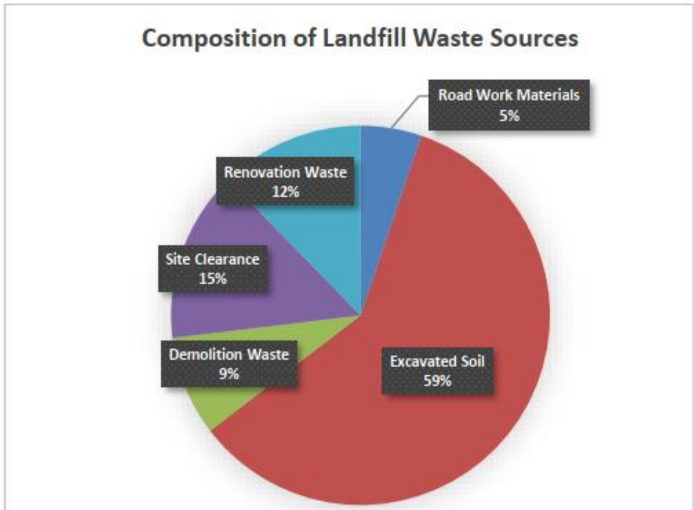

Figure 2.1: The Sources of Construction Waste in the Landfills (CIDB, 2008).

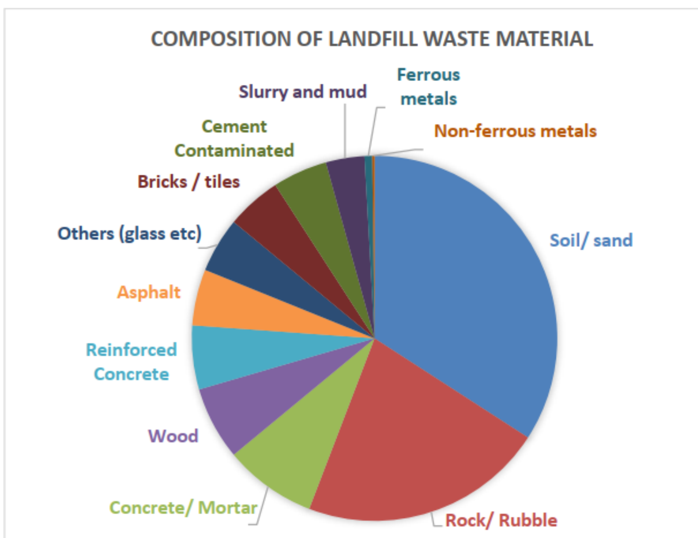

Figure 2.2: The Material Composition of Construction Waste in the Landfills (CIDB, 2008).

2.2.1 Soil

Typically, soil waste is produced during earthwork operations at the start of the building phase. In cut-and-fill construction, the quantity of earth to be excavated and replaced have never be equal. When there is an abundance of the earth, it have most likely be dumped. The design of earthwork mostly relies on the land's topography and soil condition. Significant amounts of soil waste have be generated, particularly when the area is unsuitable for development due to its mountainous and uneven terrain. to implement soil enhancement methods. Typically, the topsoil at the surface of earth cuts cannot be utilized in compacted earth fills. Therefore, the dirt have be disposed of in a landfill. Although earthwork is merely the beginning of the building phase, the major alterations to the existing land have yield large amounts of useless earth. (Lew Kar Hui,2021).

2.2.2 Concrete

According to Gálvez-Martos *et al.*, (2018), 18 kg to 33 kg of concrete per square metre (m^2) of the construction area is discarded when a new building is created. On the other hand, for every square metre (m^2) of demolition, around 840 kg of waste concrete was generated. In addition, Vasudevan (2019) stated that concrete and aggregate waste may be produced as a result of inappropriate handling of precast concrete members during shipment, incorrect concrete mix, concreting mistakes, and demolition. Lachimpadi *et al.*, (2012) claimed that on-site management for concrete or aggregate materials was inadequately supervised due to its relative affordability in Malaysia.

2.2.3 Timber

Due to the prevalence of traditional building techniques in Malaysia, lumber and plywood were mostly employed as support structures during concreting operations, temporary support in blockades, and other supporting elements. Proper to the limited durability of wood, the quantity of timber waste rises after exposure to wet weather and the absence of supervision plans to optimise their reusability on formwork. The frequency of reusing or recycling lumber and plywood on building sites is mostly determined by the quality of the construction materials utilised. Timbers of higher grade lessen the need for rectification for reuse, but timbers of lesser quality have limited reusability and are eventually dumped in landfills (Lachimpadi *et al.*, 2012).

2.2.4 Bricks

The generation of brick waste is also rather substantial due to the widespread use of brick in construction, particularly for wall construction (Ahmad *et al.*, 2014). The majority of brick waste is produced during material storage, transportation, and handling throughout the building phases (Vasudevan, 2019). By hand sorting and cleaning, it is often labour-intensive and expensive to separate potentially valuable facing bricks from impurities (Tam and Tam, 2006). Since most bricks are contaminated during demolition with mortar, rendering, and plaster, most brick debris cannot be reused or recovered and must be disposed of in landfills.

2.2.5 Metals

The metal waste consists of rebar, wire mesh, mild steel sheets, and other metal-based goods (Lachimpadi *et al.,* 2012). They are mostly attributable to the excessive cutting of steel bars, which leaves leftovers with unsuitable sizes and dimensions. Due to the diversity in standards and details for structural components, cutting errors are much more prevalent (Mydin *et al.,* 2014). However, metal trash is less prevalent than soil and concrete debris due to its greater market value, which necessitates a more stringent monitoring system on-site (Lachimpadi *et al.,* 2012). Furthermore, metal trash from the metal recycling industry is in great demand, thus its contribution to landfill garbage is negligible.

2.2.6 Plastics

The danger of material damage during loading, transit, and unloading is anticipated. As a result, delicate building components are normally properly wrapped and secured with thick and impermeable plastic bubble wrap or plastic sealer (Ajayi *et al.,* 2017). These on-site packaging materials generate an excessive amount of plastic trash, potentially as a consequence of over-packing. Plumbing cutting generates polyvinylchloride (PVC) trash, particularly during the construction of drainage, sewage, and water reticulation systems (Magalhaes *et al.*, 2017).

2.3 Factors of Generating Construction Waste

There are several reasons why building waste reduction measures are not widely used in Malaysia. Summarizes the results about the causes of construction waste development during the lifespan of a construction project. The waste stream is examined from several perspectives, including contractual, design, procurement, site operation, labour, transportation, residual, and legal and legislative considerations.

2.3.1 Conventional Way of Construction

The research conducted by Maniam *et al.*, (2018) showed conclusively that the traditional building process generated more trash than the contemporary construction method. According to Nagapan *et al.*, (2018), the present traditional building trend employs less prefabricated materials and places inadequate emphasis on new construction techniques. The standard method of building often includes multiple handling of work, which reduces waste reduction efforts and leads to increased material waste. Modern buildings incorporating fabrication may incur excessively high costs in the design of element moulds, making conventional construction more popular among builders (Lachimpadi *et al.*, 2012). In addition, technical restrictions such as unskilled labour forces, irregular construction procedures, and incorrect site management have made off-site design construction waste reduction expertise less relevant (Chi *et al.*, 2020).

2.3.2 Unsustainable Nature of the Construction Industry

According to Esa *et al.*, (2017), Malaysian construction professionals were used to linear economy-based exercises of the 'take-make-consume-dispose' idea. This level of conduct is often followed since construction supplies are plentiful and relatively inexpensive, limiting waste reduction measures (James, 2014). Aini *et al.*, (2017) found that it would be more cost-effective to dispose of old items than to properly manage waste. According to Vasudevan (2019), many industry participants are used to the unsustainable nature of the building recognized, particularly when it comes to the management of non-recyclable construction waste.

Construction waste management is difficult to implement due to the characteristics of construction plans, such as project complexity, hostile and unpredictable production background, the fragmented nature of building procurement by each project company, and the intense financial and time constraints (Teo *et al.*, 2001; Yuan, 2013). According to Wang *et al.*, (2019), owing to financial and time constraints, many customers would have less demand and interest in the building waste reduction design. Employers with limited primary resources may dedicate a small budget to less essential waste management, so diminishing the priority and significance of site waste management (Mydin *et al.*, 2014).

2.3.3 Improper Site Management

Salgn *et al.,* (2017) noted that the inefficient method of material storage and protective measures led to the development of materials waste on site. If the building supplies are carelessly piled in an exposed area without sufficient protection, they might be squandered. Bricks, blocks, cement bags, and other building materials that are exposed and unprotected might be destroyed by bad weather conditions like rain. According to Hasmori *et al.,* (2020), incorrect material handling would cause building materials to shatter and be lost, which would ultimately result in waste being produced on-site.

2.4 Benefits of Minimizing Construction Waste

2.4.1 Cost Reduction

In accordance with Vasudevan (2019), it is confirmed that 5% to 10% of the building materials are used to turn into waste, which significantly reduces the company's revenues. In order to reduce the number of building materials required and to keep the cost of material requisition under control, construction waste management must be implemented. Reduced time spent on-site sorting, processing, and managing trash helps decrease non-physical costs in addition to decreasing material cost waste (Waste & Resources Action Programme (WRAP), 2014). Transport and disposal expenses may be greatly reduced when there is less garbage that has to be disposed of in landfills (Ding *et al.,* 2018).

2.4.2 Environmental Sustainability

The amount of rubbish dumped illegally have decrease and the volume of waste delivered to landfills have be significantly reduced by following good construction waste management practises (Ding *et al.*, 2018). By reducing the amount of land needed for landfill garbage, the management of building waste have enhance environmental advantages. Additionally, minimising the amount of construction waste dumped in landfills would lessen environmental harm by limiting greenhouse gas emissions (Xu *et al.,* 2019). When construction supplies are no longer essential, less energy and water have be used to produce and transport those materials, resulting in a decrease in greenhouse gas emissions (Yusof, 2006). Furthermore, the demand for recycled materials have be boosted by an increase in the recycling rate of building debris. As a result, recycling practices have be encouraged throughout the waste-producing sector, thereby protecting the environment (Waste & Resources Action Programme (WRAP), 2014).

2.5 Implementation of Construction Waste Management in Malaysia

According to Papargyropoulou (2011), Malaysia's waste management has long been a source of concern owing to insufficient management. Only 15% of the construction garbage was collected by hired waste management businesses, according to Chen, (2015). The remaining 85%, however, went uncollected. Conventional building projects in Malaysia seemed to use less effective waste control techniques (Mydin *et al.,* 2014). According to Maniam *et al.,* (2018), Malaysia's construction industries heavily depend on traditional building techniques that produce more construction waste than more contemporary techniques like the Industrialized Building System (IBS). Begum *et al.,* (2007b) claim that using long-lasting materials that can be repaired and replenished is the most common method of waste avoidance in the Malaysian construction sector. On-site material handling and storage, however, continue to be ineffective. Due to ordering errors and poor-quality products, there are excess items that might be thrown away, increasing the pace at which waste is produced (Vasudevan, 2019). The easily overstretched waste management system in Malaysia is under growing strain as a result of the increased pace of building waste generation.

According to Aini *et al.,* (2017), by developing the National Green Policy in 2009 and the Green Building Index (GBI) evaluation for environmental practises, the Malaysian government prioritised building waste management to minimise the environmental burden. Additionally, The National Strategic Plan for Solid Waste Management was started in 2005 as a direction on how to execute solid waste management in Peninsular Malaysia (Saadi *et al.,* 2016).

Although there were quite a few rules and recommendations supporting waste management in Malaysia's construction sector, the reality remained difficult owing to poor enforcement and questionable authority requirements (Papargyropoulou, 2011; Saadi *et al.,* 2016). To promote building waste control, the different authorities attempted to reward parties that executed construction waste management effectively while punishing disobedient parties (Esa *et al.,* 2017b).

The IBS Score was created by the Malaysian government via the Building Industry Development Board (CIDB) in 2005 to show the extent of IBS implementation in any given construction project. However, this rating system has not been translated into legal methods and enforcement to assure compliance with every building project (CIDB, 2005).

As a developing nation, the present level of waste management knowledge among Malaysians is low, and garbage is often seen as unavoidable. According to Esa *et al.,* (2017b), the current standard form of contracts in Malaysia, such as the Persatuan Arkitek Malaysia (PAM) Contract 2006 and the Public Work Department (PWD) Form 203 (Revision 1/2010), do not emphasise the implementation of appropriate construction waste management. Therefore, the authorities should strengthen waste-related legislation in accordance with CIDB Malaysia's "Strategic Recommendation for Improving Environmental Practices in the Construction Industry" (CIDB, 2008).

2.6 Measures to Minimize Construction Waste

Plans for minimising construction waste may be divided into planning and management categories (Ekanayake *et al.,* 2004). An adequate waste reduction technique including planning outlines, design work, construction timetable, site layout, and procurement, must begin at an early stage. Controlling efforts must include material supply and administration, machine maintenance, waste disposal techniques, record-keeping of on-site material transactions, and even workforce training.

2.6.1 Site Waste Management Plan (SWMP)

The SWMP provides a framework for estimating and recording the kinds and amounts of construction waste that are anticipated to be generated during the project's development. It have be advised to take a number of appropriate steps to reduce the quantity of building waste sent to landfills (WRAP, 2014). For instance, Malaysia adopted the Green Building Index certification methodology. It is a framework of guidelines for designing environmentally responsible practices and evaluating such practices in order to promote waste management in the construction industry. The Leadership in Energy and Environmental Design (LEED), the Green Building Rating System in the United States and the Building Research Establishment's frameworks for sustainable building evaluation are examples of similar frameworks.

The UK's Environmental Assessment Method (BREEAM) assessment system' is Singapore's Green Mark, and Australia's Green Star (Papargyropoulou, 2011). The studies from Gálvez-Martos *et al.*, (2018) were used by SWMP to provide a preliminary cost estimate at the design stage in order to determine possible savings. The removal, separation, storage, transportation, and management of waste products are planned for later. The prospective waste stream is further used in the predevelopment phase to identify waste avoidance strategies, reuse opportunities, and recycling prospects. It is important to clearly delineate the areas used to keep supplies and rubbish on the property. The trash cans need to be placed not too far from where the garbage is produced. The SWMP should regularly get training, advancement, and updating of the documentation files.

The waste manager should be in charge of informing the participating site workers and outside stakeholders who participate in the site operations about the plan during the implementation phase. The waste manager should have the authority to delegate the task of coordinating waste avoidance with those involved parties, including contractors, vendors, service providers, and suppliers, according to EPA (2012). In particular, with respect to the issue of construction waste, it is crucial to build and maintain the habit of on-site record keeping, audit performance, and target setting. Construction waste should be separated and stored on-site using the best practices, which the waste manager should be well-versed in.

2.6.2 Circular Economy Concept

Akinade *et al.*, (2019) claim that the circular economy strategy promoted the contained material lifespan via the reuse and recycling industries. In order to decrease waste and lower resource demand while attaining sustainable development, this idea takes into account all industrial activity processes. The effectiveness of construction waste management would be impacted directly or indirectly by taking into account the project's lifetime as a whole, beginning with conceptualization and continuing through design, construction, servicing refurbishment, and destruction (Osmani *et al.,* 2008). Figure 2.3 illustrates the circular economy idea in the building sector.

The life cycle assessment (LCA) approach is used when the circular economy is in effect. To reduce waste generation and manage resource demand during the building phase, the LCA may analyse data flow and look into the management procedures for construction waste. The circular model, which replaces the conventional linear "take-make-waste" paradigm, should advance sustainable development (Akinade *et al.,* 2019). In accordance with Lu *et al.,* (2011) stated that in addition to the project lifecycle, the material lifecycle could be used to follow the material process and identify possible waste areas that might be improved.

The 3Rs of reducing, reusing, and recycling should not be the only principle of the circular economy. Esa *et al.,* (2017) said that after re-evaluating the building process and designing with waste, the addition of Re-imagine and Re-design features boosted resource efficiency. Esa *et al.,* (2017a) suggested a framework that used the micro, meso, and macro levels of the three-layer technique. The researchers emphasised the modernization of the traditional building approach at the micro-level, such as the use of prefabricated materials to simplify source material management. By explicitly specifying the relevant provisions and sections of waste management-related legislation in the agreements, the builders should be made aware of the need to carry out effective construction waste management at the meso-level. Finally, effective construction waste management is used at the macro level to guarantee that there is enough oversight, coordination, and communication throughout the building process.

Figure 2.3: Circular Economy Concept in Construction (Tikkanen, 2019).

2.6.3 Reduce, Reuse, Recycle (3R)

In order to implement waste hierarchy principles, effective waste management planning must minimise the amount of trash that is produced and maximise the usage of recovered or reused materials (WRAP, 2014). The reduction technique in construction waste management seems to be the most advantageous, cost-effective, and environmentally responsible strategy to avoid producing trash at the early project design stage (Turkyilmaz *et al.*, 2019; Salgn *et al.*, 2017). According to Lu *et al.*, (2011), waste reduction may be accomplished by government laws, design, an efficient waste management strategy, low-waste technology, and appropriate contractor attitudes.

Even if the building site functions in a sustainable way, it is impossible to eliminate all waste, and waste have still occur (Hasmori, *et al.*, 2020). Therefore, reuse is the most ideal option after reduction since it does not need complex processing and its energy consumption is not excessive. Lachimpadi, *et al.*, (2012) defined reuse as the repeated use of identical materials at the same building site for the same function, and recycling was defined as the use of construction debris at a different location for the same or a different purpose. According to Ling *et al.*, (2000), reusable or recyclable building materials include formwork, tiles, bricks, concrete, aggregates, soil, and sand. According to Turkyilmaz *et al.*, (2019), crushed concrete can be reused as a subbase for road construction or as aggregate, asphalt, drainage, and cover material.

By reducing the quantity of building trash in landfills, non-reusable material might be segregated for recycling (Nagapan *et al.*, 2014). Recycling might lower the excess cost of transferring materials and producing energy while lowering the need for new material supplies (Lu *et al.*, 2011). However, recycled materials only look appealing when they are more affordable and superior to virgin materials in terms of both price and quality (Tam *et al.*, 2006). According to Gálvez-Martos, et al. (2018), recycled building materials often resulted in inferior goods that could only be used for unrestricted uses, including sub-base fills for roads or secondary resources to create fresh concrete. The attempt to recycle is undoubtedly difficult since recycled goods must compete with cheap, plentiful, and higher-quality virgin resource resources.

2.6.4 Laws Relating to The Management of Waste in Malaysia

The Environmental Quality Act of 1974 ("EQA") is one of the primary pieces of legislation governing scheduled waste. The Act is administered by the Department of Environment under the Ministry of Natural Resources and is a provision relating to pollution prevention, abatement, and control, as well as environmental enhancement. The following sections are relevant to the management of scheduled wastes:

1. Section 34B (the control of scheduled wastes).
2. Section 22 (air pollution control).
3. Section 24 (soil pollution control).
4. Section 25 (water pollution control); and
5. Section 29 (the control of wastes disposal in Malaysian waters)

The EQR defines' scheduled waste' in Malaysia as any type of waste that falls within the waste categories listed in the First Schedule of the Environment Quality (Scheduled Wastes) Regulation 2005. The First Schedule of the Environment Quality (Scheduled Wastes) Regulation 2005 lists 77 types of scheduled wastes, which are divided into five categories, namely:

1. SW 1 – metal and metal-bearing wastes.
2. SW 2 – wastes containing principally inorganic constituents which may contain metals and organic materials.
3. SW 3 – wastes containing principally organic constituents which may contain metals and inorganic materials.
4. SW 4 -wastes which may contain either inorganic or organic constituents; and
5. SW 5 – other wastes.

Lack of technical knowledge of handling scheduled waste may impede the resolution of this issue and may be the reason why some industries fail to dispose of their scheduled waste in accordance with the Environmental Quality (Scheduled Wastes) Regulations 2005. ("EQR"). Section 8 of the EQR clearly places the responsibility on the individual/entity that generates the scheduled waste (the "waste generator") to ensure that the scheduled waste they generate is not only disposed of properly but also stored and treated in accordance with Sections 9 and 10 of the EQA (Siti Fitrah *et al.*, 2022).

2.7 Introduction to hazard identification, risk assessment, and risk control (HIRARC)

HIRARC should be conducted continually anytime there is a major danger and doubt about the efficacy. The safety and health officials must review the action plan regularly to manage the risks. The plan's sufficiency and efficacy have be evaluated whenever practicable. (Ahmadon Bakri *et al.*, 2008). Figure 2.4 was showed the flowchart of the HIRARC analysis for one of the research that has been used.

Risk is something that we all have to deal with daily. People are continually making risky judgments. Simple decisions in everyday life, such as driving, crossing the street and investing money, all include an acceptable risk. The chance and severity of a specific hazardous event happening are combined to form risk. The risk may be quantified mathematically using the equation –

Risk = Likelihood x Severity

A likelihood is a likelihood that something have happen within a certain time frame or under given conditions, therefore, the severity of an event's effects might include the harm it does to people's bodies or their health, their property, the environment, or any combination of these.

The process of control is the eradication, diminution, or inactivation of danger in such a way that the hazard poses no risk to employees in a specific area of work. Hazards should be managed at the root of the issue. Control measures should be implemented at the source to establish a preventative environment. Risk management entails taking precautionary actions to avoid damage. (Department of Occupational Safety and Health Malaysia, 2008).

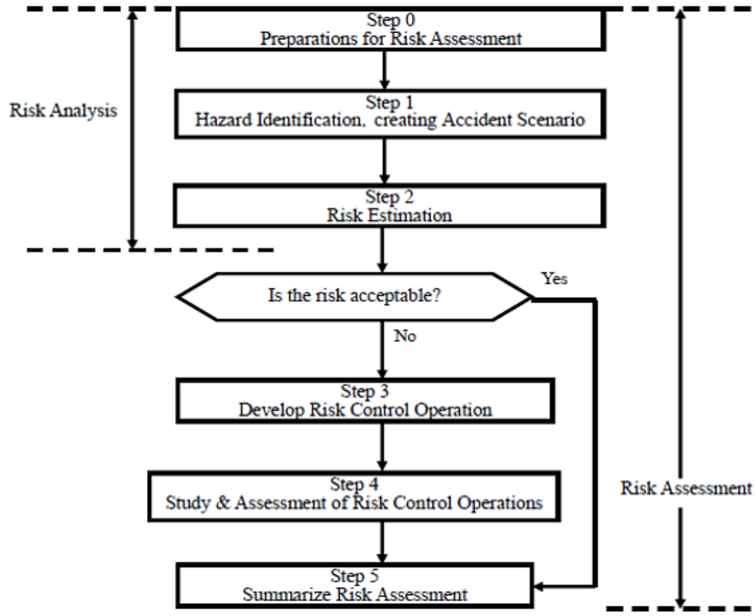

Figure 2.4: General flow of risk assessment (Nippon Kaiji Kyokai, 2009)

2.7.1 Risk Assessment Matrix

The risk level is evaluated with the Risk Priority Number (RPN) technique for each hazard. An RPN is the quantitative estimate of each hazard-related risk. It is assigned to each hazard based on three factors which are the probability of occurrence, severity rate, and hierarchy of controls. The equation above was applied to calculate the relative risk according to the likelihood and severity of the risks. The likelihood and severity rating for the hazard exposed are shown in Table 2.2 and Table 2.3. Based on the risk relative values, a 5x5 risk matrix as shown in Table 2.4 is used to assess the risk evaluation. Find the severity column in this matrix that most accurately represents the risk result before using it. Find the description that best describes the possibility that the severity have occur by following the likelihood row. The box where the row and column meet contains the risk level information. Hazards classified as “High Risk” need prompt action to mitigate the risk to life safety and/or the environment. Individuals who are accountable for needed action, including follow-up, must be identified. A more detailed risk assessment approach, such as quantitative risk assessment, may be required to establish appropriate management measures.

Table 2.2: Likelihood rating

Likelihood	**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 sometime in future	3
Remote	Has not been known to occur after many years	2
Inconceivable	Is practically impossible and has never occurred	1

Table 2.3: Severity rating

Severity	**Example**	**Rating**
Catastrophic	Numerous fatalities, irrecoverable 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

Table 2.4: The Risk Matrix

	Severity (S)				
Likelihood (L)	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**

High
Medium
Low

2.7.2 Hierarchy of control

The hierarchy of controls is a framework employed in occupational safety and health to better understand the relative effectiveness of different strategies for risk reduction and to help determine how to implement feasible and effective solutions (Sehgal Neil J *et al.*, 2021). Figure 2.5 depicts an upside-down pyramid with five areas of efficacy displayed in decreasing order: elimination, substitution, engineering controls, administrative controls, and personal protective equipment (PPE). While developed to help healthcare workers, policymakers, and the general public better understands the relative effectiveness of strategies to prevent the issues of risk that produce in such a construction site, the model has broad applicability in helping healthcare workers, policymakers, and the general public better understand the relative effectiveness of strategies to prevent the issues of risk that produce in such a construction site, similar to the research that conducts in this studies which is the identification of risk control for the hazard that happens in construction site by improper waste management.

