POLITEKNIK UNGKU OMAR

CONSTRUCTION WASTE MANAGEMENT PLATFORM (CWMP)

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(01BCT201F3028)

CIVIL ENGINEERING DEPARTMENT

SESSION 2 2022/2023

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

CIVIL ENGINEERING DEPARTMENT

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STATEMENT OF AUTHENTICITY AND PROPRIETARY RIGHTS

CONSTRUCTION WASTE MANAGEMENT PLAFORM (CWMP)

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ABSTRACT

The construction industry is considered a major stimulant to Malaysia's economy, but it also generates waste from construction activities, and the management of construction waste can pose problems if it is not properly handled, which has a negative impact on the environment and the company. The purpose of this project is to identify the types of waste generated by the YNJDC project, which will lead to the development of the construction waste management platform (CWMP) for the project and to test the effectiveness of the platform for the YTL Green Data Centre project. The idea is to implement the Internet of Things (IoT) by using technology and systematic document management throughout the Leadership in Energy and Environment Design (LEED) accreditation process. The process and appearance of the CWMP were identified through research analysis during the internship period in the YNJDC project when issues are encountered in the *LEED* document submission. These features and solutions are incorporated into the interface of the *CWMP*, which can be used to optimize and efficiently monitor documentation data. The platform is enhanced by using the QR code system which must be scanned and forwarded via a smartphone to the platform link. Testing and project results are supported by a simulation program on the function of the CWMP and a questionnaire survey using the Technology Acceptance Model (*TAM*) states that most of the selected respondents *agreed* (>80%) with the usage of CWMP and agreed that the application effectively changed the tide of LEED accreditation documents submission.

Keywords: *Construction Waste Management Platform (CWMP), systematic document management, Leadership in Energy and Environment Design (LEED), Technology Acceptance Model (TAM)*

ABSTRAK

Industri pembinaan dianggap sebagai penujah utama kepada ekonomi Malaysia, tetapi ia juga menjana sisa daripada aktiviti pembinaan, dan pengurusan sisa pembinaan boleh menimbulkan masalah jika ia tidak dikendalikan dengan betul, yang memberi kesan negatif kepada alam sekitar dan syarikat. Tujuan projek ini adalah untuk mengenal pasti jenis sisa yang dijana oleh projek YNJDC, yang akan membawa kepada pembangunan platform pengurusan sisa pembinaan (CWMP) untuk projek dan untuk menguji keberkesanan platform untuk Pusat Data Hijau YTL projek. Ideanya adalah untuk melaksanakan Internet of Things (IoT) dengan menggunakan teknologi dan pengurusan dokumen yang sistematik sepanjang proses akreditasi Leadership in Energy and Environment Design (LEED). Proses dan rupa bentuk CWMP telah dikenal pasti melalui analisis penyelidikan semasa tempoh latihan dalam projek YNJDC apabila isu ditemui dalam penyerahan dokumen LEED. Ciri dan penyelesaian ini digabungkan ke dalam reka bentuk CWMP, yang boleh digunakan untuk mengoptimumkan dan memantau data dokumen dengan cekap. Platform ini dipertingkatkan dengan menggunakan sistem kod QR yang boleh diimbas dan digunakan melalui telefon pintar ke pautan platform. Pengujian dan keputusan projek disokong oleh program simulasi mengenai fungsi CWMP dan tinjauan soal selidik menggunakan Technology Acceptance Model (TAM) menyatakan bahawa kebanyakan responden yang dipilih bersetuju (>80%) dengan penggunaan CWMP dan bersetuju bahawa aplikasi ini berkesan dalam mengubah corak arus penyerahan dokumen akreditasi LEED.

Kata Kunci: Platform Pengurusan Sistem Pepejal (CWMP), Pengurusan dokumen secara sistematik, Leadership in Energy and Environment Design (LEED), Technology Acceptance Model (TAM).

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CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

The planning, design, and construction of roads, bridges, subdivisions, buildings, municipal services, and heavy infrastructure are all part of civil engineering technology. Civil engineering technicians operate in a wide range of settings, including construction. The construction sector has long related to negative repercussions on our mother planet.

YTL construction is building a specific modern building design with the ownership of the YTL Power to construct a data center which is Johor Data Center (YNJDC). Data Center is a building dedicated spaces within a building or a group of buildings use to combine all computer appliances for computer systems and associated components such as telecommunication and storage system. Since IT operations are crucial for business continuity, it generally includes relevant or backup components digitally rather than conventional method of using hardcopy to store that require physical spaces. Data Center to be simple yet specific is an infrastructure for power supply, data communication connections, environmental controls such as air conditioning, fire suppression systems and various security devices. A large data center is and industrial scale operation using as much electricity as a small town.

Due to the rapid urbanization of each nation on the globe it is projected by United Nation (UN), in total that the world actually projected to add 230 Billion m2 that is equal to 2.5 trillion ft2 of building by 2060 with the growth of construction project that being scheduled. This rapid urbanization poses a big challenge to fight against climate change, as the construction sector has a tremendous impacts on the environment. Buildings are the one of the big contributors to greenhouse gas emissions all along their lifecycle, from their construction phase, usage and demolition waste produced yearly. During construction phase, most of the emission

come from making intensive carbon material based construction items such as concrete and steel that which could account for as much as 10% of the world annual greenhouse gas emissions. In a 2019 article highlighting the impacts of greenhouse emissions on the environment, The Guardian referred to concrete as “The Most Destructive material on Earth”.

The green movement has been significantly transformed since its early formative days. It is also pre-described that by implementing green technology is actually a leap step of transformation in construction age of technology as the new revelation on achieving more sustainable type of building. For more deeper and better understanding of the modern green movement, it helps to try and trace its origins back from the beginning. Around the time that the “glass box” style high rise had become the icon of every country city, a forward thinking of architects, environmentalist, and ecologist were inspired by the growing environmental movement and the increasing rate of fuel cost that were prevalent during the 1970 era. The genesis of these two scenarios ultimately resulted in the modern build green movement. Through the late decades starting from the seventies, much research were commissioned on energy efficiencies processes. This research resulted in the more efficiency electrical and mechanical appliances that are available on today’s market.

The LEED Certification which stands for Leadership in Energy and Environmental Design is the Green Building Accreditation tools applied by YNJDC for its green building accreditation system. The LEED Certification process is fairly accommodating of project schedules, however the Guidebooks provides recommendations for successfully managing the process in an efficient and economical manner. For LEED certification and accreditation, all specific building request must fulfill as below by project phase :

1. Planning / Pre-design Phase

2. Project Schematic Plan

3. Design Development

4. Construction Documents

5. Construction Administration.

As for the project of YTL Construction which is YNJDC that represents as a Data Centre held in Kulai,Johor, the building itself it said to have its own reputation on the LEED building list and the will be named as a green building when it is constructed. By naming the building with the LEED certification, there will be daily, monthly and yearly documents that needed to be managed in order to comply with the accreditation system assigned by the LEED programs. The implementation of the Construction and demolition waste management on site were part of the greater quality of the LEED accreditation that needed to be obey by the project that are applying for this green building accreditation programme that will surely increase the rate of the LEED rate of YNJDC that are targeting for 62 grades for gold accreditation level.. Although there should be various kind of challenge that have to be faced by the construction team as to manage the demolition and construction wasted since every construction project commutes in the pile industrial waste

The practice of establishing a sustainable ecosystem based on ecological principles is known as sustainable construction. Sustainable construction, according to Professor Charles J. Kibert, is based on six principles: "conserve, reuse, recycle/renew, protect nature, and generate non-toxic and high quality." Sustainable construction is not only excellent for the environment, but it is also a solid reason to pursue sustainable techniques. Implementing ecologically friendly techniques in the construction business has numerous benefits, including reduced waste, economic stimulation, and promotion of sustainability. Furthermore, sustainable construction can be viewed as a long-term investment. We can meet the requirements without jeopardising the needs of future generations by conserving energy, water, and natural resources through reuse, recycling, innovative design, and waste and pollution reduction and management.

1.2 RESEARCH BACKGROUND.

Although there is no universal definition of construction and demolition waste, waste is mostly classed depending on the origin and type of these waste, Building and demolition waste is defined as garbage generated during the construction, renovation, or demolition of structures. Buildings of various types (both residential and non-residential) as well as roads and bridges are examples of structures. “Concrete, asphalt, wood, metals, gypsum wallboard, and roofing are common components of construction and demolition waste" (Franklin, 1998).

Meanwhile, the rise in construction waste has exacerbated the landfilling problem. Malaysia has a limited number of landfills, and the construction wastes quickly fill them up, causing landfill saturation. Furthermore, Malaysia is a developing country with little waste management expertise and skills. The lack of effective and proper waste management solutions has resulted lack of construction waste management. In fact, implementing an effective and efficient construction waste management method and practices is the long-term solution to lowering building costs, preventing the depletion of natural aggregate supplies, resolving the landfill problem, and protecting the natural environment also helps the company on applying the LEED accreditation effectively with proper method.

A part of the aim also were to create awareness among the construction workers and team about the importance of proper management of these waste that can afflict the balance of the future economy and environmental effect that would not be seen in such a small period and will be reveal in the future and this mistake that cannot be turned back when the pages have it sides on the future community.

As a result, the goal of this study paper is to examine, to offer, to improvise and conclude on a proper construction waste management system that might improve the project’s current construction waste management system.

1.3 PROBLEM STATEMENT.

As already been observe on-site, most of the construction and demolition waste onsite were not effectively manage as the construction waste were scattered without proper designated area around the site for the certain type of construction waste as in the figure below:

Figure 1.1: Steel waste and concrete waste were not separated effectively.

Figure 1.2: Pile head demolition concrete waste were placed scattered around the site.

The method of construction waste on site were not very clear in order to separate the waste by its own separable type to ease the recycling method and needed to be demolished or manage with a sustainable way to ensure the outgoing of the waste to the proper hand. Moreover, construction waste need to be dispose sustainably with proper construction waste management to comply with the requirements needed for the LEED accreditation program by using the LEED waste measuring tools to measure the volume of weight each time of disposal period.

The construction waste need to be collected and demolished from the project site with proper demolition contractors that comply with the regulation of Environmental Quality Regulations 2005. From the various method of disposition of waste, the proper method needs to be discover and decide to ensure the right method is being used on site for the accreditation purposes and to follow the progress of work at site.

1.4 Research Objectives

This study aims to solve the issue regarding YNJDC construction waste management that had been stated in the problem statement.

i. To identify the type of construction waste from the YNJDC project through site observation based on LEED requirements.

ii. To develop the construction waste management platform for the YNJDC project that is vary with the LEED accreditation.

iii. To test the effectiveness of CWMP for the YNJDC project.

1.5 Research Questions. (4W 1H)

1.5.1 WHY

- Why construction and demolition waste need to be managed.

o Implementing an effective and efficient construction waste management method is the long-term solution to make the accreditation submission process for the company and to reduce the time needed to discover proper construction waste management process for the LEED accreditation.

1.5.2 WHAT

- What is the demolition and Construction Waste on YNJDC site collected as an example?

o Excess Pile Head Wastage
o Concrete Waste
o Formwork Waste
o Lubricant Oil
o Blasting Wastage

- What is the use of construction and demolition waste on site?

o Temporary purposes
o Machinery lubrication
o Concrete level marking
o Formwork support
o Pile Reinforcement bar buildup

1.5.3 WHO

- Who is responsible in implementing the construction waste management?
  - Construction Manager
  - HSE
- Who is supposed to be assigned to make sure the implementation of construction waste management.
  - Site Team

1.5.4 WHEN

- When is the construction and demolition waste can be implemented on site?
  - During temporary construction.
  - During rectification work.
  - Additional soil stabilization purposes.
- When the stockpile of demolition waste buildup?
  - Accessive pile head above the ground.
  - Crushing procedure onsite to demolish material.
  - Blasting area.
- When is the submission needed for the LEED accreditation programme
  - Weekly
  - Monthly
  - One time submission.

1.5.5 HOW

- How to manage the site construction and demolition waste on site based on the requirements needed from the LEED accreditation programme.
- How to implement the usage of construction and demolition waste on site
- How to encourage site team and worker about the benefits of using demolition waste on site
  - Questionnaire
  - Project presentation.

1.6 Scope Of Study.

The information for the research were gathered by observation during the WBL period about the method of YNJDC harvest their construction waste and the information gathered from the coordinator team of the project about the LEED accreditation and the aspects that need to be take note in order to comply with the requirements.

By developing CWMP to measure and monitor the wastage weight during each collection of construction waste by the delivery order and the receipt gathered from the designated construction waste management company that comply with the Environment Quality Regulation 2005.

By distributing the questionnaire that have been selected and created with Technology Acceptance Model (TAM) method questionnaire by interviews with the correct authorities and personnel along the construction project, experts validators for the project information and validation from the experts lecturer that studies more about the construction waste management and also engineers that have experience on handling the green building accreditation program.

By using and implementing the Technology Acceptance Method (TAM) method of research after understanding the structure of the problems and the hindrance that managers face while solving it that may consist of 3 steps:-

a. Issues that need to be resolved.

b. Alternate solutions that are available to solve the problem.

c. Criteria used to evaluate the alternative solution.

1.7 Research Significant.

Green building is redefining building practice and Malaysia is poised for early adoption in recognition of the potential economic and environmental benefits that pursue to it. Apart of green building developments goals by the project, the management of construction waste maangement also play roles on achieving this achievement.

By listing out the construction waste of the YNJDC project might also helps the company in finding the best and suitable way to harvest and reuse also manage the wastage around the construction area to increase the rate of their LEED accreditation by implementing the waste management. This studies also intend to offer method of implementation on using this waste material for good use by exchanging the outcome of the research projects in terms of cost, time and material consumption on sites and also the impacts on environmental surroundings. According to research conducted in neighbouring Singapore, green buildings save roughly 10% in running costs and boost market value by approximately 2%. The average savings from a sample of 23 rehabilitated buildings (office, retail, hotel, and mixed-use developments) was around 17% of the original cost.

The research project also aims to studies the implementation chance on site by gathering the information from site and construction team about the consent of the continuity of the research project and research about the method available to reuse and manage these resources based on the implementation various kind of waste management method as listed about how to exactly manage these kind of waste and reuse the items for good. Not only the method of implementation that will be studies but also the effects of the research project implementation for the main project LEED scoring and SDG criteria that about to be achieve by successfully implementing the construction waste management.

Moreover, the research project at the same time targets to create morality value from the project by raising awareness that some of these demolition wastes were also usable and need to be manage sustainably consider acceptable to be implemented even as a temporary option in order to raise the environmental value of the project and to the project team themselves about the importance of Reuse, Reduce and Recycle method feasibly by proper management method.

1.8 Conclusion

In conclusion, the development of infrastructure which are a common component of the living environment, has a significant impact on health, social well-being and living situation (Manaf et al.,2009). The need for new construction is stronger and getting greater year by year to come, which could result in a large increase in the amount of waste produced. The definition of the construction industry and better waste management is the purposes this study can be summed up as all work on civil engineering and building projects. It is also mention about proposing and handling the waste management for the YNJDC as Malaysia's expanding growth has slowly harmed the environment and disrupt the ecosystem which becomes a significant issue about why Green Building practices is well recommended for each construction industry.

Construction waste is generated in the construction industry in general, including the Malaysian construction industry. According to most studies, the important construction waste problem in Malaysian building industries were its own construction waste since it is the most constituted waste component in these industries and produces serious waste difficulties.

Moreover, by having the LEED program inside the company which practices good green practices on its successful project, the company will be manageable to organize a goal to reach the accreditation purposes by handling the waste management seriously and on track with the slogan of its company which is "Building The Right Thing"

Chapter 1 of this studies also allows the writer to gather information and compile relevance studies about how to plan in managing the construction waste management. the idea of the project based on the needs of the company to comply with the requirements that have been set by the LEED program and what to do is to manage the waste management and proposing a suitable practice in the YNJDC project to gain more points and comply with the law of Malaysia's government about schedule waste and waste management in construction since YNJDC project were targeting for 62 points from the accreditation system for gold certification.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Construction Waste Management.

It is crucial environmental management is effective (Krajl, 2010). The Malaysian government has suggested several different methods for managing building trash. Regrettably, it has not yet reached the necessary degree of efficacy for controlling construction trash (Abu Eusuf et al., 2012). One sustainable development strategy to reduce waste and prevent adverse environmental effects is the management of construction trash (Yuan, 2013). Monitoring, collection, transport, processing and disposal of garbage are all parts of the waste management system. Nevertheless, it is described (Nagapan et al., 2012) that construction waste management as pa process that to ensure good practices are followed, tools to identify the most appropriate waste streams, and target rates for trash production. The process cycle of an organization to as management (CIDB, 2007) it is also crucial to control the construction trash at the construction site (Rajendran, 2012).

Along with that, (Jaillon et al., 2009) claimed that waste management is the act of distributing garbage to the appropriate location. Also, according to (Fauziah & Agamuthu, 2012), waste management is the field that deals with the generation, storage, collection, transport, processing, and disposal of solid waste while also taking into account environmental, economic, aesthetic and societal considerations. The Malaysian government has made an excessive number of attempts to reduce construction waste production issues by providing landfill space. However the contractor failure to execute effective waste management resulted in the improper handling of construction waste.

Construction waste material needs to go through numerous procedure before being disposed of. It should not be disposed of directly. It should be handled in accordance with the 1997 proposal by Peng et al. for an appropriate waste management hierarchy. According to the hierarchy of waste management, waste product should be first be reduced, reused, and recycled before being properly dumped at a landfill. The waste management hierarchy has been improved as shown in figure 2.2 by additional study (Wolsink, 2010). By reducing waste generation that took things one step further by proposing additional steps to the waste management.

Figure 2.1: Waste Management Hierarchy

(Peng et al., 1997)

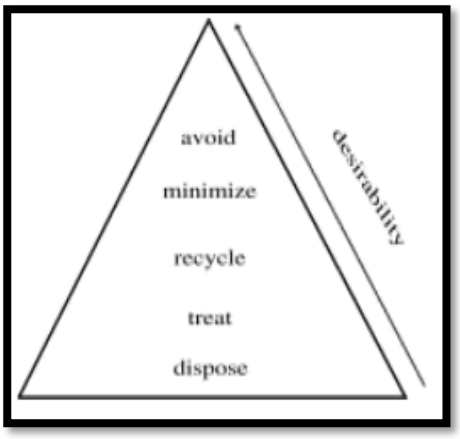


Figure 2.2: Improved Waste Management Hierarchy

(Wolsink,2010)

The next step should be take into consideration is to reuse some of the building waste, such as using broken brick and concrete as a sub-grade of access road to the construction as already being practiced in the YNJDC site, since the waste generated is not entirely preventable. It is possible to classify the waste product by separating the type of the construction waste for recycling if it cannot be utilised on the site due to certification and inspection issue. To decrease the amount of building wasted dumped in landfills, several actions must be made. Consequently, it will increase the landfills useful life. By following the waste management hierarchy steps, YNJDC can sustain its waste management system that is comply with the accreditation scoring procedure.

Construction waste condition in Malaysia

Until today, the problem of unlawful dumping has not yet been satisfactorily addressed by construction waste management. Malaysia produces over 25,600 tonnes of trash every day as a result of its rapid urbanisation and growth (Badgie et al., 2012). There are seven different categories of solid waste management including those produced by residential, commercial, institutional, construction and demolition, municipal services and other human activities (Sreenivasan et al. 2012).

Just 76% of Malaysia solid wastes were successfully collected (Md Zain et al., 2012). Only 5% of solid waste was recycled according to the percentage and 95% of the waste product was collected and dumped in local landfills. In order to clarify the objective and priorities of construction waste management, it is crucial for the government to provide detailed explanation of construction waste management.

As a result, the government has launched a number of measures to address Malaysia's construction waste issues. The idea of the initiative used in the research was described as various plans and strategies for enhancing services or any system necessary and designed to address any difficulties regarding construction waste (Agarwal & Chaudry, 2015),

The disposal of any solid waste includes with its demolition and destruction, incineration, deposits or decomposition, ("The Malaysia Solid Waste And Public Cleansing Management Act," 2007). In Malaysia, putting building debris in landfills is one of the standard method of disposal ("The Ingenieur," 2009). There are approximately around 289 landfills in total, not including dumping. Unfortunately, 113 of these landfills are no longer in use because of opposition from the neighbourhood inhabitants or because they are completely full. The balance of the 176 active landfills are shown in Table 2.1 below as research gathered by (Nagapan, Ismail & Ade)

Table 2.1

Landfills Distribution in Malaysia

State	Operational Landfills	Non-Operational Landfills
Perlis	1	1
Kedah	11	4
Pulau Pinang	1	2
Perak	20	9
Pahang	19	13
Selangor	7	12
Federal Territory Putrajaya	0	0
Federal Territory KL	0	7
Negeri Sembilan	8	10
Melaka	2	5
Johor	13	21
Kelantan	13	4
Terengganu	9	12
Federal Territory Labuan	1	0
Sabah	20	1
Sarawak	51	12
Total	176	113
Overall Landfills	289	

Note: from “Department of National Solid Waste Management, The Ingenieur,2009”

The purpose of this Construction Waste Management Plan [CWMP] shall be to ensure that waste generated during the construction and building works of the JDC shall be managed and disposed of in a way that ensures compliance with relevant requirements set out in the Environmental Quality Act of 1974.