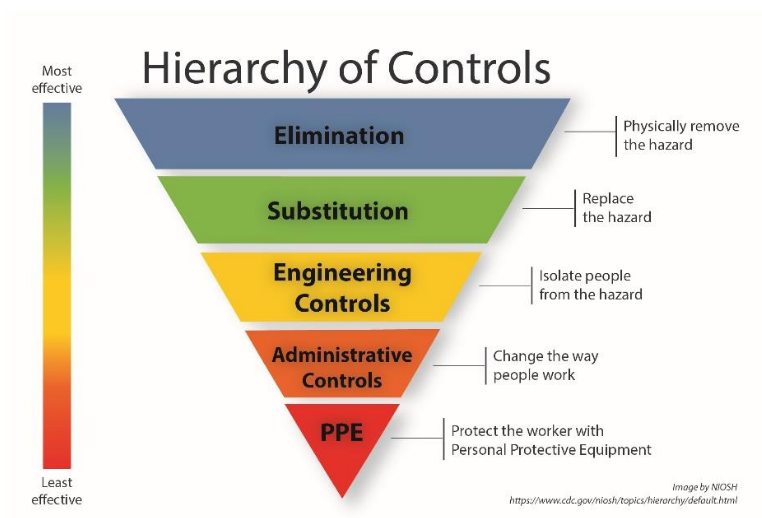

Figure 2.5: Hierarchy of control for safety and health problem (NIOSH, 2022)

2.8 Occupational Accident and Disease Statistics

The number of occupational injuries in 2021 was 21,534 instances, a 34.1 per cent decrease from the 32,674 cases registered in 2020 the data was shown in figure 2.6. Because of the drop in incidents, the rate of occupational injuries per 1,000 employees in 2021 fell by 0.75 points to 1.43. (2020: 2.18). Meanwhile, the number of fatal occupational injuries reduced by 11 instances in 2021 to 301 cases, down from 312 cases in 2020, bringing the incidence of fatal occupational injuries per 100,000 employees down to 2.00 in 2021, down from 2.09 the previous year (Department of Statistics Malaysia, 2022).

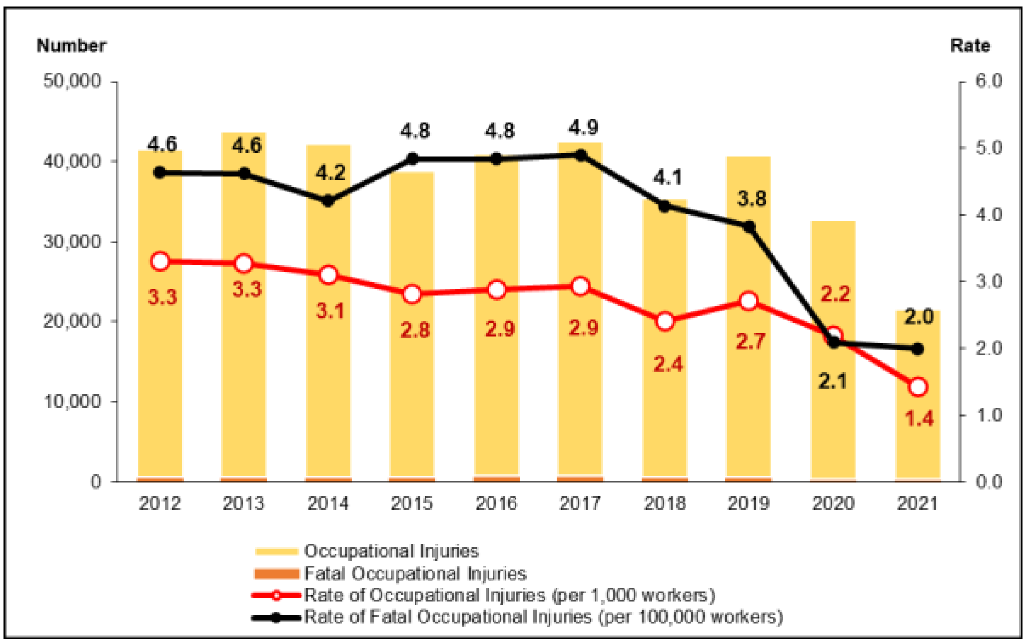

Figure 2.6: Number and Rate of Annual Occupational Injuries and Fatal Occupational Injuries, 2012-2021 (Department of Statistics Malaysia, 2022)

According to the graph of the Occupational Safety and Health Act 1994 (OSHA) sector (Act 514) which is shown in figure 2.7, the Manufacturing sector had the most 2021 occupational injuries with 7,994 instances, followed by Services (4,299 cases), Construction (2,297 incidents), and Wholesale and Retail Trade (2,297 cases) (1,979 cases). Except for mining and quarrying, the number of occupational injuries decreased in all industries compared to the previous year. Manufacturing had the greatest incidence of occupational injuries in 2021, with 3.20 instances per 1,000 employees, followed by Construction (1.98) and Utilities (1.98). (1.95). Meanwhile, the Hotel and

Restaurant business had the lowest incidence of occupational injuries, with 0.18 instances reported. Mining and quarrying were the second industry to have a rise in 2021, rising to 6.3 in the rate of fatal occupational injuries. The data also show that, except for Mining and Quarrying (2021: 10.98; 2020: 3.65), Utilities (2021: 4.90; 2020: 1.87), Transport, Storage, and Communication (2021: 4.26; 2020: 1.42) and Finance, Insurance, Real Estate, and Business Services (2021: 2.78; 2020: 1.56), all sectors experienced a decrease in fatal occupational injuries in 2021 (Department of Statistics Malaysia, 2022).

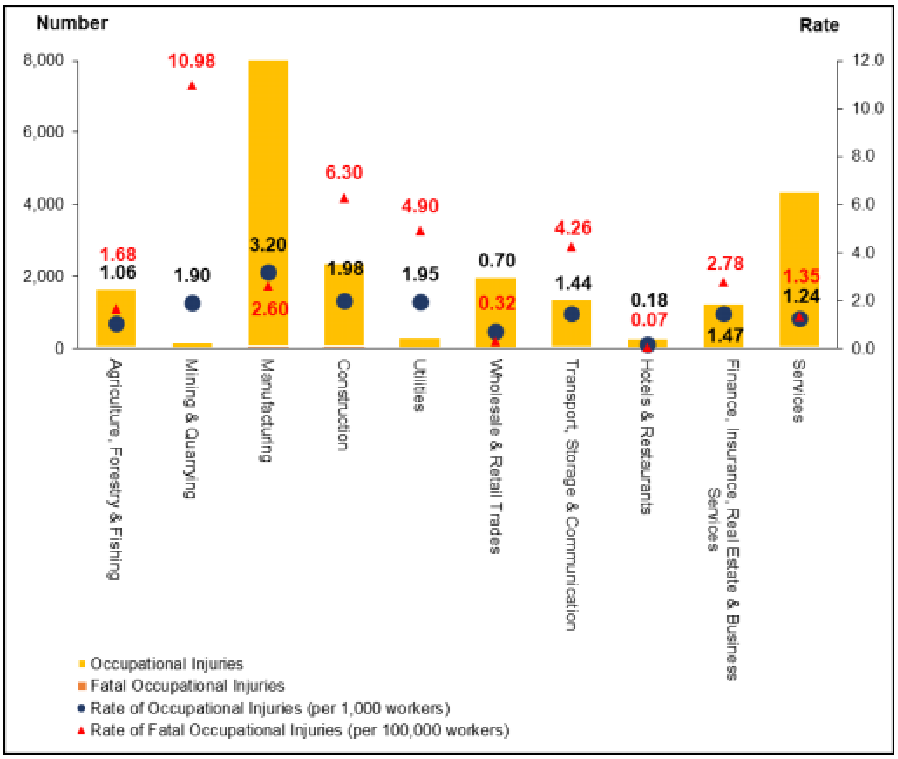

Figure 2.7: Occupational Injuries and Fatal Occupational Injuries by Sector Act 514, 2021 (Department of Statistics Malaysia, 2022)

In accordance with figure 2.8 showed that types of accidents in the high risk was starting from stepping On, striking against, or struck by objects, including falling objects (5,330 injuries, 109 fatalities), falls of persons (4,094 injuries, 95 deaths), and other types of unclassified accidents account for 60.8 per cent of occupational injuries (3,661 injuries, 0 death). Figure 2.9 shows that the bulk of these accidents is caused by the working environment (10,412 incidents), modes of transportation and lifting equipment (3,129 cases), and machines (2,222 cases) (Department of Statistics Malaysia, 2022).

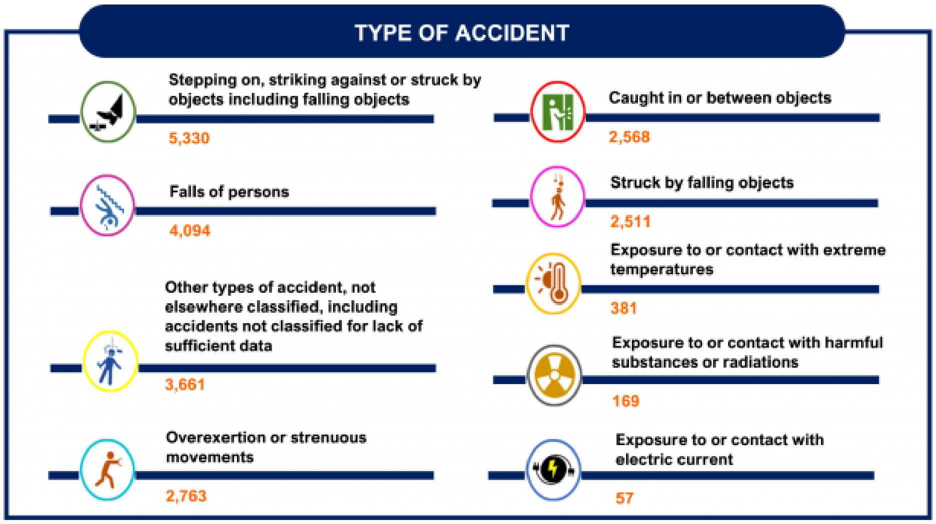

Figure 2.8: Number of Occupational Injuries by Type of Accident, 2021 (Department of Statistics Malaysia, 2022)

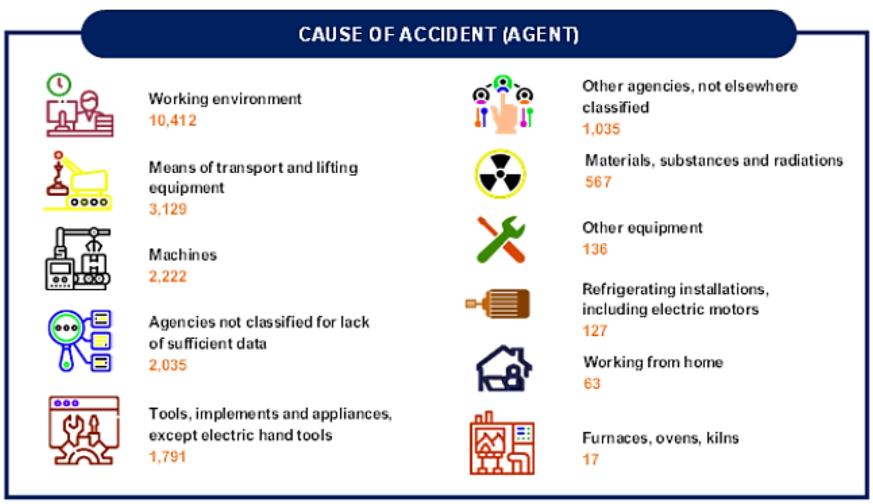

Figure 2.9: Number of Occupational Injuries by Cause of Accident, 2021 (Department of Statistics Malaysia, 2022)

2.9 Pareto Analysis

Pareto analysis is a method for commercial decision-making that is broadly utilized in a variety of other domains, such as welfare economics and quality control. It mostly adheres to the “80-20 rule.” As a tool for making decisions, Pareto analysis statistically distinguishes a small number of good or unpleasant input components that have the most influence on the output (Mark *et al.,* 2015)

According to the Pareto principle, 80% of a project’s benefits may be obtained by completing 20% of the labour, or, in the other direction, 80% of problems can be linked to 20% of the causes. A strong tool for decision-making and measuring quality is Pareto analysis. In the broadest sense, it’s a method for gathering the information required to establish priorities. (Ashok *et al.,* 2012)

Moreover, Pareto analysis is a creative technique of looking at issue causes since it stimulates and organizes cognition. However, it may be constrained by its omission of potentially significant issues, which may be minor at first but have worsen with time. It should be used in conjunction with other analytical methods, such as failure mode and effects analysis and fault tree analysis. The 80-20 rule may be used to identify problems depending on whether they affect earnings, customer complaints, technical difficulties, product defects, or delays and backlogs caused by missed deadlines. Each of these concerns is rated based on the amount of income or sales lost, the amount of time spent, and the number of complaints received. Here is a summary of the Pareto analysis stages (Taman and Tanya, 2015).

I. Identify the issues
II. List or identify the source of the difficulties or problems, keeping in mind that there may be several sources.
III. Score the issues by giving each one a score that prioritizes the issue based on the extent of the negative effect on the firm.
IV. Sort the concerns into categories, such as customer service or system difficulties.
V. Create and execute an action plan to tackle the issues, concentrating initially on the higher-scoring problems.

Not every problem have have a high score, and some minor issues may not be worth addressing at first. Companies may handle problems more effectively by directing resources to high-impact issues or higher scores. These issues have a significant influence on profitability, sales, and consumers.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter covers the approach used to identify risks, which was followed by risk assessments to enhance the safety of construction waste collection and handling on-site. The same process was applied in the area of study. The technique was separated into three sections: hazard identification, risk assessment, and risk control measure recommendations. In general, the Department of Safety and Health's standard HIRARC form have be used to identify, collect, and analyze all of the aforementioned information.

3.2 Research Design

The study collects both primary and secondar y data. Primary data was collected by delivering questionnaires to construction site stakeholders, site workers, etc. Secondary data was collected from archived papers to identify hazards, and a risk matrix ranking was utilized to evaluate and analyze risks and control strategies. To carry out the study, certain stages were devised. Several site visits were made in order to gather data.

There is a clear relationship between the adoption of safety measures and the dangers posed by construction waste disposal on-site. It relies on a variety of variables, including the nature and intensity of the task, the frequency of accidents, the monitoring by relevant authorities, the cost, etc. Consequently, the objective of HIRARC is to identify every hazard-related parameter in order to minimize risk and improve safety. The research design process is shown in Figure 3.1. This process is divided into three phases which is the first phase was the start-up, the second phase is the assessment part and the third phase was the end or review part.

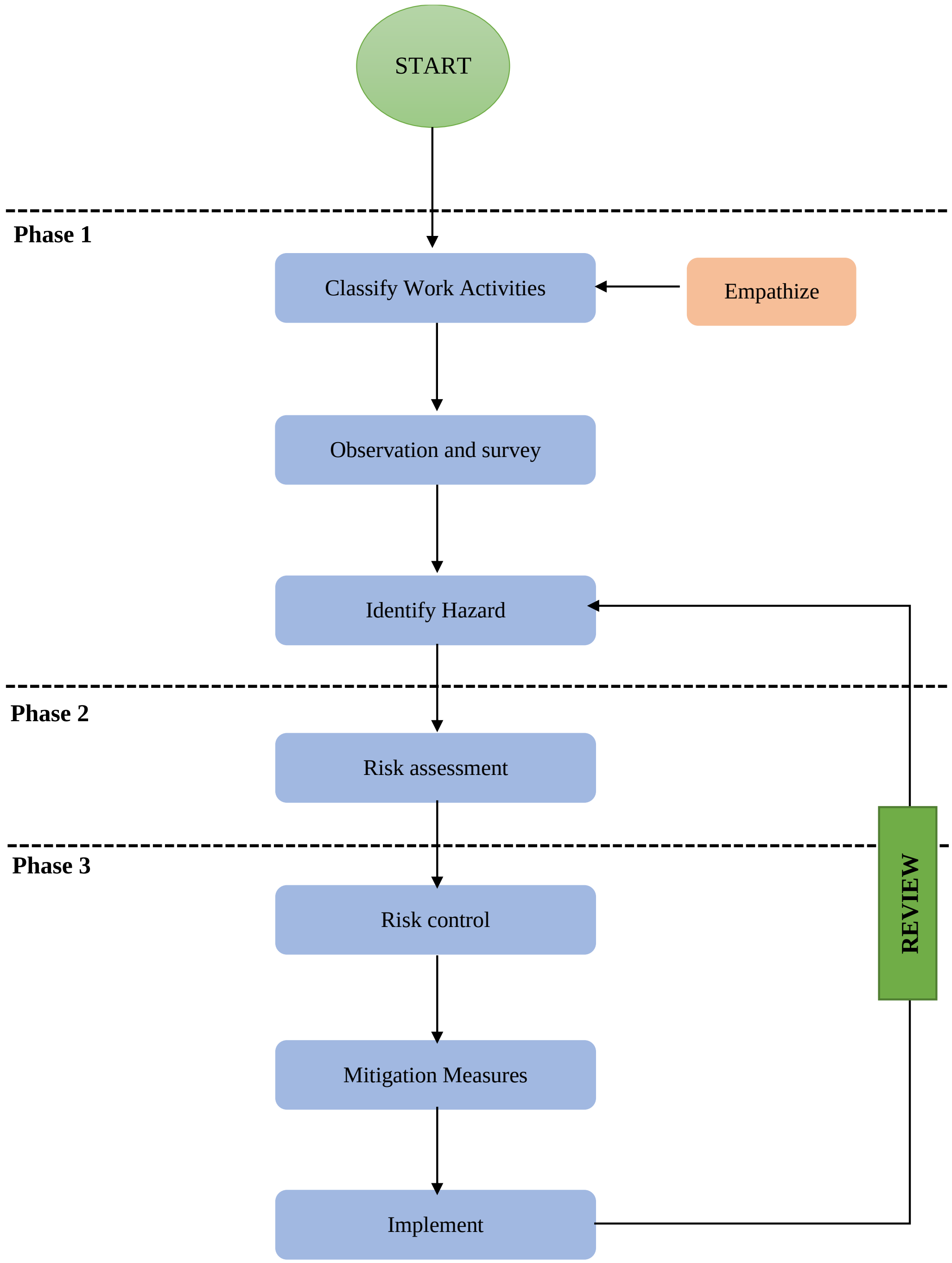

Figure 3.1: Research Framework

3.3 Data Collection

The methodology of this research is divided into several parts. Other concepts were also used to assess the results of research investigations and perform a literature review, as well as to anticipate the project's progress and conduct a literature review. Throughout the process of completing this thesis project, a three-phased methodology have be used to investigate and collect the data analysis of this research.

3.3.1 Phase 1 – Identify the potential risks associated with improper construction waste at a site.

As stated in the research design process, phase 1 consists of identifying the main findings by classifying work activities and a literature review in which the issue related to the study topic have been defined. The classification of activity sources in each task description is the initial stage in this phase of data processing. In this study, hazard events were determined based on the source of the risk and hazard, such as from waste material, machinery, industrial equipment, working environment, and materials utilized in the process of potentially hazardous workers in sites. The information was gathered by direct observation, and questionnaire distribution.

From the data collection that collected after observation and questionnaire, the classification of hazard activities have be consulted with the worker's and employer's opinions and observations by interviewing them to follow the main process of this study which is identifying hazards and potential risks of that happen because of improper construction material collection or waste disposal. In this process, the accident or near misses have be identified by interviewing the stakeholders and workers at construction sites. In general, investigations were conducted for all injuries (even the smallest ones), all incidents with potential for harm (reported and unrecorded), and all "Near Misses" where severe injury was a possibility. Following the identification of the impact, goals for its resolution have be defined along the road to resolution.

3.3.2 Phase 2 – Perform hazard analysis with the severity of an issue to categorize the risks.

Consequently, the process of this study has continued with Phase 2, which analyses the findings from phase 1 by conducting the Risk Assessment. After identifying the hazards, the next step was to analyze the risks by looking at the likelihood, probability of exposure, and possible effects. The categories of current and fundamental risk represent the level of risk that has been examined. To determine the amount of each risk detected, multiplication is done at the current risk category following the intervention, review control, and risk reduction.

This risk assessment categorizes the level of risk by using tools of a risk matrix to find the severity and likelihood of the hazard. This risk matrix have recognize the level of risk, which is from high to low. The combination of these characteristics yields a risk estimate or risk rating. According to research, basic knowledge about dangers and their impacts was required to evaluate the risk rating. The level of the risk was recognized based on the results, and the existing control measure was accessed to strengthen the mitigation measure in the future phase.

3.3.3 Phase 3 – Access the current risk control practices by making suggestions for improvement to reduce the related risk.

In addition to phase 2, the process was followed to Phase 3 by accessing the risk control of existing control to improve this risk control for the identified hazard. Moreover, the process of mitigation measures has been predictable to the high threat level found in risk assessment. Control suggestions are made based on risk identification and risk assessment results at the construction site. The control measure has been recommended better solution for the existing control. The process of proposing alternate solutions to recognized hazards is referred to as the improvement of control. When making control suggestions, engineering considerations or technical controls, administrative elements, and the supply of safety equipment in the form of personal protection equipment tailored to departmental environmental circumstances. This tool was used by the hierarchy of control and have been implemented. The final stage of this process has been a review of phase 1 if the process of is failed at the end stage.

3.4 Sampling Design method

The sampling design technique specifies how the sample units have been chosen. The sampling method is determined by the study goals, the availability of financial resources, time restrictions, and the nature of the research topic. All sampling techniques may be divided into two categories: probability sampling and non-probability sampling. Moreover, the size of the sample is mostly determined by the sort of sampling design applied. The requirements and choices for how the research process have been implemented are laid out in this stage. Given that the interviewers and their colleagues would spend the majority of their time on field duty, a precise definition of the sample plans would make their job simple and save them from having to fix operational issues.

Therefore, for the purpose of gaining a deeper understanding of the hazard identification, risk assessment, and risk management techniques used on construction sites, questionnaires and interviews were used as a tool to gather data for this research. A 40 sample have been chosen and a questionnaire handed out to construction site personnel and employers. Quantitative analysis was performed on the questionnaire and personal interview data. The percentage was computed using simple mathematical techniques. In order to calculate the risk level of such risks, The data from the questionnaire survey were analyzed using XLSTAT to compose the weightage of questionnaire by collect the mode of the frequency in order to compute the risk level of those hazards. Then, the risk assessment results from the weightage index were analyzed using the risk matrix and table of risk analysis, which are derived from probability and severity. Then, they have be using semi-structured interviews with 10 workers, and impressions of the safety situation at the workplace were gathered. Then, using the same sample, a small number of samples have been used to determine the adoption of risk management on building sites.

Adequate hazard identification may involve a substantial amount of work and time. In addition, it may be necessary to do it regularly to guarantee its efficacy. The most successful method for identification is to divide the work into distinct regions and concentrate on those areas. On the basis of this hazardous waste, chemicals, processes, or environment, priority have been given to the most hazardous area and high exposure level. Moreover, the scenario of the hazard also would be conducted based on the situation of the sites and data analysis. This method was not confirmed, but if necessary, means it would happen to collect and prove the statement of research. This process is included in phase 1 until phase 2 to reach the objectives of the thesis.

In addition, from the level of risk assessment found in data analysis, there have been planned risk control or mitigation measure for the hazard that have find out. The improvement of the risk control has been conducted based on the hazard which is the high level of risk. This high-level risk has been found by using the tools of Pareto analysis which is using the rule of 80-20 to find the main causes of the high-level risk happening. The usage of this method was easiest to find the mitigation measure for the appropriate hazard. These also find problems depending on whether they affect technical defects, or delays caused by the impacts. Then, fishbone diagram has been done to identify the cause and effect of the hazards for the selected activities.

From using the Pareto analysis, the next step would be followed to phase 3 which is risk control by improving or finding the mitigation measure for the high risk of hazard. The mitigation measure has been recommended by using instruments according to the pyramid of the hierarchy of control. Based on the high-risk hazard that is identified in construction sites has improved risk control from the least effective which has started with applying PPE, administrative control, engineering control, and substitution and to the most effective which is elimination: physically removing the hazard.

Last but not least, the process has continued with the improvement of risk control. Before the improvement was made, the research article and its item relationship was identified by using Bibliometric analysis. The mitigation measure has been improved based on the analysis to the selected activities. This risk control has been improved among the workers and employers at the construction site to measure the effectiveness of the risk control to the hazard. This has been conducted by distributing the questionnaire to the construction stakeholders to know their satisfaction level to know effectiveness. If the research study was successful at the end of the process it showed that the objectives are achieved. If not, the success it implies, the steps of the process should be reviewed from the first phase.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This study consists of three primary components. The first component involves categorizing work tasks to identify potential work-related dangers. The next component entails evaluating the level of risk through conducting risk assessments. The final component focuses on implementing measures to enhance risk control. The research methodology follows a specific process, which includes data collection through observations, conducting interviews with both professionals and workers and distributing questionnaires across all three phases mentioned in the flowchart. By doing so, the author gathers the perspectives of the respondents regarding the existing issue, which will be used to formulate the problem statement for this study.

In this chapter, all the findings and data obtained from the observation, questionnaire, and site-based interviews are presented and explained. Additionally, this chapter discusses the outcomes related to the objectives of the project. It will provide a justification for the results obtained in relation to the aims of the study and determine whether the objectives have been successfully achieved or not.

4.2 Data Collection and Analysis

The questionnaire was distributed to various respondents, including project managers, engineers, site supervisors, consultants, and clients. Its purpose was to identify the problems occurring on the site and gather viewpoints on how to address these issues. The respondents were asked to provide their opinions on improving the mitigating measures developed by the student. Additionally, interview surveys were conducted with six participants. The obtained results are presented in the form of tables, graphs, and figures to visually illustrate the findings. The data were analyzed using the software of XLSTAT for the questionnaire, Pareto analysis and bibliometric analysis to collect the final analysis data of research.

4.3 Data Analysis - Phase 1

The initial phase of the questionnaire is divided into three parts: A, B, and C. Section A focuses on the demographic profile of the respondents. Section B explores the opinions and professional experiences of the participants regarding the selected work activity. In Section C, the focus shifts to the respondents' perspectives on work hazards. This section specifically emphasizes the classification of activities and the identification of hazards that have arisen at the construction site due to improper construction waste collection. This questionnaire was convenient online survey forms distributed to the WBL industry and other construction industry out there. (Refer appendix 4)

4.3.1 Sociodemographic of Respondents

In general, the survey respondents exhibited a wealth of professional knowledge and extensive experience within the construction industry (Wang, et al., 2019). Therefore, the feedback provided by the respondents effectively shed light on the issues related to hazards resulting from construction waste in Malaysia.

The survey links were shared by almost more than 40-50 people via Facebook, WhatsApp and E-mail. The completion rate of this survey was 90%, indicating that only 40 respondents could properly respond to the survey. In this respondent, the male is leading with 57% than the female with 43%. The respondents involved 7 project directors, 9 project managers, 2 project engineers, 4 site engineers, 4 quantity surveyors, 2 safety and health supervisors, 4 site supervisor and 4 planning engineers. Table 4.1 illustrates the demographic distribution of the participants, revealing that a majority of the informants had a closely related background in building and construction.

Among the respondents, 15.28% held project managerial positions, indicating their involvement in higher-level decision-making roles. Additionally, 90% of the informants had received tertiary education, signifying their academic qualifications. Furthermore, 35% of the participants were experienced professionals in the construction field, boasting over six to ten years of practical work experience. Moreover, 20% of the respondents experienced eleven to fifteen years and 18% of the respondents experienced sixteen to twenty years.

Table 4.1: Sociodemographic of the first questionnaire Respondents

Parameter	**Category**	**Frequency**	**Percentage (%)**
Gender	Male	23	57
	Female	17	43
Age	20-30 year	11	27
	31-40 year	9	22
	41-50 year	10	25
	51-60 year	5	13
	61 years and above	5	13
Academic Qualification	STPM/Certificate	4	10
	Diploma	17	42
	Degree	10	25
	Master	6	15
	PHD	3	8
Designation	Project Director	7	18
	Project Manager	9	23
	Project Engineer	2	5
	Site Engineer	8	20
	Planning Engineer	4	10
	Site Supervisor	4	10
	Quantity Surveyor	4	10
	Safety and Health Supervisor	2	5
Working Experience	6-10 years	14	35
	1-5 years	8	20
	11 - 15 years	8	20
	16-20 years	7	18
	More than 20 years	3	8

4.3.2 Background Information of the Questionnaire

In this section, the background information regarding the respondents' views is examined. Specifically, the focus is on their opinions related to the classified work activity of construction waste management practices on construction sites in Malaysia. The presence of hazards associated with the selected work activities in the respondents' current companies is also investigated. Once the hazardous work activities affecting the safety and health of workers are identified, the study explores the respondents' opinions on the necessity of hazard identification in construction waste management. The respondents are then asked to select multiple hazards that have either occurred or are likely to occur at the construction site based on the work activity. Following this, the study examines the potential causes and effects of the selected work activity hazards in the subsequent process.

4.3.2.1 Part B - Site activity affects the health and safety of employers and employees at a construction site.

Part B of the questionnaire in the first phase focused on classifying work activities that have occurred or are likely to occur at construction sites due to poor management of construction waste disposal. The purpose of this phase was to gather information and insights from the respondents regarding specific work activities that contribute to the improper handling of construction waste on-site. By identifying and categorizing these activities, the study aimed to better understand the challenges and potential areas for improvement in construction waste management practices.

Figure 4.1 reveals the level of perception among professional workers regarding improper construction waste materials handling at construction sites. The findings demonstrate one of the selected work activities, which was identified through surveys and observations, is indeed happening at construction sites. This indicates that the workers are aware of the inadequate waste management practices in the construction industry in Malaysia. However, their willingness to address these issues is impeded by the lack of commitment from management to waste reduction initiatives (Teo and Loosemore, 2001).

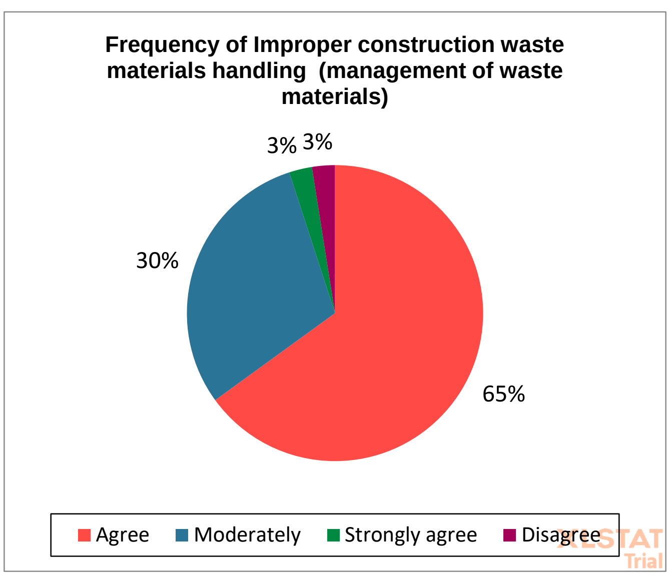

Figure 4.1 Percentage of relative frequency for the first work activity

Based on the information provided in Table 4.2, it can be observed that 65% of the professional workers have agreed on the work activity of improper construction waste materials handling (management of waste materials). This indicates that a majority of the respondents recognize this particular work activity as problematic or in need of improvement. Furthermore, 30% of the respondents have expressed a moderate opinion, suggesting that they consider this work activity somewhat acceptable.

Table 4.2 Results of first work activity data for Descriptive statistics

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
a) Improper construction waste materials handling (management of waste materials)	40	100	26	Agree	26	65
				Moderately	12	30
				Strongly agree	1	2.5
				Disagree	1	2.5

Figure 4.2 provides valuable insights into the perception of professional workers regarding scattered building materials or construction waste on construction sites. The findings indicate that one of the selected work activities, identified through surveys and observations, is indeed taking place at construction sites. Specifically, the first potential hazard identified within the scattered building work activities on the floor is the risk of workers encountering "taken nails" from the building materials scattered on the access road. Additionally, another hazard highlighted is the potential for workers to "stumble" due to the obstruction caused by scattered building materials blocking their access route to the ground floor. This suggests that the workers are aware of the insufficient waste management practices prevalent in the construction industry.

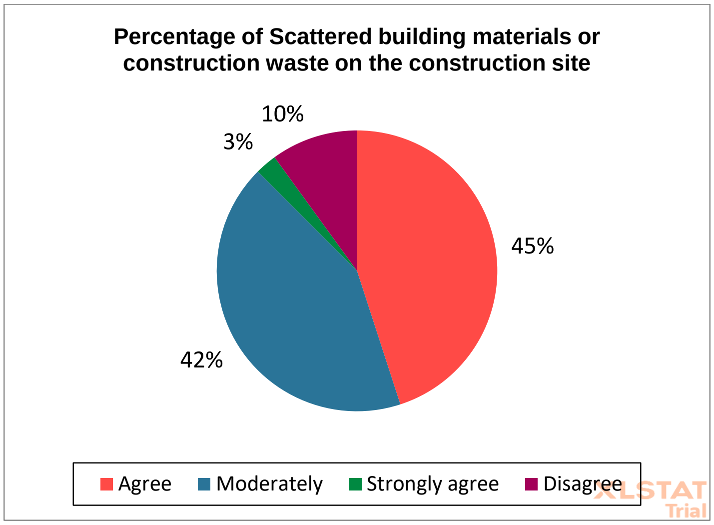

Figure 4.2 Percentage of relative frequency for the second work activity

Based on the information presented in Table 4.3, it is evident that 45% of the professional workers have agreed on the work activity of scattered building materials or construction waste on construction sites. This indicates that a majority of the respondents acknowledge the issue and see the need for improvement in this particular work activity. Additionally, 43% of the respondents have expressed a moderate opinion, suggesting that they have reservations or concerns about the activity but do not strongly disagree. Only 10% of the respondents disagree with the work activity, indicating a minority who do not find it acceptable. Overall, the positive responses outweigh the negative ones, indicating a general acceptance or recognition of the work activity, albeit with some reservations.

Table 4.3 Results of second work activity data for Descriptive statistics

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
b) Scattered building materials or construction waste on the construction site.	40	100	18	Agree	18	45
				Moderately	17	43
				Strongly agree	1	2.5
				Disagree	4	10

Figure 4.3 provides valuable insights into the perception of professional workers regarding poor housekeeping on construction sites. The findings indicate that one of the selected work activities, identified through surveys and observations, is indeed taking place at construction sites. This suggests that the workers are aware of focuses on the issue of inadequate cleanliness or organization on construction sites, indicating a lack of proper waste management practices. This is because there are no inadequate or subpar methods and procedures in place for managing and handling waste materials.

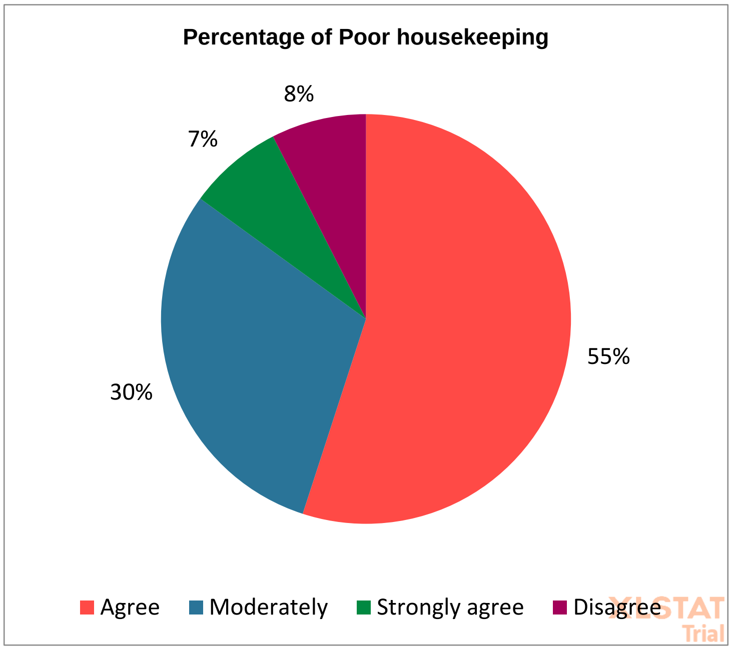

Figure 4.3 Percentage of relative frequency for the third work activity

The data presented in Table 4.4 clearly shows that 55% of the professional workers agree with the work activity of poor housekeeping. This indicates that a majority of the respondents recognize the issue and acknowledge the need for improvement in this specific aspect of their work. Furthermore, 30% of the respondents express a moderate opinion, indicating that they have some reservations or concerns regarding the activity but do not strongly disagree with it. In contrast, only 8% of the respondents disagree with the work activity, representing a minority who do not find it acceptable. Overall, the proportion of agreed responses is higher than that of disagreed responses, suggesting a general acceptance or recognition of the work activity, although with some reservations.

Table 4.4 Results of third work activity data for Descriptive statistics

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
c) Poor housekeeping	40	100	22	Agree	22	55
				Moderately	12	30
				Strongly agree	3	7.5
				Disagree	3	7.5

Figure 4.4 offers valuable insights into how professional workers perceive unsafe behaviour and attitudes of workers, specifically the practice of throwing unused building materials in the surrounding working environment. The findings reveal that this selected work activity, identified through surveys and observations, is indeed observed at construction sites. One potential hazard associated with this work activity on high-level floors is the risk of workers unintentionally hitting others due to their lack of attention to safety measures while throwing unused materials. Additionally, the potential hazard of respiratory disorders arises from the dust generated when workers frequently throw unused building materials, which can easily be inhaled.

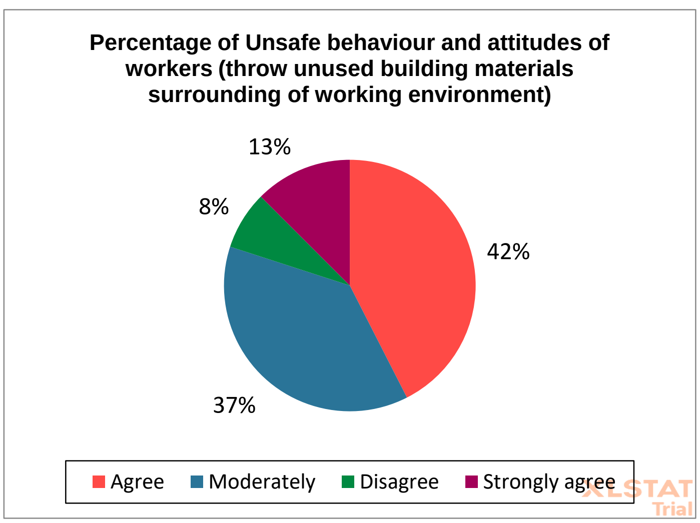

Figure 4.4 Percentage of relative frequency for the fourth work activity

The data presented in Table 4.5 clearly indicates that a significant majority of professional workers, comprising 43% of the respondents, agree with the work activity involving unsafe behaviour and attitudes of workers, particularly the act of throwing unused building materials in the surrounding working environment. This suggests that a majority of the participants recognize the issue and acknowledge the need for improvement in this specific aspect of their work. Additionally, 38% of the respondents express a moderate opinion, while 13% strongly agree, indicating that they have some reservations or concerns about the activity but do not strongly disagree with it. In contrast, only 8% of the respondents disagree with the work activity, representing a minority who do not find it acceptable. Overall, the proportion of respondents who agree with the work activity is higher than those who disagree, indicating a general acceptance of this activity among the participants. As a result, this work activity was deemed suitable to be pursued in the subsequent phases of the methodology.

Table 4.5 Results of fourth work activity data for Descriptive statistics

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
d) Unsafe behaviour and attitudes of workers	40	100	17	Agree	17	43
				Moderately	15	38
				Strongly agree	5	12.5
				Disagree	3	7.5

Figure 4.5 provides valuable insights into the perception of professional workers regarding the unsafe condition of the construction site. The findings indicate that the selected work activity, identified through surveys and observations, is indeed present at construction sites. One potential cause of the unsafe condition is the presence of puddles on the basement stairs, which can lead to workers falling due to the presence of moss resulting from long-standing water that lacks exposure to sunlight. Another potential hazard is the risk of slipping, especially for workers who do not wear safety shoes, as they can easily slip when walking through water puddles. However, the ability of Professional workers to address these issues is impeded by the lack of monitoring from site management to implement waste reduction initiatives.

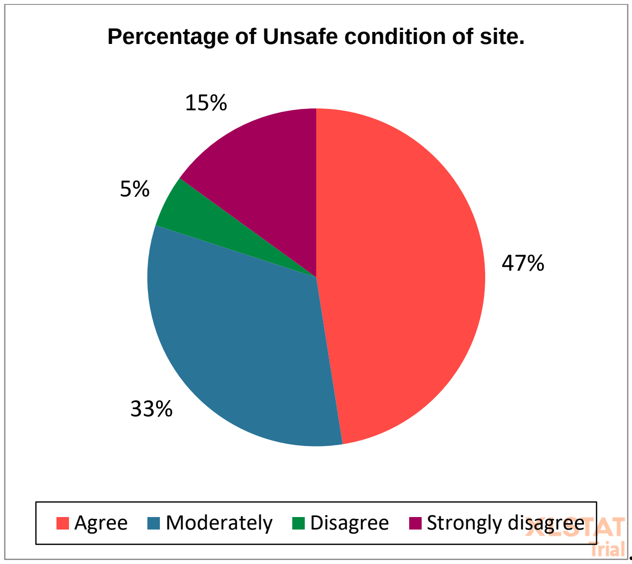

Figure 4.5 Percentage of relative frequency for the fifth work activity

Based on the data presented in Table 4.6, it is evident that 48% of the professional workers agree with the work activity of unsafe condition of the construction site. This majority consensus indicates that a significant portion of the respondents recognize the issue and acknowledge the need for improvement in this aspect of their work. Furthermore, 33% of the respondents express a moderate opinion, indicating that they have some reservations or concerns about the activity but do not strongly disagree with it. On the other hand, 15% strongly disagree with the work activity, representing a minority who strongly oppose it. Only 5% of the respondents disagree with the work activity, further emphasizing the overall acceptance or recognition of the issue. In summary, the data show a general agreement among the respondents regarding the work activity, with some reservations expressed by a portion of the contributors.

Table 4.6 Results of fifth work activity data for Descriptive statistics

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
e) Unsafe condition of the construction site	40	100	19	Agree	19	48
				Moderately	13	33
				Disagree	2	5
				Strongly disagree	6	15

Figure 4.6 offers valuable insights into the perception of professional workers regarding the does not provide separate waste collection bins at construction sites. The findings reveal that the selected work activity, identified through surveys and observations, is indeed prevalent at construction sites. One potential cause of the unsafe condition is the presence of puddles on the basement stairs, which can result in workers slipping and falling due to the accumulation of moss caused by stagnant water that lacks exposure to sunlight. Another potential hazard is the increased risk of slipping, particularly for workers who do not wear safety shoes, as they are more prone to slipping when walking through water puddles. However, the ability of professional workers to address these issues is hindered by the lack of monitoring and commitment from site management to implement waste reduction initiatives.

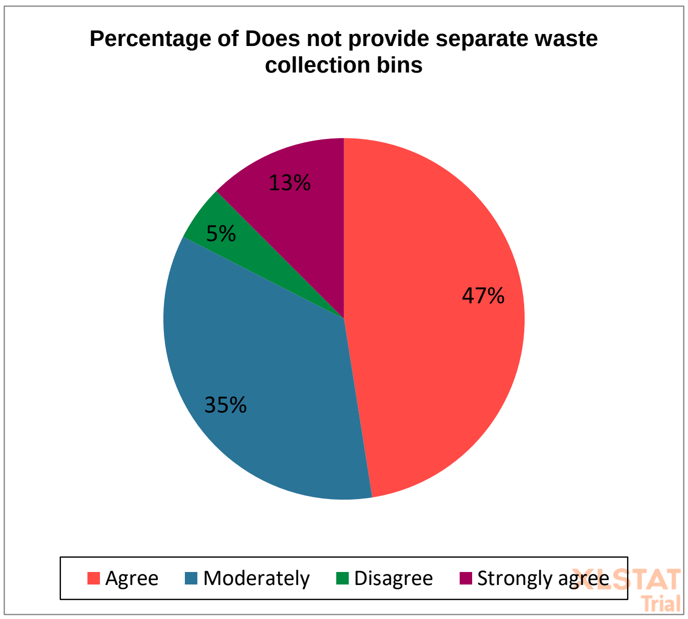

Figure 4.6 Percentage of relative frequency for the sixth work activity

Based on the data presented in Table 4.7, it is evident that 48% of the professional workers agree with the work activity of does not provide separate waste collection bins at the construction site. This majority consensus indicates that a significant portion of the respondents recognize the issue and acknowledge the need for improvement in this aspect of their work. Furthermore, 35% of the respondents express a moderate opinion, indicating that they have some reservations or concerns about the activity but do not strongly disagree with it. On the other hand, 13% strongly disagree with the work activity, representing a minority who strongly oppose it. There 5% of the respondents disagree with the work activity, further emphasizing the overall acceptance or recognition of the issue. In summary, the data show a general agreement among the respondents regarding the work activity, with some reservations expressed by a portion of the contributors.

Table 4.7 Results of sixth work activity data for Descriptive statistics

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
f) does not provide separate waste collection bins	40	100	19	Agree	19	48
				Moderately	14	35
				Disagree	2	5
				S. disagree	5	12.5

Figure 4.7 provides valuable insights into the perception of professional workers regarding the Construction and demolition waste are exposed and unprotected. The findings indicate that the selected work activity, identified through surveys and observations, is indeed present at construction sites. One potential cause of the unsafe condition is the presence of puddles on the basement stairs, which can lead to workers falling due to the presence of moss resulting from long-standing water that lacks exposure to sunlight. Another potential hazard is the risk of slipping, especially for workers who do not wear safety shoes, as they can easily slip when walking through water puddles. The workers, despite being aware of the issues and hazards associated with improper waste management practices, face significant challenges in addressing them due to the absence of commitment from management to implement effective waste reduction initiatives. This lack of commitment creates a barrier that limits the workers' capacity to take appropriate actions and make necessary improvements in waste management on construction sites.

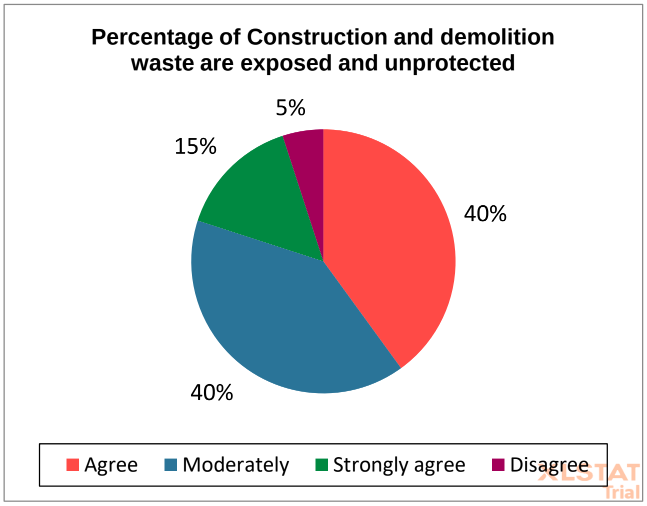

Figure 4.7 Percentage of relative frequency for the seventh work activity

Based on the data presented in Table 4.8, it is evident that 40% of the professional workers agree with the work activity of Construction and demolition waste are exposed and unprotected. This majority consensus indicates that a significant portion of the respondents recognize the issue and acknowledge the need for improvement in this aspect of their work. Furthermore, 40% of the respondents express a moderate opinion, indicating that they have some reservations or concerns about the activity but do not strongly disagree with it. On the other hand, 15% strongly disagree with the work activity, representing a minority who strongly oppose it. Only 5% of the respondents disagree with the work activity, further emphasizing the overall acceptance or recognition of the issue. In summary, the data show a general agreement among the respondents regarding the work activity, with some reservations expressed by a portion of the contributors.

Table 4.8 Results of seventh work activity data for Descriptive statistics

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
g) Construction and demolition waste are exposed and unprotected	40	100	16	Agree	16	40
				Moderately	16	40
				Strongly agree	6	15
				Disagree	2	5

4.3.2.2 Part C - Work activity hazard

In the first phase of the questionnaire, Part C specifically aimed to identify hazards associated with work activities that have either occurred or are likely to occur at construction sites due to poor management of construction waste disposal. The objective of this phase was to gather information and insights from the respondents regarding hazards related to the specific work activities identified in Part B, which contribute to the improper handling of construction waste on-site. Identifying hazards was one of the processes involved in the first process of HIRARC, Hazard Identification. The purpose of identifying and categorizing these hazards was to gain a deeper understanding of the challenges and potential areas for improvement in construction waste management practices. This part was produced with multiple choice hazards, where the respondents was select more than one hazards for each work activities.