Table 2.2:

Research compilation and comparison

Sources (Author)	Findings/Method/ Objectives	Remarks (Strength/Weakness)
Asokan Pappua,, Mohini Saxenaa , Shyam R. Asolekarb Regional Research Laboratory (CSIR), Habib Ganj Naka, Bhopal–462026, India b CESE, Indian Institute of Technology, Bombay-400076, India	Proposing Types and nature of solid wastes and their recycling and utilisation potentials	Priority should be given to developing additional areas of study for the use of all forms of trash in attaining sustainable development. This can be done by doing lab and pilot scale of research
NURZALIKHA SAADI , ZULHABRI ISMAIL* AND ZARINA ALIAS Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Shah Alam, Malaysia Journal of Sustainability Science and Management Volume 11 Number 2, December 2016: 101-114	Review of Construction waste management initiatives in Malaysia	Proposing a listing of definition of waste from different part of perspective and classification of construction waste materials

Sasitharan Nagapan , Ismail Abdul Rahman , Ade Asmi , Aftab Hameed Memon , Imran Latif Faculty of Civil and Environmental Engineering, Universiti Tun Hussein Onn Malaysia, 2012 IEEE Colloquium on Humanities, Science & Engineering Research (CHUSER 2012), December 3-4, 2012, Kota Kinabalu,	Issues in Construction Waste Management : The Need For Sustainable Waste Management	Proposing construction waste management and environmental challenge faced by different country around asia including Malaysia, Hong Kong and Singapore for better reference.

Sources (Author)	**Findings/Method/ Objectives**	**Remarks (Strength/Weaknes s)**
Godwin Uche Aliagha, Maizon Hashim, Afeez Olalekan Sanni, Kherun Nita Ali Journal of Energy Technologies and Policy ISSN 2224-3232 (Paper) ISSN 2225-0573 (Online) Vol.3, No.11, 2013 – Special Issue for International Conference on Energy, Environment and Sustainable Economy (EESE 2013)	Review Of Green Building Demand Factors For Malaysia	Reviews factor that could enhance green building demand in Malaysia as well as underlining challenges and barriers on implementing Green Building in Malaysia in terms of Construction waste Management

J. T. Kevern, A.M.ASCE JOURNAL OF PROFESSIONAL ISSUES IN ENGINEERING EDUCATION AND PRACTICE. APRIL 2011 DOI: 10.1061/(ASCE)EI.1943-5541.0000048	Green Building and Sustainable Infrastructure: Sustainability Education for Civil Engineers	Framework including sustainable design/thinking in a new civil engineering course as well as the outcomes of the pilot programme including implementing LEED in project.
Standard Specifications for Buildings Works (2005 Edition), Ministry of Works, 1-15. YTL Construction In House Training Course on Management in accordance with the Environmental Quality (Schedule Waste)	**Construction Waste Management: Malaysian Perspective.**	Preparing and listing out of Authorities involving in construction waste management according to Malaysia Act of Standard Specification for Building Works.

2.2 Type of Construction Waste

Building waste can be divided into two categories, physical waste and non-physical waste, as depicted in figure 2.3. Material loss is a common way and method that physical waste is produced. It makes a major contribution to landfill. More than 50% of the waste produced by the construction industry is disposed into landfills, according to studies by (Hwang & Yeo). Reference stated that construction debris occupied roughly 26% of the landfill. Another recent study, as in noted that Spain produced 39.27 million tonnes of waste whereas China produced about 40% of the world waste. The biggest cause of time and cost overruns for construction projects, on the other hand are non-physical construction wastes.

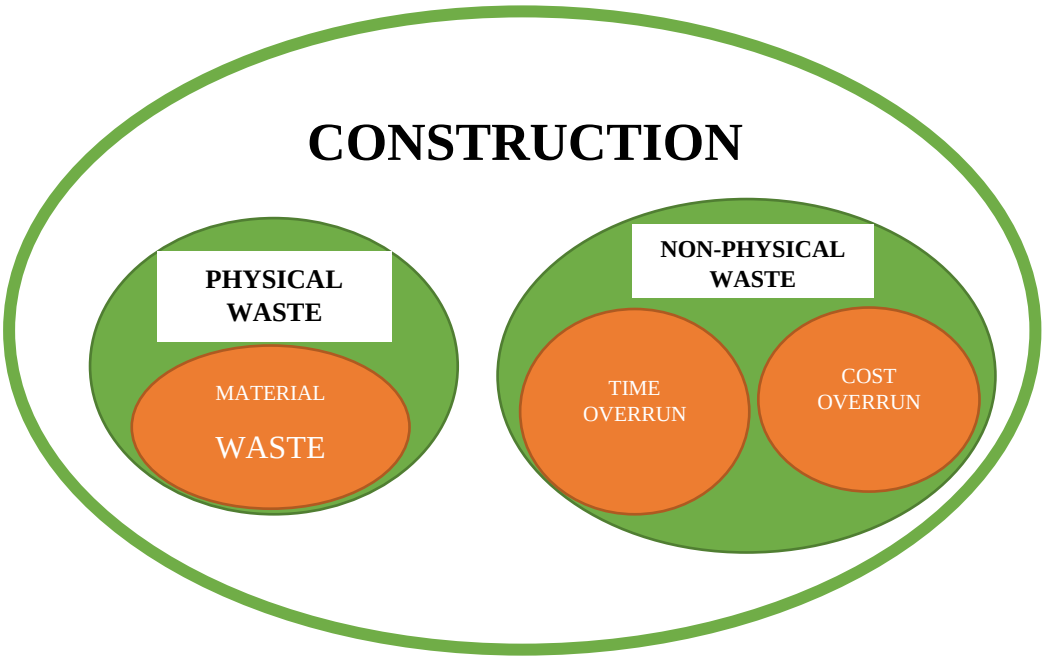


Figure 2.3: classification of construction waste

Physical waste and non-physical waste are the two groups that the construction site's wastes fall under. The term "Physical Waste" refers to resources that are lost, damaged, beyond repair, useless, or lost during construction process. According to (Nagapan, 2012), non physical waste are connected to cost overruns and delays in construction projects. This could be understood as non-physical losses like time and money.

The growing volume of construction waste production in Malaysia is regarded by Begum (2010) as a significant element in the context of Malaysia. Due to the rapid expansion of construction-related activities in Malaysia, enormous amounts of construction waste have been produced throughout the country. Various housing demands have made various personnel in charge of construction projects aware of construction waste and have advised them to think about the increasing amount of construction wastes in structures (Nasaruddin, 2008).

Conducted research on various forms of construction waste product in Malaysia and divided them into six major categories. The first category of waste was concrete-related, accounting about 12.36% of the total waste, followed by brick waste (6.54%) metal waste (9.62%) plastic wastes (0.43%), wood waste (69.10%) and other waste (2%) of the total (Faridah, 2004). The findings of the study shows that wood had historically been regarded as Malaysia's most wasteful construction materials.

The focus of this project is exclusively on physical waste. The sort of garbage and waste generated at the YNJDC site was determined by site visit and observational approach. The construction site of YNJDC site were observed during the duration of the WBL and there are several types of wastes on site which is concrete waste, timber waste, steel bar waste, demolition waste and brick waste.

Concrete Waste.

Concrete waste is one of the common construction wastes that can be identified in the construction industry, figure 2.4 show the concrete waste generated from the demolition process of the excess pile head for the YNJDC site.

Figure 2.4: Concrete waste

Timber Waste.

Timber waste is a wood base product that often use in the construction industry, this timber waste occurs due to the packaging of the wooden palette for cement and other deliveries purpose. Other than packaging, timber product waste also comes from the expired formwork from the construction site due to the timber characteristics that expands and defect and cannot be use continuously.

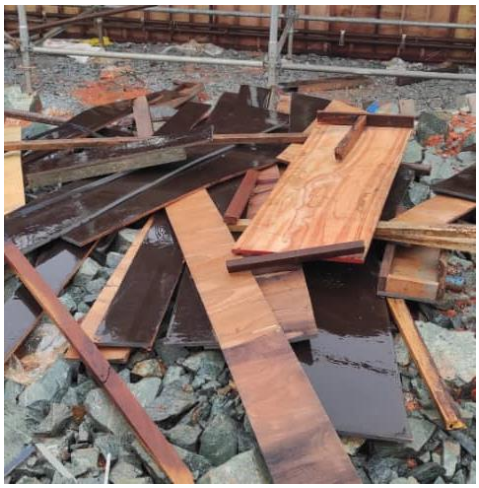


Figure 2.5: Timber waste

Metal Waste

A steel reinforcement is one of the important elements in construction. The waste commonly occurs at the site due to pile hacking process as been shown in figure 2.6, since the internal of the piling structure is consist of reinforcement. As being observe at the YNJDC site it has been determine that most of the steel bars waste were generated from the pile crushing procedure.

Figure 2.6: Reinforcement bar (metal) waste.

Demolition Waste.

Some site that origins from a non-discovered land or never been excavated might be experiencing blasting procedure as excavation process encounter rock surface beneath the ground inside the construction project. These areas where then undergo demolition process by blasting the area. The debris and residue of the blast consist of rock that consider as demolition waste that need to be extracted from the site as shown in Figure 2.7.

Figure 2.7: Demolition waste by blasting procedure

Brick and Masonry Waste

Brick and masonry waste are normally waste that are considered as architectural waste from rectification residue and architectural part that were being demolished for certain reason. Some of the masonry waste are generate from the cutting of brick done by the worker due to brick size according to the type of brick bond the project is using. Figure 2.8 shows example of brick and masonry waste that are available in YNJDC project.

Figure 2.8: Brick and Masonry Waste.

2.3 Type of Waste demolition in Construction Waste Management.

Different waste products cannot be easily classified or assigned to classes using traditional criteria (Kan A). Researchers have suggested and created a few educational techniques. These days, not all wastes fall into the same traditional category and require the same elimination process. It is extremely difficult and impossible to set up and run a different management system for different type of waste especially in business where waste types are so diverse (Cardak O, 2009). Hence the need for a management system that would get eliminate and dispose waste has evolved.

Landfill Method

Yet, a landfill is now and was not designed to be a typical environmental circumstance. An actual landfill is more like a secure storage space. A landfill is made to stop degradation and prevent hazardous contamination of the environment. Even organic waste like paper and grass clipping decay relatively slowly in a landfill when deprived of oxygen and water.

In Malaysia, it has long been customary to discard recyclable and unsorted construction waste in landfills. Wastes are still merely dumped in open area of land without any attempt at recovery or recycling, despite the tremendous potential and chances for recovering solid waste. Malaysia recycling rate is only 5% higher than of its neighbouring countries, demonstrating how frequently recycling is practised here.

Figure 2.9: Landfill Waste Management Method

Incineration Method

Both small-scale incinerators and larger scale industrial incinerators burn waste. Waste that is solid, liquid, or gaseous is disposed of using it. It is acknowledge as a useful technique for getting rid of some types of hazardous waste (such as biological medical waste). Because of the problems like the production of gaseous contaminants, incinerating garbage is a contentious technique of solid waste, including bottom ash and residues from air pollution management. in addition to having a high concentration of inorganic compounds, incineration leftovers also have a high concentration of carbon compounds that result from incomplete combustion, unburned organic matter, and carbon compounds that were created during the incineration.

Although Malaysia could not rely solely on landfills method of disposing construction waste, the incinerator is regarded as one of the disposal alternatives in addition to landfills. There are now five small incinerators in Malaysia, located on the island of Pulau Pangkor, Perak, Pulau Langkawi in Kedah, Pulau Tioman and Cameron highland. Each has a capacity less than 100 tonnes. In Taman Beringin, Kuala Lumpur, Bukit Payung, Johor and Sungai Udang, Melaka, three sizeable incinerators will be constructed. Today, clinical and hazardous waste are the main type of waste that are being incinerated in Malaysia where 100% of the waste is burned. Figure 2.10 below explained about the incineration method that are being used in the incinerators factories.

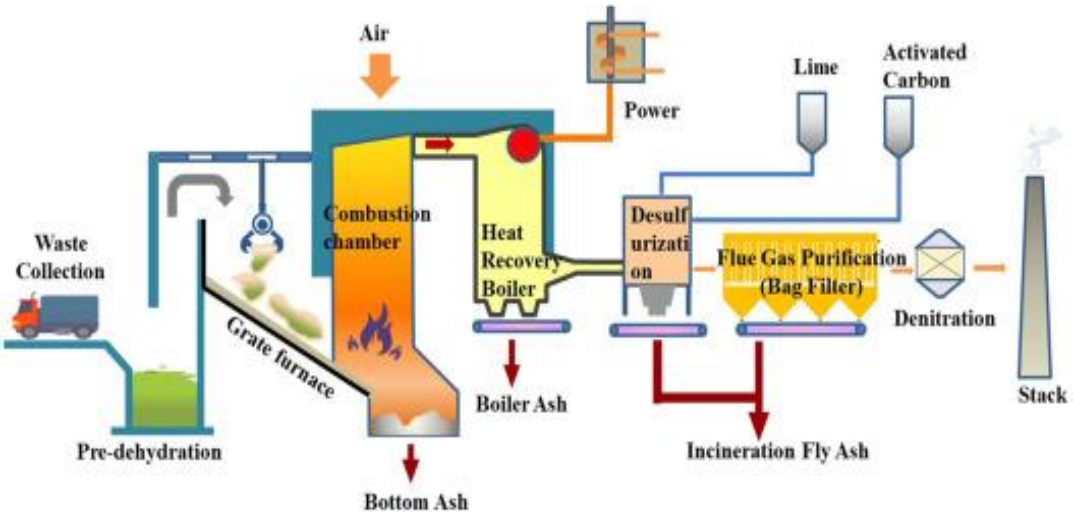


Figure 2.10: Incineration Waste Management Process

On-site waste Sorting

The waste must be sorted on-site before disposal as this is the better approach to lessen the impacts of landfills if waste reduction practises in design and construction have been applied. Doing on-site construction waste sorting (CWS) has greatly lessened the detrimental effects of construction operation on the environment by the research of (Lu and Yuan, 2012). More construction materials are being separated at the source on-site, which directly contributes to the improvement of CWS and significantly improves the effectiveness of resource reuse and recycling. Less construction waste is now being disposed of in the landfills to improved on-site CWS resources.

Figure 2.11 below, shows the example of on-site waste sorting method by bin separation with the label included to mark the type of waste and to ease the designated waste contractor to proceed with the weight distribution and different type of site waste sorting and the recycle and reuse method can easily be implemented by the contractors and on site respectively.

Figure 2.11: On-site construction waste separation method.

Off-Site Construction Waste Sorting

As example form an Asian country which is Hong Kong as being stated from the research, that the Hong Kong government must provide facilities far off-site sorting of mixed materials in the construction industry (Ming-zhi & Gao, 2006). The decomposable organic waste will subsequently be added to the main waste disposal stream, while the inert material will be used as public fill. In order to recover useful components from mixed construction waste, the first construction waste recycling facilities was established at the South East New Territories (SENT) landfill in 1998. The government then started the off-site CWS programme and constructed two CWS facilities, one in each of the areas of Tuen Mun and Tuseng Kwan O, in 2006 for the purpose of classifying and segregating construction waste before its final disposal. Since its introduction, these two waste sorting facilities have handled a sizeable volume of construction waste and reduce the needs for more landfill area to be nominated.

2.4 The Reason of Construction Waste Management

According to Borneo Post (2013), Malaysia produced 33,000 tonnes of solid waste each day with the observation stated on 2012. Meanwhile, the Malaysian government spent RM 1,136.00 million on waste management in 2010. Spending on non- hazardous solid waste made up to RM 920.5 million (81.0%) of this total, while scheduled waste came in at RM 215.6 million (19.0%) based on the data provided on Department of Statistic Malaysia, 2011). Thus, the Malaysian government has started taking action on solving the issue through legal instruments and research on the best wat to manage construction waste due to the detrimental impact that the growing waste generation has on the environment.

A Site Waste Management offers a structure that can assist project managers or contractors in anticipation and documenting the quantity and the type of construction wates that is available on site that is helps in putting up proper management measures to lessen the amount of waste that will be transferred to a landfill and waste contractors that is likely to be produced in a project ("WRAP," 2007). A construction waste management tries to reduce issues like illegal and unlawful dumping by correctly documenting waste removal activities as well as to increase material resources efficiency by incorporating reuse, reduce and recycle (Journal of Applied Environmental and Biological Sciences).

The Traditional waste management system has changed into a new waste management system as a result of the encouragement to respond a better sustainable development specifically, it has moved from a single selection support on the locations of the waste to more concepts of waste arrangement known as the 3R concept. The three elements of the 3R approach are reducing waste, recycling and reusing resources. To reduce is to select and apply elements that will lower the value of the waste that is produced. Using construction waste as the resource is recycling. Using waste that is still in a usable state is known as recycling. When compared to reuse and recycling, reduce is the most crucial factor for reducing waste (Yoshida, H, 2007).

On the sustainable perspective, sustainability is a dynamic, constantly evolving process. As a result, sustainable design from yesterday would not be relevant today. The future generation of sustainable design will necessitate decisions from qualified, knowledgeable engineers due to lack of general acceptance in definition and current information, as well as the bureaucracy around building and design codes. Sustainable design takes into account every single stage of a project life cycle, including planning, building, operating and maintaining also replacing it. The choices that is ideal for one action may not be ideal for another. The relative importance of the economic, environmental, and societal repercussion will change depending on the project and the area. The triple bottom line typically introduces competing interest and competing facts, both which trained engineers must

synthesise. Being sustainable is difficult, but engineers can make wise choice by learning and comprehending the concept of sustainable construction on their projects.

Green Building are created to limit the quality and the effect or urbanisation into the environment by a recycling method to reduce the impact on the environment. In order to attain sustainable future, experts have urged that the danger to the environment, society and economy must be minimised in the short and long terms. To create a sustainable ecosystem, it is necessary to drastically reduce the amount of resources that is being used in construction. Yet, a significant consumer of these resources is the construction sector (Boyle, 2004). The general principles of green building could play a significant role in tackling climate change challenges and helping to create a sustainable future environment as being urge by the Sustainable Development Goals (SDG).

The Leadership in Energy and Environmental Design (LEED) is a Green Building Rating System that being implemented in the YNJDC project for its green building accreditation tools that acts as a framework for ecologically sustainable building that incorporates best practices for responsible waste management into construction activities. It is widely use in United States (LEED, 2004). When construction projects follow LEED guidelines, they receive points and eventually received a certification. Other than that, The Building Research Establishment's Environmental Assessment Method (BREEAM) rating system is being used by the UK, the Green Building Index Certification (Real Estate and Housing Property Developers Association Malaysia, 2010) in Malaysia as a local Green Accreditation certification, Green Mark in Singapore, Green Star in Australia and many others all use comparable frameworks for sustainable building and developments. All of theses frameworks have sustainable resources and waste management elements promoting the adoption of a site waste management strategy to direct entire process, from developing design through decommissioning.

2.5 Parties Involve In Construction Waste Management.

Solid Waste Management Plan (SWMP)

The solid waste management strategy was unveiled in 2005 as part of the National Strategy Plan for Solid Waste Management. Peninsular Malaysia is implementing the strategic plan through 2020. Because of the inefficient handling of the waste in Malaysia, which has had detrimental effects on the environment, a waste management strategy is becoming more crucial. The Malaysia government has made an effort to solve these issues as seen by the adoption of the Solid Waste and Public Cleaning Management act (Act672).

The National Solid Waste Management Department and the Solid Waste Management and Public Cleaning Corporation are two new federal organisations created to carry out the solid waste management policies (Papargyropoulou,2011). The Ministry of Housing and Local Government (MHLG) reported that by 2020, the organisation aimed to recycle 22% of all waste product collected. The 9th Malaysia Plan (2006-2010) has incorporated the idea of recovering into the current method to lessen waste. To obtain a better organised waste management, the strategies must be changed. According to (Nizam & Yusoff, 2010), there are three key ways for boost waste minimization which is by:

- Raising awareness of the need to reduce waste.
- Enhancing the efforts related to reduction, recycling and reuse.
- Enhancing the functions of government organisations to guarantee that policies are implemented successfully.

Figure 2.12: SWM Environment

Figure 2.13: SW Corp Malaysia

Construction Industry Development Board (CIDB)

To ensure continuity and consistency with the national agenda in achieving the Eleventh Malaysian Plan Thrust, the Construction Industry Development Board (CIDB) launched the Construction Industry Transformation Programme 2016-2020 (CITP) in September 2015 as the continuation of the Construction Industry Master Plan (CIMP) 2006-2015. Quality, safety and professionalism, Environmental Sustainability, Productivity, and internationalisation are the four major thrusts being introduced in CITP to guide the reform of the construction sector (CIDB, 2015). Consequently, in order to create a sustainable infrastructure, the second strategic thrust of CITP was created. To address the issues holistically, five strategic initiatives have been carefully developed to promote innovation in sustainable construction, promotes compliance with environmental sustainability ratings and requirements, concentrate on public projects to sparhead the adoption of sustainable practises, encourage industry adoption of sustainable practises and minimise irresponsible waste during construction (CIDB, 2015). Yet, these strategies must be put into action if the Malaysian construction industry is to attain environmental sustainability.

Figure 2.14: CIDB Malaysia logo

Waste Management Contractors.

Waste contractors offers advice and physical tasks as services. The contractors spokes with had price agreements with waste contractors, giving the site managers financial incentives. The waste management companies rent out trash bin that as called “Roro Bin” and bags to the site managers, who have them frequently picked up or emptied weekly or monthly depending on the contracts. When working on a large project, the waste contractors will meet with the site manager to decide on the quantity of the containers to be used, where should be placed, and to provide guidance on how to remove waste from the structures. This depends on the sorting area available, the scope of the project and the volume and kind of waste products. Managing the flow of traffic on-site when containers are being loaded is crucial from safety standpoint. Smaller initiatives only require the physical removal of sorted waste from the site.