Table 4.9 provides insights into the perspectives of professional workers regarding work activity hazards that have occurred and may occur at construction sites, specifically related to the safety and health of workers. The findings indicate that all of the selected work activities, identified through surveys, observations, and interviews with workers at selected sites, are indeed present at construction sites. This suggests that the workers are not aware of the inadequate safety management practices in the Malaysian construction industry. However, their ability to address these issues is delayed by the lack of supervision and oversight from management, particularly in the waste reduction department and safety department at the site.

Therefore, according to Table 4.9 below, it’s related that the work activities hazard depends on an incident that happened at the construction site and the response received from the professional workers that show the incident that happened at their construction site. Hence, from the seven hazards that selected, Improper construction waste materials handling (management of waste materials) was received the highest response to the hazard of Inhalation of gas materials such as Fuel / Exhaust, Fall and trip and striking against, or struck by objects, including falling objects where its show that this work activity was need to survey urgently before any fatality would happen at the construction site.

Moreover, Scattered building materials or construction waste on the construction site received the highest response to the hazard of Exposure to or contact with harmful substances, radiation, or electric shock, Fall and trip and Fall from height which shows that this work activity also needs to take immediate action before any casualty would happen at the construction site. For the work activity poor housekeeping and unsafe behaviour and attitudes of workers (throw unused building materials surrounding of working environment) was received the same highest hazards which the slippery because of unstable floor and fall and trip where its because of improper housekeeping at the construction site.

Furthermore, the unsafe condition of site received the highest response to the hazard of Exposure to or contact with harmful substances, radiations, or electric shock and slippery, this is because of the improper placement of materials and electric wire and sockets at the floor of the site walking. Work activity of does not provide separate waste collection bins received the highest response to the hazard of Inhalation of gas materials such as Fuel / Exhaust and Environmental issues (Air, Water and etc pollution), because of does not provide separate waste bin, workers have collected all the waste in same bin, the glass, rebar or metals, concrete, and so on was collected in one Roro bin were make the environmental issues such as land pollution, air pollution posing a serious health hazard to the workers.

Among the selected work activities, "Construction and demolition waste is exposed and unprotected" has been identified as posing the highest hazards in terms of environmental issues such as air and water pollution, as well as the risk of falls and trips. This indicates that the improper management of construction and demolition waste can have significant impacts on the environment, including pollution, and can also pose risks to the safety of workers. It highlights the importance of implementing appropriate measures to protect the environment and ensure the safety of workers by addressing the hazards associated with the exposure and lack of protection of construction and demolition waste.

Table 4.9 Results for the work activity hazards that received the highest response.

Work Activities	Hazards received the highest response	Numbers of response
Improper construction waste materials handling (management of waste materials)	Inhalation of gas materials such as Fuel / Exhaust	20
	Fall and trip	10
	Striking against, or struck by objects, including falling objects	15
Scattered building materials or construction waste on the construction site	Exposure to or contact with harmful substances, radiations or electric shock	19
	Fall from height	15
	Fall and trip	12
Poor housekeeping	Slippery	16
	Fall and trip	11
Unsafe behaviour and attitudes of workers (throw unused building materials surrounding of working environment)	Slippery	17
	Fall and trip	20
Unsafe condition of site	Exposure to or contact with harmful substances, radiations, or electric shock	18
	Slippery	17
Does not provide separate waste collection bins	Inhalation of gas materials such as Fuel / Exhaust	18
	Environmental issue (Air, Water and etc pollution)	17
Construction and demolition waste are exposed and unprotected	Environmental issue (Air, Water and etc pollution).	17
	Fall and trip	10

4.4 Data Analysis - Phase 2

The second phase of the questionnaire consists of three sections: A, B, and C. Section A gathers demographic information about the respondents, providing a profile of the participants. Section B focuses on capturing the opinions and professional experiences of the respondents regarding the likelihood of hazards associated with the selected work activities. This section aims to understand the perception of the respondents regarding the probability of encountering these hazards in their work environment. (Refer Appendix 5)

In Section C, the focus shifts to the severity of the hazards associated with the work activities. This section involves conducting a risk assessment to assess the level of risk posed by these activities. Risk assessment involves examining various situations, processes, and potential hazards present in the workplace. The objective is to identify and estimate the risks associated with these activities thoroughly. The risks identified are then communicated through various means to effectively convey the distribution of risk across different areas of the workplace. To collect data for this questionnaire, convenient online survey forms were distributed to professionals working in the Work-Based Learning (WBL) industry and other sectors of the construction industry. This method allowed for easy and efficient data collection, reaching a wide range of respondents in the target industries.

4.4.1 Sociodemographic of Respondents

The second questionnaire followed a similar approach to the first questionnaire in terms of data collection. Survey links were shared through various channels such as Facebook, WhatsApp, and email, reaching out to approximately 40-50 individuals. The completion rate of the survey was high at 90%, with 40 respondents providing valid responses. In terms of gender distribution, male respondents constituted the majority at 63%, while female respondents accounted for 37% of the participants. The respondents included individuals from different roles in the construction industry, including 8 project directors, 9 project managers, 8 safety and health supervisors, and 15 site supervisors.

Table 4.10 provides an overview of the demographic distribution of the participants, indicating that a significant proportion of the respondents had backgrounds closely related to building and construction. Around 43% of the respondents held project managerial positions, highlighting their involvement in decision-making roles at a higher level. Moreover, 92% of the participants had tertiary education, indicating their academic qualifications.

Regarding work experience, 35% of the respondents had one to five years of experience, while 20% were experienced professionals with six to ten years of practical work experience in the construction field. Furthermore, 18% of the respondents had eleven to fifteen years of experience, and another 20% had sixteen to twenty years of experience. Overall, the second questionnaire had a good response rate and attracted participants from diverse roles and experience levels in the construction industry, providing valuable insights into the perceptions and experiences of professionals in the field.

Table 4.10: Sociodemographic of the Respondents for second questionnaire

Parameter	**Category**	**Frequency**	**Percentage (%)**
Gender	Male	25	63
	Female	15	37
Age	20-30 year	9	22
	31-40 year	11	27
	41-50 year	5	13
	51-60 year	10	25
	61 years and above	5	13
Academic Qualification	STPM/Certificate	3	8
	Diploma	10	25
	Degree	17	42
	Master	6	15
	PHD	4	10
Designation	Project Director	8	20
	Project Manager	9	23
	Site Supervisor	15	38
	Safety and Health Supervisor	8	20
Working Experience	6-10 years	8	20
	1-5 years	14	35
	11 - 15 years	7	18
	16-20 years	8	20
	More than 20 years	3	8

4.4.2 Background Information of the Questionnaire

In this section, the study focuses on gathering information about the respondents' views and opinions based on risk assessments conducted at construction sites regarding work activity hazards related to construction waste management practices in Malaysia. The aim is to understand the presence of hazards associated with these work activities in the respondents' respective companies. The study investigates the risk levels of hazardous work activities that impact the safety and health of workers.

It also explores the existing risk control measures implemented at the selected sites. The respondents are required to select a hazard that they perceive to have either a likelihood or severity of incidents scale at the construction site, based on the work activity hazards identified. Furthermore, the study examines the potential causes and effects of the selected work activity hazards in subsequent processes. This analysis helps in understanding the underlying factors contributing to these hazards and the potential consequences they can have on the construction site and workers' safety and health.

4.4.2.1 Part B and Part C - Risk Assessment – (Likelihood x Severity)

Part B of the questionnaire in the second phase aimed to conduct a Risk Assessment for the likelihood of hazards associated with poor management of construction waste disposal at construction sites. The objective of this phase was to gather information and insights from the respondents regarding the impact level and recurrence of risks that contribute to the improper handling of construction waste on-site. The respondents were asked to provide their views and opinions on the likelihood of different hazards occurring based on the available information. By identifying and categorizing the risk level, the study aimed to gain a better understanding of the challenges and potential areas that require urgent improvement in construction waste management safety practices.

The Risk Assessment process involved estimating the probability of hazards occurring, as well as their potential consequences. This information would help in identifying the level of risk associated with each hazard and prioritizing necessary measures to mitigate those risks. Overall, the goal was to gain insights into the existing risk landscape and highlight areas where improvements are needed in construction waste management safety practices.

According to the data presented in Table 4.11, the risk assessment results were obtained through observations and interviews conducted with professional workers and workers at construction sites. To ensure the flexibility and inclusiveness of the collected data, a questionnaire was distributed to various construction industries to gather their perceptions on these issues. The findings of the risk assessment indicate that the level of risk associated with the selected work activities and their hazards in Malaysia is still not adequately recognized by professional workers and workers. This suggests a lack of awareness regarding the potential risks involved in these activities.

However, despite their lack of awareness, the respondents expressed a willingness to address these issues. Unfortunately, their efforts to mitigate the risks are hindered by the lack of commitment from management to implement waste reduction initiatives. This highlights the importance of organizational support and management involvement in addressing the identified risks. During the risk analysis process, various factors were considered, including the effects of recognized risks on project objectives, manageability, timing, probability of occurrence, and their relationship to other risks.

These factors were taken into account to gain a comprehensive understanding of each risk type and to develop appropriate approaches for mitigating them. By considering these factors and adopting suitable risk mitigation strategies, the capacity to effectively manage and reduce risks can be enhanced. This approach aligns with the principles outlined by Jaber (2019), which emphasize the need for an adequate and appropriate approach to mitigating risks in construction projects.

1. Activity 1 (Improper construction waste materials handling (management of waste materials)):

   Based on the risk assessment results presented, three potential hazards have been identified and assessed for their likelihood and severity, resulting in corresponding risk values. The first potential hazard is the inhalation of gas materials such as fuel or exhaust, which has been assigned a likelihood rating of 4 and a severity rating of 4. The resulting risk value is 16, indicating a high level of risk associated with this hazard. The second potential hazard is falls and trips, with a likelihood rating of 3 and a severity rating of 5. The calculated risk value is 15, also indicating a high level of risk. The third potential hazard is striking against or being struck by objects, including falling objects. It has been assigned a likelihood rating of 4 and a severity rating of 4, resulting in a risk value of 16, again indicating a high level of risk.

Through on these risk assessments, it is evident that these activities pose significant risks to the safety and health of workers. The risk values indicate a high level of potential harm and the need for immediate control measures to mitigate these risks. The identified hazards should be addressed promptly to prevent any potential fatalities or near-miss incidents among the workers.

2. Activity 2 (Scattered building materials or construction waste on the construction site):

   Based on the risk assessment results provided, three potential hazards have been identified and evaluated for their likelihood and severity, resulting in corresponding risk values. The first potential hazard is exposure to or contact with harmful substances, radiations, or electric shock, which has been assigned a likelihood rating of 4 and a severity rating of 5. The calculated risk value is 20, indicating a high level of risk associated with this hazard.The second potential hazard is falls and trips, with a likelihood rating of 4 and a severity rating of 5. The resulting risk value is also 20, indicating a high level of risk.

   The third potential hazard is falls from height, which has been assigned a likelihood rating of 4 and a severity rating of 4. The calculated risk value is 16, indicating a high level of risk. These risk assessments clearly demonstrate that these activities present significant risks to the safety and health of workers. The high-risk values indicate a substantial potential for harm, emphasizing the urgency of implementing control measures to mitigate these risks. It is crucial to address these identified hazards promptly to prevent potential consequence or incidents happen among the workers.

3. Activity 3 (Poor housekeeping):

   Based on the risk assessment results provided, two potential hazards have been identified for the housekeeping activity, namely slippery surfaces and falls and trips. Both hazards have been assigned a likelihood rating of 3 and a severity rating of 3, resulting in a risk value of 9 for each hazard. These risk values indicate a medium level of risk associated with these hazards.

The medium level of risk suggests that there is a probability of exposure to these hazards, ranging from 40% to 39%, and the potential outcomes may result in minor injuries. However, it is important to note that even though the risk level is medium, these hazards still pose a significant risk to the safety and health of workers.

4. Activity 4 (Unsafe behaviour and attitudes of workers (throw unused building materials surrounding of working environment)):

    Based on the risk assessment results provided, two potential hazards have been identified for the unsafe behavior and attitudes of workers activity: slippery surfaces and falls and trips. The first hazard, slippery surfaces, has been assigned a likelihood rating of 3 and a severity rating of 3, resulting in a risk value of 9, indicating a medium level of risk. The second hazard, falls and trips, has a likelihood rating of 3 and a severity rating of 2, resulting in a risk value of 6, indicating a low-medium level of risk.

    The medium level of risk for slippery surfaces suggests a probability of exposure ranging from 40% to 39%. This means that there is a significant chance of encountering slippery surfaces during the housekeeping activity, which could result in minor injuries to workers. The low-medium level of risk for falls and trips indicates a probability of exposure ranging from 10% to 39%, suggesting a lower but still notable likelihood of incidents occurring.

    It is important to recognize that even though the risk level is categorized as medium or low-medium, these hazards still pose a significant risk to the safety and health of workers. Minor injuries can lead to discomfort, reduced productivity, and potential long-term effects on the well-being of workers.

5. Activity 5 (Unsafe condition of site):

    Based on the risk assessment results provided, three potential hazards have been identified for the unsafe condition of site activity: exposure to harmful substances, radiations, or electric shock, and slippery surfaces. The first hazard has been assigned a likelihood rating of 3 and a severity rating of 4, resulting in a risk value of 12, indicating a medium level of risk. The second hazard, slippery surfaces, has a likelihood rating of 2 and a severity rating of 2, resulting in a risk value of 4, indicating a low level of risk.

The medium level of risk for exposure to harmful substances, radiations, or electric shock suggests a probability of exposure ranging from 40% to 39%. This indicates that there is a significant chance of encountering these substances or hazards during the housekeeping activity, which could result in moderate to severe health effects for workers.

It is important to implement appropriate safety measures and provide workers with proper training and protective equipment to minimize the risk associated with this hazard. The low level of risk for slippery surfaces indicates a probability of exposure of less than 10%. While the likelihood of incidents occurring is relatively low, it is still essential to address this hazard to prevent slips, trips, and falls, which can lead to injuries.

6. Activity 6 (Does not provide separate waste collection bins):

Based on the risk assessment results provided, two potential hazards have been identified for the activity of not providing separate waste collection bins. The first hazard is the inhalation of gas materials such as fuel/exhaust, which has been assigned a likelihood rating of 3 and a severity rating of 3, resulting in a risk value of 9, indicating a medium level of risk. The second hazard is environmental issues (air, water, etc. pollution), with a likelihood rating of 4 and a severity rating of 3, resulting in a risk value of 12, also indicating a medium level of risk.

The medium level of risk for the inhalation of gas materials such as fuel/exhaust suggests a probability of exposure ranging from 40% to 39%. This indicates that there is a significant chance of workers coming into contact with these substances during the activity of improper waste collection, which can lead to moderate to severe health effects. It is crucial to implement proper safety measures, provide appropriate training to workers, and ensure the use of protective equipment to minimize the risk associated with this hazard.

The medium level of risk for environmental issues indicates a probability of exposure ranging from 40% to 39%. This emphasizes the importance of addressing this hazard to prevent health problems such as lung infections, skin infections, and other issues related to environmental pollution caused by the improper collection of construction waste. Proper waste management practices, including the provision of separate waste collection bins, can significantly reduce the risk of environmental pollution and its associated health hazards.

Overall, it is essential to prioritize the health and safety of workers by implementing effective waste management practices and control measures. This includes providing training on proper waste disposal methods, ensuring the availability of separate waste collection bins, and promoting environmental awareness in construction sites. By addressing these hazards and mitigating associated risks, the well-being of workers and the surrounding environment can be safeguarded.

7. Activity 7 (Construction and demolition waste are exposed and unprotected):

Based on the risk assessment results provided, two potential hazards have been identified for the activity of Construction and demolition waste being exposed and unprotected. The first hazard is environmental issues such as air and water pollution, which has been assigned a likelihood rating of 3 and a severity rating of 2, resulting in a risk value of 6, indicating a low-medium level of risk. The second hazard is falls and trips, with a likelihood rating of 3 and a severity rating of 2, resulting in a risk value of 6, also indicating a low-medium level of risk.

The low-medium level of risk for falls and trips indicates a probability of exposure ranging from 10% to 39%. This suggests that there is a notable likelihood of incidents occurring, such as workers encountering waste materials and potentially experiencing falls or trips as a result. It is important to address this hazard by implementing safety measures, such as proper storage and disposal of waste materials, maintaining clean and organized work areas, and providing workers with adequate training on identifying and navigating potential fall and trip hazards.

Table 4.11: Level of Risk Assessment for the selected hazard

Work Activities	Hazards identified	Risk Assessment		Risk Value	Risk Level
		Likelihood	Severity		
Improper construction waste materials handling (management of waste materials)	Inhalation of gas materials such as Fuel / Exhaust	4	4	16	High
	Fall and trip	3	5	15	High
	Striking against, or struck by objects, including falling objects	4	4	16	High
Scattered building materials or construction waste on the construction site	Exposure to or contact with harmful substances, radiations or electric shock	4	5	20	High
	Fall from height	4	5	20	High
	Fall and trip	4	4	16	High
Poor housekeeping	Slippery	3	3	9	Medium
	Fall and trip	3	3	9	Medium
Unsafe behaviour and attitudes of workers (throw unused building materials surrounding of working environment)	Slippery	3	3	9	Medium
	Fall and trip	3	2	6	L-Medium
Unsafe condition of site	Exposure to or contact with harmful substances, radiations, or electric shock	3	4	12	Medium
	Slippery	2	2	4	Low
Does not provide separate waste collection bins	Inhalation of gas materials such as Fuel / Exhaust	3	3	9	Medium
	Environmental issue (Air, Water and etc pollution)	4	3	12	Medium
Construction and demolition waste are exposed and unprotected	Environmental issue (Air, Water and etc pollution).	3	2	6	L-Medium
	Fall and trip	3	2	6	L-Medium

4.5 Pareto Analysis To Identification Of The Immediate Action Needed Activity

Controlling the high-risk improper construction waste management work activity is crucial for maintaining effective quality and safety standards. One of the tools that can be utilized for controlling risks is Pareto Analysis. Figure 4.8 presents a Pareto chart displaying the results obtained from the HIRARC Analysis. The risk scores obtained are ranked using the Pareto principle.

According to the Pareto chart, it can be observed that the hazard of scattered building materials or construction waste on the construction site has the highest score, indicating it as the most critical risk to address. This is followed by the hazard of improper construction waste materials handling (management of waste materials) and the absence of separate waste collection bins. Poor housekeeping is ranked as the least significant risk among the identified hazards.

The Pareto principle suggests that a significant portion of the effects often comes from a small number of causes. In this context, the Pareto chart helps prioritize and focus efforts on the most influential risks that contribute to the improper construction waste management. By addressing the top-ranked hazards, such as controlling scattered building materials and improving waste materials handling practices, organizations can effectively reduce the overall risk associated with construction waste management.

It is important to note that while poor housekeeping is ranked as the least level of risk, it should not be overlooked. Maintaining good housekeeping practices is still crucial for ensuring a safe and organized work environment. Even though it may have a relatively lower risk level compared to other hazards, poor housekeeping can still contribute to incidents and should be addressed to promote overall safety and efficiency.

By applying the 80-20 rule, the Pareto chart confirms that the three hazards of Scattered building materials or construction waste on the construction site, Improper construction waste materials handling (management of waste materials), and Does not provide separate waste collection bins account for 81.97% of the total hazard issues. This aligns with the principle that a small number of causes contribute to a significant portion of the effects.

Based on the Pareto chart, these three hazards should be the main focus when implementing control measures to address safety issues in construction sites. Allocating resources and efforts towards controlling these hazards can lead to a more efficient and effective risk management approach. It is important to note that the priority of control measures should be set according to the decreasing order of the hazards on the Pareto chart. The hazard of Scattered building materials or construction waste on the construction site should receive the highest priority, as it contributes the most to the risk score. The hazard of Improper construction waste materials handling (management of waste materials) should be the next priority, followed by the hazard of Does not provide separate waste collection bins. Poor housekeeping, which ranked as the least significant risk, can be addressed with a lower priority. Additionally, the due dates for implementing control measures can also be set based on the priority established by the Pareto chart.

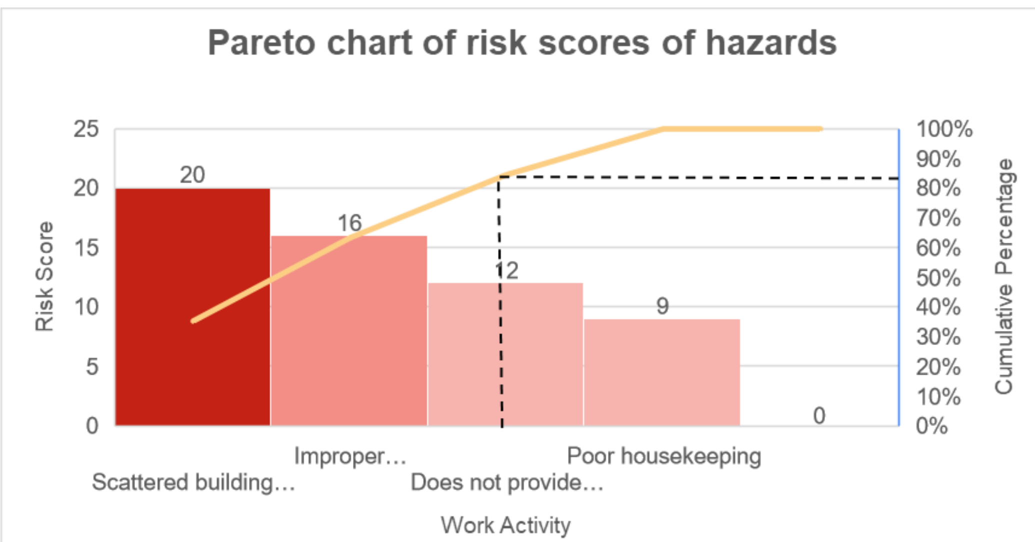

Figure 4.8 Pareto analysis chart of the most high-risk hazards

4.6 Fishbone Diagram (Cause-and-Effect Diagram) Analysis of the main work activity

Figure 4.9 shows the fishbone diagram analysis to find out the cause and effect of the selected most four main risk level need to improve the control measure. The first activity Scattered building materials or construction waste on the construction site was caused by mankind factors are due to workers that are inexperienced, unprotected when working, and unawareness of safety when handling materials or construction waste, improper placement of electric appliances. There, are scattered sharp materials such as wood with sharp nails that do not take out from it, rebar are on the floor are not properly arranged, and electric wires and power plugs like extension wires are placed on the wet areas not properly guarded. This can effect the workers by happen some errors due to improper workplace design. Moreover, this was also contact with exposed wires and contact with high body injury such as nails striking, electric shock, and etc.

Secondly, the improper handling and management of construction waste materials can be attributed to various human factors, including unsafe behavior and attitudes of workers, as well as unstable floors at the construction site. These factors contribute to the ineffective disposal and cleanup of waste materials, posing risks to workers' safety and health.

One of the reasons for improper waste management is the failure of workers to follow proper procedures and guidelines for handling and disposing of waste. Workers may exhibit unsafe behavior by neglecting to clean up the waste immediately after completing their work activities. Instead, they leave the waste scattered around the working area, leading to a hazardous and unstable environment. The presence of unstable floors can further exacerbate the issue. Improperly disposed waste materials can contribute to an unstable floor condition, increasing the likelihood of falls and trips for workers. This poses a direct risk to their safety and can result in injuries.

Moreover, the improper disposal of waste materials can also have adverse effects on workers' health. If hazardous materials are not appropriately disposed of, workers may come into contact with harmful substances, leading to illnesses or other health issues. To address these challenges, it is crucial to focus on improving worker behaviour and attitudes towards waste management. Proper training and awareness programs can help educate workers about the importance of following waste management protocols and maintaining a clean working environment. Additionally, implementing measures to ensure the stability of floors and providing designated waste collection bins can promote safer and more efficient waste management practices at construction sites.

The failure to provide separate waste bin collection for different types of waste can have significant implications for workers' health and well-being. When waste is indiscriminately thrown into a single waste bin without proper separation, it can lead to several health issues for the workers. One of the potential health risks is the inhalation of bad smells and air pollution resulting from mixed waste. This can lead to respiratory problems as workers breathe in the contaminated air. The presence of harmful substances and pollutants in the air can irritate the respiratory system, causing breathing difficulties, coughing, and other respiratory ailments.

Additionally, the improper disposal of waste without separation can contribute to the spread of bacteria and other pathogens. Workers who come into contact with the waste, either directly or indirectly, are at risk of developing skin infections. The presence of hazardous materials in the waste can also increase the likelihood of workers contracting lung infections and other serious health conditions. To mitigate these health risks, it is essential to implement proper waste management practices that include separate waste bin collection for different types of waste. This enables the appropriate disposal and treatment of waste, reducing the potential for air pollution and the spread of harmful pathogens. Providing workers with personal protective equipment, such as masks and gloves, can also help minimize their exposure to hazardous substances and protect their health.

Poor housekeeping practices can significantly contribute to the improper management of construction waste and create an unsafe working environment. When there is a lack of emphasis on maintaining cleanliness and orderliness at the construction site, various hazards can arise, increasing the risk of bodily injuries for workers. One of the potential risks associated with poor housekeeping is the increased likelihood of workers striking against objects. When construction waste is scattered and not properly organized, there is a higher chance of workers accidentally colliding with objects, leading to injuries such as bruises, cuts, or even fractures. Additionally, the presence of sharp materials that have not been properly disposed of or stored can pose a significant danger, as workers may inadvertently step on or fall onto these materials, resulting in puncture wounds or more severe injuries.

Furthermore, inadequate supervision of housekeeping work can exacerbate the situation. Without proper oversight and monitoring, the cleanliness and organization of the construction site may deteriorate, creating an environment where hazards are more likely to occur. A lack of accountability and enforcement of housekeeping standards can contribute to a disregard for safety measures and an increased risk of accidents and injuries. To address these issues, it is crucial to prioritize and enforce good housekeeping practices on construction sites. This includes regular clean-up and removal of construction waste, proper storage and disposal of materials, and maintaining clear and organized work areas. Effective supervision and regular inspections are necessary to ensure that housekeeping standards are being met and maintained consistently throughout the construction project.

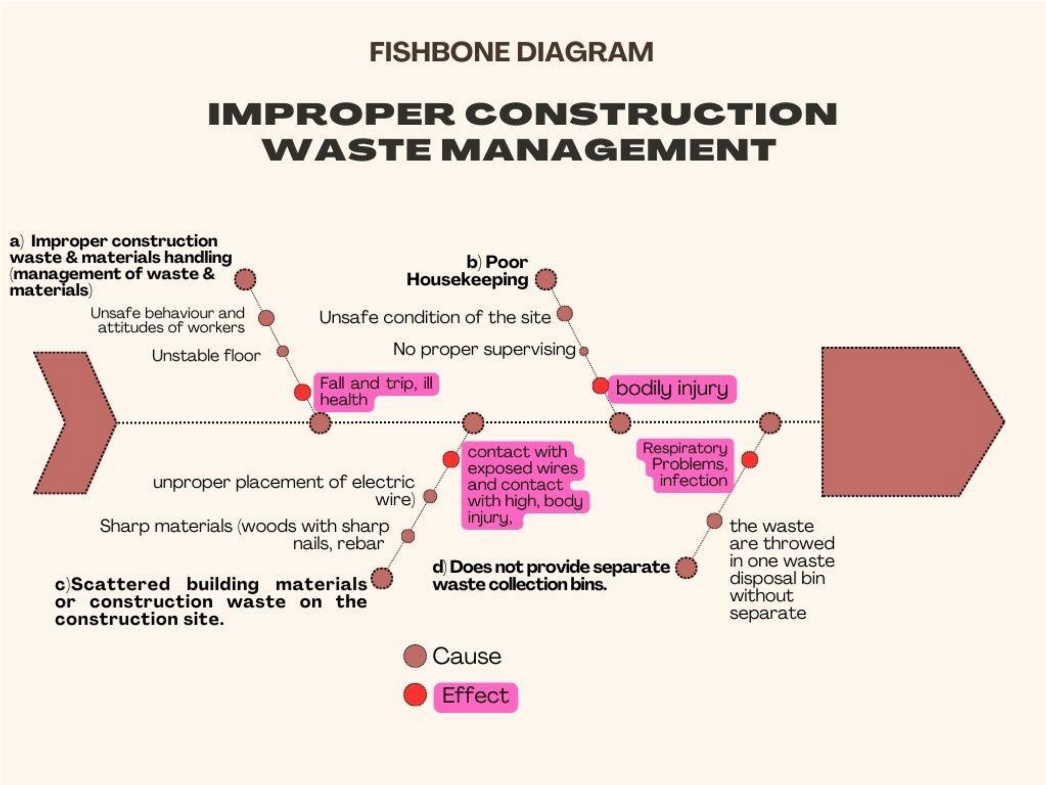

Figure 4.9 Fishbone diagram for the most high-risk hazards

4.7 Bibliometric analysis for improvement of risk control

The aim of using this method is to quantify the documents referring to bibliometric analysis as a working tool in the following thesis to know the relationship between the research studies for further analysis of the improvement made through the hierarchy of control for the existing risk control of work activities. Before improvement was made to the existing control, the researcher has been accessing the existing control that made at industries for the particular work activities. (Refer Appendix 2)

It is concerning to note that the existing risk control measures are not being effectively implemented or followed by the workers on the construction site. Even with flexible risk control measures in place, it appears that there is a lack of awareness, adherence, and enforcement of these controls. Non-compliance with risk control measures can significantly undermine the effectiveness of safety protocols and increase the likelihood of accidents and incidents. When workers do not give proper attention to the established rules and guidelines, they are more susceptible to potential hazards and their associated risks. This not only puts their own safety at risk but also impacts the overall safety and health of everyone on the construction site.

In addition to worker non-compliance, the lack of supervision and enforcement by professional workers further exacerbates the situation. Supervisors and professionals on the construction site play a crucial role in ensuring that workers follow the established safety protocols and risk control measures. If they neglect their supervisory responsibilities and do not actively monitor and enforce compliance, it can contribute to an environment where safety standards are not upheld. To address these issues, it is necessary to promote a culture of safety and foster greater awareness and understanding among all workers, including both professional workers and general workers.

4.7.1 Network Visualization of the research article authors

The network visualization in Figure 4.10 provides a graphical representation of the relationship and relatedness of journals in terms of co-citation links. The proximity of all journals in the visualization indicates their level of relatedness, with closer journals indicating stronger connections. The strength of co-citation links between journals is represented by lines. In the context of this thesis, the network visualization identified that the research article has a significant degree of networking with more than 40 other articles, accounting for approximately 57.50% total link of strength of the overall relatedness. This indicates a substantial interconnectedness between the collected data and the research data, highlighting the integration and utilization of various sources to support the research.

Furthermore, the network visualization also incorporates visual cues to convey additional information. The size of the label and the circle representing an item indicate its weight or importance, with larger sizes indicating higher significance. The color of an item denotes the cluster to which it belongs, helping to identify distinct groups or categories within the network. The lines connecting the items represent the co-citation links between the articles, illustrating the interconnections between them. For instances, there are 176 links from 119 items for this research articles was calculated.

Overall, the network visualization provides a comprehensive view of the relationships and connections among the research articles, offering insights into the degree of relatedness and the weight/importance of individual items. It serves as a valuable tool for understanding the scholarly landscape and identifying key references or sources of information in the field of study.

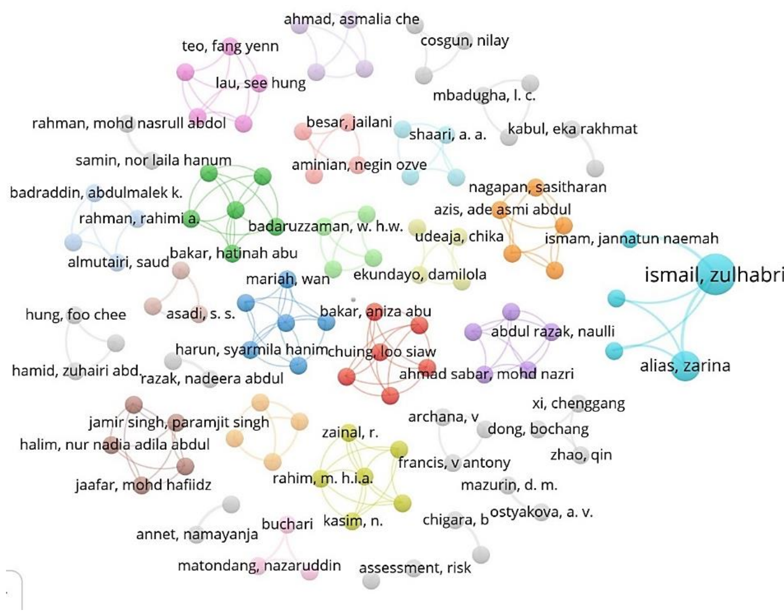

Figure 4.10 Networking Visualization of bibliometric analysis

4.7.2 Overlay Visualization of the research article authors

The overlay visualization in Figure 4.11 incorporates a color bar in the bottom right corner of the visualization. The presence of the color bar indicates that the colors used in the visualization are determined by the scores of the items being represented. In this particular case, the colors in the overlay visualization represent the impact factors of journals. The color bar provides a reference for mapping the scores to specific colors. For instance, journals colored in shades of blue to purple indicate impact factors below 0.999. Journals colored in green are associated with an impact factor around 1.001, while journals colored in yellow have an impact factor of 1.002 or higher. By using colors to represent the impact factors of journals, the overlay visualization allows for a visual understanding of the varying degrees of impact or influence that different journals have in the field. It provides a quick and intuitive way to identify and differentiate journals based on their impact factors, aiding researchers in assessing the significance and relevance of the articles and sources being analyzed.

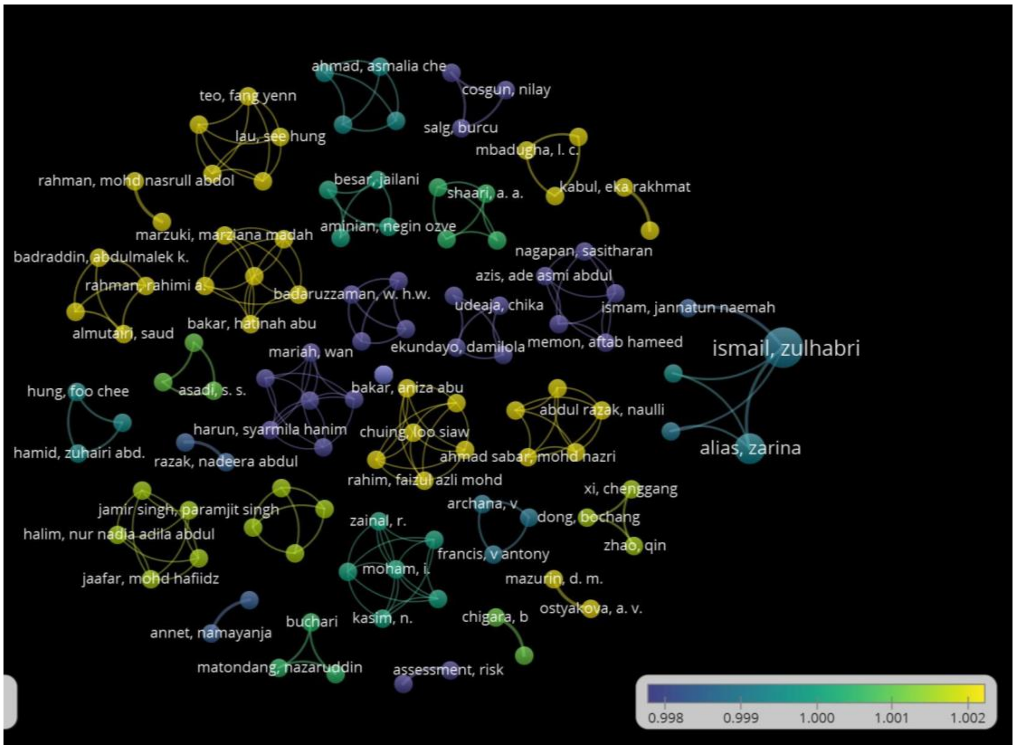

Figure 4.11 Overlay Visualization of bibliometric analysis

4.7.3 Item Density Visualization of the research article authors

In the density visualization presented in Figure 4.12, each item is represented by a label, similar to the network and overlay visualizations. However, the main feature of density visualization is the use of colours to represent the density of items at each point. The colour of each point in the density visualization indicates the density of items in its neighbourhood. If a point has a larger number of items in its vicinity and those items have higher weights, the colour of the point will be closer to yellow. This signifies a higher density of items and indicates a stronger presence or influence of those items in the surrounding area.

On the other hand, if a point has a smaller number of items in its neighborhood and those items have lower weights, the colour of the point will be closer to blue. This indicates a lower density of items and suggests a weaker presence or influence of items in that area. By visualizing the density of items using colors, the density visualization helps to identify areas of higher and lower concentration of items. It provides insights into the distribution and clustering of items, allowing researchers to explore patterns and relationships within the data.

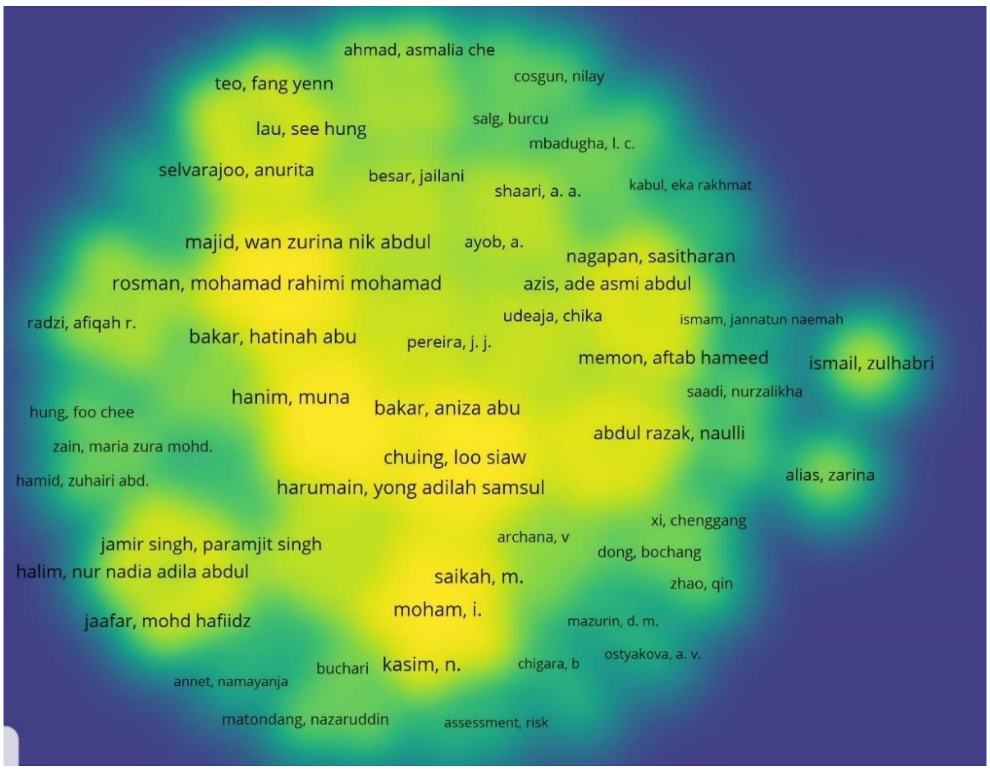

Figure 4.12 Item Density Visualization of bibliometric analysis

4.7.4 Cluster Density Visualization of the research article authors

In the cluster density visualization depicted in Figure 4.13, the colour of each point in the visualization is determined by the clusters to which the items belong. To generate the colour of a certain point, the colours of different clusters are mixed together based on their weights. The cluster density visualization is only available if the items have been assigned to clusters. In this case, the cluster calculation resulted in 37 clusters from the more than 40 articles. The weight given to the colour of a specific cluster is determined by the number of items belonging to that cluster in the vicinity of the point.

Additionally, the weight of an item is also considered in the cluster density visualization. This means that not only the number of items belonging to a cluster affects the colour, but also the weight of those items contributes to the final colour representation. By visualizing the cluster density, researchers can identify patterns and relationships between different clusters of items. The visualization provides a comprehensive overview of the distribution and concentration of clusters, allowing for deeper insights into the underlying structure of the data.

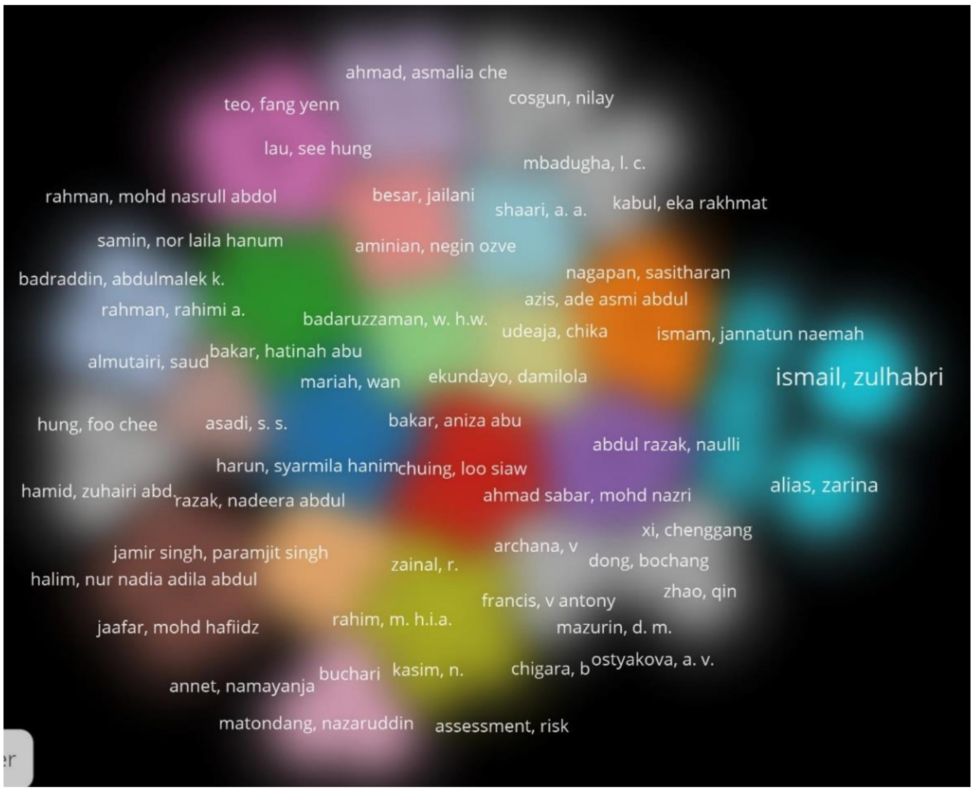

Figure 4.13 Cluster density visualization of bibliometric analysis

4.8 Data Analysis - Phase 3

The questionnaire's third phase comprises three parts: A, B, and C. Part A aims to collect demographic information from the participants, providing a profile of the respondents. Part B focuses on evaluating the current risk control measures associated with specific work activities and assessing the satisfaction of the participants regarding these measures and potential improvements. The objective is to gain an understanding of how satisfied respondents are with the existing risk control practices in their respective industries and their perception of the effectiveness of proposed improvements. (Refer Appendix 6)

Part C shifts the focus to the perception of enhancing risk control for work activities. This section involves selecting appropriate control measures and ensuring compliance with established control hierarchies. After determining the risk levels, control efforts are organized based on the level of risk. The concept of risk control hierarchy, as discussed in research articles and influenced by ideas such as the Internet of Things (IoT), is applied and continually improved. The aim of this section is to assess the current risk control measures and provide suggestions for enhancing risk control to mitigate the selected work activities.

To collect data for the questionnaire, convenient online survey forms were distributed among professionals working in the Work-Based Learning (WBL) industry and other sectors of the construction industry. This method facilitated easy and efficient data collection, reaching a broad range of respondents within the target industries.

4.8.1 Sociodemographic of Respondents

The third questionnaire followed a similar data collection approach as the previous questionnaires, utilizing various channels like Facebook, WhatsApp, and email to share survey links. The survey reached approximately 30-40 individuals, with a high completion rate of 90% and 30 valid responses. The gender distribution showed that 67% of the participants were male, while 33% were female. The respondents represented different roles in the construction industry, including project engineers, site supervisors, safety and health supervisors, and planning engineers.

Table 4.12 in the study presents a demographic overview of the participants, highlighting their close association with the building and construction field. Approximately 40% of the respondents held project managerial positions, indicating their involvement in higher-level decision-making. Moreover, 83% of the participants had tertiary education, emphasizing their academic qualifications. In terms of work experience, 33% of the respondents had one to five years of experience, while 50% were experienced professionals with six to ten years of practical work experience in construction.

Additionally, 17% of the participants had eleven to fifteen years of experience. Overall, the third questionnaire received a good response rate and attracted participants from diverse roles and experience levels within the construction industry, offering valuable insights into the perceptions and experiences of professionals in the field.

Table 4.12: Sociodemographic of the third questionnaire Respondents

Parameter	Category	Frequency	Percentage (%)
Gender	Male	20	67
	Female	10	33
Age	20-30 year	10	33
	31-40 year	15	50
	41-50 year	5	17
Academic	Certificate	5	17
Qualification	STPM/Diploma	19	63
	Degree	6	20
Designation	Project Engineer	5	17
	Planning Engineer	7	23
	Site Supervisor	5	17
	Safety and Health Supervisor	13	43
Working	6-10 years	15	50
Experience	1-5 years	10	33
	11 - 15 years	5	17

4.8.2 Part B (Risk Control)

4.8.2.1 Assessing current risk control and improvement of risk control

This section consists of 5 questions that utilize the Likert scale to measure the effectiveness and likelihood of respondents' perceptions towards the existing risk control. The Likert scale allows the researcher to assess the level of agreement or disagreement of the respondents with the statements provided. The scale ranges from 1 (strongly disagree) to 5 (strongly agree), allowing respondents to choose the number that best represents their point of view and level of agreement or disagreement.

Figure 4.14 presents the satisfaction level of professional workers regarding the flexibility of the current risk control measures implemented for health and safety in the construction industry. The results obtained from bibliometric analysis and surveys on the hierarchy of control indicate that there is a significant lack of satisfaction among workers. This suggests that the existing waste management practices in the construction industry in Malaysia are not being properly followed by workers. Therefore, it is crucial to implement immediate improvements in risk control measures at construction sites to address this issue.

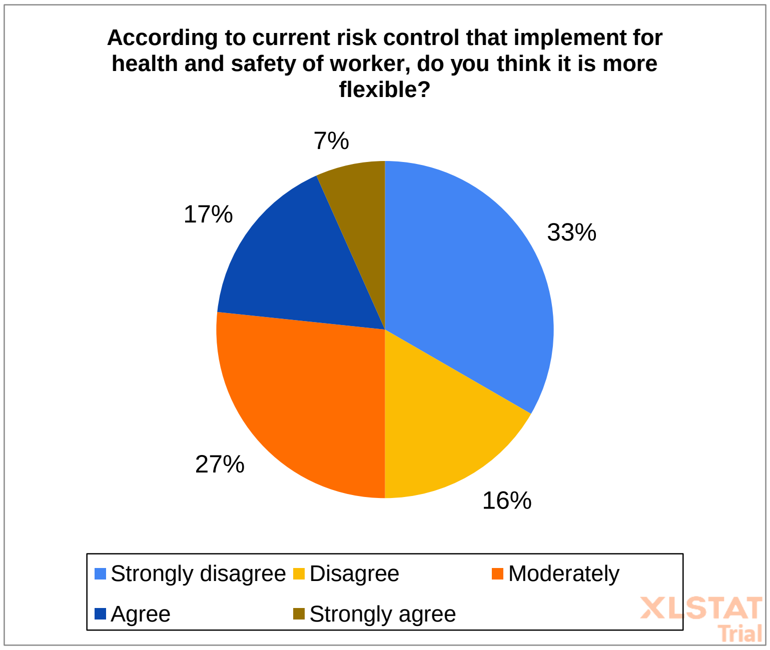

Figure 4.14 Percentage of relative frequency for the existing risk control for Q1

According to the data presented in Table 4.13, it is evident that a significant portion of professional workers, accounting for 33%, strongly disagreed with the flexibility of the current risk control measures implemented for health and safety in the construction industry. This indicates a clear dissatisfaction and a belief that the current risk control measures are not adequately flexible. Additionally, 17% of respondents expressed disagreement, further supporting the notion that improvements are needed. Furthermore, 27% of respondents expressed a moderate opinion, suggesting that they find the statement somewhat acceptable but still acknowledge the need for improvement. Collectively, these findings highlight a general recognition among the respondents that the current risk control measures require enhancements to ensure flexibility and effectiveness.

Table 4.13 Results of the existing risk control data for Descriptive statistics for Q1

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
a) According to current risk control that implement for health and safety of worker, do you think it is more flexible	30	100	10	Strongly Disagree	10	33
				Disagree	5	17
				Moderately	8	27
				Agree	5	2.5

Figure 4.15 showcases the level of satisfaction among professional workers regarding the adequacy of current risk control measures in ensuring the health and safety of workers. The analysis of bibliometric data and survey responses on the hierarchy of control reveals a substantial dissatisfaction among workers in this regard. This indicates that the existing waste management practices in the Malaysian construction industry are not being effectively adhered to by workers. As a result, it is imperative to promptly introduce improvements in risk control measures at construction sites to address this pressing issue.