For this operation, a specialised waste transportation company that are vary to the requirements set by the governmental minister of environmental department must be hired since the YNJDC is applying the LEED accreditation and the legal documentation of the waste record is crucial. The key duties of the waste management contractors expert on this project included providing waste collecting bins and labelling the bins to correspond with the waste streams listed in the contractors waste management plan. Early discussions with the waste management specialist allowed for the design of appropriate ways to dispose of different waste streams and the establishment of a fee structure based on the items that being transported away from the site. in accordance with the contractors waste management plan, any waste that was collected from the site may become its property, and any refunds for recyclables had to be credited to the waste removal contractors account.

2.6 Waste Management Law in Malaysia

One of the government endeavours, the strategy is crucial for preserving the environment. The broad legal framework of the waste management policy has to be expanded with the creation of pertinent legislation and laws (Abu Eusuf, 2012). Therefore, the existence of policy is crucial as an effort to present the government with clearer aims and priorities in the management of construction waste and environmental protection through formulation of suitable laws, legislation, rules and standards (Din, 2007).

In this section, the particular law enforcement that being applied in Malaysia is describe that is vary to the YNJDC, Kulai site by YTL Construction.

Solid Waste and Public Cleansing Management Act 2007 (Act 672)

In order to encourage waste reduction and recycling and to outlaw illegal dumping, the Solid Waste and Public Cleansing Management Act 2007 (Act672) was created in 2007. Solid Waste and Public Cleansing Management Corporation (SWCorp Malaysia) and the National Solid Waste Management Department (Jabatan Pengurusan Sisa Pepejal Negara-JPSPN) are the two organisation established under the Solid Waste Management and Public Cleansing Corporation Act 2007 (Act673) to ensure that Act 672 is properly implemented. Several strategies, policies and standards are proposed, created and set by the JPSPN, while the SWCorp Malaysia is in charge of their implementation, enforcement, and recommendations. The SWCorp Strategy Plan 2014-2020, which places an emphasis on seven fundamental strategies to be utilised as a primary reference for solid waste management up to 2020, is also being implemented by SWCorp Malaysia.

The purpose of the act is to enhance and guarantee high quality solid waste management services. Waste management systems like the 3Rs require waste to be segregated, and failure to comply with Act's rules is punishable by harsh fines (Agumuthu & Fauziah, 2011).

Environmental Quality Act (Act 127)

This Act include provisions for environmental improvement, pollution, prevention, mitigation and control. The following parts make up the whole initial (I), Administration (II), Licensing (III), Pollution Prevention and Control (IV), Appeal and Appeal Board (V), and Other (VI). The Director General of Environmental Quality and the Minister in charge of environmental protection share all authority and duties related to environmental protection.

The purpose of the law is to avoid, mitigate, control and improve environmental conditions. The wastes that are mentioned in this act are more generally related to environmental issues. The wastes are classified as radioactive, liquid, solid and gaseous (Sasitharan, 2012) The wastes are either regular waste or scheduled waste. This regulation of law also included with the certain method of handling solid waste and scheduled waste such as notification of the generation of scheduled waste, disposal of scheduled waste. Treatment of scheduled wastes and also the proper storage method for chemical based waste for better care and management.

For particular type of waste, this act also includes with different code number for each type of the waste recorded and most of the code will start by the letter of 'SW' meaning Scheduled Waste. As the enactment that have been decided, this act comes with a documentation and guideline also offer training programme for companies and environmental officer to take part in the management of this act in the company which is compulsory.

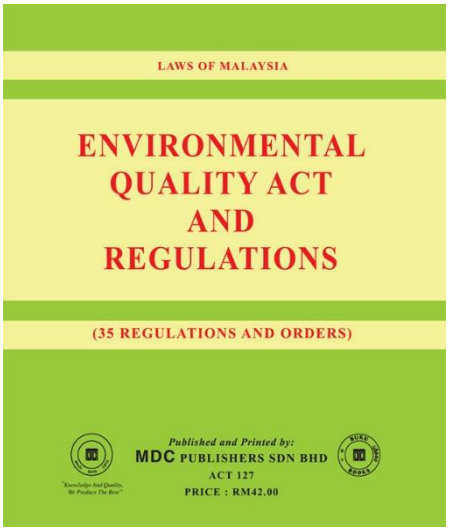


Figure 2.15: Environmental Quality Act and Regulation Guideline Book.

Pembinaan Malaysia Act 1994 (Act 520)

An act to create the Lembaga Pembangunan Industri Pembinaan Malaysia, establish its role in the building sector, and address related issues. Only part 1 and part IX of this act are applicable to building waste issues. Construction projects are covered in part 1, whereas enforcement and investigation are covered further in part VIII of the act. The Act is intended to fulfil obligations related to national construction projects. Investigation personnel are given the authority to investigate a construction site at any time. This enforcement statue grants the authorities to deal with construction debris left behind during the site clearance process (Sasitharan, 2012).

The function of the Lembaga Pembangunan Industry Pembinaan Malaysia is to;

a) To promote and stimulate the development, improvement and expansion of the construction industry.
b) To advise and make recommendation to the Federal Government and the State Government on matters affecting or connected with the construction industry.
c) To promote, stimulate and undertake research into any matter relating to the construction industry.
d) To promote stimulate and assist in the export of the service relating to the construction industry.
e) To provide consultancy and advisory services with respect to the construction industry.
f) To promote and encourage quality assurance in construction industry.
g) To regulate the conformance of standards for construction workmanship and materials.
h) To obtain, publish, initiate and maintain information relating to the construction industry including the establishment of a construction industry information system.
i) To provide, promote, review and coordinate training in the construction industry.

2.7 Sustainable Development Goals (SDG)

Figure 2.16: Sustainable Development Goal criteria

The SDGs will be a statement of aspiration, not a legally enforceable agreement, like it forerunners during the year of 2015 by the United Nation General Assembly (UNGA). This is a disadvantage since states might more likely to break their promises as a result. However, it is also a chance because governments might be more inclined to adopt and agenda that is more expansive in scop and vision if it places not legally binding responsibilities on them. By creating a share vision for 2030, officials and politicians may be inspired to think creatively about the future metropolis whose foundations are currently being laid in this nascent stage of globalisation rather than their usual preoccupations with short-term political gain or narrowly defined national interests.

Through the ideals that symbolise or support sustainable development, we can define it still another way. However, idea like sustainable development, have multiple connotations. Values are typically expressions or beliefs in particular things, traits or actions. Usually, they are describes in terms of goodness or attractiveness or in the opposite case as being unpleasant or something to be avoided. They are frequently define, motivate or arouse feeling. The attitudes are framed by these SDG standards, which also serve as a benchmark for social and individual actions.

Despite the wealth of literature research, more explanation of the murky issues surrounding SDG is needed because decision maker need better data and information on how the principles and the pillars of SDG relate to one another as well as better understanding of how these relationships affect what can be done to advance human development (Abubakar & Hylton,2019). There are 17 pillar which is listed on SDG, which are seen on Figure 11. It has been demonstrated that pillar number nine which is industry, innovation and infrastructure that what are meant for this project to approach in order to create a sustainable design and product.

One of the key sectors contributes to economic growth and social progress in a nation is the construction industry. Reduced environmental consequences and unlawful dumping are the outcome of inadequate waste management techniques being used in construction projects. This research were significantly to the implementation of SDG since the YNJDC project is a type of green building structure that harvest the renewable energy by using solar panel upon its completion for another years coming. By this aspect it is targeted the YNJDC project would be having to have the criteria of SDG by implementing the construction waste management efficiently which as listed below:

Figure 2.17: SDG 7 Affordable And Clean Energy

These criteria of SDG 7 could be achieved by YNJDC project as being proposed that this project will be equipped with a solar farm area to harvest renewable energy to produce electricity upon its completion to supply certain value of electricity capacity for the building to run.

Figure 2.18: SDG 11Sustainable city and Community

The amount of waste that needs to be disposed of in landfills has increased due to the construction industries in Malaysia rapidly growth which is a positive outcome of the urbanisation programme. Soon to be, landfills are unable to permanently hold the growing amount of wastes from the country or even the area of construction in YNJDC. The sustainable action by having the proper construction waste management that will be directly manage with the correct way will create a sustainable background for the project as the project not only handling the disposing method but also the implementation of 3R practises in the projects for a sustainable city action for the future benefit of the area and the building itself.

Figure 2.19: SDG 12 Responsible Consumption and production.

By having a well-managed construction waste management practises and system in the YNJDC project, the SDG 12 criteria can be achieved as being discussed that some of the demolition waste from the YNJDC project were used on-site to reduce the consumption of fresh nature resources such as the demolition debris from the blasting process for the project were use for the site temporary access area rather than having the fresh aggregate for the land infill for temporary soil stabilisation and the timber waste from the YNJDC project that the resource are from the used formwork are being constructed for workers temporary rest area for better application of 3R method in the project.

Figure 2.20: SDG 13 Climate Action

Throughout the previous two decades, there have been more and more construction wastes as a result of inadequate waste management procedure done by certain construction project by the research done by (Nagapan, 2012). Construction waste not only adds to garbage but also has a negative impact on Malaysia ecology. Nonetheless, international and domestic investment in construction sector has boosted job possibilities and boosted the economy of the country. By having the right construction waste management in the YNJDC project, the practises will be taken as a climate action procedure by the company to reduce the consumption of land in the peninsular Malaysia for the waste landfill purposes since the conventional practises is consuming the resources of the nature and will affect the sustainable of the environment.

2.8 Sustainable Construction Practices.

Over time, the necessities for sustainability has gain acceptance on a global scale. The Sustainable Development Goals (SDG) have recently replaced the Millenium Development Goals (MDG) of the United Nations, Suggesting a continuing need for such programmes. Natural resources depletion is a growing issue, and both national and international governments are being pushed to find sustainable solutions. This implies that savvy buyers and owners of construction projects will continue to look for cutting-edge yet sustainable projects that among other things that will save energy, save money, improve the environment and are socially safe.

The SDG are relevant to many facets of society, including the construction industry. The construction industry needs to be developed in order to meet the SDG's definitions of global sustainability. As being said by the research by (Vanderly, 2011) stated that "construction sector is globally consuming 40 to 75 percent of the total value of materials extracted". According to figures mentioned in the International Resource Panel 2017. Additionally, 25 percent of the water used worldwide is used by the construction industry. Furthermore according to the Global Report 2018 of the Global Alliance for Buildings and Construction, the sector responsible for buildings and construction accounted for 36 percent of global final energy consumption in 2017, Additionally, this industry was in charge about 39 percent of emissions in 2017.

Furthermore, despite advancements in building systems and building envelops, according to predicted trends in the same report, energy demand is still rising. Due to improved building energy efficiency and the decarbonisation of the power sector, which counteract population increase and floor area growth, emissions related to buildings remain at a steady state. This indicates that if the SDG target are meant to be met, more reductions are required.

This is why as the company that stick on slogan of "Building The Right Thing" from YTL construction they are tend to met the requirement in order to preserve the environment and the project running in the Kulai, Johor area which is YNJDC the tend to harvest natural energy by planting a solar plant area to harvest the energy right from the mother nature.

2.9 Leadership in Energy and Environmental Design (LEED) Rating Tools.

The YTL Johor Data Centre [JDC] at Kulai Johor is part of an overall green masterplan development by YTL to further the development of data centers in Malaysia. The project team is applying for the Leadership in Energy and Environmental Design (LEED) V4 rating. The site is located in the district of Kulai, Johor Darul Ta'zim. The site is a greenfield location consisting of former palm oil estate, SPYTL is the Main Contractor for this project with a development area of 56,128.57 sq.m.

The purpose of this Construction Waste Management Plan [CWMP] shall be to ensure that waste generated during the construction and building works of the JDC shall be managed and disposed of in a way that ensures compliance with relevant requirements set out in the Environmental Quality Act of 1974.

2.9.1 The Green Building Movement

The green building movement aided in the development of numerous parallel initiative. One of the most effective sustainability assessment techniques is the world for master planning initiatives, infrastructure, and buildings is BREEAM, which was developed in the United Kingdom by the Building Research Establishment in 1990. It covers several life cycle stages, including New Construction and Refurbishment, among other things. Since the program's founded in 1990, there have been more than 539,000 building registered for assessment. In fact, BREEAM is a widely used indicator of a building's environmental performance since it provides criteria for best practices in sustainable building design and construction.

New and significant building environmental rating system were introduced in the 1990s. additionally, as a global awareness of environmental issues grew, a number of international conference were held, including the Green Building Challenge (GBC), which was organised by the CANMET Energy Technology Center of Natural Resources Canada and held in Vancouver, Canada, in October 1998. This occasion was a well attended affair with representatives from 14 nations. These conferences had as their objective the development of a global environmental rating system for building that would take into account local, national, and worldwide environmental, economic, and social justice factors.

Malaysia has created its own national grading system, the Green Building Index (GBI), to access the environmental performance and design of Malaysian structures, the Malaysian Institute of Architects and the Association of Consulting Engineers Malaysia (ACEM) collaborate to create the GBI grading system (CBRE, 2010). The goal of GBI is to save energy, resources, recycle materials and modify buildings to fit the climatic, cultural and environmental conditions of Malaysia. The six main areas of interior environment quality, energy efficiency, materials and resources, sustainable site planning and management, water efficiency, materials and resources, sustainable site planning and management, water efficiency and innovation make up the GBI rating system for the buildings.

2.9.2 Leadership in Energy and Environmental Design (LEED)

The Leadership in Energy and Environmental Design (LEED) green rating system developed by the U.S Green Building Council (USGBC) is now widely used in the commercial building industry. In the United States, commercial construction normally proceeds with the engagement of an architect by the owner and engineer by the architect when needed. Hence, for the majority of conventional projects, the engineers information on the specific LEED area, but were urged to elaborate with project examples, experiences and recommendations for getting in touch with others in the specialised field on LEED projects.

When USGBC was established in 1993, it signalled a renewed national commitment to high performance green building techniques (Kibert, 2008). In order to promote a built environment that is ecological responsible, financially successful, and capable of producing healthy places to live and work, USGBC consist of business, contractors, universities, government organisations and other stakeholders working together (USGBC Research Committee, 2011). In order to give building owners and operators a framework for identifying and putting into practise workable and quantifiable green building design, construction, operations and maintenance solutions, their LEED program widely recognised as green building certification system that was created in March 2000. (USGBC,2011).

Five primary areas of environmental and human health promoted by LEED are indoor environmental quality, energy efficiency, water efficiency, and sustainable site development (SS/WE)(IEQ). According to USGBC's 2009-2013 strategic plan, the LEED program's contribution to the growth of green building was a key factor in the organisation success (USGBC, 2011b). with the use of encouraging mechanisms and predetermined performance requirements, the LEED rating tool system encourages the adoption of sustainable green building methods as the action to the global crisis that are growing inside the environment due to the world urbanisation and technological process.

SPYTL has the objective to have effective management of construction waste at the JDC development site, by maximising recycling of construction waste and minimising the environmental impact of construction waste. SPYTL shall also endeavour to divert or reduce at least 80% by weight of the total construction waste materials generated onsite. Waste materials shall inevitably be generated during the construction of the proposed data centre development but management of these generated waste materials, including segregation at source, shall help to ensure maximum recycling, reuse and recovery is achieved, in accordance with current local and national waste targets. Wherever possible, left-over material (e.g. timber cut-offs or metal rebar) and any suitable construction materials shall be reused on or off site.

By applying this method of research onto the project the valid information and feedback from the respondents can be used a valuable data sources for the research. The questionnaire about the research will be gathered and spread to the right person according to the topic of the research. Individual with valid knowledge, person with validation with the topic of the research and the appointed person that engraved with better knowledge about the subject will be chosen for the feedbacks of the projects to give better understanding and recommendations about the project further movement and to improve the reports, findings and the results of the research that can be used by the YTL Construction for YNJDC, Kulai project for its LEED validation and scoring outcomes.

2.10 Industrial Revolution 4.0 (IR4.0)

From roughly 1760 until between 1820 and 1840 in the United Kingdom, continental Europe and the United States, there was a transition to new industrial techniques known as the Industrial Revolution. This change included the transition from manual which is the traditional method to machine production methods, new ways of producing chemicals, growth in the use of steam and water power, the development of machine tools and the introduction of the mechanised factory system. The Industrial Revolution also cause population growth to accelerate at a rate of a different level from the different perspective of the world with the expanding scheme of the world information and technology expansion.

The IR4.0 guiding principle refers to the latest digitalization, robotisation and increasing use of information and communication technology. Due to its complexity needs on following the expansion of global technology and information the building industry nevertheless has expanded slowly as the process for this revolution require greater thinking and adaption to technology. The traditional, labour- intensive business practices still being used in the construction industry led to high energy consumption, environmental harm and low project delivery also with the delays of information receive. Furthermore, the building sector has started to look toward IR 4.0 due to the limitation on human movement and resources brought on by the recent tragic COVID 19 pandemic.

Figure 2.21: Industrial Revolution Timeline

The industry are moving progressively past the third revolution and in the forth just enhancing the automation and technology of the third revolution as opposed to the more important changes that took place between the previous industrial revolutions. The Internet Of Things, machine learning and artificial intelligence are all examples of smart system (AI). This will allow for much more advance automation to the point where smart factories could operate successfully with less involvement of humans.

2.11 Internet Of Things Practices.

The internet of things (IoT) is an emerging technology that is anticipated to offer promising solutions to transform the operation and function of numerous existing industrial systems including transportation, manufacturing and will be entering the wide construction industry which being practiced by most of the companies today. For instance, the transportation and also construction industry will be able to track and refer either document, relevant construction data and for transportation, they may be able to track the whereabout of the vehicle and monitor its movement also forecast the future location and potential traffic which is a pretty handy feature offered by the one who utilised to develop intelligent document and

construction systems to their project. When the phrase of Internet of Things (IoT) was first coined, it was meant to refer to radio-frequency identification (RFID)-enable uniquely identifiable connected system.

A smart network called the Internet of Things is capable of automatically detecting, controlling and programming items. The term itself now refers to all electrical and electronic device that are connected to the internet, regardless their size or capabilities, except for those that are principally used for human-to-human communication or conventional internet. The scope of the internet ever broadening beyond basic machine to machine communication (Bennatia, Amina & Maaruf Ali,2008).

The growth of its technology enables communication between its surrounding both directly and indirectly. In order for the Internet of Things to function, object must be connected to internet. Once connected, the object or device can then be remotely monitored or controlled. Forecasts say there are 75.44 billion devices connected to the Internet of Things by 2025 and people will experience life surrounded by networks that reach a trillion of a lifetime (In Lee & Kyoochun, 2015).

Types of internet of things can widely be seen that currently have the highest usage among people around the globe which is the use of social media like WhatsApp, Telegram and Facebook Messenger which is also the kind of Internet of Things application that is heavily used by the construction industry companies. Apart of IoT implementation program is also the email that serves as an exchange of information and the use of GPS system in order to locate, share or give location among people using the nowadays IoT gadgets.

Therefore, the players of IoT should continue to deploy and encourage each industry participant because most of the practise of IoT is being done on the behalf of the individual importance and not broaden to the community to the improvement of the construction especially on documentation part of the project. The Malaysian IoT market is probably another reasonable part that why is this technology is not being use much in the construction sector as well as the social sector which majority of the user think that IoT is only about. Some part of the main reason was probably because the majority of IoT items are expensive due to massive tools of technology.

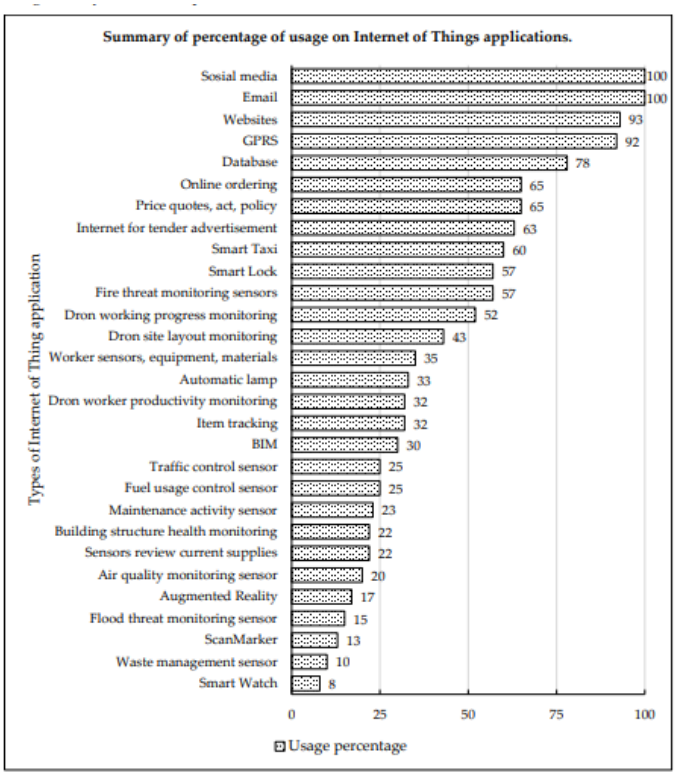


Figure 2.22: Summary of percentage usage of IoT applications.

Based on study initiated by Syamsul H. Mahmud, Laromi Assan and Rashidah Islam from faculty of built environment from University Teknologi Malaysia (2018) on Figure 2.22 above, shows that generally the percentage of respondents from the research are using the good use of IOT. However, the result indicate that Malaysia's construction industry is still underutilizing the IoT. This is because just 12 application kinds are use more frequently than those who do not, whereas 17 application types are utilised less frequently. The majority of respondent from the research has heard of each sort of IoT application, according to the appraisal of the respondents knowledge of these application. This demonstrate that those involved in the construction industry are aware that the application do exist.