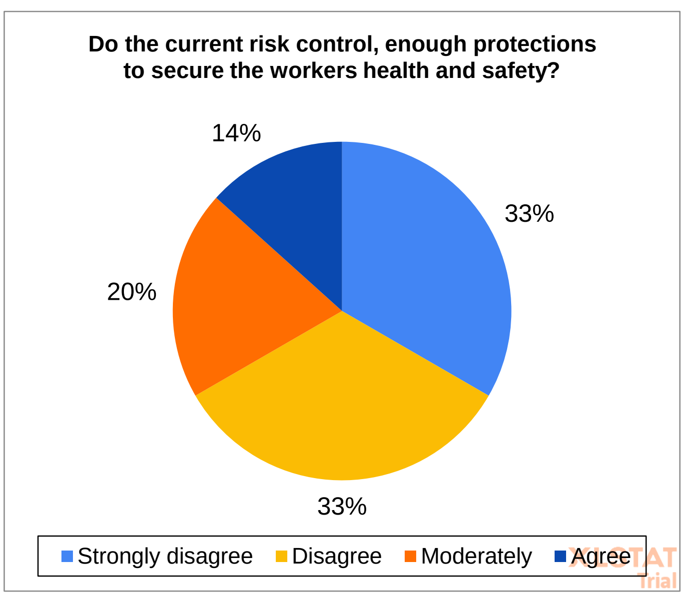

Figure 4.15 Percentage of relative frequency for the existing risk control for Q2

The findings presented in Table 4.14 reveal a clear dissatisfaction among professional workers regarding the adequacy of current risk control measures in ensuring the health and safety of workers. A substantial majority, comprising 66% of the respondents, either strongly disagreed or disagreed with the statement, indicating a lack of confidence in the existing measures. This strong disagreement suggests that the current risk control measures are perceived as insufficient in providing adequate protection for workers. Furthermore, only a small proportion (13%) of respondents agreed with the statement, implying that they find the measures somewhat acceptable but still recognize the need for improvement. This widespread dissatisfaction and lack of agreement emphasize the urgent need for implementing enhanced risk control measures that are more feasible and operative in addressing the health and safety concerns of workers in the construction industry.

Table 4.14 Results of the existing risk control data for Descriptive statistics for Q2

Variable\Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
b) Do the current risk control, enough protections to secure the worker's health and safety?	30	100	10	Strongly Disagree	10	33
				Disagree	10	33
				Moderately	6	20
				Agree	4	13

Based on the information presented in Figure 4.16, it is evident that there is a significant level of dissatisfaction among professional workers regarding the adoption of current risk control measures. The data obtained from the analysis of articles and survey responses indicate that workers are not effectively adopting the existing waste management practices in the Malaysian construction industry. This highlights a lack of compliance and adherence to the established risk control measures. In order to address this pressing issue, it is crucial to implement prompt improvements in risk control measures at construction sites, ensuring better adoption and adherence to enhance worker safety and mitigate risks effectively.

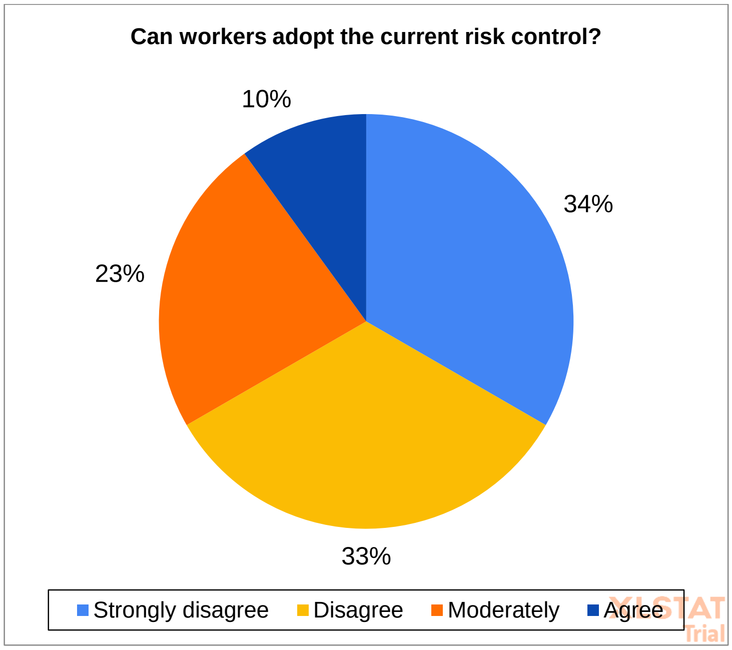

Figure 4.16 Percentage of relative frequency for the existing risk control for Q3

The data presented in Table 4.15 highlights a notable level of dissatisfaction among professional workers regarding the adoption of current risk control measures. The majority of respondents, accounting for 66% of the sample, expressed strong disagreement or disagreement with the statement, indicating a lack of trust and satisfaction with the existing measures. This indicates that workers perceive the current risk control measures as inadequate in ensuring the safety and well-being of workers. Conversely, only a small portion of respondents (10%) agreed with the statement, suggesting a moderate level of acceptance while still acknowledging the need for improvement. These findings underscore the widespread dissatisfaction and lack of commitment among workers towards the current risk control measures. Consequently, urgent action is required to implement enhanced risk control measures that are more practical and effective in addressing the health and safety concerns of workers in the construction industry.

Table 4.15 Results of the existing risk control data for Descriptive statistics for Q3

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
C) Can workers adopt the current risk control?	30	100	10	Strongly Disagree	10	33
				Disagree	10	33
				Moderately	7	23
				Agree	3	10

The findings depicted in Figure 4.17 indicate a notable degree of dissatisfaction among professional workers concerning their compliance with the rules and processes outlined in the current risk control measures. The data obtained from the analysis of articles and survey responses reveal that workers are not adequately embracing the waste management practices established in the construction industry. This signifies a lack of willingness and commitment to adhere to the prescribed risk control measures. To address this critical concern, it is imperative to promptly introduce improvements in risk control measures at construction sites. This will facilitate better adoption and adherence by workers, thereby enhancing worker safety and effectively mitigating risks.

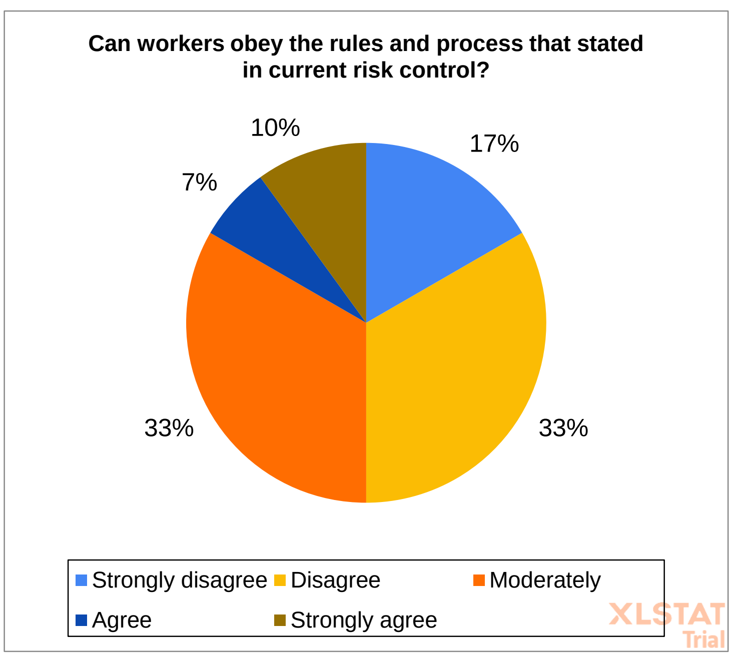

Figure 4.17 Percentage of relative frequency for the existing risk control for Q4

The findings from Table 4.16 reveal a significant level of dissatisfaction among professional workers when it comes to their adherence to the rules and processes outlined in the current risk control measures. The majority of respondents, comprising 50% of the sample, expressed either strong disagreement or disagreement with the statement, indicating a lack of trust and satisfaction with the existing measures.

This highlights a clear perception among workers that the current risk control measures are not sufficient in ensuring their safety and well-being in their daily work lives. On the other hand, a smaller but still notable proportion of respondents (30%) expressed a moderate level of satisfaction, suggesting some level of acceptance of the current risk control measures. However, it is important to note that even within this group, there is a recognition of the need for improvement.

These findings emphasize the urgent need for action to address the dissatisfaction and lack of confidence among workers regarding the current risk control measures. It is crucial to implement enhanced risk control measures that are more practical and effective in addressing the health and safety concerns of workers in the construction industry. By doing so, the industry can work towards creating a safer and more secure work environment, ensuring the well-being of its workforce.

Table 4.16 Results of the existing risk control data for Descriptive statistics for Q4

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
d) Can workers obey the rules and process that stated in current risk control?	30	100	10	Strongly Disagree	5	17
				Disagree	10	33
				Moderately	10	33
				Agree	2	7

The data presented in Figure 4.18 indicates a notable level of dissatisfaction among professional workers regarding the effectiveness of current risk control measures in addressing the proper handling of construction waste or materials at the site. The findings from the analysis of articles and survey responses suggest that workers are not fully embracing the waste management practices established in the construction industry. This lack of willingness and commitment to adhere to the prescribed risk control measures highlights a significant challenge in ensuring proper waste management and handling at construction sites. It is crucial to address this concern promptly by introducing improvements in risk control measures. These improvements should aim to enhance worker adoption and adherence to the prescribed practices, thereby improving worker safety and effectively mitigating risks associated with construction waste and materials handling.

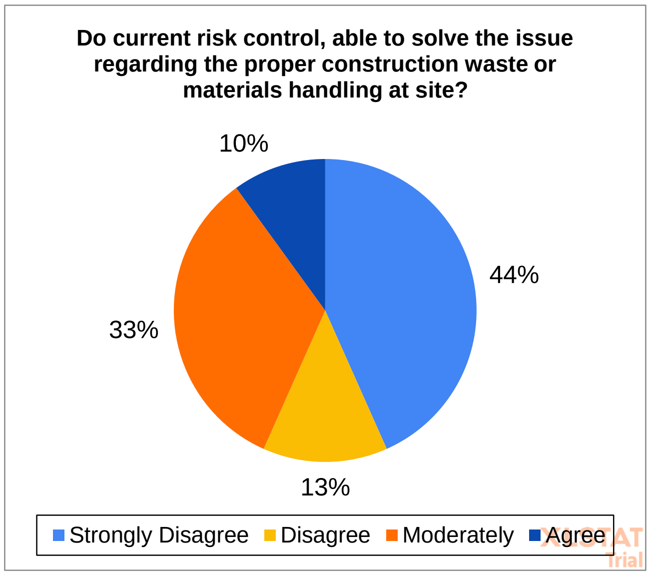

Figure 4.18 Percentage of relative frequency for the existing risk control for Q5

The data presented in Table 4.17 reveals a significant level of dissatisfaction among professional workers regarding the effectiveness of current risk control measures in addressing the proper handling of construction waste or materials at the site. The majority of respondents, accounting for 56% of the sample, expressed either strong disagreement or disagreement with the statement, indicating a lack of trust and satisfaction with the existing measures. On the other hand, a smaller but still notable proportion of respondents (33%) expressed a moderate level of satisfaction, suggesting some level of acceptance of the current risk control measures. However, it is important to note that even within this group, there is a recognition of the need for improvement.

These findings highlight the urgent need for action to address the dissatisfaction and lack of confidence among workers regarding the current risk control measures. It is crucial to implement enhanced risk control measures that are more practical and effective in addressing the health and safety concerns of workers in the construction industry. By doing so, the industry can work towards creating a safer and more secure work environment, ensuring the well-being of its workforce. This may involve revisiting and revising existing practices, providing additional training and resources, and fostering a culture of safety and compliance within the construction industry.

Table 4.17 Results of the existing risk control data for Descriptive statistics for Q5

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
e) Do current risk control, able to solve the issue regarding the proper construction waste or materials handling at site?	30	100	13	Strongly Disagree	13	43
				Disagree	4	13
				Moderately	10	33
				Agree	3	10

4.8.2.2 Satisfactory level towards improvement of risk control

This section consists of 5 questions that utilize the Likert scale to measure the effectiveness and likelihood of respondents' perceptions towards the improvement of risk control. The Likert scale allows the researcher to assess the level of agreement or disagreement of the respondents with the statements provided. The scale ranges from 1 (strongly disagree) to 5 (strongly agree), allowing respondents to choose the number that best represents their point of view and level of agreement or disagreement.

The data presented in Figure 4.19 indicates a level of satisfaction among professional workers regarding the adaptability of the proposed improvements in risk control measures for the health and safety of workers. The findings from the analysis of articles and survey responses suggest that the professional workers found the proposed improvements to be adaptable and effective in reducing the hazards associated with improper construction waste management at the construction site. This indicates that the professional workers were generally supportive of the improvements made to the existing risk control measures and believed that these changes would successfully address the challenges related to construction waste management. The data suggests that the proposed improvements were well-received and seen as practical and applicable by the professional workers.

Figure 4.19 Percentage of relative frequency for the improvement of risk control Q1

Based on the Table 4.18, the majority of respondents, accounting for 50% of the sample, expressed either strong agreement or agreement respectively with the statement, indicating trust and satisfaction with the improvement of measures. This suggests that these respondents believe that the current risk control measures effectively address the adaptability of the proposed improvements in risk control measures for the health and safety of workers. However, it's important to note that challenges may still arise in implementing these risk control measures, despite the overall satisfaction expressed by the majority of respondents.

Table 4.18 Results of the improvement of risk control data for Descriptive statistics for Q1

Variable\Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
a) According to improvement of risk control that implement for health and safety of worker, do you think it is more adaptable?	30	100	15	Agree	15	50
				Strongly Agree	15	50

The data presented in Figure 4.20 actually indicates a level of satisfaction among professional workers regarding the adequacy of the proposed improvements in risk control measures for securing the health and safety of workers. The findings from the analysis of articles and survey responses suggest that the professional workers expressed satisfaction with the proposed improvements and believed that they provided sufficient protections to ensure the health and safety of workers. This indicates that the professional workers perceived the improvements as effective measures in addressing the challenges associated with construction waste management.

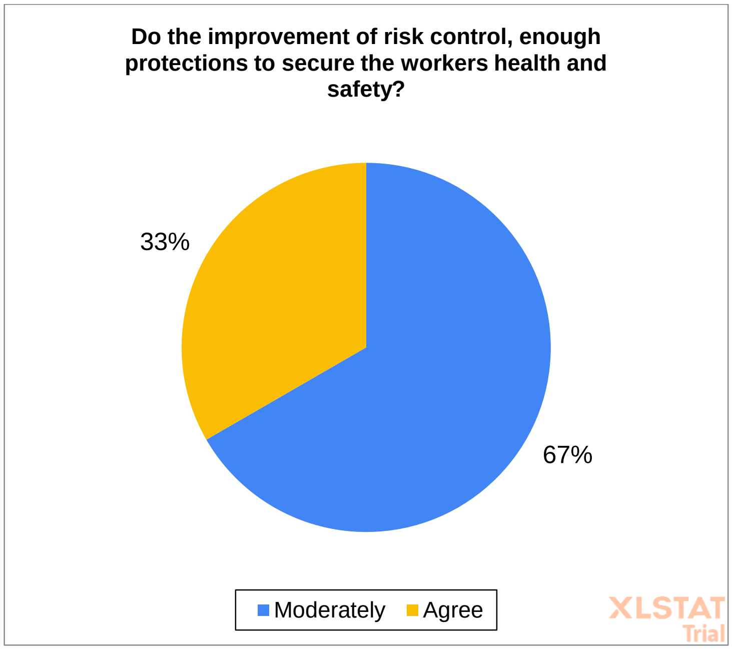

Figure 4.20 Percentage of relative frequency for the improvement of risk control Q2

According to the information provided in Table 4.19, most of the respondents, representing 67% of the sample, expressed agreement with the statement regarding the adequacy of the proposed improvements in risk control measures for securing the health and safety of workers. Additionally, 33% of the respondents expressed a moderate level of agreement. These findings indicate that the majority of respondents had trust and satisfaction with the improvement of measures and believed that they would effectively address the health and safety concerns of workers.

However, it is important to acknowledge that challenges may arise during the implementation of these risk control measures, despite the overall satisfaction expressed by many respondents. It is crucial to consider that real-world implementation of any measures can encounter practical difficulties or unforeseen obstacles that may affect their effectiveness. These challenges may include factors such as organizational barriers, resource limitations, or changes in work processes. Therefore, it is essential to proactively address and overcome these challenges to ensure the successful implementation and sustained effectiveness of the proposed risk control measures.

Table 4.19 Results of the improvement of risk control data for Descriptive statistics for Q2

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
b) Do the improvement of risk control, enough protections to secure the workers health and safety?	30	100	20	Agree	20	67
				Moderately	10	33

Based on the data presented in Figure 4.21, it can be observed that there is a notable level of satisfaction among professional workers regarding their ability to adopt the proposed improvements in risk control measures. The findings obtained from the analysis of articles and survey responses indicate that the professional workers expressed satisfaction with these improvements and believed that they effectively provided sufficient protections to ensure the health and safety of workers.

These findings suggest that the professional workers were receptive to the proposed improvements and believed that they would contribute to enhancing the overall safety measures in the workplace. The level of satisfaction expressed by the workers indicates their confidence in the effectiveness and practicality of the proposed risk control measures.

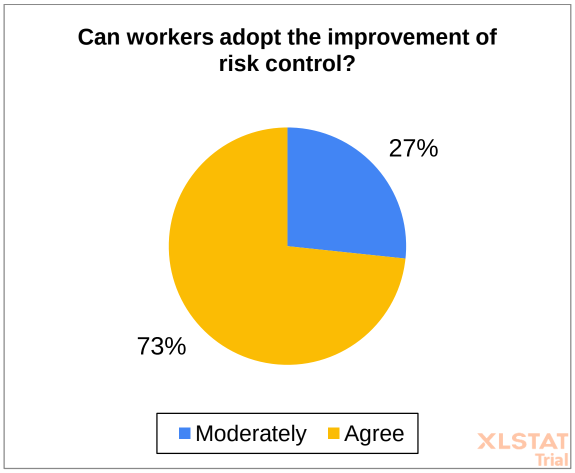

Figure 4.21 Percentage of relative frequency for the improvement of risk control Q3

Based on the information presented in Table 4.20, it is evident that a significant majority of the respondents, accounting for 73% of the sample, expressed agreement with the statement regarding the adequacy of the proposed improvements in risk control measures for securing the health and safety of workers. This indicates a high level of trust and satisfaction among the respondents regarding the effectiveness of these measures. Furthermore, 26% of the respondents expressed a moderate level of agreement, suggesting that they also recognized the potential benefits of the proposed improvements but may have had some reservations or concerns. Despite the moderate agreement, this group of respondents still acknowledged the overall positive impact that the improvements could have on securing the health and safety of workers.

These findings highlight a consensus among the respondents regarding the effectiveness and suitability of the proposed improvements in risk control measures. The majority of respondents believed that these measures would contribute to enhancing the safety and well-being of workers in the construction industry.

Table 4.20 Results of the improvement of risk control data for Descriptive statistics for Q3

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
c) Can workers adopt the improvement of risk control?	30	100	22	Moderately	8	26
				Agree	22	73

Based on the data presented in Figure 4.22, it is evident that there is a significant level of satisfaction among professional workers regarding their ability to obey the rules and processes outlined in the improvement of risk control measures. The findings from the analysis of articles and survey responses indicate that the professional workers expressed a high level of satisfaction with these improvements, indicating the level of satisfaction suggests that the professional workers feel confident and capable of adhering to the rules and processes outlined in the improved risk control measures.

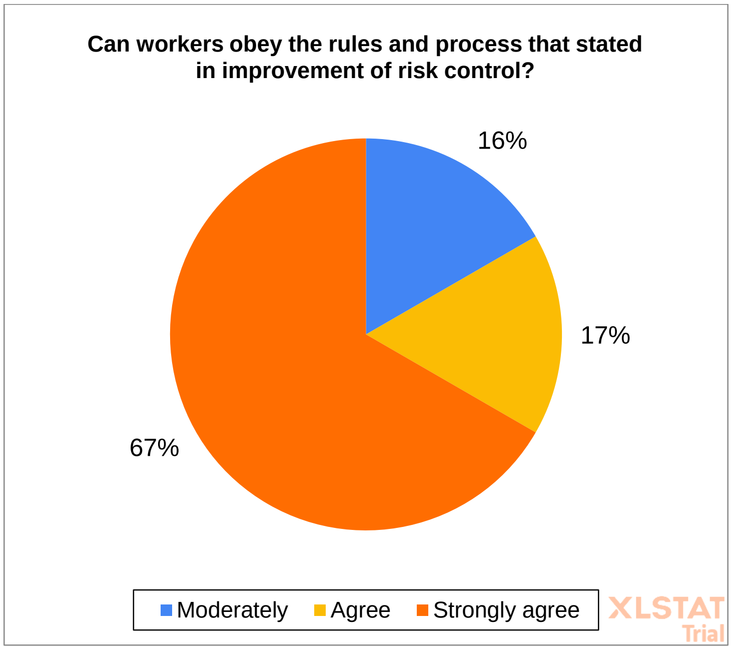

Figure 4.22 Percentage of relative frequency for the improvement of risk control Q4

Based on the information provided in Table 4.21, it is clear that a significant majority of the respondents, representing 84% of the sample, expressed agreement with their ability to obey the rules and processes outlined in the improvement of risk control measures. This high level of agreement indicates a strong sense of confidence and satisfaction among the respondents regarding the effectiveness and practicality of these measures. The fact that such a large proportion of respondents agreed with the statement highlights their belief that the proposed improvements in risk control measures are feasible, reasonable, and conducive to promoting worker safety and health. This level of agreement suggests that the respondents perceive themselves as capable of complying with the rules and processes outlined in the improved measures, and they recognize the importance of doing so for ensuring a safe working environment.

Additionally, 17% of the respondents expressed a moderate level of agreement, indicating that they recognized the potential benefits and value of the proposed improvements but may have had some reservations or concerns. This moderate level of agreement suggests that these respondents may have acknowledged the importance of following the rules and processes, albeit with some degree of caution or hesitation.

Table 4.21 Results of the improvement of risk control data for Descriptive statistics for Q4

Variable\Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
d) Can workers obey the rules and process that stated in improvement of risk control?	30	100	20	Moderately	5	17
				Agree	5	17
				Strongly Agree	20	67

Based on the data presented in Figure 4.23, it is clear that there is a significant level of satisfaction among professional workers regarding the ability of the improvement of risk control measures to solve the issue regarding the proper construction waste or materials handling at the site. The findings from the analysis of articles and survey responses indicate that the professional workers expressed a high level of satisfaction with these improvements, indicating their perception in the efficiency of these measures.

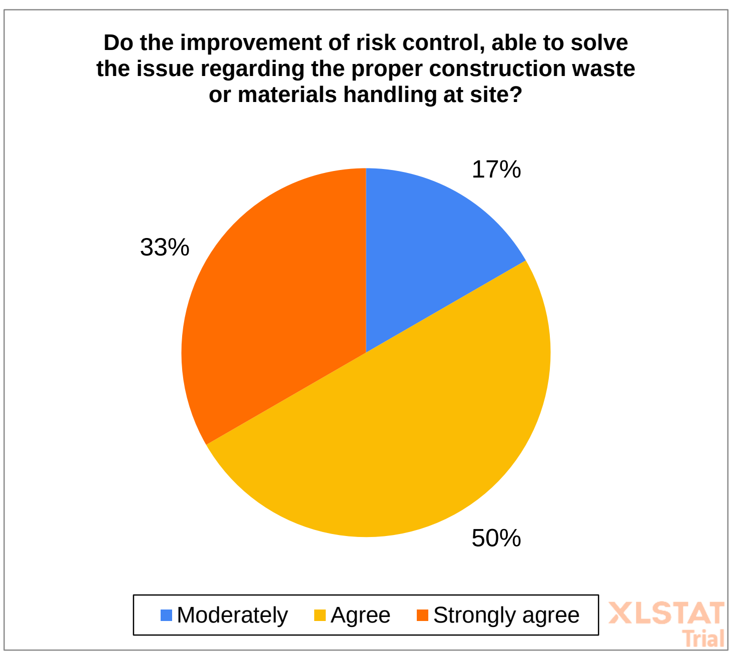

Figure 4.23 Percentage of relative frequency for the improvement of risk control Q5

Based on the information provided in Table 4.22, it is evident that a significant majority of the respondents, comprising 83% of the sample, expressed strong agreement or agreement with the ability of the improvement of risk control measures to solve the issue regarding the proper construction waste or materials handling at the site. The fact that such a large proportion of respondents agreed with the statement demonstrates their belief that the proposed improvements in risk control measures are not only feasible but also reasonable and conducive to promoting worker safety and health. Furthermore, the 17% of respondents who expressed a moderate level of agreement indicate that they recognized the potential benefits and value of the proposed improvements.

Table 4.22 Results of the improvement of risk control data for Descriptive statistics for Q5

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
e) Do the improvement of risk control, able to solve the issue regarding the proper construction waste or materials handling at site?	30	100	15	Moderately	5	17
				Agree	15	50
				Strongly Agree	10	33

4.8.3 Part C (Improvement of Risk Control)

This section consists of 3 questions that utilize the Likert scale to measure the efficacy and strength of respondents' perceptions towards the improvement of risk control. The Likert scale allows the researcher to assess the level of agreement or disagreement of the respondents with the statements provided. The scale ranges from 1 (strongly disagree) to 5 (strongly agree), allowing respondents to choose the number that best represents their point of view and level of agreement or disagreement.

The data presented in Figure 4.24 indicates a level of satisfaction among professional workers regarding the belief that utilizing improved risk control measures would be more convenient for addressing safety and health issues related to improper construction waste. The findings from the analysis of articles and survey responses suggest that the professional workers viewed the proposed improvements as adaptable and effective in reducing the hazards associated with improper construction waste management at the construction site.

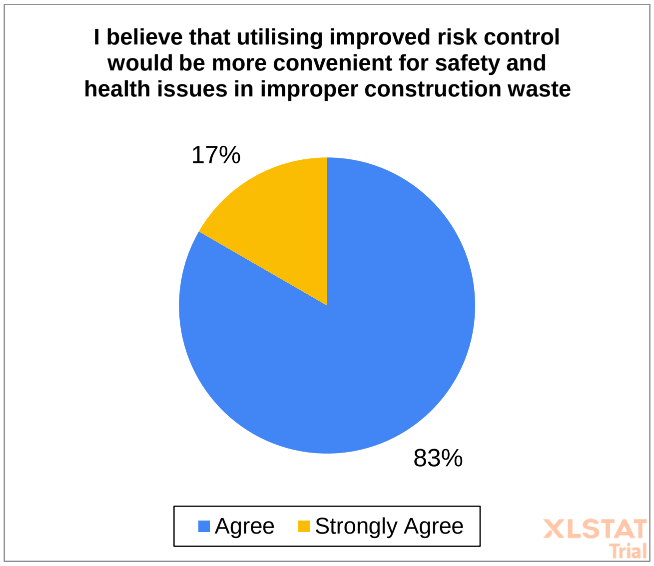

Figure 4.24 Results of the improvement of risk control data for Descriptive statistics for Q1

Based on the information you provided from Table 4.23, it is clear that a significant majority of the respondents, accounting for 83% of the sample, expressed agreement with the belief that utilizing improved risk control measures would be more convenient for addressing safety and health issues related to improper construction waste. This high level of agreement suggests that the respondents believe the proposed improvements in risk control measures are practical and effective in addressing the specific safety and health concerns associated with improper construction waste. Additionally, the 17% of respondents who expressed strong agreement further emphasize the recognition of the potential benefits and value of the proposed improvements. Their strong agreement indicates a high level of confidence in the convenience and efficacy of these measures.

Table 4.23 Descriptive statistics Results of the effectiveness for improvement of risk control for the Q1

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
a) I believe that utilising improved risk control would be more convenient for safety and health issues in improper construction waste	30	100	25	Agree	25	83
				Strongly Agree	5	17

The data from Figure 4.25 signifies that the professional workers expressed a sense of satisfaction with the proposed improvements and recognized the potential benefits for workers' safety and health. This suggests that they believe implementing these improved risk control measures will lead to positive outcomes and contribute to a safer and healthier work environment.

Figure 4.25 Results of the improvement of risk control data for Descriptive statistics for Q2

Based on the information you provided from Table 4.24, it is clear that a significant majority of the respondents, accounting for 50% of the sample, expressed agreement with the proposed improvements and recognized the potential benefits for workers' safety and health. Additionally, the 50% of respondents who expressed strong agreement further emphasize the recognition of the potential benefits and value of the proposed improvements. This high level of agreement suggests that the respondents consider the proposed improvements in risk control measures are operative in addressing the specific safety and health concerns associated with improper construction waste. Their durable agreement indicates a high level of confidence in the convenience and efficacy of these measures.

Table 4.24 Descriptive statistics Results of the effectiveness for improvement of risk control for the Q2

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
b) I believe implement the improved risk control would be beneficial for workers safety and health	30	100	15	Agree	15	50
				Strongly Agree	15	50

Figure 4.26 indicates that professional workers expressed a sense of satisfaction with the intention to recommend improved risk control measures to their colleagues for the consideration of safety and health at the construction site, it suggests that these workers believe in the effectiveness and positive impact of implementing these measures. Their intention to recommend the improved risk control measures indicates their confidence that these measures can contribute to a safer and healthier work environment for themselves and their colleagues. It is important to prioritize safety and health in any work environment, particularly in the construction industry where risks and hazards are prevalent. By implementing improved risk control measures and promoting their adoption among workers, organizations can work towards creating a culture of safety and ensuring the well-being of their workforce.

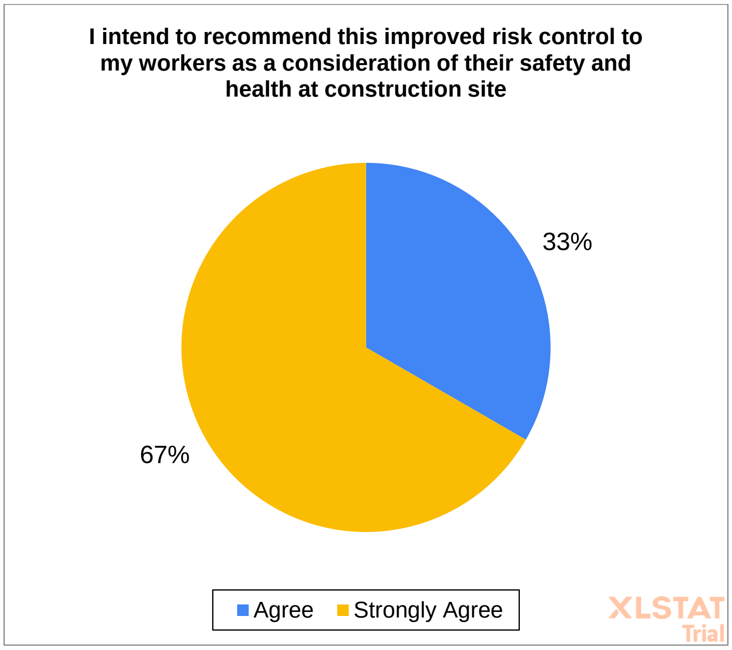

Figure 4.26 Results of the improvement of risk control data for Descriptive statistics for Q3

Based on the information you provided from Table 4.25, it is clear that a significant majority of the respondents, accounting for 67% of the sample, expressed agreement with the intention to recommend improved risk control measures to their colleagues for the consideration of safety and health at the construction site. Additionally, the 33% of respondents who expressed agreement further emphasize the recognition of the possible encouragements and value of the proposed improvements. When workers are willing to recommend these measures to their colleagues, it indicates a sense of satisfaction and belief in their efficacy. This willingness to promote the measures can contribute to a culture of safety and encourage widespread adoption among workers, ultimately leading to a safer and healthier work environment. It's important for organizations to encourage and support the sharing of safety practices and recommendations among workers, as it helps create a collective responsibility for safety and enhances overall risk management efforts.

Table 4.25 Descriptive statistics Results of the effectiveness for improvement of risk control for the Q3

Variable\ Statistic	Nbr. of observations	Breakdown per subsample (%)	Mode frequency	Scale	Frequency per category	Rel. frequency per category (%)
c) I intend to recommend this improved risk control to my workers as a consideration of their safety and health at construction site	30	100	20	Agree	10	33
				Strongly Agree	20	67

4.9 Summary of Result and Discussion

It appears that the chapter has been mentioned focused on conducting a comprehensive analysis of work activities, hazards, risk assessments, and improvements in risk control measures related to construction waste management. The chapter utilized three different types of questionnaires to gather data and insights. The first questionnaire, conducted in Phase 1, aimed to classify work activities and identify associated hazards. This questionnaire likely helped in understanding the nature of different work activities and the potential risks involved. In Phase 2, a second questionnaire was administered to conduct risk assessments based on the identified hazards. The level of risk was then analyzed using Pareto analysis, which helps prioritize the high-risk hazards for further investigation and mitigation.

Following this, the chapter likely discussed the use of a fishbone diagram analysis to classify the causes and effects of selected work activities. This analysis aids in understanding the underlying factors contributing to the identified hazards. In Phase 3, the chapter presented the data analysis of a third questionnaire, which assessed the satisfaction of respondents with the existing risk control measures and the improvements made to reduce associated risks. This questionnaire likely aimed to gather feedback on the effectiveness of the implemented measures and identify areas for further enhancement. Throughout the questionnaires, detailed information was collected, including response rates, sociodemographic data of the respondents, and descriptive statistics. This helps provide a comprehensive understanding of the respondents' perspectives and allows for a more robust analysis of the data.

Additionally, the chapter likely included a discussion on the background information related to the status of improper construction waste collection, as evidenced by the mode index and relative frequency of the index in Malaysia. This information could provide context for the importance of addressing construction waste management issues in the country. Overall, the chapter appears to have employed a systematic approach, combining different research methods and questionnaires to gather data and analyze the effectiveness of risk control measures and improvements in construction waste management.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The study described in the passage aimed to investigate the framework design of HIRARC (Hazard Identification, Risk Assessment, and Risk Control) assessment for improper construction waste management in CLCE construction sites. The researcher focused on the WBL (Work-Based Learning) industry and collected information from various construction sites in Malaysia. The specific construction site where the research was conducted was the Honda office and Workshop building construction site in Jalan Kuala Kangsar, Ipoh, Perak.

Based on an extensive literature review, the study identified seven work activities related to construction waste management. These activities were further examined through a survey administered to practitioners in Malaysia's construction industry to determine their ranking. The study explored various factors influencing the effectiveness of waste minimization efforts in construction, emphasizing the importance of understanding the interconnected variables to improve the overall waste management system.

The primary objective of the study was to propose a framework design that would help identify hidden risks associated with improper construction waste management, assess the level of risk through risk assessments, assess the existing risk control measures, and provide suggestions for improvement. The findings indicated that most construction companies in Malaysia acknowledged the need for extra efforts to address construction waste risks based on their current practices. However, the study revealed that while the respondents recognized construction waste risk as an important issue, proper waste disposal was not prioritized in project development and building designs. Waste control was not considered a central activity in construction progress, and many companies did not implement any waste-related plans in their projects. The study emphasized the role of industry players in investigating proper waste management alongside project budgets and timelines in construction operations.

According to Table 5.1 in Appendix 3, the finalize of research of the HIRARC assessment was presented according to HIRARC analysis format. The data for the work activity, selected hazards and risk assessment have been discussed in result and discussion. According to the discussion, the several improvements was made to the existing risk control, related to it the first activity of Improper construction waste & materials handling (management of waste & materials) has existing risk control of dispose of the waste into the RORO bin, use appropriate PPE (hand glove) and proper diesel storage area, but the workers are not followed this rule properly at construction site.

Therefore, according to research articles and hierarchy of control, improvement was made for this activity by provide safety jackets that contain much space that can place easy materials or waste (nails, hammers, and small materials), this can help the worker who worked at the high floor to place the materials with them before the return to the ground floor; secondly Install CCTV or used drones' system to detect the workers always in safety situations such as making sure the workers wear full PPE during work and this types of improvement always make sure the professional worker s and workers always beware on their attitudes during work, for instance's, the workers who lack on wearing appropriate PPE for the particular work can properly wear it and this also prevent the workers throw unused materials to the surrounding of the construction site.

Moreover, the second activity Poor housekeeping has existing risk control of ensure the working area is properly cleaned and housekeeping is done and use appropriate PPE during Housekeeping. This on also the workers are obey the rule and the professional workers also not properly monitoring it. Hence, the improvement was made by providing proper rack placement to arrange chemical/oil substances near to the working place of using this kind of substances, the site supervisor should prepare a schedule to do 5-minute housekeeping every day after work finishes and the supervisor should inspect and order the workers clear immediately on unsafe condition of site.

Additionally, the third activity Scattered building materials or construction waste on the construction site has existing risk control of properly dispose of all the waste or materials at the work location and use appropriate PPE during disposal. But still some of the workers are not follow the rules properly. Thus, the improvement was made by waste or materials should clean immediately on the spot without letting it on the site floor after related work are done; Do not operate or placed electrical tools at wet place, instead place the wire connection ate safer place like the wire or sockets are not crossing the access way or walking area of workers.

Last but not least, the fourth activity does not provide separate waste collection bins at the construction site has existing risk control of provide one waste collection bin only for all types of waste which is Roro Bin and wear gloves and avoid pinch point during dispose of waste. Henceforth, the improvement was made to make the safety more adoptable and flexible by separate the Roro bin into three sections to collect the construction waste according to the most collected type of waste such as glass, rebar or metals, concrete and provide other one waste collection for ergonomic waste to use by site workers to approaches them implement the 'reduce, reuse and recycle (3R)' practices before send the wastes to the landfill. The workers also should use appropriate PPE during handling the waste or unused materials to avoid stepping or touching pinch point or sharp point of materials.

The improvement of risk control also suggest by implied that modern methods of construction design such as using CCTV or drones had great potential to reduce construction waste risks and hazard production from construction sites. The application separation of waste collection bin into three types would reduce environmental issues such as air pollution, land pollution, water pollution and so on; this is because, most of the construction sites collect all the waste in one collection bin without separate, then send to landfill like that, at the landfill also there are not implement the 3R practices and some of the landfill still doing illegal dumping could lead the world affect from environmental issues and global warming. This kind of problem lead to effect on construction industry by impact the economic, social and environmentally sustainable development challenging. This study provided greater insights and verification of the findings from the questionnaire surveys. Based on this study, the following recommendations were concluded.

Therefore, by implementing these types of improvements in current risk control measures, we can effectively manage existing hazards and prevent future ones, ensuring the safety and well-being of workers. It is crucial for construction professionals to have a comprehensive understanding of sustainability practices in construction health and safety to fully leverage the benefits of sustainability within their companies. In this research, the improvements were aligned with the Sustainable Development Goals (SDGs) to create a construction site that is both safe and sustainable. Specifically, the improvement efforts targeted SDG 8, which aims to protect labor rights and promote safe working environments for all workers, including migrant workers, women migrants, and those in precarious employment. Additionally, SDG 3, which focuses on good health and well-being, was addressed by addressing the unique challenges faced by construction workers who are more vulnerable to injuries and illnesses. The implemented improvements in risk control contribute to changing this situation and ensuring progress towards achieving these SDGs.

Furthermore, SDG 11, Sustainable Cities and Communities, is another important aspect to consider. Buildings play a significant role in shaping cities, and incorporating green building practices is vital for creating sustainable urban environments. Green buildings offer solutions that prioritize energy and water efficiency, contributing to the overall sustainability of cities. Additionally, it is crucial to prioritize the creation of healthy buildings. Given that people in urban areas spend a significant portion of their time indoors (which has likely increased even more during the pandemic), the impact of buildings on our well-being should not be overlooked. Moreover, adopting environmentally-friendly practices in construction can help reduce waste. This can be achieved by improving materials management, ensuring proper recycling processes, and minimizing the amount of waste generated during construction. By implementing these measures, we can contribute to a more sustainable construction industry and reduce its overall environmental footprint.

In summary, in the other hand, workers at construction sites engage in various tasks that may expose them to hazards, such as working near heavy construction machinery, working from heights like roofs or scaffolding, or operating machinery and electrical equipment in damp environments using temporary electrical circuits. While there are similarities between the risks in construction and other industries, there are also unique concerns that contractors and safety experts must address. Implementing a safety and health management system in the construction industry is particularly challenging due to factors like competitive bidding processes, temporary workforce arrangements, environmental considerations related to outdoor work settings, and the presence of multiple employers on worksites. The Construction Workplace Safety Program should be implement in the all the construction site to aims the identification, manage, or eliminate construction-related hazards through the adoption of safe work practices, training, and compliance with local, state, and federal regulations, playing a significant role in society.

5.2 Recommendations

The study's results serve as a valuable resource for comparative waste-related risk studies, particularly within the context of Malaysia. It is important to note that the participants of the questionnaire surveys were exclusively from Malaysia, and therefore the findings should be interpreted and applied within the same context. The differences in laws, regulations, construction methods, and weather conditions between countries may limit the transferability and comprehensiveness of the study's findings to other regions. Future studies should consider exploring the applicability of these findings in different countries before implementation.

Regarding the rating questions in the questionnaire, the weightage of the features was based on the participants' subjective opinions regarding the relative importance of these factors. However, since different respondents assigned different values to the scale points, the reliability of the derived weightage from the 5-point Likert scales may be questioned. To validate the outcomes obtained from the questionnaire surveys, it is suggested to conduct interviews with construction industries outside the scope of the original study.

The main objective of this study was to establish proper waste management practices that can significantly reduce waste-related risks in construction activities. The study provided soft measures that can be applied in construction waste management, regardless of the specific construction skills and techniques employed. These measures offer guidance and recommendations for improving waste management practices in the construction industry.

As a summary, in the future there are some recommendations need to made for the improvement of current risk control such as, for the provide separate collection bin could be produce with the system of measure itself the weight of waste and type of the waste and can detect if the bin if full. Moreover, the construction companies also would provide award of bouses to the workers who properly followed the safety rules and mitigation measures that set by the industries. In future, industries should implement 3R practices for construction waste at sites by giving training and the importance of applying 3R at construction sites to the workers.

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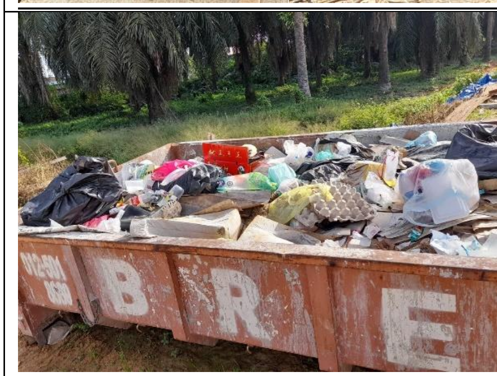
APPENDIX

APPENDIX 1

PICTURES OF RESEARCH AREA AND ITS PROBLEM

Work activities identified in the survey area which is still unaware by the workers at the site

	• Scattered construction materials and waste surrounding site
 	• Poor housekeeping
 	• Poor housekeeping • Scattered construction materials and waste surrounding site

	• Improper waste management collection
	• Workers’ attitude towards handling waste and materials at the site does not wear full PPE.
	• Improper waste collection (no separate bin to throw the waste) • All the waste are collected in one RORO bin

	• The electric wires are placed in wet areas and in the way of the walking area of the workers. • The machines are not properly placed.
	• Harmful substance such as fuel/ oil are not properly arranged.

APPENDIX 2

EXISTING HIRARC ASSESSMENT ANALYSIS

SKYLINE ENTITY SDN. BHD. (COMPANY NO. 1013256-A)	CADANGAN MEMBINA D[illegible] MENYIAPKAN KOMPLEKS PUSAT PENYELENGG[illegible]AAN KENDERAAN DI ATAS LOT 51119 (JALAN KUALA KANGSAR), MUKIM HULU KINTA, DAERAH KINTA, IPOH, PERAK DARUL RIDZUAN UNTUK TETUAN SKYLINE ENTITY SDN. BHD. HAZARD IDENTIFICATION, RISK ASSESMENT & RISK CONTROL (HIRARC) FOR LIFTING WORK	CLCE
Doc No. : HIRARC/22/001 Rev No.: 0	CLCE CONSTRUCTION SDN. BHD.	Issue date : 29 Dec 2022 Rev date :

PROBABILITY (P)	EXAMPLE / DESCRIPTION	RATING
MOST LIKELY	THE MOST LIKELY RESULT OF THE HAZARD/EVENT BEING RELIZIED	5
POSSIBLE	HAS A GOOD CHANCE OF OCCURING AND IS NOT UNUSUAL	4
CONENABLE	MIGHT BE OCCUR AT SOMETIME IN FUTURE	3
REMOTE	HAS NOT BEEN KNOWN TO OCCUR AFTER MANY YEARS	2
INCONCEVABLE	IS PRACTICALLY IMPOSSIBLE AND HAS NEVER OCCURED	1

		SEVERITY (S)				
		1	2	3	4	5
PROBABILITY (P)	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

SEVERITY (S)	EXAMPLE / DESCRIPTION	RATING
CATASTHOPHIC	NUMOUROUS FATALITIES IRRECOVERABLE PROPETIES DAMAGE & PRODUCTIVITY	5
FATAL	APPROXIMATELY ONLY SINGLE FATALITY, MAJOR PROPARTY DAMAGE IF HAZARD IS RELIZED	4
SERIOUS	NOT FATAL INJURIES, PERMANENT DISABILITY	3
MINOR	DISABLING BUT NOT PERMENENT DISABILITY	2
NEGLIBLE	MINOR ABBRASIONS, BRUISES, CUT, FIRST AID TYPE OF INJURIES	1

	CODE	CRITICALITY OF RISE	
S	SEVERITY	H	HIGH RISK (15 TO 25 POINTS)
P	PROBABILITY OF OCCURENCE	M	MEDIUM RISK (8 TO 12 POINTS)
RL	RISK LEVEL	L	LOW RISK (0 TO 6 POINTS)

Prepared by :	Review by :	Approve by :
Date : 29/12/2022	Date :	Date : 30/12/2022

SKYLINE ENTITY SDN. BHD. (COMPANY NO. 1013256-A)	**CADANGAN MEMBINA DAN MENYIAPKAN KOMPLEKS PUSAT PENYELENGGARAAN KENDERAAN DI ATAS LOT 51119 (JALAN KUALA KANGSAR), MUKIM HULU KINTA, DAERAH KINTA, IPOH, PERAK DARUL RIDZUAN UNTUK TETUAN SKYLINE ENTITY SDN. BHD.**	CLCE
	HAZARD IDENTIFICATION, RISK ASSESMENT & RISK CONTROL (HIRARC) FOR LIFTING WORK	
Doc No. : HIRARC/22/001 Rev No.: 0	**CLCE CONSTRUCTION SDN. BHD.**	Issue date : 29 Dec 2022 Rev date :

1. Hazard Identification				**2. Risk Analysis**				**3. Risk Control**	
No	**Work Activity**	**Hazard**	**Which can cause/ effect**	**Existing Risk Control (if any)**	**Likelihood**	**Severity**	**Risk**	**Recommended Control Measures**	**PIC (Due date/ status)**
1.	Preliminary (Before toolbox talk)	Not receiving proper safety training which cause wrong selection tool	Body injury	1. HSE Induction	2	2	4	1. Apply PTW and conduct toolbox meeting to discuss job with all personnel	Supervisor engineer and operator
2	Crane Inspection	Uncertified operator and crane	Properties damage	1. Toolbox talk	2	2	4	1. Inspect crane operator cert and crane PMA	Supervisor engineer and operator
3	Mobilization (Crane parking)	Wrong selection vehicle machinery, skidding during parking	Body injury	1. Toolbox talk 2. Wear appropriate PPE	3	2	6	1. Visit the site and assess the access before mobilization and ensure all equipment are fully secured before the transporting begins	Supervisor, engineer operator signalman
		Uncontrolled traffic management	Traffic collision		3	2	6	1. Traffic controllers' signs, high-visibility vests to be worn	
		Unstable working platform	Toppling of machineries		3	3	9	1. Ensure all equipment are fully secured before the transporting begins	
		Improper check lifting apparatus	Properties damage		3	3	9	1. Ensure check belt and sling in good condition Never use damaged wire rope slings. 2. Ensure check belt and sling in good condition. During lifting, the Safe Working Load must not be exceeded.	
		Accident due to Incompetent driver and expired crane validity	Toppling of machineries		3	3	9	1. Ensure that the lifting routes do not collide with any object, so striking objects must be avoided while lifting	

SKYLINE ENTITY SDN. BHD. (COMPANY NO. 1013256-A)	CADANGAN MEMBINA D MENYIAPKAN KOMPLEKS PUSAT PENYELENGG AAN KENDERAAN DI ATAS LOT 51119 (JALAN KUALA KANGSAR), MUKIM HULU KINTA, DAERAH KINTA, IPOH, PERAK DARUL RIDZUAN UNTUK TETUAN SKYLINE ENTITY SDN. BHD. HAZARD IDENTIFICATION, RISK ASSESMENT & RISK CONTROL (HIRARC) FOR LIFTING WORK	CLCE
Doc No. : HIRARC/22/001 Rev No.: 0	CLCE CONSTRUCTION SDN. BHD.	Issue date : 29 Dec 2022 Rev date :