2.12 Construction Document Management System

The term “DMS” refers to the repository that compile and stores documents and enable the end user to get the information they require from the system that contain the files. In certain writing. From (Aurelia P & Ana T, 2008), DMS refers to the repository that store documents and allows end-users to retrieve required information. Some literature has combined the meanings of the term document management with other concepts such as communication and knowledge management, and information system. From dictionary reference (businessdictionary.com) concludes DMS as the coordination and control of the flow of paper-based and electronic documents in a secure manner so they can be use effectively by authorised persons as and when required. Storage retrieval, processing, printing, routing and dissemination of corporate documents are all types of document flow as described. Additionally, a digital DMS is a software programme that gathers documents (whether they are printed or digital) for security purposes of storing the information, retrieval and archiving.

Knowledge is fast overtaking cash, commodities, equipment, and real estate as the most crucial resource for organisational performance as the new economy shifts toward a knowledge-based economy. Document used in the construction industry contain knowledge that, if used effectively can benefit and enhance the management of work and also boost the performance of construction firms.

Smaller construction enterprises in Jordan are more likely to adopt traditional manual techniques of document filling because in the management opinions, these methods are much more simpler and less expensive to implement than the modern method of document management. However, these method are “ineffective for retrieving information because of the necessity prior knowledge and comprehension of document content as well as extensive skill and time from the information seeker” (Qady & Kandil, 2010).

2.13 Design Thinking

Design thinking is a problem-solving approach and a mindset that emphasizes human cantered and empathetic solutions. It is a methodology used to tackle complex problems and generate innovative solutions by understanding and addressing the needs and desires of the end users or customers. Within the context of design thinking we focus on the value created by design for the client. In this context the more difficult problem is to measure and gauge the value. Design thinking has to focus on producing a design solution that communicates positively with target audience rather than merely looking different aesthetically (Harris, 2010).

Design thinking typically follows a structured process that involves several stages. These stages include:

Empathize: Designers immerse themselves in the user's context to gain insights and develop a deep understanding of their needs, challenges, and motivations.

Define: Based on the insights gathered, designers reframe the problem by defining a clear problem statement or a design challenge that captures the core issues to be addressed.

Ideate: In this stage, designers generate a wide range of ideas and potential solutions, employing brainstorming techniques and encouraging wild and unconventional thinking.

Prototype: Designers create tangible representations of their ideas, which can be low-fidelity prototypes or mock-ups that allow for rapid testing and iteration.

Test: Prototypes are tested and evaluated with real users to gather feedback and insights, facilitating the refinement and improvement of the design.

Throughout the design thinking process, iteration is key. Designers continually cycle through the stages, refining their understanding, ideating new solutions, and testing and iterating on prototypes until a viable, desirable, and feasible solution is achieved.

2.14 GlideApps

The implementation of GlideApps for engineering purposes refers to leveraging the capabilities of the GlideApps platform to develop and deploy customized mobile or web applications specifically designed as CWMP for YNJDC LEED accreditation to meet the unique needs and requirements of engineering projects and processes.

GlideApps is a visual app development platform that allows users to create intuitive and interactive applications without the need for extensive coding knowledge. It provides a user-friendly interface and a range of features that enable the development of functional and visually appealing applications.

The platform provides drag-and-drop functionality, allowing users to easily incorporate different data inputs, interactive elements, and visualizations. This flexibility enables engineers to tailor the app to their exact needs, improving efficiency and streamlining engineering operations. GlideApps can also facilitate real-time data collection and analysis, which is crucial in engineering projects. By integrating data sources and sensors, engineers can capture and analyze data on-site, monitor equipment performance, track progress, and make informed decisions promptly. This real-time access to data enhances productivity, quality control, and project management.

Furthermore, GlideApps can enhance collaboration among engineering teams by providing a centralized platform for communication, document sharing, and project updates. Engineers can access the app from multiple devices, allowing for seamless information exchange and improved teamwork, regardless of their location or time zone.Another advantage of GlideApps is its ability to integrate with other systems and platforms. Engineers can connect their apps with existing software and databases, ensuring data consistency and interoperability. This integration capability enables engineers to leverage existing tools and systems, creating a comprehensive and interconnected engineering ecosystem.

In summary, using GlideApps for engineering purposes involves utilizing the platform's features and flexibility to create customized applications that address the specific needs of engineering projects. By leveraging GlideApps, engineers can streamline processes, improve data collection and analysis, enhance collaboration, and optimize efficiency in engineering operations.

2.15 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a widely recognized theoretical framework used to understand and predict the acceptance and adoption of new technologies by individuals or users. It seeks to explain how users' attitudes and perceptions towards a technology influence their intention to use it. TAM explains the motivation of users by three factors; perceived usefulness, perceived ease of use, and attitude toward use (Hamed, 2017).

The TAM proposes that two primary factors determine the acceptance and adoption of a technology: perceived usefulness (PU) and perceived ease of use (PEOU). Perceived usefulness refers to the extent to which an individual believes that using the technology will enhance their performance or productivity. Perceived ease of use refers to the degree to which an individual perceives the technology as easy to learn and use and this method of data analysis is being used for the technological acceptance level of CWMP.

According to the TAM, users' attitudes towards a technology, as shaped by their perceptions of usefulness and ease of use, significantly influence their behavioural intention to adopt or use the technology. In turn, the behavioural intention leads to the actual adoption and usage behaviour.

The TAM also suggests that external factors, such as social influence and facilitating conditions, can indirectly influence users' attitudes and intentions. Social influence encompasses factors like subjective norms and the influence of others, while facilitating conditions refer to the availability of resources and support needed to use the technology effectively.

In terms of data analysis, the TAM typically involves quantitative research methods to gather data on users' perceptions and intentions. Surveys or questionnaires are commonly used to collect data from a sample of users. The survey items are designed to measure variables such as perceived usefulness, perceived ease of use, attitudes, behavioral intentions, and external factors. In the Information Systems field, researchers have widely used the Technology Acceptance Model to study the adoption of various technologies and TAM has arguably become the most influential theory in the IS field. Researchers have also extended TAM (Wixom & Todd, 2005).

Data analysis for the TAM often includes statistical techniques such as regression analysis, where the relationships between variables are examined to determine the significance and strength of their associations. Specifically, researchers analyze the relationships between perceived usefulness, perceived ease of use, attitudes, and behavioral intentions. They may also examine the influence of external factors on users' attitudes and intentions.

Through data analysis, researchers can gain insights into the factors driving user acceptance and adoption of a technology, identify areas of improvement, and develop strategies to enhance users' perceptions of usefulness and ease of use. Figure 2.23 below illustrates the numerous TAM extensions that can be used to pinpoint the central ideas behind the two belief constructs of perceived utility and perceived usability. As a result, it is stated that these models maintain the same basic structure and underlying assumptions as the Technology Acceptance Model (TAM).

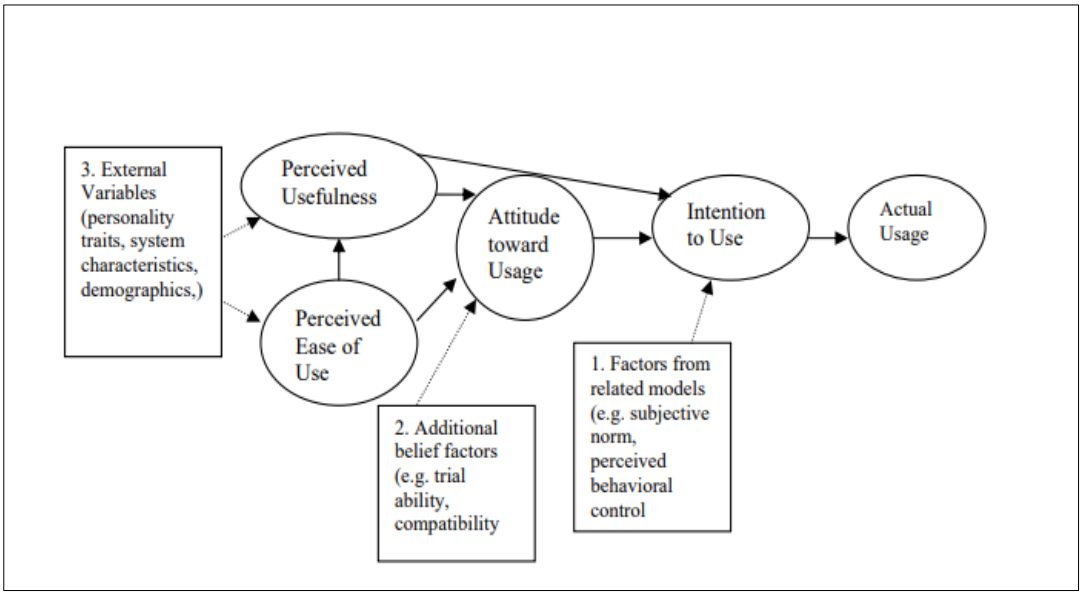


Figure 2.23: Technology Acceptance model flow extension
by (Wixom & Todd, 2005)

In summary, the Technology Acceptance Model (TAM) provides a framework for understanding and predicting users' acceptance and adoption of new technologies. It emphasizes the importance of perceived usefulness and perceived ease of use, as well as the influence of external factors. Data analysis techniques, such as regression analysis, are commonly used to analyze the relationships between variables and draw conclusions about users' attitudes and intentions.

2.16 Conclusion.

In conclusion, by implementing the technology and make good use of it will give advantage to the construction industry sector to achieve greater efficiency of their work and reducing the risk and the probability for the documents delays for the YNJDC waste management documentation. Apart of this construction waste management project, it is being developed that the project proposed will be equipped with waste management documentation application to manage the documents such as the waste management record ticket, proof of dumping and the LEED accreditation documentation submission. By simplified method, the document can be travelled virtually with the use of Internet of Things to the parties involved such as project manager, site engineers and project coordinator even the waste consultant can access required file as proposed from this chapter.

By nurturing the Industrial Revolution (IR 4.0) into the project, the benefit the process of documents can be shorten by discovering a proper method of implementation of technology throughout the industry. A project sustainability is crucial since it might offer solution with a favourable environmental impact. So it is preferable to develop a product that applies the use of green technology. International organisation uses sustainable development as a catchphrase, and it is discussed on conference and in scholarly paper which is the literature review for late researcher. The significance of sustainability has grown through time to become a major worldwide issue.

To wrap the whole explanation is all about making the company more sustainable and on track with the technology available without even noticing it to be favourable and handy for their works. By implementing the use of right method for the LEED accreditation purposes and document management it is already discussed to give benefit to the company through documentation and management which will make the company more exact with their documents without delays and late of submission. implementation could be a challenge since the use of these kind of technology is not well known as for social purposes. By introducing a correct yet affordable way, it is hope that current technology will also give better understanding to the certain parties about how technologies work in this era.

CHAPTER 3
METHODOLOGY

3.1 INTRODUCTION

The methodology and the process of developing the construction waste management will be explained in this chapter. Also, this chapter will outline the techniques used to identify the issue, and from the beginning to the finish of the project, the right technique will use to be applied to the project completion. This approach is utilised to accomplish the project's goals in a way that will produce and acceptable process and outcome. It will detail the approach taken by this study. Moreover, this chapter will cover every step of the study process, including the population, population frame and interview sampling method about the selection of the respondent throughout the project. The chosen mode of analysis and data gathering method are thoroughly explained in this chapter.

Other than that, the methodology used to investigate the necessary approach to construct a questionnaire that are planned to be broken down into section to examine the effect of the project being implied to the construction waste management practice of the company polled and the effectiveness as the project while running throughout the YNJDC project to be sure. Research methodology also refers to the procedure or tactics used to locate, identify, decision-making and analyse the data on the subject which is the construction team and the coordinator management team. the construction industry is infamous with its waste products outcome due to massive development, risk management and nature resources as being discussed on the previous chapter that leads incapability of handling the waste management correctly with the requirements of LEED.

During the WBL period, which is scheduled for 10 months of internship, observation was conducted to identify the potential issue and yet the possible solution for the project which regarding to the construction waste management as the task is being handled by the project coordinator and the construction team for the LEED accreditation program. In order to practise the proper construction waste management as being planned observation on the YNJDC site is needed to determine the type of waste collected on the site whether it is mainly scheduled waste or solid waste to determine the method of disposal vary with the verification needed on documentation for the LEED accreditation document submission.

Method of document in this LEED accreditation project is needed to ease the flow of the document submission via online method to prevent delays and to provide better data acquisition method without physically submitting the document in the YNJDC office. By using the guideline of USGBC LEED V4.0 BD+C : Data Centre for Johor Data Centre Malaysia that already been decided on October 2022 for construction waste management plan on the terms of targeted waste material that constitute 5% of each category by weight are targeted for diversion by SPYTL during the construction period and the proof of the waste distribution and the weight must be prepared in the document submission that sometimes might be delayed by the waste contractor.

Moreover the idea for this project is to centralised the document submission into one platform rather than only research about proposing a suitable method for the YNJDC Construction waste management for the accreditation purposes. The data were conventionally processed by physically handle the documents to the site engineers that were entitle to handle the waste management in the project and the ticket would be give to the quantity surveyor for another process of work of calculating and through the LEED accreditation personnel for monthly submission. as being observer by interviews with the construction team and the LEED team of the YNJDC, the process takes time since some of the person in charge for the purposes kind of delaying the documents process and it would be much easier for the process to be digitalise by a system that can view and print the document immediately.

3.2 RESEARCH DESIGN

Initially speaking, the project was designed to research about the waste management implementation that being applied on site as if its suitable for the LEED accreditation requirement that being applied by the YNJDC project. The research also aimed to analyses types of construction waste disposed from the site and to validate the disposal procedure that have been implemented on site for the YNJDC LEED accreditation. As weekly observation identified that the project requires an improvement to the waste management documentation aspects that the site LEED teams were having problem since the required documents that supposed to be sent by the waste management contractor were to be delayed due to several circumstances by the company. That is when the idea of development of CWM platform were idealise during the period of the project were being managed to ease the documentation flow of the construction waste management tickets and dumping record to be sent as monthly progress of the LEED accreditation as required for the project to do so.

These programme's major function is for the document records and management which can be access whereas the documents which contains dumping history, weight records. reference, waste description and any other relevant information might inserted. The project differs from records management software like already use by the YTL Construction for the YNJDC project which is the ACONEX system that later will be discussed in this chapter regarding the documents resources and storage which store and transmit documents for archival and reviewing purposes. It only sometimes accesses such paper and usually only upon request from an internal user of the software that still not very practical among the site team.

Research design for this project is important to identify the specified problem and find relevant and yet subjective results of solution to identify the steps required to identify any other relevant problems that might be related to the problem.

The research design in this study is included with design thinking method that acquire solution from the problem related and actual site situation to reach the company and the management approval about the problem existence in the company construction waste management. Diagram 3.2 displays the research design of this project in which the way and method of this project study has been taken into consideration for the CWMP platform.

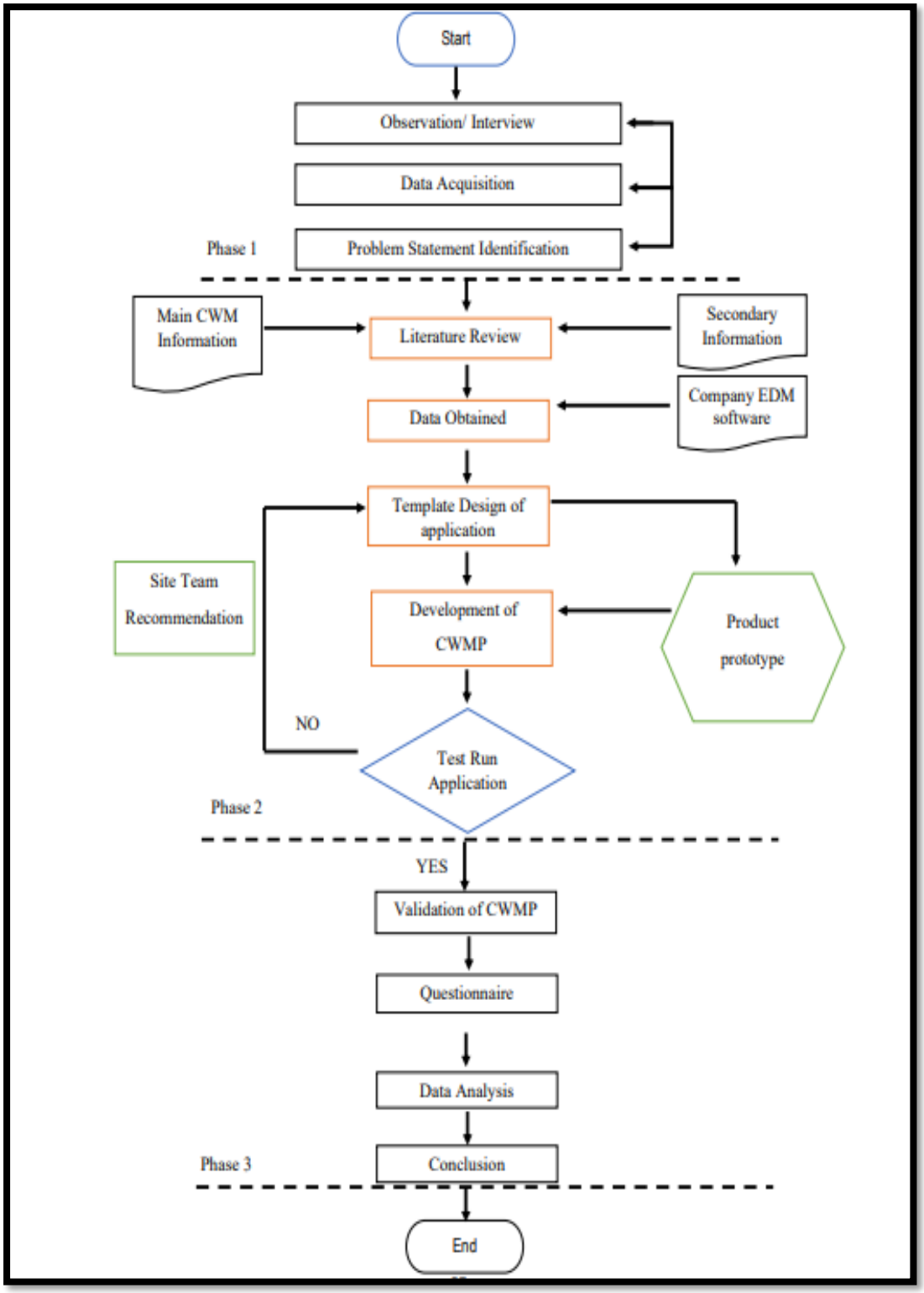


Figure 3.1: Research Methodology Flow Figure

3.3 CWMP Design Framework

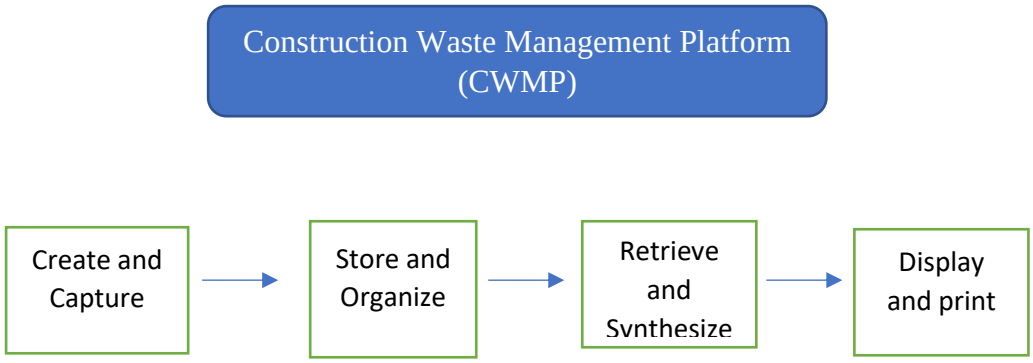


Figure 3.2: CWMP Design Framework

The research framework on Diagram 3.2 notional layered were designed to be used to sum up this technological era in Electrical Document Management (EDM) which the sublayer of the document technology infrastructure consists of document management functions that cut across the phases of document processing. This set of functions is what enables documents to be managed as information resources rather than as a collection and storage of files. Theses document management function includes:

1. Create and Capture

- To give access to the user to create the document with the platform in order to ease the document submission process rather than have to manually handling the receipt or the documents to the designated officer that takes time to process and to submit due to confirmation and administration issues.
- To capture the document in order to be able to create files of document that will be recorded by date for the monthly submission of the LEED Accreditation.

2. Store and organize

- The platform needs to be able to meet the requirement of its function to store the document through the user or admin storage file to record the file and save the document in case the document were meant to be retrieve back in the future.

- The stored document need to be able to be organize and easily find by using the platform without the need of the user to search for the document in the deep storage of the phone which will take extra time same as finding the folder.

3. Retrieve and Synthesize

- The document created by the platform then need to be retrieve and being synthesize since the in the GlideApps can be converted into Excel format, the documents can be easily be traced and recorded digitally with an appropriate system.

4. Display and Print

- The platform should be able to display the document back and be able to print the document since the documents were design to be in “PDF” format in order to be printed out for further action since the documents that being proposed by the project would require to have manually signed by authorise person as the standard operation that being practised in YTL Construction which is compulsory for the documents proof of existence

3.4 Design Template.

Design templates are pre-made graphics and writing that can be changed. In order to preserve the uniformity among user and the platform itself, template are frequent created to follow pre-determined standards or criteria. The prototype that was being design and meant to follow predetermined standard or criteria based on the research that has being done about the necessity display or interface for the platform to allow the ease of access for the user. This application will be developed utilising an online document creator or by trained IT professional. It is more manageable to establish and create the template design to develop the platform with the information given and the need of the user which is the site team to make the platform more accessible.