1. Hazard Identification				2. Risk Analysis				3. Risk Control	
No	Work Activity	Hazard	Which can cause/ effect	Existing Risk Control (if any)	Likelihood	Severity	Risk	Recommended Control Measures	PIC (Due date/ status)
4	During lifting (Placing material)	Overturning of the crane	Properties damage	1. Toolbox talk 2. Wear appropriate PPE	3	3	9	1. Never abruptly swing or stop the crane 2. The mobile crane shall only be operated on a firm, level ground that adequately supports the weight of the crane and loads	Supervisor, engineer operator signalman
		Falling objects and failure due lifting gear	Body Injury		3	3	9	1. Never use damaged wire rope slings 2. During lifting, the Safe Working Load must not be exceeded 3. Tie the material properly 4. Barricade working area regarding radius of lifting.	
		Collision with obstacles	Properties damage		3	3	9	1. When moving uphill or downhill, the boom angle shall be adjusted to the safe working condition	
		Touching overhead power lines	Properties damage		3	3	9	1. Ensure that the lifting routes do not collide with any object, so striking objects must be avoided while lifting 2. Adjust the boom length to ensure the crane is operating within the extent of the safe operation radius 3. Signalman need to give proper information to operator by using hand signal or walkie-talkie	
		Breaking the boom sling	Properties damage		3	3	9	1. Ensure that the automatic safe load indicator is installed 2. The weight of the load shall not exceed the Safe Working Load	
		Heavy rain, thunderstorm, and heavy wind	Properties damage		3	3	9	1. Stop work immediately	
5	Housekeeping (Cleaning workplace)	Slip and trip due to wire rope and other crane accessories	Body Injury	1. Toolbox talk 2. Wear appropriate PPE	3	2	6	1. Properly arrange wire rope and other crane accessories at storage location 2. Wear glove and avoid pinch point	Supervisor engineer and operator
6	Demobilize (Unloading equipment)	Uncontrolled traffic management	Traffic collision	1. Toolbox talk 2. Wear appropriate PPE	3	2	6	3. Traffic controllers' signs, high-visibility vests to be worn	Supervisor engineer and operator

APPENDIX 3

HIRARC ANALYSIS OF RESEARCH

HAZARD IDENTIFICATION				RISK ASSESMENT				RISK CONTROL	
No	**Work Activity**	**Hazard**	**Cause/effect**	**Existing risk control**	**likelihood**	**severity**	**risk**	**Recommended control measure**	**PIC (Due Date)**
1	Improper construction waste & materials handling (management of waste & materials)	-Inhalation of gas materials - Fall and trip - Striking against, or struck by objects	C - Unsafe behaviour and attitudes of workers E - ill health	• Dispose of the waste into the RORO bin • Use appropriate PPE (hand glove) • Proper diesel storage area	4	4	16	• Provide safety jackets that contain much space that can place easy materials or waste (nails, hammers, and small materials) • Install CCTV or used drones' system to detect the workers always in safety situations such as making sure the workers wear full PPE during work	Supervisor (1/6/2023)
2	Poor Housekeeping	1. Slippery 2. Fall and trip	C - Unsafe condition of the site, uneven floor, sharp object E - bodily injury	• Ensure the working area is properly cleaned and housekeeping is done. • Use appropriate PPE.	3	3	9	• Provide proper rack placement to arrange chemical/oil substances. • Prepare a schedule to do 5-minute housekeeping every day after work finishes. • The supervisor should inspect and clear immediately on unsafe condition of site	Supervisor (1/6/2023)
3	Scattered building materials or construction waste on the construction site.	1. Exposure to or contact with harmful substances, radiations or electric shock 2. Fall from height 3.Fall and trip	C - Sharp materials (woods with sharp nails, rebar, or unproper placement of electric wire) E - contact with exposed wires and contact with high, body injury, fatigue, or errors due to workplace design.	• Properly dispose of all the waste or materials at the work location • Use appropriate PPE.	4	5	20	• Waste or materials should clean immediately without letting it on the site floor. • Do not operate or placed electrical tools at wet place. • Install CCTV or used drones' system to detect the workers	Supervisor (1/6/2023)
4	Does not provide separate waste collection bins.	1. Inhalation of bad smell of all waste 2. Environmental problem	C – All the waste are throwed in one waste disposal bin without separate and send to landslide E - Respiratory Problems, infection	• Provide one waste collection bin for all types of waste: Roro Bin • wear gloves and avoid pinch point	4	3	12	• Separate the Roro bin into three sections to collect the construction waste according to the most collected type of waste. • Use appropriate PPE	Supervisor (1/6/2023)

Table 5.1 HIRARC Assessment Analysis of Research

APPENDIX 4

PHASE 1 QUESTIONNAIRE

Construction Site Safety Identification Through the *HIRARC* Analysis.

To whom it may concern
Dear Sir/Madam,

I am Muniswary Jeevarajan, I am in my final year of a student of Bachelor of Civil Engineering Technology from the Department of Civil Engineering, Ungku Omar Polytechnic (PUO) was currently conducting a research study of a final year project on the title of Hazard Identification, Risk Assessment and Risk Control (HIRARC) at the construction site mainly on construction waste and material managing in the site. The cooperation of your feedback helps us to propose a more sustainable construction site.

Hazard Identification, Risk Assessment and Risk Control (HIRARC) were one of the survey tools which will be used in every industry to identify the hazard or risk that would happen in the workplace and this hazard that can make any fatality, near-misses or death to the employers and employees at the ongoing construction site. These surveys collect valuable data related to the risk and undetected hazards that occur on the construction site due to the unsafe working environment of the site because of construction waste or materials. This information allows employers to understand the health and safety measurement or performances, measure trends, provide input to safer workplace development, forecasting and plan for area-wide construction needs and services and purpose progress in implementing project management quality control.

Objectives:

- To identify the potential hazard analysis associated with improper construction waste materials at a site.
- To perform risk analysis with an issue's severity to categorise the consequence level that would happen.
- To access the current risk control practices by making suggestions for improvement to reduce the related risk.

This questionnaire consists of THREE sections, in which each round of survey is not expected to exceed 10 minutes in duration. Your responses will be kept confidential and strictly used for academic purposes only.Your participation in this survey is truly appreciated.

SECTION A : BACKGROUND INFORMATION

1. 1.Gender

Mark only one oval.

- Male
- Female

2. 2.Age

Mark only one oval.

- 20 – 30 year
- 31 – 40 year
- 41 - 50 year
- 51 – 60 year
- 61 year and above

3. 3.Race

Mark only one oval.

- Malay
- Chinese
- Indian
- Other: ______________________

4. 4.Education

Mark only one oval.

- SPM
- STPM/Diploma
- Certificate
- Degree
- MASTER
- PHD

5. 5.Designation

Mark only one oval.

- a) Project director
- b) Project manager
- c) Project engineer
- d) Site engineer
- e) Planning engineer
- g) Quantity surveyor
- h) Site Supervisor
- i) Safety and health supervisor
- j) Site worker
- k) Others:

6. 6. Work Experience

Mark only one oval.

- 1- 5 years
- 6 -10 years
- 11 - 15 years
- 16 - 20 years
- More than 20 years

PART B: WORK ACTIVITY

Fill the form according to choices that given below.

(1: Strongly disagree 2: Disagree 3: Moderately 4: Agree 5: Strongly agree)

collection bins.					
g) Construction and demolition waste are exposed and unprotected					

8. Others

PART C: WORK ACTIVITY HAZARD

Based on the answer to section A above, the work activity above will make the employer and employee life to hazards at the construction site if undetected. According to your opinion, what kind of hazard would happen and lead to near-misses or accidents for the workers?

7. Site activity affects the health and safety of employers and employees at a construction site.

Mark only one oval per row.

	Strongly disagree	Disagree	Moderately	Agree	Strongly agree
a) Improper construction waste materials handling (management of waste materials)					
b) Scattered building materials or construction waste on the construction site.					
c) Poor housekeeping					
d) Unsafe behaviour and attitudes of workers (throw unused building materials surrounding of working environment)					
e) Unsafe condition of site.					
f) Does not provide separate waste					

9. **(* Please choose one to more than two choice for every question)**

Check all that apply.

	Environmental issue (,Air, Water and etc pollution)	Unstable floor - Falls from height.	Uneven floor - Slippery.	Striking against, or struck by objects, including falling objects.	Inhalation of gas materials such as Fuel / Exhaust.	Fall and trip	Exp to cor w harr subt radi or el sh
a) Improper construction waste materials handling (management of waste materials)	☐	☐	☐	☐	☐	☐	☐
b) Scattered building materials or construction waste on the construction site.	☐	☐	☐	☐	☐	☐	☐
c) Poor housekeeping	☐	☐	☐	☐	☐	☐	☐
d) Unsafe behaviour and attitudes of workers (throw unused building materials surrounding of working environment)	☐	☐	☐	☐	☐	☐	☐

e) Unsafe condition of site	☐	☐	☐	☐	☐	☐	☐
f) Does not provide separate waste collection bins.	☐	☐	☐	☐	☐	☐	☐
g) Construction and demolition waste are exposed and unprotected	☐	☐	☐	☐	☐	☐	☐

10. Others

____

END OF QUESTION

Thank you for your cooperation

APPENDIX 5

PHASE 2 QUESTIONNAIRE

Construction Site Safety Identification Through the *HIRARC* Analysis.

To whom it may concern
Dear Sir/Madam,

I am Muniswary Jeevarajan, I am in my final year of a student of Bachelor of Civil Engineering Technology from the Department of Civil Engineering, Ungku Omar Polytechnic (PUO) was currently conducting a research study of a final year project on the title of Hazard Identification, Risk Assessment and Risk Control (HIRARC) at the construction site mainly on construction waste and material managing in the site. The cooperation of your feedback helps us to propose a more sustainable construction site.

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Objectives:

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- To perform risk analysis with an issue's severity to categorise the consequence level that would happen.
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SECTION A : BACKGROUND INFORMATION

1. 1.Gender

Mark only one oval.

- Male
- Female

2. 2.Age

Mark only one oval.

- 20 – 30 year
- 31 – 40 year
- 41 - 50 year
- 51 – 60 year
- 61 year and above

3. 3.Race

Mark only one oval.

- Malay
- Chinese
- Indian
- Other: ______________________

4. 4.Education

Mark only one oval.

- SPM
- STPM/Diploma
- Certificate
- Degree
- MASTER
- PHD

5. 5.Designation

Mark only one oval.

- a) Project director
- b) Project manager
- c) Project engineer
- d) Site engineer
- e) Planning engineer
- g) Quantity surveyor
- h) Site Supervisor
- i) Safety and health supervisor
- j) Site worker
- k) Others:

6. 6. Work Experience

Mark only one oval.

- 1- 5 years
- 6 -10 years
- 11 - 15 years
- 16 - 20 years
- More than 20 years

PART B: Risk Assesment - Likelihood

Based on the hazard's cause and effect below, how often has this event happened in the past or would happen to workers' safety and health in the future?

Fall and trip - body injury, fatigue or errors due to workplace design.	⬭	⬭	⬭	⬭	⬭
Exposure to or contact with harmaful subtances, radiations or electric shock. - contact with exposed wires and contact with high voltage	⬭	⬭	⬭	⬭	⬭

8. Others

____

PART C: Risk Assesment - Severity

Based on the hazard's cause and effect below, what are the severity would happen to workers' safety and health?

7. **Fill the form according to choices that given below.**

1. Very Unlikely - *Is practically impossible and has never occurred*
2. Unlikely - Has not been known to occur after many years
3. Conceivable/moderate - Might be occur at sometime in future
4. Likely - Has a good chance of occurring and is not unusual
5. Most likely - The most likely result of the hazard / event being realized

Mark only one oval per row.

	1-Very Unlikely	2-Unlikely	3-Conceivable/moderate	4-Likely	5-Most likely
Environmental issue (Air, Water and etc pollution). - Health issues	⬭	⬭	⬭	⬭	⬭
Falls from height - unstable floor with unused material.	⬭	⬭	⬭	⬭	⬭
Slippery - body injury, fatigue or errors due to workplace design.	⬭	⬭	⬭	⬭	⬭
Striking against, or struck by objects, including falling objects.	⬭	⬭	⬭	⬭	⬭
Inhalation of gas materials such as Fuel / Exhaust - ill health.	⬭	⬭	⬭	⬭	⬭

9. **Fill the form according to choices that given below.**

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

Mark only one oval per row.

	1-Negligible	2-Minor	3-Serious	4-Major or Fatal	5-Death or Catastrophic
Environmental issue (Air, Water and etc pollution). - Health issues	⬭	⬭	⬭	⬭	⬭
Falls from height - unstable floor with unused material.	⬭	⬭	⬭	⬭	⬭
Slippery - body injury, fatigue or errors due to workplace design.	⬭	⬭	⬭	⬭	⬭
Striking against, or struck by objects, including falling objects.	⬭	⬭	⬭	⬭	⬭
Inhalation of gas materials such as Fuel / Exhaust - ill	⬭	⬭	⬭	⬭	⬭

health.					
Fall and trip - body injury, fatigue or errors due to workplace design.	⬭	⬭	⬭	⬭	⬭
Exposure to or contact with harmaful subtances, radiations or electric shock. - contact with exposed wires and contact with high voltage	⬭	⬭	⬭	⬭	⬭

10. Others

____

Skip to section 5 (END OF QUESTION)

END OF QUESTION

Thank you for your cooperation

APPENDIX 6

PHASE 3 QUESTIONNAIRE

Construction Site Safety Identification Through the *HIRARC* Analysis.

To whom it may concern
Dear Sir/Madam,

I am Muniswary Jeevarajan, I am in my final year of a student of Bachelor of Civil Engineering Technology from the Department of Civil Engineering, Ungku Omar Polytechnic (PUO) was currently conducting a research study of a final year project on the title of Hazard Identification, Risk Assessment and Risk Control (HIRARC) at the construction site mainly on construction waste and material managing in the site. The cooperation of your feedback helps us to propose a more sustainable construction site.

Hazard Identification, Risk Assessment and Risk Control (HIRARC) were one of the survey tools which will be used in every industry to identify the hazard or risk that would happen in the workplace and this hazard that can make any fatality, near-misses or death to the employers and employees at the ongoing construction site. These surveys collect valuable data related to the risk and undetected hazards that occur on the construction site due to the unsafe working environment of the site because of construction waste or materials. This information allows employers to understand the health and safety measurement or performances, measure trends, provide input to safer workplace development, forecasting and plan for area-wide construction needs and services and purpose progress in implementing project management quality control.

Objectives:

- To identify the potential hazard analysis associated with improper construction waste materials at a site.
- To perform risk analysis with an issue's severity to categorise the consequence level that would happen.
- To access the current risk control practices by making suggestions for improvement to reduce the related risk.

This questionnaire consists of THREE sections, in which each round of survey is not expected to exceed 10 minutes in duration. Your responses will be kept confidential and strictly used for academic purposes only.Your participation in this survey is truly appreciated.

SECTION A : BACKGROUND INFORMATION

1. 1.Gender

Mark only one oval.

- Male
- Female

2. 2.Age

Mark only one oval.

- 20 – 30 year
- 31 – 40 year
- 41 - 50 year
- 51 – 60 year
- 61 year and above

3. 3.Race

Mark only one oval.

- Malay
- Chinese
- Indian
- Other: ____________________

6. 6. Work Experience

Mark only one oval.

- 1- 5 years
- 6 -10 years
- 11 - 15 years
- 16 - 20 years
- More than 20 years

PART B: Risk Control

Based on the work activity, hazard and current risk control was shown in figure, according to current HIRARC plan of industries that was implement at site to control the workers safety and health there are improvement are made on current control. Please answer the questions below according to the figured showed.

Work activity, hazard and current risk control, improvement of risk control

Current Risk Control Hazard

Work Activity	Hazard - cause and effect	Risk Control	Improved Risk Control
a) Improper construction waste & materials handling (management of waste & materials) - Unsafe behaviour and attitudes of workers	1. Inhalation of gas materials. – ill health 2. Unstable floor -Fall and trip 3. Striking against, or struck by objects	• Dispose of the waste into the RORO bin • Use appropriate PPE (hand glove) • Proper diesel storage area	➢ Provide safety jackets that contain much space that can place easy materials or waste (nails, hammers, and small materials) to make workers can place in that safety jackets without throwing surrounding site. ➢ Install CCTV or used drones system to detect the workers always in safety situations such as making sure the workers wear full PPE during work
b) Housekeeping ❖ Unsafe condition of the site	1. Uneven floor – slippery and fall 2. sharp object – bodily injury	• Ensure the working area is properly cleaned and housekeeping is done. • Use appropriate PPE.	➢ Provide proper rack placement to arrange chemical/oil substances ➢ Prepare a schedule to do 5-minute housekeeping every day after work finishes ➢ The supervisor should inspect and clear immediately on unsafe condition of site
c) Scattered building materials or construction waste on the construction site. - Sharp materials (woods with sharp nails, rebar, or unproper placement of electric wire)	1. Exposure to or contact with harmful substances, radiations or electric shock - contact with exposed wires and contact with high voltage 2. Fall and trip - body injury, fatigue, or errors due to workplace design.	• Properly dispose of all the waste or materials at the work location • Use appropriate PPE.	➢ Waste or materials should clean immediately without letting it on the site floor ➢ Do not operate or placed electrical tools at wet place ➢ Install CCTV or used drones system to detect the workers
d) Does not provide separate waste collection bins.	1. Inhalation of bad smell of all waste - respiratory problems 2. Striking against, or struck by objects	• Provide one waste collection bin for all types of waste: Roro Bin • wear gloves and avoid pinch point	➢ Separate the Roro bin into three sections to collect the construction waste according to the most collected type of waste

4. 4.Education

Mark only one oval.

- SPM
- STPM/Diploma
- Certificate
- Degree
- MASTER
- PHD

5. 5.Designation

Mark only one oval.

- a) Project director
- b) Project manager
- c) Project engineer
- d) Site engineer
- e) Planning engineer
- g) Quantity surveyor
- h) Site Supervisor
- i) Safety and health supervisor
- j) Site worker
- k) Others:

7. According to current risk control that created for health and safety of worker, do you think it is Fill the form according to choices that given below.

(1: Strongly disagree 2: Disagree 3: Moderately 4: Agree 5: Strongly agree)

Mark only one oval per row.

	1 - Strongly disagree	2 - Disagree	3 - Moderately	4 - Agree	5 - Strongly agree
According to current risk control that implement for health and safety of worker, do you think it is more flexible?	⬭	⬭	⬭	⬭	⬭
Do the current risk control, enough protections to secure the workers health and safety?	⬭	⬭	⬭	⬭	⬭
Can workers adopt the current risk control?	⬭	⬭	⬭	⬭	⬭
Can workers obey the rules and process that stated in current risk control?	⬭	⬭	⬭	⬭	⬭
Do current	⬭	⬭	⬭	⬭	⬭

Do current risk control, able to solve the issue regarding the proper construction waste or materials handling at site?

risk control, able to solve the issue regarding the proper construction waste or materials handling at site?

of risk control?					
Do the improvement of risk control, able to solve the issue regarding the proper construction waste or materials handling at site?	◯	◯	◯	◯	◯

9. Others

____

PART C: Improvement of Risk Control

Kindly answer the question according to improvement made on risk control for health and safety of worker

8. **Fill the form according to current risk control and improvement that made for health and safety of worker. Fill the form according to choices that given below.**

(1: Strongly disagree 2: Disagree 3: Moderately 4: Agree 5: Strongly agree)

Mark only one oval per row.

	1 - Strongly disagree	2 - Disagree	3 - Moderately	4 - Agree	5 - Strongly agree
According to improvement of risk control that implement for health and safety of worker, do you think it is more adaptable?	⬭	⬭	⬭	⬭	⬭
Do the improvement of risk control, enough protections to secure the workers health and safety?	⬭	⬭	⬭	⬭	⬭
Can workers adopt the improvement of risk control?	⬭	⬭	⬭	⬭	⬭
Can workers obey the rules and process that stated in improvement	⬭	⬭	⬭	⬭	⬭

10. Fill the form according to choices that given below.
(1: Strongly disagree 2: Disagree 3: Moderately 4: Agree 5: Strongly agree)

Mark only one oval per row.

	1 - Strongly disagree	2 - Disagree	3-Moderately	4-Agree	5-Strongly agree
I believe that utilising improved risk control would be more convenient for safety and health issues in improper construction waste	⬭	⬭	⬭	⬭	⬭
I believe implement the improved risk control would be beneficial for workers safety and health	⬭	⬭	⬭	⬭	⬭
I intend to recommend this improved risk control to my workers as a consideration of their safety and health at construction site	⬭	⬭	⬭	⬭	⬭

11. Others

Skip to section 5 (END OF QUESTION)

END OF QUESTION

Thank you for your cooperation

APPENDIX 7

GANTT CHART SEMESTER 7 AND SEMESTER 8

NO.	WORK DESCRIPTION		SEM 7																			
			SEP			OCT					NOV				DEC				JAN			
			W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20
			12/09/22 - 17/09/22	19/09/22 - 24/09/22	26/09/22 - 01/10/22	03/10/22 - 08/10/22	10/10/22 - 15/10/22	17/10/22 - 22/10/22	24/10/22 - 29/10/22	3/10/22 - 05/11/22	07/11/22 - 12/11/22	14/11/22 - 19/11/22	21/11/22 - 26/11/22	28/11/22 - 03/12/22	05/12/22 - 10/12/22	12/12/22 - 17/12/22	19/12/22 - 24/12/22	26/12/22 - 31/12/22	02/01/23 - 07/01/23	09/01/23 - 14/01/23	16/01/23 - 21/01/23	23/01/23 - 28/01/23
1	REGISTRATION AT WBL INDUSTRY																					
2	RESEARCH INTRODUCTION	Definition of research																				
		Get an idea from the construction site and site office																				
3	RESEARCH TOPIC	Definition of topic																				
		Identify the issues and the solutions																				
4	RESEARCH TOPIC	Investigate the problems																				
5	RESEARCH TOPIC	Discuss with WBL supervisor about the project																				
6	RESEARCH FRAMEWORK	Problem statement																				
		Literature Review																				
7	RESEARCH FRAMEWORK	Research Objective																				
		Literature Review																				
		Research Methodology																				
8	RESEARCH FRAMEWORK	Research Design																				
		Draft of Chapter 1 (Introduction)																				
		Draft of Chapter 2 (Literature Review)																				
		Draft of Chapter 3 (Methodology)																				
9	PROPOSAL PRESENTATION	Defend proposal presentation																				
10	PROPOSAL	Editing of proposal																				
11	FINAL EDITING OF PROPOSAL																					
12	SUBMISSION OF FINAL PROPOSAL																					
13	FINAL EVALUATION & KEY-IN PROCESS OF MARKS																					

Legend:
Plan
Actual

NO.	WORK DESCRIPTION		SEM 8																			
			JAN/FEB				MAR					APR				MAY				JUN		
			W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20
			30/01/23 - 04/02/23	06/02/23 - 11/02/23	13/02/23 - 18/02/23	20/02/23 - 25/02/23	27/02/23 - 04/03/23	06/03/23 - 11/03/23	13/03/23 - 18/03/23	20/03/23 - 25/03/23	27/03/23 - 01/04/23	03/04/23 - 08/04/23	10/04/23 - 15/04/23	17/04/23 - 22/04/23	24/04/23 - 29/04/23	01/05/23 - 06/05/23	08/05/23 - 13/05/23	15/05/23 - 20/05/23	22/05/23 - 27/05/23	29/05/23 - 03/06/23	05/06/23 - 10/06/23	12/06/23 - 17/06/23
1	REGISTRATION AT WBL INDUSTRY																					
2	PREPARATION FOR DATA COLLECTION	Resources identification and selection																				
3	PROJECT IMPLEMENTATION AND DEVELOPMENT	Product development/data collection																				
4	PROJECT IMPLEMENTATION AND DEVELOPMENT	Product development/data collection																				
5	PROJECT IMPLEMENTATION AND DEVELOPMENT	Product development/data collection																				
6	PROJECT IMPLEMENTATION AND DEVELOPMENT	Product development/data collection																				
7	PROJECT IMPLEMENTATION AND DEVELOPMENT	Product development/data collection																				
8	PROJECT IMPLEMENTATION AND DEVELOPMENT	Test run the project																				
9	RESULTS AND ANALYSIS	Interpret the results State and summarize all the results																				
10	REPORT WRITING	Continuation on the writing of final report.																				
11	Preparation For Final Year Project Dissertation and Presentation at industry																					
12	Preparation For Final Year Project Dissertation and Presentation at PUO																					
13	FYP presentation.	Final report/thesis submission																				

Legend:
Plan
Actual