To make the project more achievable and reliable for the user to user, the project will be design on harnessing the advantage of QR code to ease the documentation process to easily login and direct the user to the platform. The QR code were meant to be scanned using the smartphone and the link to the Construction Waste Management Platform “CWMP” will appear. The user then can insert the document inside the platform and easily submitted to the system that will be equipped with proper revision regarding the date, time and submission purpose also with the separation type of waste collect on that day.

The QR designed with the link to the platform will be created as a template to be place on each of the construction waste bin that already being placed around the site for the waste contractor to scan and submit the document digitally. The sample of QR code will be show on the figure 3.3 below.

Figure 3.3: QR Code sample.

3.5 Design Thinking

A concise demand is transformed into a final product or design solution through process of design that called a design thinking process. High levels of creativity are utilised during the design process, but in a way, what is regulated and guided by the process in order to provide realistic, workable solution to the design problem that meets or exceeds the stated objective of the brief. Design is an activity that serve both economic and creativity aims by the objective of the product, even through creativity in design is crucial. The design process aids in insuring that a design satisfies each of the requirements which the method is crucial for generating a wide range of potential answer and makes use of a number of mechanism or techniques that inspire participants to seek out original or creative solutions (G. Ambros, Pharris. Design Thinking 2010).

For this project, to design a project with proper method and proper documentation that surely need a certain guideline and a form of strategies to produce and acquire relevant and correct data for the research of the SIDREP project. Based on the reference about design thinking from "R Wolniak- 2017", every design project may employ this conception that may consist of five sequential stages of design thinking throughout the process, every stage is necessary and must be completed without skipping any of them which is

1. Empathy
2. Define
3. Ideate
4. Prototype
5. Test

3.5.1 Empathy

Empathy stage uses in-depth observation about the problem and solution for the problems or survey to ascertain the characteristics of the audience for which the product is intended to do so. On this process, the project can find the required details regarding the needs and usage of the product. Innovation always begin with a careful evaluation of the requirements and expectations of current and potential user, as well as with an awareness of the product technical constraints and commercial environment.

During this phase of empathy, observation, interaction with the site team through interviewing and self-experience as the researcher itself as a part of the site team for the project progress on YNJDC LEED accreditation which is in the Quality Assurer and Quality Control team (QAQC) are utilised as the approach for identifying the targeted individual, problem and also specifics of the problem as well as the solution that the user or site team require in order to create a suitable project for the findings. Table 3.1 shows briefly about the method used for this part of design thinking process:

Table 3.1

Empathy method of Design Thinking.

Observation	During 10 months of WBL period, certain problem and issue on site were already list out and the crucial problem on-site were filtered in order to create a solution that is effective for the results of the project.
Self-Engagement : Direct Interview • Project Coordinator • QAQC Team • Safety Department	Direct interview were initiated in order to get confirmation with the project team regarding the waste management that have been already practised on YNJDC site and to study the correct wat of handling waste vary to the LEED accreditation requirement and to study the awareness among the project team about the Green Building program that been applied by the project.
Experience • Documentation experience • Submission experience • Managing experience	By self experience faced by the researcher, a proper solution can be proposed to get correct sequence about the project problem, solution and documentation.

3.5.2 Define

In this phase of design thinking, the user needs should be specified in this research. To ascertain the scope of the issue, the research should conduct a synthesis of the data gathered throughout the earlier stages of empathy process. The user requirement for the project should be presented in a design brief as a proof the product was design and managed based on the needs of the user and not by self-interest purposes. These could be basic or sophisticated, verbal, or written definition. A brief ought to state clearly what is the main objective the design must be achieve. Meanwhile, the stage is relatively challenging since individuals naturally focus on established solution and avoid moving in the ambiguity of numerous other options as well as moving to a more digitalise and systematic method.. However, it should be noted that the solutions that are concentrated too quickly might be sufficient to meet the needs of the user of the CWMP project.

In this define process, it is noticed that the major problem that happened during LEED documentation process is:

1. Aconex server is only to record and act as an archive for constructional purpose of the project and were not delegated for the LEED accreditation purpose.

2. It is complicated at early stage to obtain the waste contractor tickets that holds the record for the weight, type and dumping site as the waste being collected from the site.

3. Site team were not very informed about the condition and the requirement that needed to be fulfilled to achieve the LEED accreditation status.

4.Manual scheduled work on documentation.

Based on the defining results, the design and interface of the project would be generated with proper idea and recommendations from the user in the next stage of design thinking to give clarification about the main reason of the design being made to suits the needs of the user.

3.5.3 Ideate

At this point, the research should come up with as many original ideas that can be used as a technique such like brainstorming process. Awareness must be kept as ideas and solutions should be considered when the brainstorming process in accordance with the criteria of the project. In addition, through technical expertise, which is the LEED advisor and managers from the site, coming up with good ideas also calls for inventiveness, intuition to proceed with the project and imagination to give better understanding about the project that is about to be design. This phase should be complete by analysing the ideas and choosing the best ideas, after which a prototype solution should be constructed at the next phase of the ideate and also the design must be decide at this point of design thinking part to be use as one of the numerous design approaches to give clear image about the main function of CWMP.

The idea of CWMP is that all the proposed documents are meant such as the dumping ticket, the date of collection, weight and method of waste type distribution to be inserted in to one platform in order to organize the documents and information neatly. Below is the sketch of graphical item that show the preferences and the idea of the CWMP to be simply explained in figure 3.4.

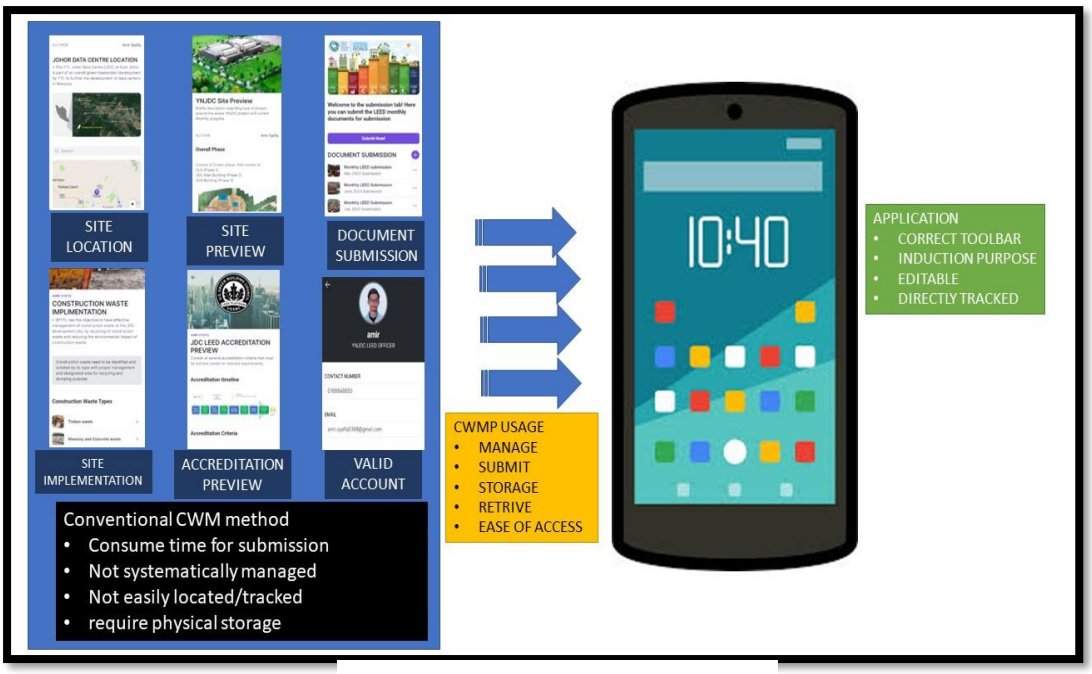


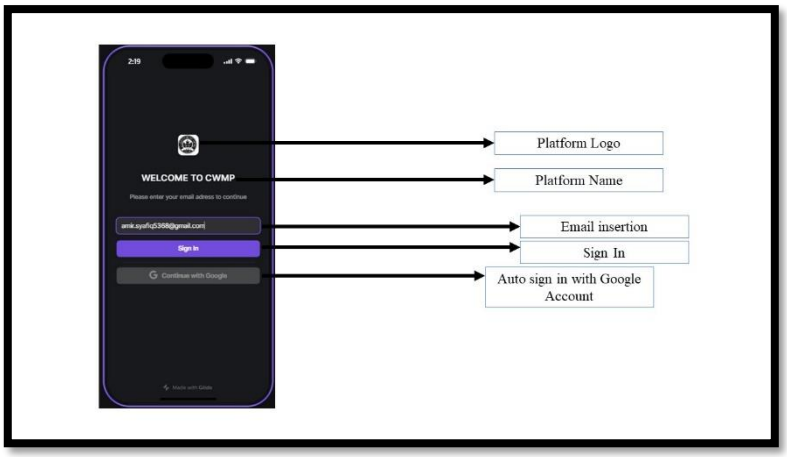
Figure 3.4: CWMP functions

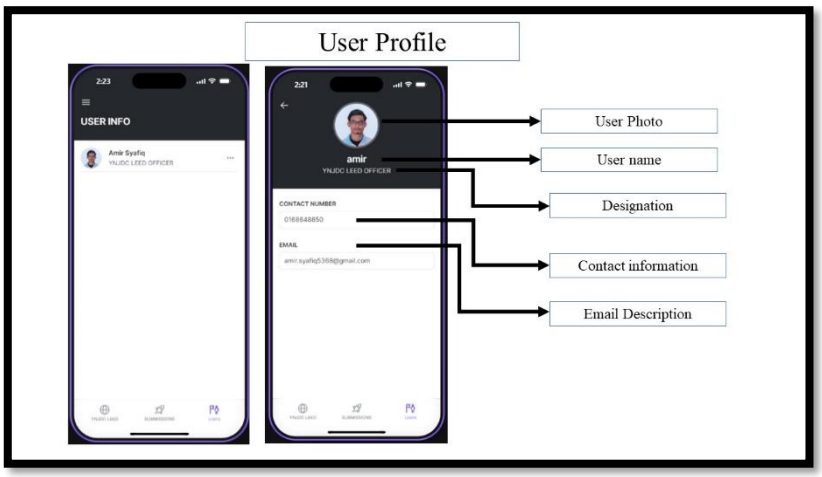
3.5.4 Prototype.

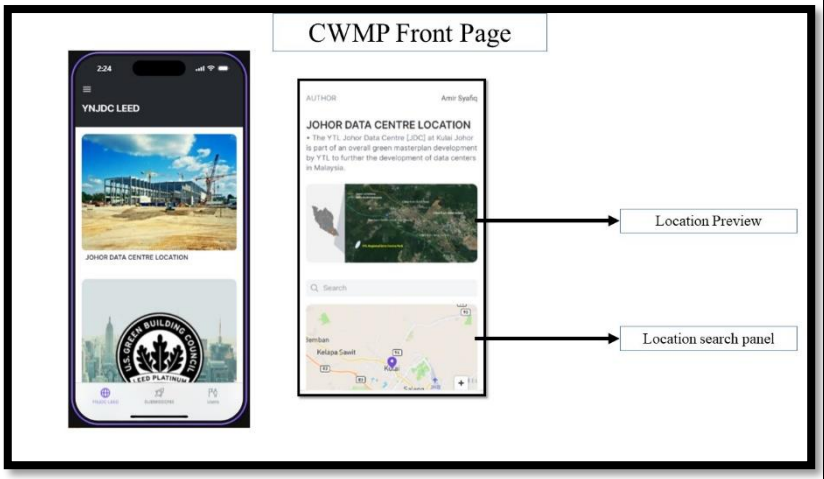
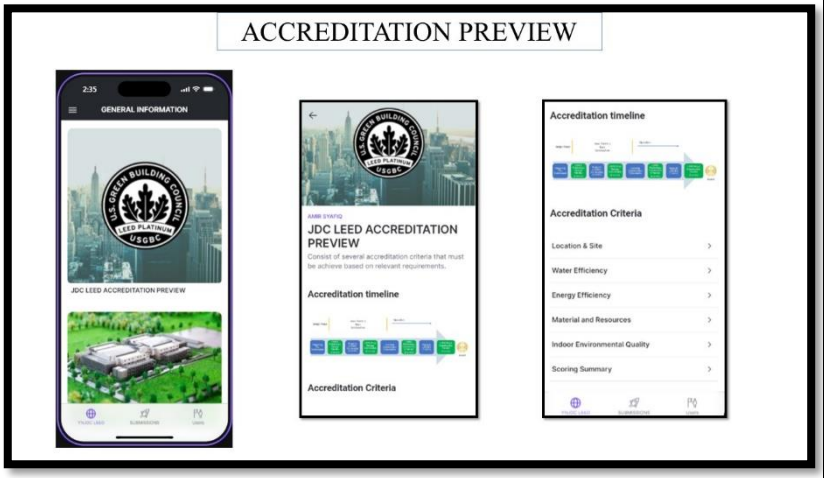
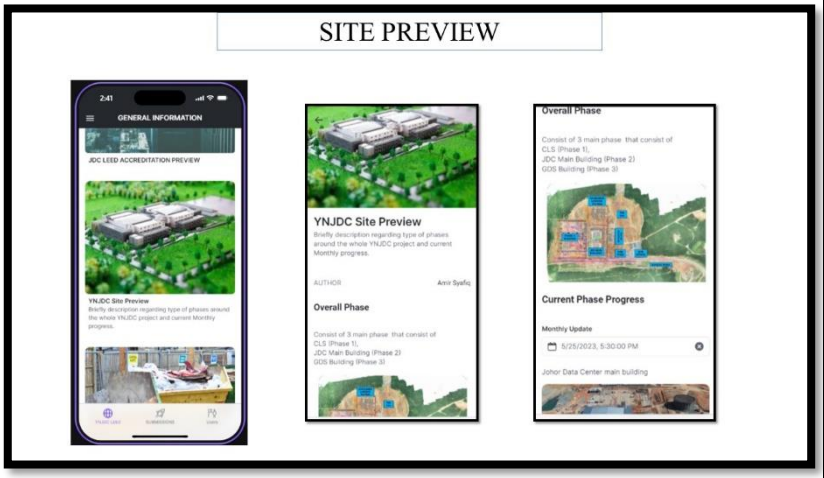
A prototype is a simple experimental model that can be used and affordable to be test or validate within the prototype concepts, design hypothesis, and other conceptualization-related elements. This enables the engaged designers to make any necessary adjustments or prospective alterations in the design course. The one thing of all prototypes have in common is that they are all physical manifestation of ideas created with the relevant data that come out as a design. Table 3.2 below demonstrates the nature of working using the CWMP application to organise and fill the documents inside web with the usage of Glideapps.

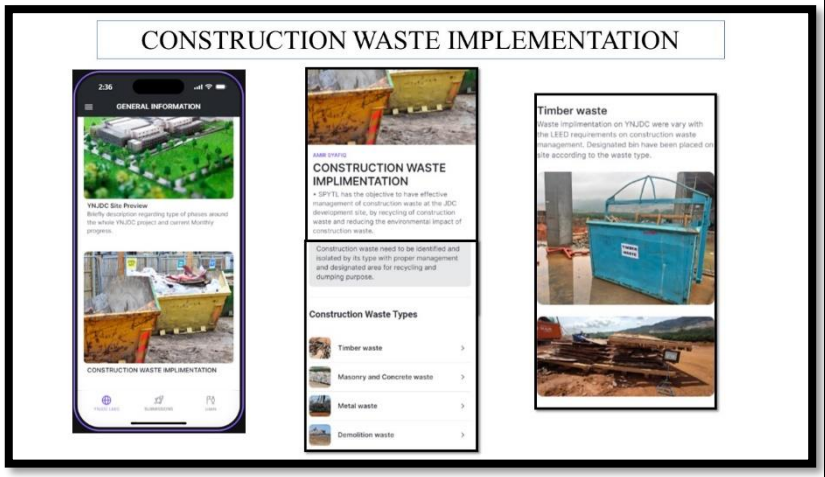
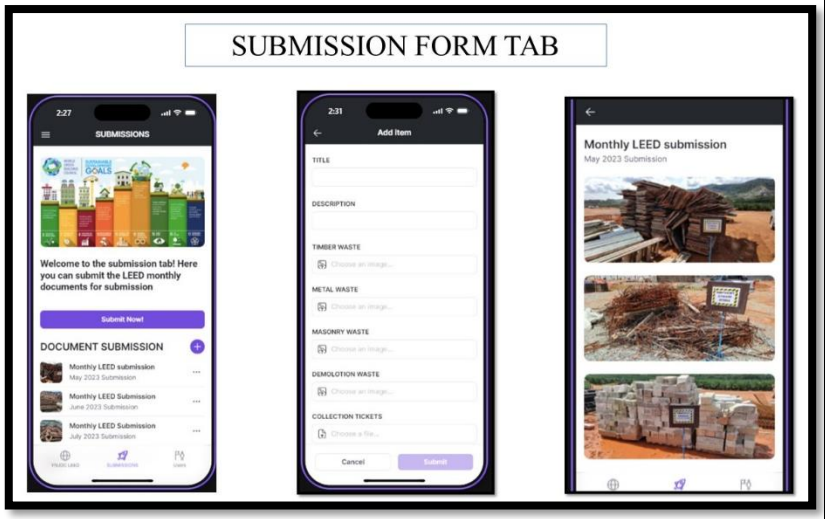
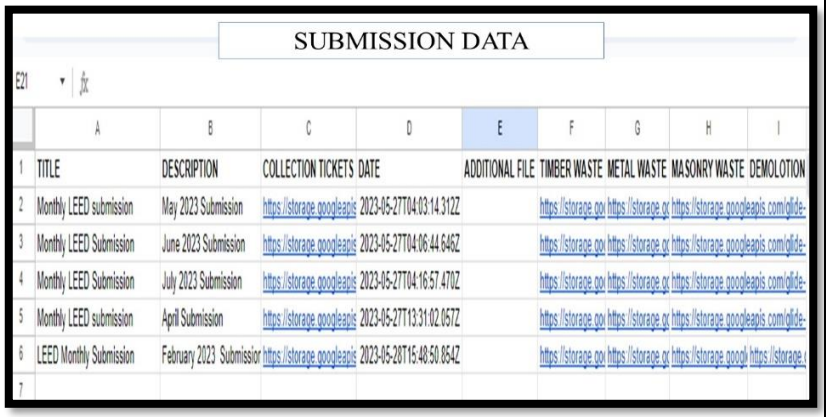
Table 3.2

CWMP Prototype simulation.

INTERFACE	DESCRIPTION
	This is the front interface of Construction Waste Management Platform (CWMP) where the user of the application have to login with their certified Google email or just click on the magic button to directly sign in by Google. The user have to click on the login button for the next interface

	Upon login using the email, the user would have to create their account in the CWMP. By clicking the "Create Account" button, the user would be directed to the account form where the user have to fill all the requirements need in order to create an account for the platform in order to acquire certified permission to enter the CWMP
	The user profile interface show the user photo, user name, designation, contact information and email description for the record of the administration of CWMP to allow certain user for access.

	CWMP front page which is the main tab of the application displays the YNJDC location for site introduction purpose and also equipped with the location search bar for better access for the user. This page also use as a presentation purpose.
	The accreditation information displays the timeline regarding the LEED accreditation timeline for the project to succeed with its criteria that consist of all environmental, energy and design of the project.
	The site preview interface works to give better visual perspective about the progress ongoing within the site and give better review and information about the site phases and location of different phases of the whole projects with monthly update about the site.

	The construction waste implementation on site displays the implementation method on handling the waste in site by segregating the type of waste available.
	Submission tabs in the application included with submission form where the supervisor or the LEED officer for YNJDC can uploads live documents on site and monitor the submission data and the submission properties monthly right after the submission.
	The submission data can be monitor right after the submission being made inside the spreadsheet data that have been made that updates directly with the time on the application and the items can be extracted by clicking the link.

3.5.5 Test.

Test phase is the final part of the design thinking that be used to validate the application vary to the need of the user. The test should be conducted in much different ways such as live test form the user. The result of the test will be recorded as data to confirm the workability and the performance of the app by organizing a questionnaire that consist of questions, answers and recommendations about the product proposed to the user. The result of the data is then being transferred into a graphical method where consist of graphs, pie charts or many other significant visual aid to illustrate the result of the test.

During the testing phase, the questionnaire are sent out for the user to fill in order to acquire the correct data about the response of the user for CWMP workability and it is really achieves the objective of the project itself and question that are product related were important to ensure the data collected will be vary to the subject and objective. The source of the questionnaire data and method of questioning would be implementing the method of Technology Acceptance Model (TAM), (F.D.Davis, 1989). Moreover, consideration of improvement will be taken form the test phase to get better result and idea of improvement for the sustainability of CWMP.

The test data will consist of data acquire form the designated online form by google form as in Figure 3.5.

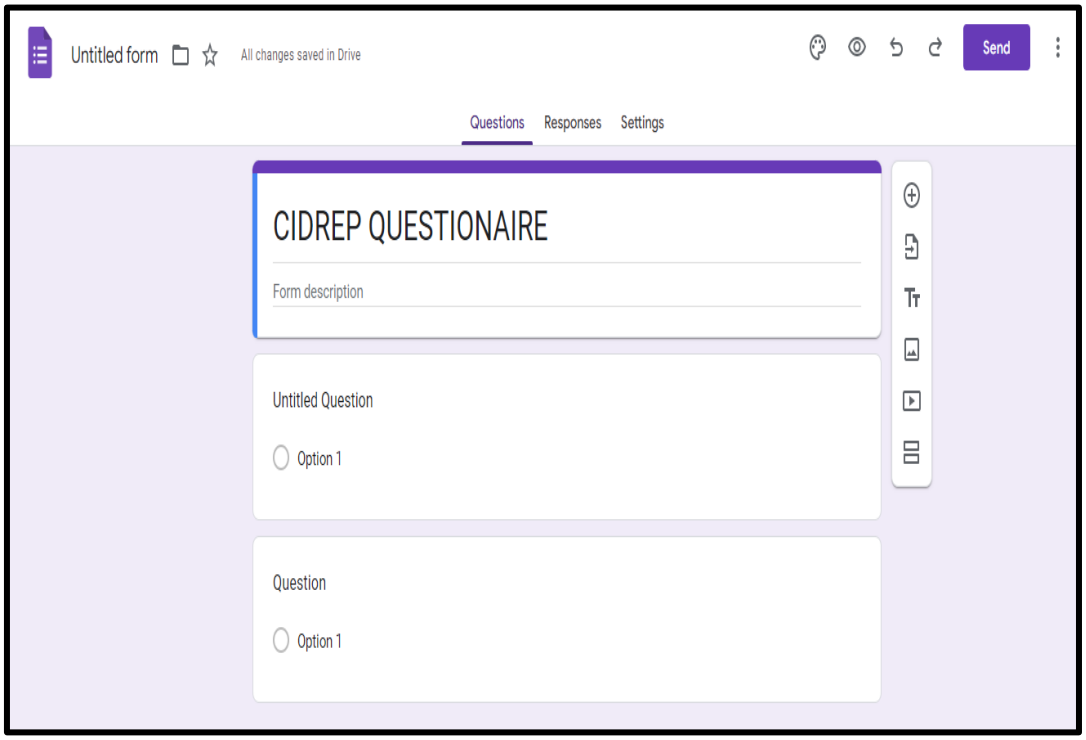


Figure 3.5: Online questionnaire form by Google

3.6 Conclusion

In conclusion, implementing efficient construction waste management is essential to foster sustainable growth and reducing negative impacts on the environment. The construction industry produces a lot of waste, including materials, debris, and potentially dangerous compound that can harm ecosystems, community health, and natural resources.

Construction companies can benefit in several ways by implementing effective waste management procedures. For YNJDC project that located in Kulai, Johor, the waste management implementation need to vary with the LEED accreditation that have been selected for the type of accreditation that the project applies which is the US Green Building Council's LEED BD+C Rating System for the design and construction of commercial buildings, as applicable to the project scope for the JDC development.

Implementation of waste management strategies for construction projects also lessens environmental contamination and complies with the Sustainable Development Goal (SDG) that complies with goal 7,11,12 and 13. By properly classifying, recycling, and discarding waste, ecosystem quality is preserved and human health is safeguarded preventing contamination of the land, water, and air. Additionally, it lessens the need for landfill space, which is frequently scarce and can have a negative impact on nearby communities.

As for the sum, the Construction Waste Management Platform offers a solution by promoting and suggesting the better way of implementing the waste management on the YNJDC site and also helps with the accreditation documents by summarising the data collected on site such as the waste management photos that are required.

More than that, the CWMP also have been certified by the project safety team to use the application as a tool for workers induction, to explain to the worker with better platform about the waste implementation on site visually for better understandings. Additionally, the apps data collection is being displayed on the application submission record for the right authorities to monitor the progress of the monthly LEED file submission for better review and supervision purposes.

CHAPTER 4

RESULT: ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

In this chapter, the expected result from the project that has been carried out by questionnaire had been extracted and being explain in this chapter. The finding of the project was being observe after the completion of the Construction Waste Management Platform CWMP. The questionnaire focuses on users that is connected with the outcome of the CWMP and act as the observer of the LEED accreditation under the context of construction waste management. After the completion of the CWMP applications, the application were tested and were being demonstrated for better review to give the site team and the future user of the application better explanation about the role of CWMP. The data analysis and findings consist of 19 questions that being separated into six sections which is, demographic data section, Section A (perceive ease of use), Section B (Perceived Usefulness), Section C (Attitude towards using technology), Section D (Behavioural intention to use), Section E (Comments and recommendations). The questionnaire was delivered to 11 on site experts regarding the project field of study to obtain valid data collection and recommendations which is engineers, lead architects, construction managers and HSE officers from the safety department.

This chapter demonstrates and explicates the results and data in the research that already being obtained by the questionnaire and throughout the interview from the YNJDC project. The chapter would also discussed about the results of the objectives of this project to verify that the objectives is vary with the description. In this chapter also, the results are being rationalized based on the data obtained from the questionnaire.

4.2 Data Collection and Finding.

The results shown from the questionnaire that has been distributed to the respondents which consist of engineers, lead architects, construction managers and HSE officers to get valid review about the performance and the permittable content of the CWMP application. The respondent also were required to write their opinion and suggestion on how to improve the application for any change of wording information and user interface for more systematic enhancement through authorisation of documents insertion. The surveys have been conducted for 11 respondents. The results obtained will be presenting a complete result and analysis of the study in the form of tables, graphs, and figure so that the key information is emphasized.

4.3 Data Collection of Questionnaire

The questionnaire consists of six different sections, demographic data section, Section A (perceive ease of use), Section B (Perceived Usefulness), Section C (Attitude towards using technology), Section D (Behavioural intention to use), Section E (Comments and recommendations). The pattern of the questionnaire that have been selected is based on the type of research selected method of user acceptance based on the Technology Acceptance Model (TAM) by F.D.Davis which is one of the most cited model in the field of technology acceptance. The questionnaire set are distributed by link to all the respondents that using online form for better data collection and flexible reach in order to ease each respondent by using Google Form.

4.3.1 Demographic Data

Demographic data is the background of the respondents, which contains of 4 items which is:

i. Gender
ii. Age Group
iii. Designation
iv. Work experience

I) Gender

Pie charts and table on appendix D shows the result of the questionnaire with the total number of respondents of 11 selected individuals that vary with the LEED Accreditation and Safety personnel.

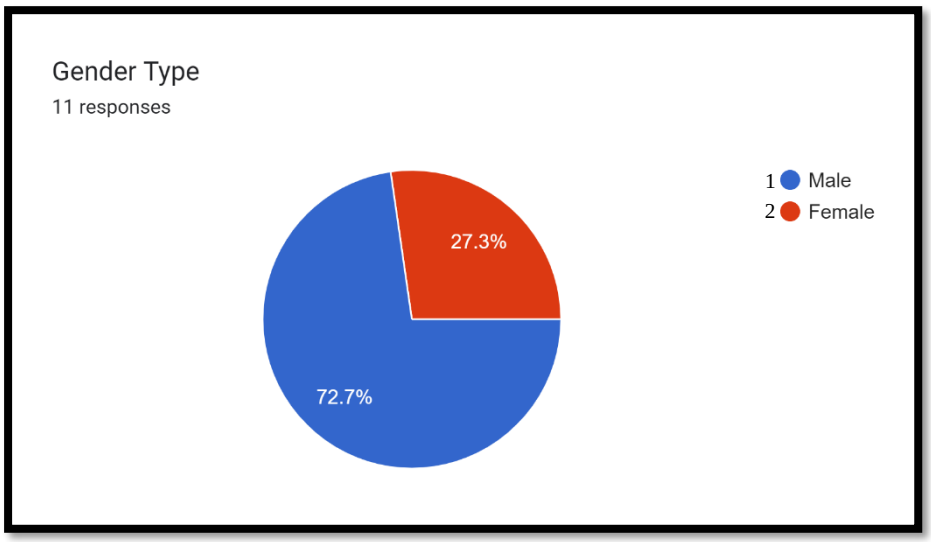


Figure 4.1: Distribution of respondents by gender.

Figure 4.1 shown above indicates the distribution of male and female respondents by the result of the questionnaire. From the 11 respondents as stated on figure 4.1 above shows 72.7% of the respondents is male meanwhile 27.3% of the respondents is female. The Figure legend is the distribution of the category for each gender by number which 1 represent the male and 2 represented female. The result (mean=1.18) for the gender category based on the table displayed on the appendix proofs that majority of the respondents is particularly men.

II Age (years)

Pie charts and table on appendix D shows the result of the questionnaire with the total number of respondents of 11 selected individuals that vary with the LEED Accreditation and Safety personnel regarding the age of the respondents that influence the outcome of the CWMP data about the validation of the respondents age and experience in the industries.

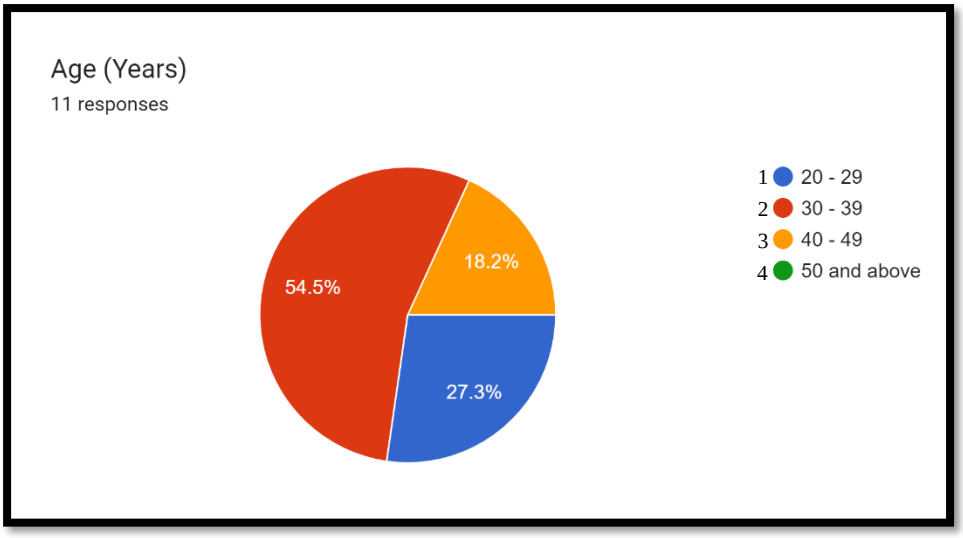


Figure 4.2: Distribution of respondents by age(years).

Based on the Figure 4.2 shown about the distribution of respondents by age(years), indicates that the majority of respondents were aged around 30-39 years old with the results of 54.5% with the frequency of 6 respondents because the majority of the team were at the range of age. Second is most selection for the age of the respondents is 20-29 years old with the frequency of 3 respondents. And lastly for the age of 40-49 years old with the frequency of 2 respondents. The results data for this questionnaire were stated on table in the appendix which indicates (mean=1.9) to conclude that the result shown the majority of the respondent is at the age selection of 2 which is 30-29.

III Designations

Table 4.1 below shows the result of the questionnaire with the total number of respondents of 11 selected individuals that vary with the LEED Accreditation and Safety personnel regarding the age of the respondents that influence the outcome of the CWMP data about the validation of the respondents age and experience in the industries.

Table 4.1

Designation of the respondents

DESIGNATION
QAQC Eng
Lead Architect
Deputy Draughting Manager (Arch)
TECHNICAL OFFICER (HSE)
Deputy Construction Manager
TECHNICAL ASSISTANT (HSE)
Safety Health Officer
Construction Manager
GBI Engineer
Landscape Architect
Project Engineer (C&S)

Table 4.1 indicates the distribution of the designation within the 11 respondents. As stated early in the introduction of the questionnaire, the online for were distributed to the selected staff within the YNJDC project and the project boards of directors to achieve validation and endorsement information about the CWMP aims and functions within the right respondents that can give effective data to the research questionnaire and to make sure that the data provided from the questionnaire is based on the correct respondents and valid designation within the project and for the LEED accreditation. From the 5 above presents that the 11 respondents for this project questionnaire consist of engineers, managers, safety officers, architects and from the Green Building Index council.

IV) Work Experience

Pie charts and table below shows the result of the questionnaire with the total number of respondents of 11 selected individuals that vary with the LEED Accreditation and Safety personnel regarding the age of the respondents that influence the outcome of the CWMP data about the validation of the respondents age and experience in the industries.

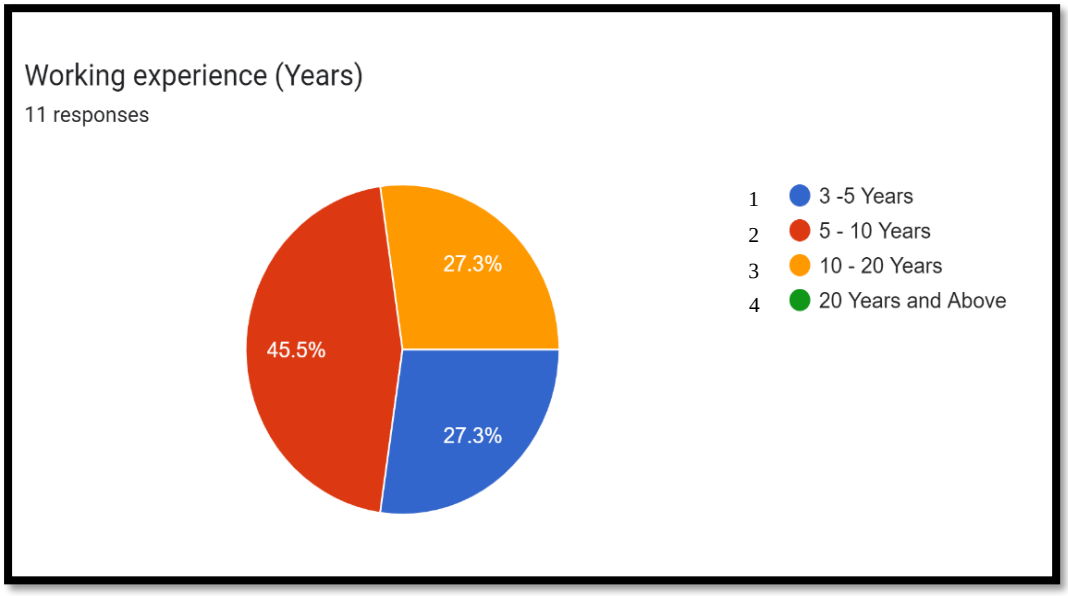


Figure 4.3: Distribution of respondents by working experience.

Based on the questionnaire result shown on the pie charts on Charts 4.3 above indicates that the questionnaire age level is being separated into 4 selections of duration and the respondent have to pick either one and the pole of the selection is selected into range and not specific number to give better access of selection to the user. The data gathered from the questionnaire shows that about 45.5% of the 11 respondents of the YNJDC project boards had a working experience at a range of 5 to 10 years within the field.

This type of questionnaire is required to achieve validity about the respondents experience in the construction. The application had been demonstrated to all of the respondents before the questionnaire is being delivered to obtain valid information and legitimate data about the project and not only creating the result of questionnaire by gathering randomise respondent. This questionnaire is gathered based on the qualitative research method for valid information and data result.

4.3.2 Section A: Perceive ease of use.

This section consist 5 question and the type of question that being applied to the questionnaires is based on the Technology Acceptance Model (TAM) (Davis,1989) that use to measure the impact of perceived ease of use towards the intention to the usage of CWMP application. This will allow the researcher to study the respondent level of acceptance and approval regarding the statement given. This section all allows the respondent to indicates the level of acceptance and non-acceptance towards the application by selecting the most appropriate selection based on the scales given which is :

1= Totally not agree to 5= Totally agree.

The question for this part of questionnaire have been expanded into 5 different question which is:

i. The use of CWMP increases efficiency in managing documents.
ii. The use of CWMP increases the fluency of documents submission.
iii. The use of CWMP increases the productivity of documents submission and documents tracing.
iv. The LEED information in the CWMP is understandable.
v. I found that CWMP is very useful for the project.

I. The use of CWMP increases efficiency in managing documents.

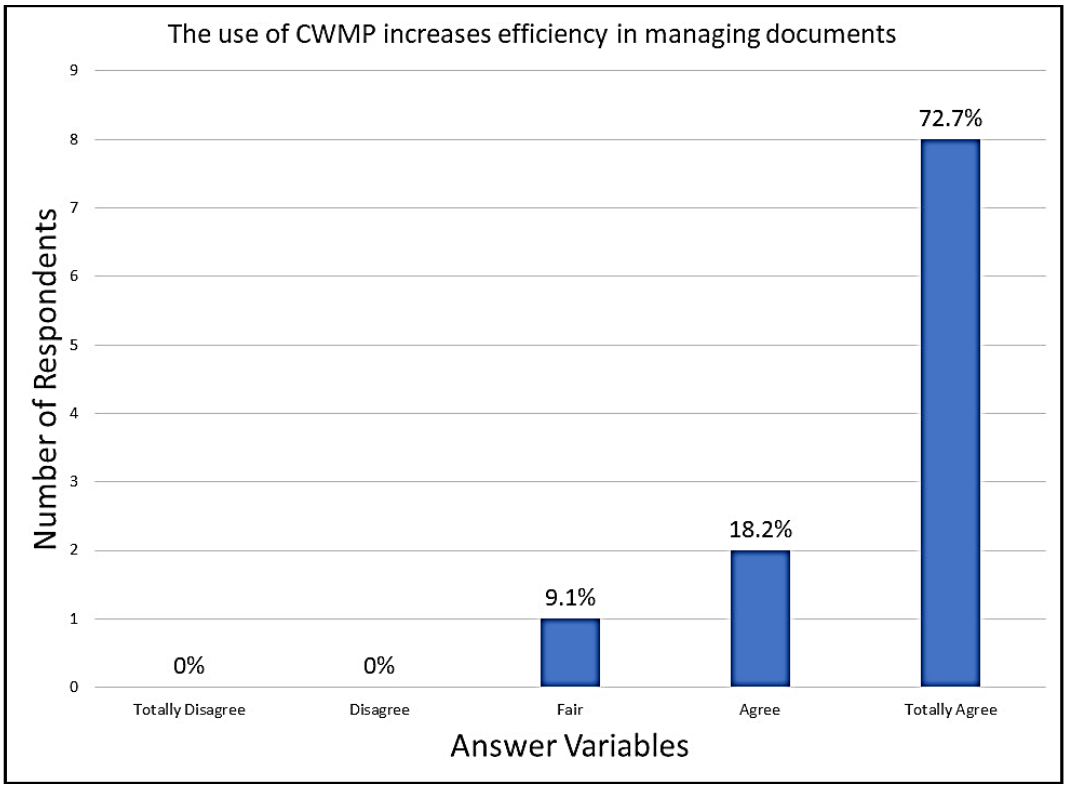


Figure 4.4: CWMP perceived of use.

Figure 4.4 above indicates that from 11 respondents, 8 respondents are totally agreeing that with the use of CWMP increases the efficiency in managing documents, while 2 respondents agree on the stated statement that the usage of CWMP increases the efficiency in managing documents and 1 of the respondents were fairly agrees about the statement. This questionnaire resulted that the mean value is 4.6. and based on table on the appendix shows that the respondents agreement to the statement is 100% agrees as all the results is at scale 3 to 5. The percentage of respondents distribution is demonstrated on Figure 4.4.

II. The use of CWMP increases the fluency of documents submission.

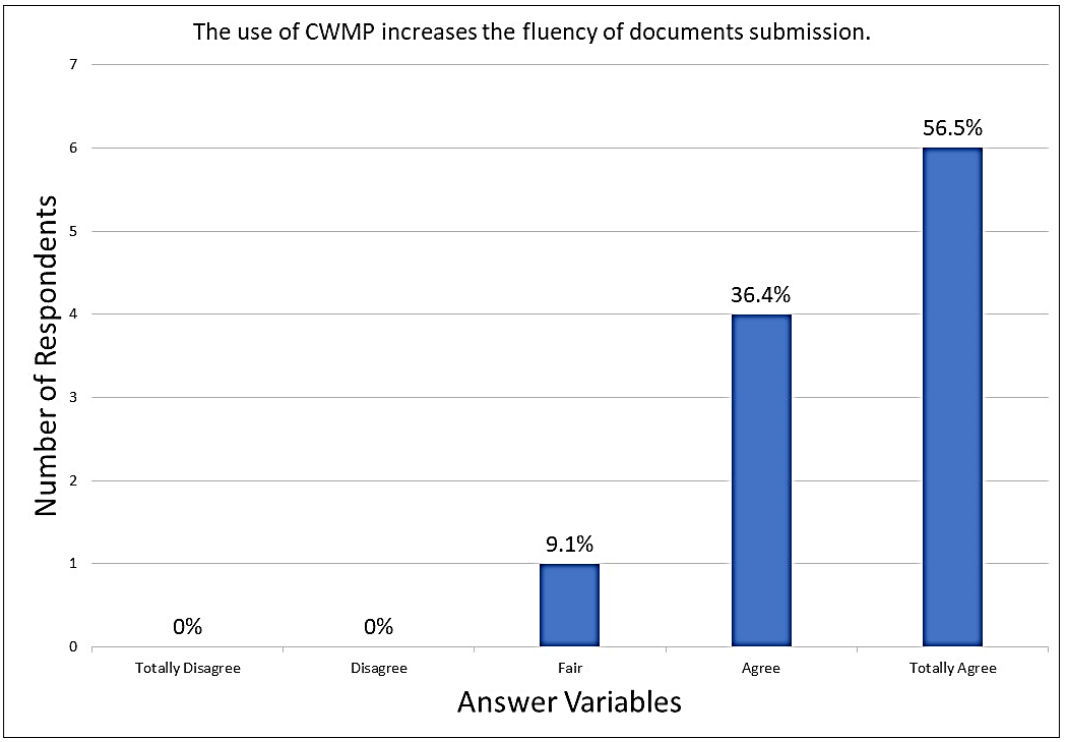


Figure 4.5: CWMP impacts on document submission.

Figure 4.5 above indicates that from 11 respondents, 6 respondents are totally agreeing that with the use of CWMP increases the fluency of document submission, while 4 respondents agree on the stated statement that the usage of CWMP increases the efficiency in managing documents and 1 of the respondents were fairly agrees about the statement. This questionnaire resulted that the mean value is 4.45. and based on table on the appendix shows that the respondents agreement to the statement is 100% agrees as all the results is at scale 3 to 5. The percentage of respondent distribution is demonstrated on Figure 4.5.

III. The use of CWMP increases the productivity of documents submission and documents tracing.

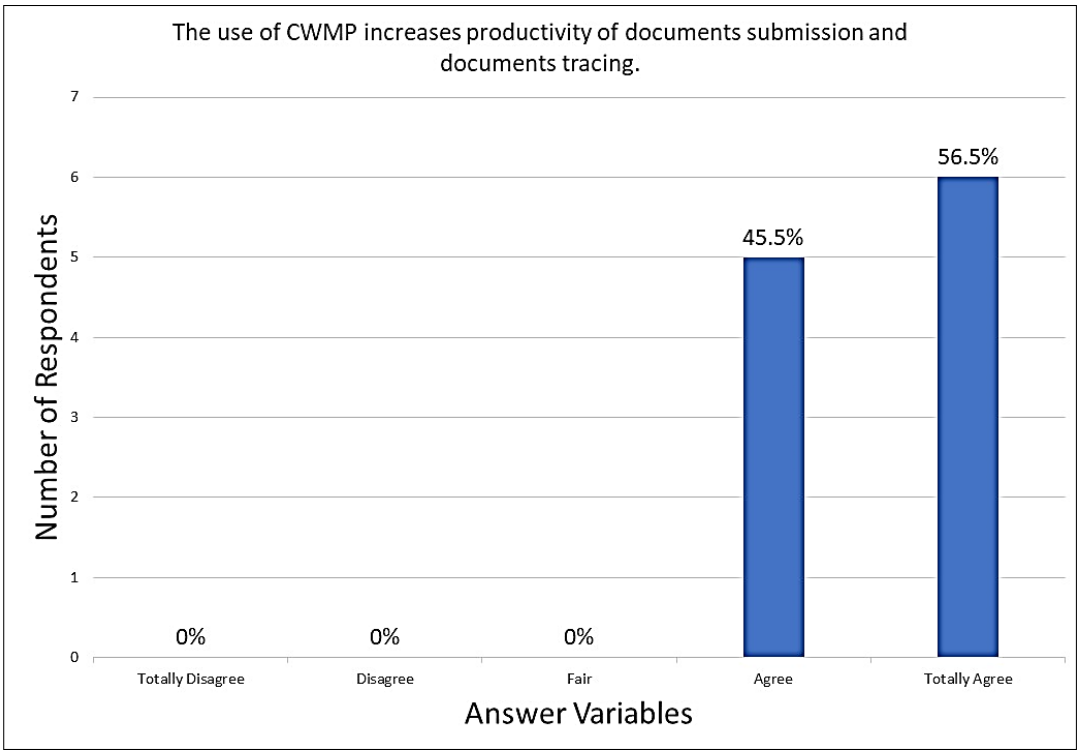


Figure 4.6: CWMP performance on submission and tracing of documents

Figure 4.6 above indicates that from 11 respondents, 6 respondents are totally agreeing that with the use of CWMP increases productivity of documents submission and tracing progress, while 5 respondents agree on the stated statement that the usage of CWMP increases the efficiency in managing documents and 1 of the respondents were fairly agrees about the statement. This questionnaire resulted that the mean value is 4.45. and based on table shows on the appedix that the respondents agreement to the statement is 100% agrees as all the results is at scale 3 to 5. The percentage of respondent distribution is demonstrated on Figure 4.6.

IV. The LEED information in the CWMP is understandable.

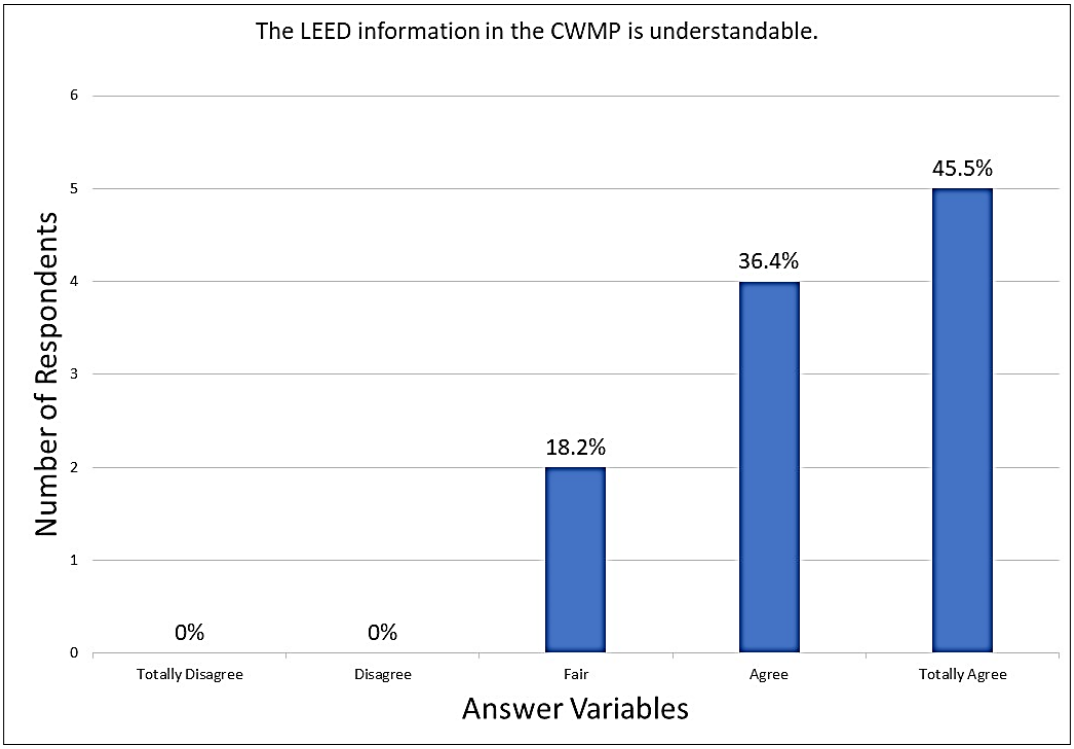


Figure 4.7: level of user understanding of CWMP.

Figure 4.7 above indicates that from 11 respondents, 5 respondents are totally agreeing that the LEED information regarding the accreditation in the CWMP is understandable, while 4 respondents agree on the stated statement that the usage of CWMP increases the efficiency in managing documents and 2 of the respondents were fairly agrees about the statement. This questionnaire resulted that the mean value is 4.27. and based on table on the appendix shows that the respondents agreement to the statement is 100% agrees as all the results is at scale 3 to 5. The percentage of respondent distribution is demonstrated on Figure 4.7.

V. I found that CWMP is very useful for the project.

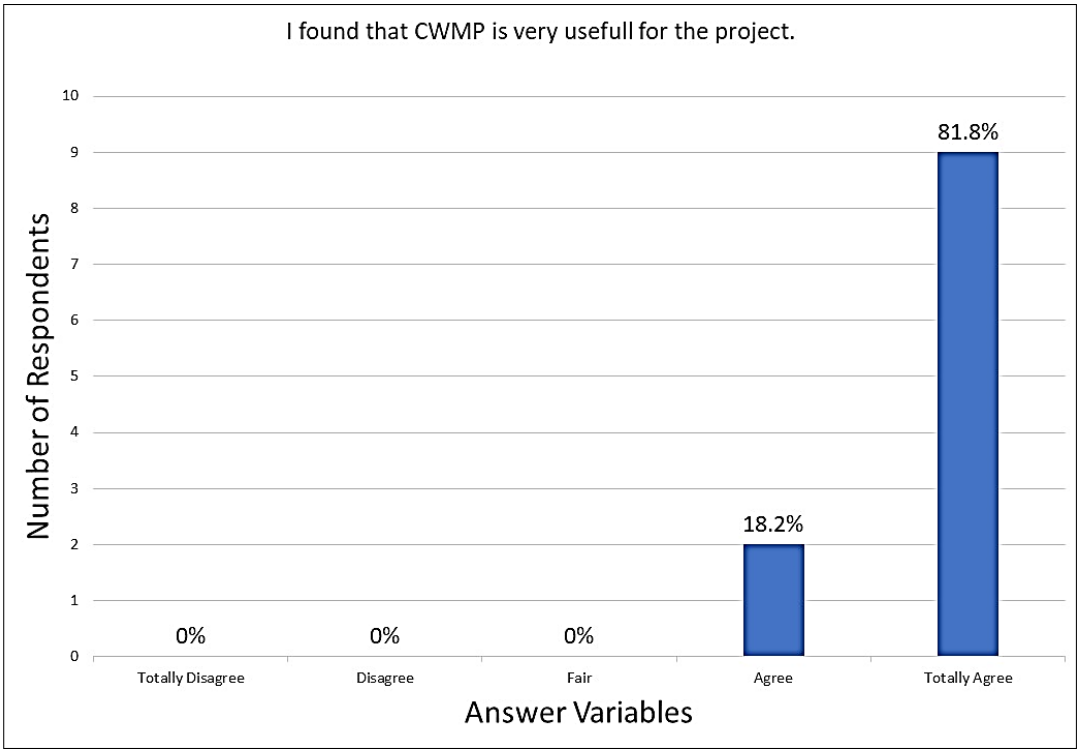


Figure 4.8: level of user acceptance towards CWMP.

Figure 4.8 above indicates that from 11 respondents, 9 respondents are totally agreeing CWMP is very useful, while 2 respondents agree on the stated statement that the usage of CWMP is very useful. This questionnaire resulted that the mean value is 4.8. and based on table on the appendix shows the respondents that agreed to the statement is 100% as all the results is at scale 3 to 5. The percentage of respondent distribution is demonstrated on Figure 4.8.

4.3.3 Section B: Perceive Usefulness

This section consist 4 question and the type of question that being applied to the questionnaires is based on the Technology Acceptance Model (TAM) (Davis,1989) that use to measure the impact of perceived usefulness towards the intention to the usage of CWMP application. This will allow the researcher to study the respondent level of confidents regarding the statement of questions given. This section all allows the respondent to indicates the level of acceptance and non-acceptance towards the application by selecting the most appropriate selection based on the scales given which is :

1= Totally not agree to 5= Totally agree.

The question for this part of questionnaire have been expanded into 4 different question which is:

i. I found that it is easy to use the CWMP.
ii. CWMP can be use to learn about LEED progress in the project.
iii. I found that function of CWMP is clear and understandable.
iv. I found that it is easy to manage documents using the CWMP.

I. I found that it is easy to use the CWMP.

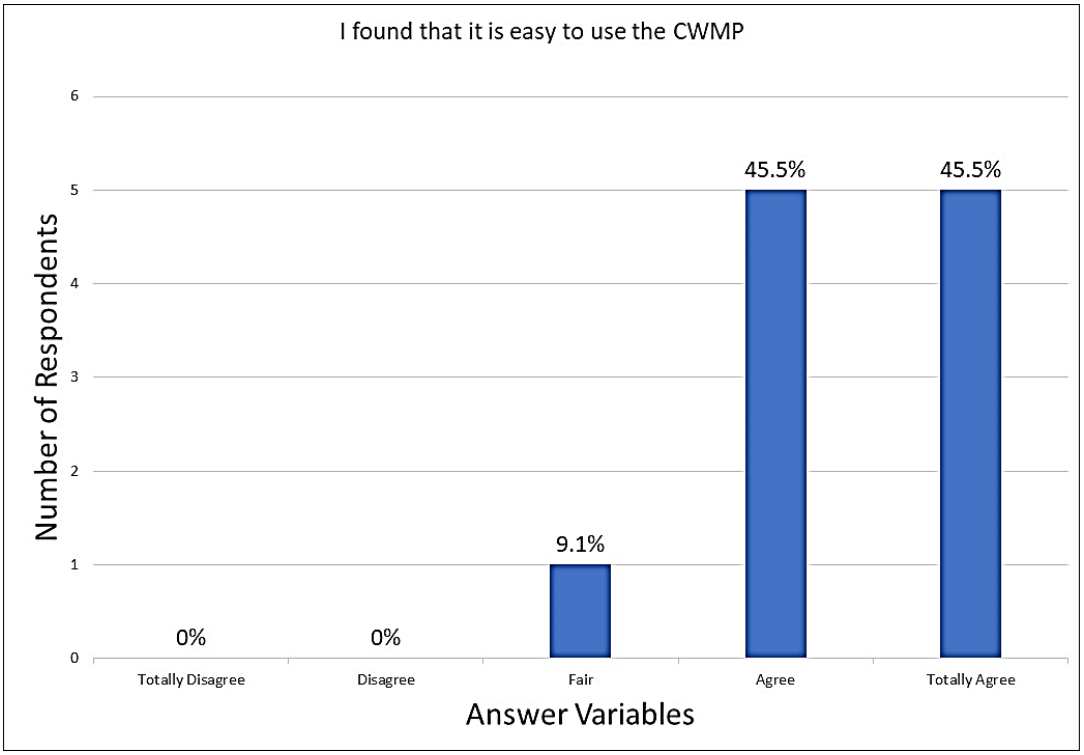


Figure 4.9: level of user acceptance towards CWMP perceive usefulness.

Figure 4.9 above indicates that from 11 respondents, 5 respondents are totally agreeing that it is easy to use CWMP for the project, while 5 respondents agree on the stated statement CWMP is easy to be use and 1 of the respondents were fairly agrees about the statement. This questionnaire resulted that the mean value is 4.36. and based on table on the appendix shows that the respondents agreed to the statement is 100% agrees as all the results is at scale 3 to 5. The percentage of respondent distribution is demonstrated on Figure 4.9.

II. CWMP can be use to learn about LEED progress in the project.

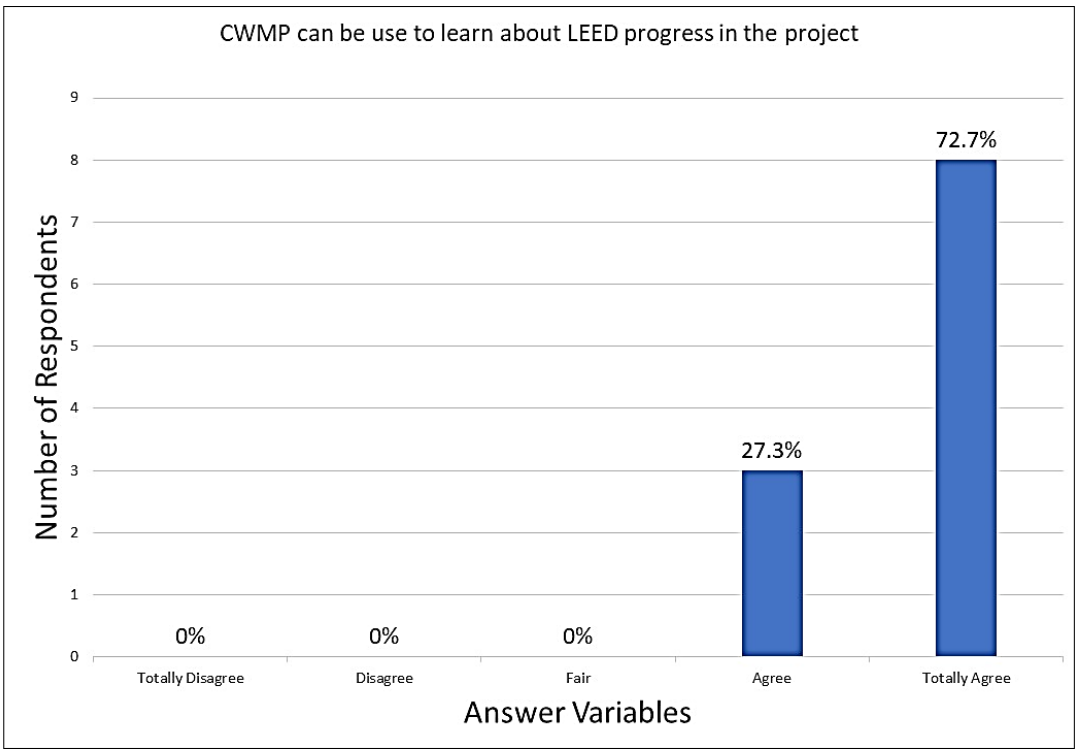


Figure 4.10: CWMP can be used as an informational platform.

Figure 4.10 above indicates that from 11 respondents, 8 respondents are totally agreeing that it is easy to use CWMP can be use as an informational platform, while 3 respondents agree on the stated statement. This questionnaire resulted that the mean value is 4.72. and based on table on the appendix shows that the respondents agreed to the statement is 100% agrees as all the results is at scale 3 to 5 and the standard deviation result at 0.47. The percentage of respondent distribution is demonstrated on Figure 4.10.

III. I found that function of CWMP is clear and understandable.

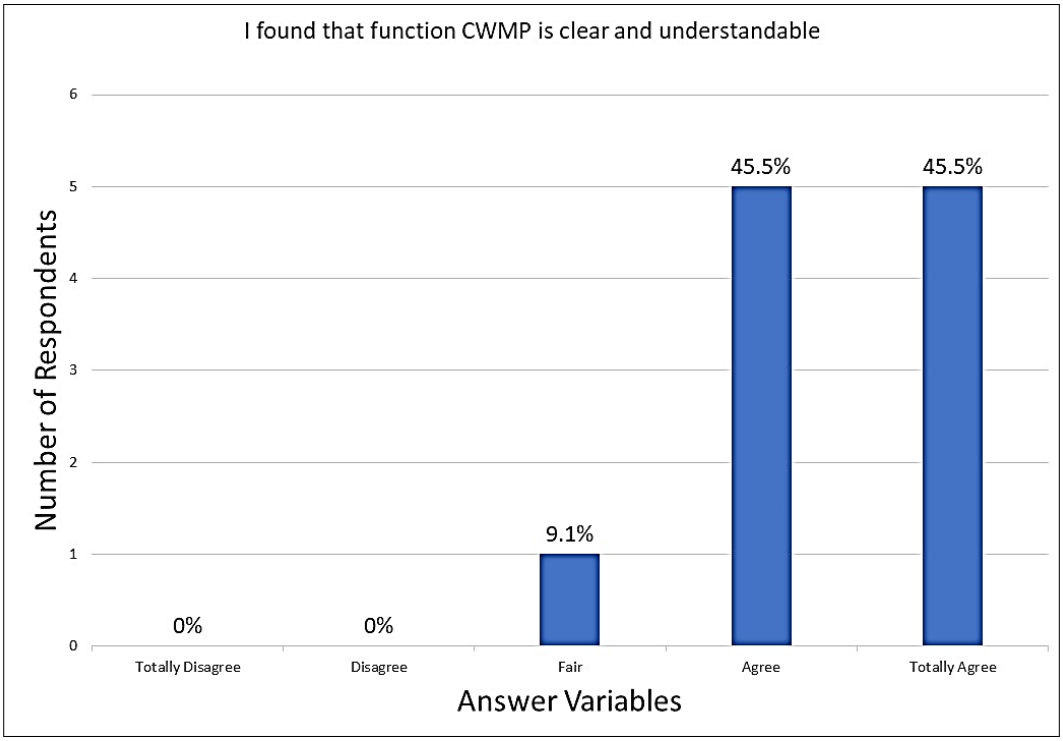


Figure 4.11: CWMP function is clear and understandable.

Figure 4.11 above indicates that from 11 respondents, 5 respondents are totally agreeing that it is easy to use CWMP function is clear and understandable, while 5 respondents agree to the idea of CWMP functions and 1 of the respondents were fairly agrees about the statement. This questionnaire resulted that the mean value is 4.36. and based on table on appendix shows that the respondents agreed to the statement is 100% agrees as all the results is at scale 3 to 5 and the standard deviation result at 0.67. The percentage of respondent distribution is demonstrated on Figure 4.11.

IV. I found that it is easy to manage documents using the CWMP.

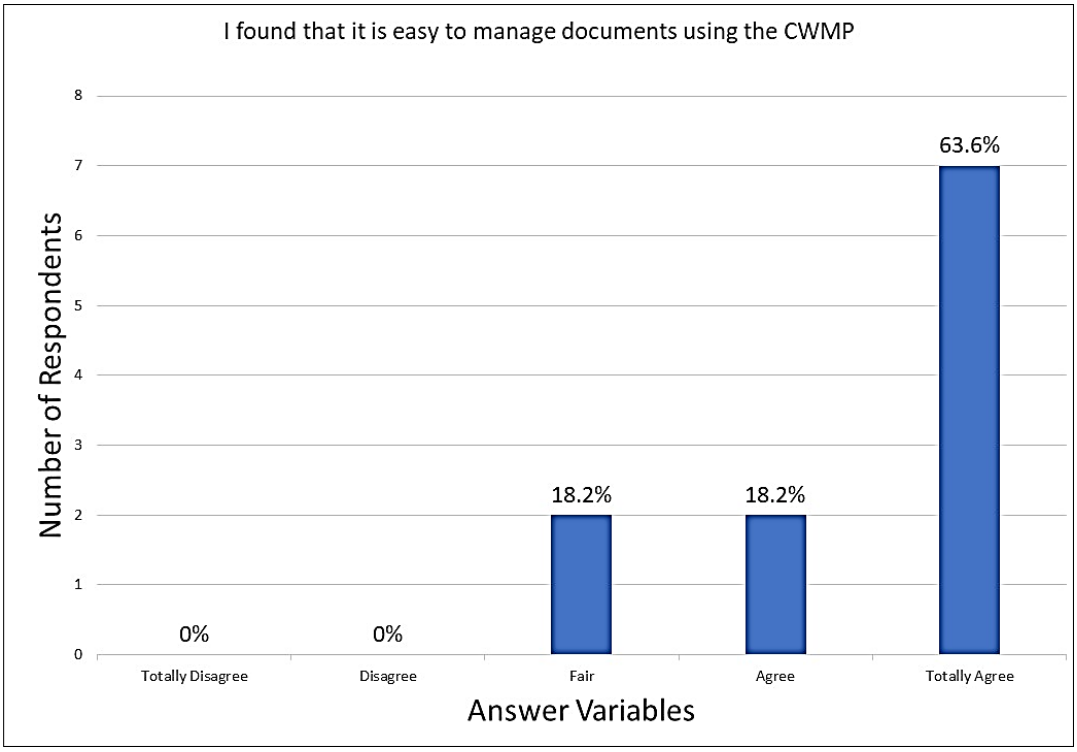


Figure 4.12: CWMP able to manage document easily.

Figure 4.12 indicates that from 11 respondents, 7 respondents are totally agreeing that CWMP able to manage document easily , while 2 respondents agrees to the idea of CWMP able to manage document easily and 2 of the respondents were fairly agrees about the statement.. This questionnaire resulted that the mean value is 4.45. and based on table on appendix shows that the respondents agreed to the statement is 100% agrees as all the results is at scale 3 to 5 and the standard deviation result at 0.82. The percentage of respondent distribution is demonstrated on Figure 4.12.

4.3.4 Section C: Attitude Towards Using Technology

This section consist 3 question and the type of question that being applied to the questionnaires is based on the Technology Acceptance Model (TAM) (Davis,1989) that used to measure the attitude towards using technology and the intention to the usage of CWMP application. This will allow the researcher to study the respondent level of respondents behaviour regarding the statement of questions given. This section all allows the respondent to indicates the level of acceptance and non-acceptance towards the application by selecting the most appropriate selection based on the scales given which is :

1= Totally not agree to 5= Totally agree.

The question for this part of questionnaire have been expanded into 4 different question which is:

i. I wish to manage documents using CWMP.
ii. I will always feel comfortable using CWMP for LEED documents submission.
iii. I will use CWMP for my work.

I. I wish to manage documents using CWMP.

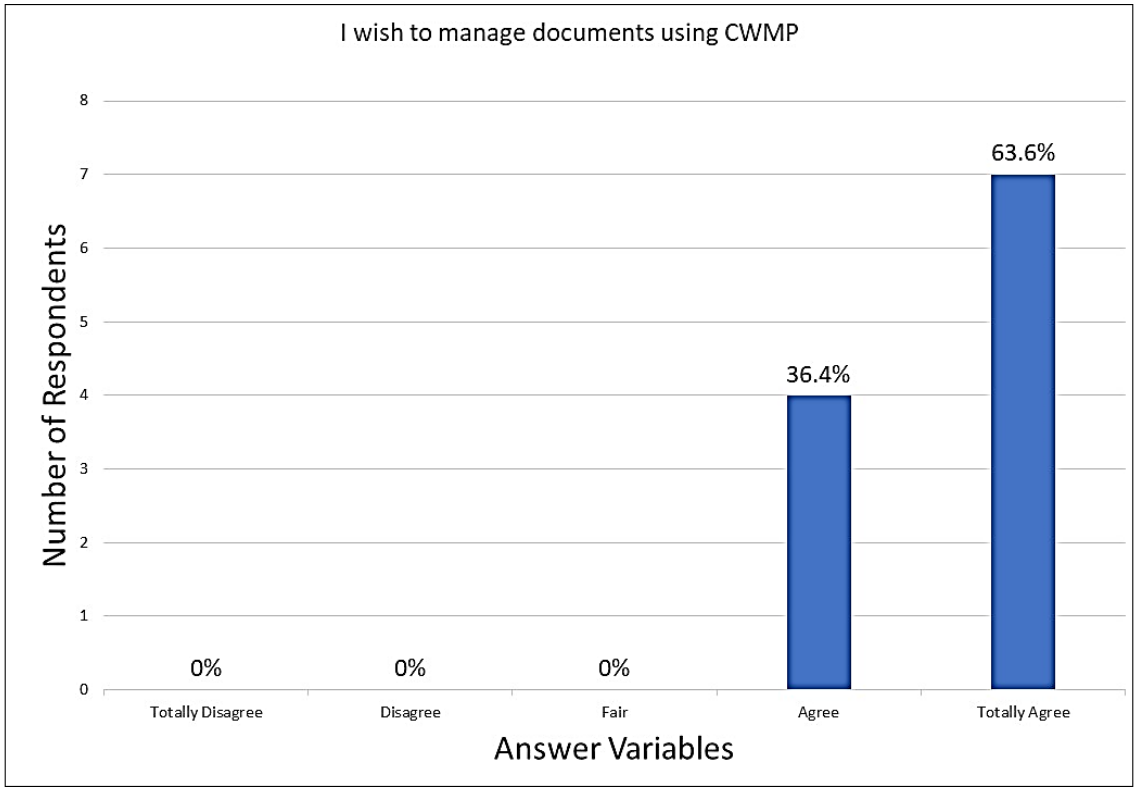


Figure 4.13: Respondents wish to use CWMP.

Figure 4.13 indicates that from 11 respondents, 7 respondents are totally agreeing that the respondents wish to manage documents using CWMP , while 4 respondents agrees to the statement. This questionnaire resulted that the mean value is 4.63. and based on table on the appendix shows that the respondents agreed to the statement is 100% agrees as all the results is at scale 3 to 5 and the standard deviation result at 0.5. The percentage of respondent distribution is demonstrated on Figure 4.13.

II. I will always feel comfortable using CWMP for LEED documents submission.

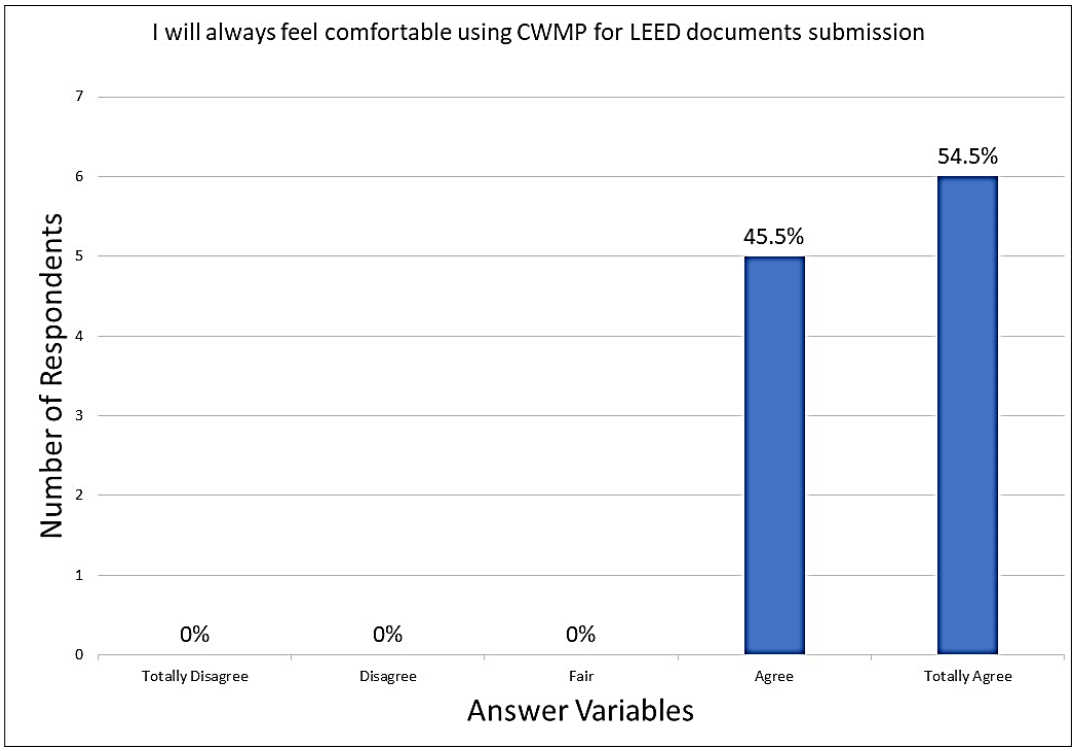


Figure 4.14: CWMP is accessible and easy to work on.

Figure 4.14 indicates that from 11 respondents, 6 respondents are totally agreeing that the respondents are comfortable to access and easy to work with while 5 respondents agrees to the statement. This questionnaire resulted that the mean value is 4.54. and based on appendix shows that the respondents agreed to the statement is 100% agrees as all the results is at scale 3 to 5 and the standard deviation result at 0.5. The percentage of respondent distribution is demonstrated on Figure 4.14.

III. I will use CWMP for my work.

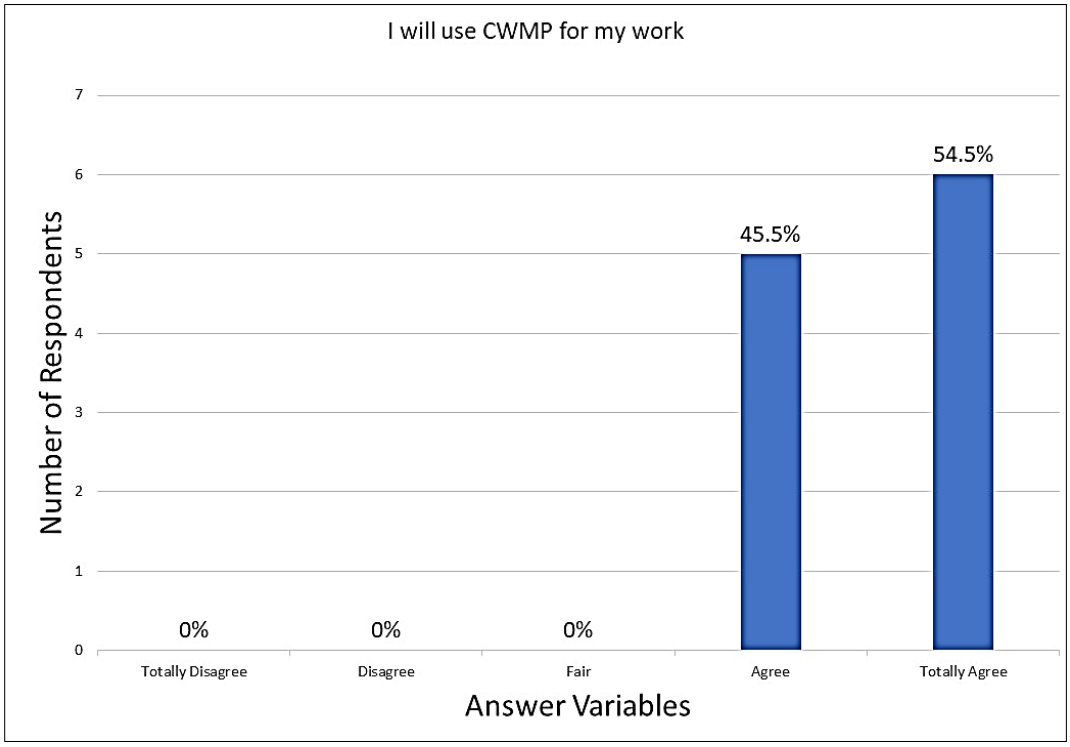


Figure 4.15: CWMP acceptance to be use as working tool.

Figure 4.15 above indicates that from 11 respondents, 6 respondents are totally agreeing that the respondents wishing to use CWMP for their work regarding LEED submission.. This questionnaire resulted that the mean value is 4.54. and based on appendix shows that the respondents agreed to the statement is 100% agrees as all the results is at scale 3 to 5 and the standard deviation result at 0.5. The percentage of respondent distribution is demonstrated on Figure 4.15.

4.3.5 Section D: Behaviorial Intention To Use

This section consist 4 question and the type of question that being applied to the questionnaires is based on the Technology Acceptance Model (TAM) (Davis,1989) that used to measure the respondents behaviour and intention to the utilization of CWMP application. This will allow the researcher to study the level of respondents behaviour regarding the statement of questions given. This section all allows the respondent to indicates the level of acceptance and non-acceptance towards the application by selecting the most appropriate selection based on the scales given which is :

1= Totally not agree to 5= Totally agree.

The question for this part of questionnaire have been expanded into 4 different question which is:

i. CWMP makes the document management more interesting.
ii. CWMP makes the document management more attractive.
iii. I tend to use CWMP.
iv. I always delighted to use the CWMP on site.

I. CWMP makes the document management more interesting.

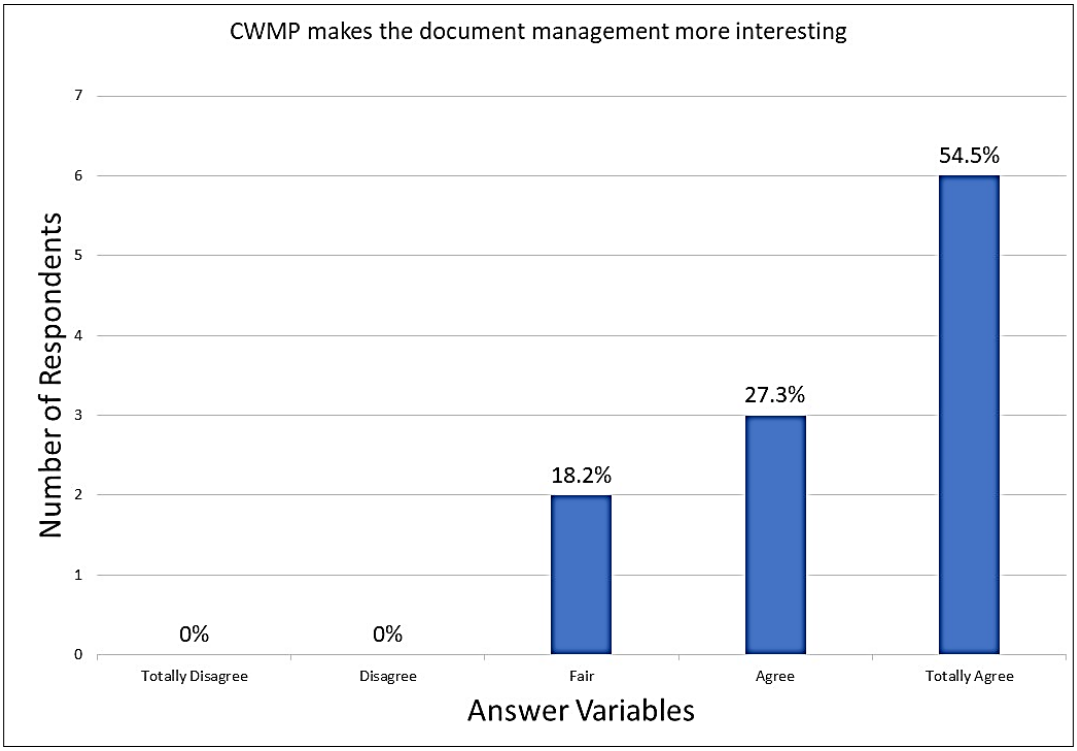


Figure 4.16: CWMP is interesting to use.

Figure 4.16 and table on appendix D indicates that from 11 respondents, 6 respondents are totally agreeing that the respondents more interested with CWMP in order to management documents, while 3 respondents agrees to the statement and 2 of the respondents were fairly agrees about the statement. This questionnaire resulted that the mean value is 4.36. and based on table in appendix that the respondents agreed to the statement is 100% agrees as all the results is at scale 3 to 5 and the standard deviation result at 0.5. The percentage of respondent distribution is demonstrated on Figure 4.16.

II.CWMP makes the document management more attractive.

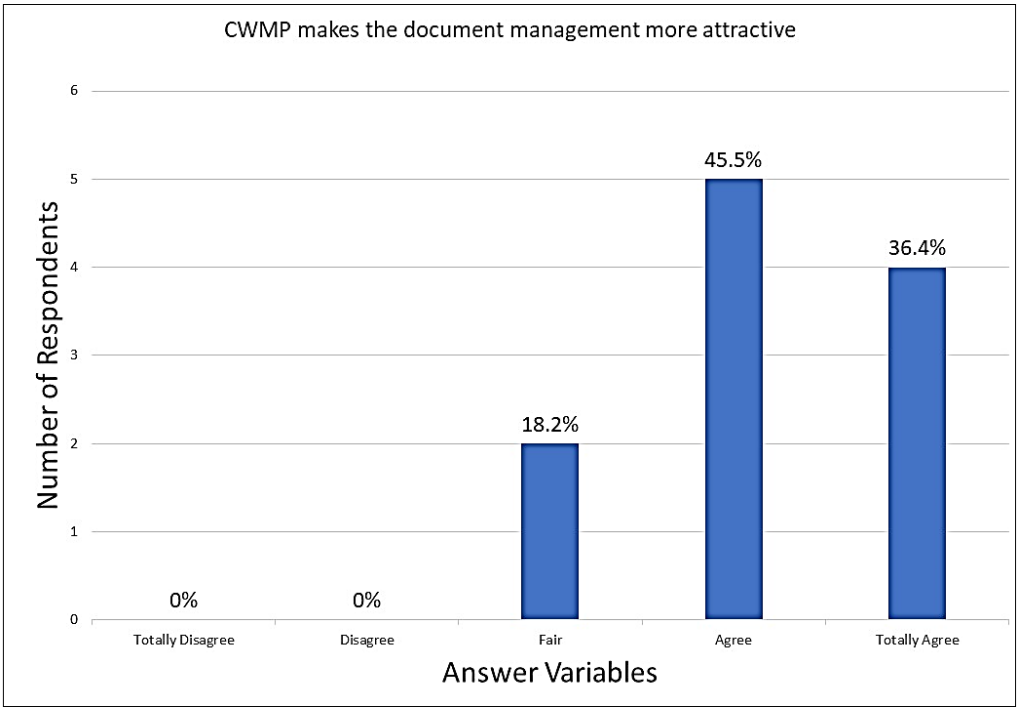


Figure 4.17: CWMP function is attractive.

Figure 4.17 indicates that from 11 respondents, 4 respondents are totally agreeing that the respondents feel that using CWMP is more attractive while 5 respondents agrees to the statement and 2 of the respondents were fairly agrees about the statement. This questionnaire resulted that the mean value is 4.16. and based on table in the appendix shows that the respondents agreed to the statement is 100% agrees as all the results is at scale 3 to 5 and the standard deviation result at 0.75. The percentage of respondent distribution is demonstrated on Figure 4.17.

III.I tend to use CWMP.

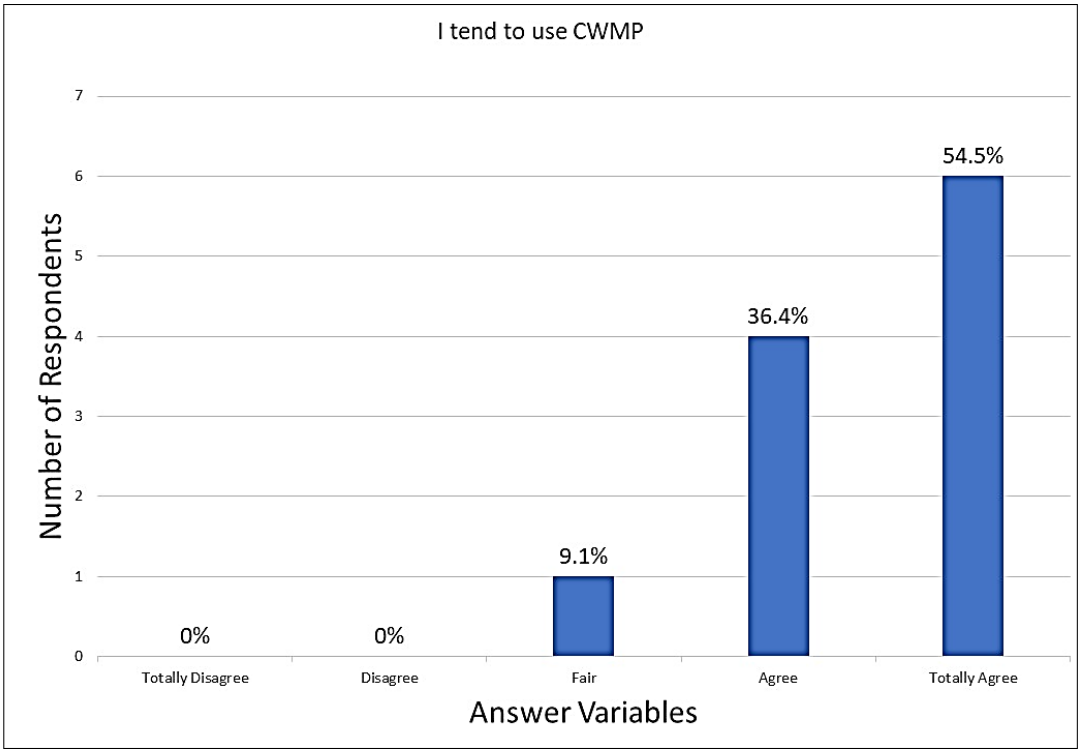


Figure 4.18: The YNJDC LEED team tend to use CWMP.

Figure 4.18 indicates that from 11 respondents, 6 respondents are totally agreeing that the respondents tend to use CWMP, while 4 respondents agrees to the statement and 1 of the respondents were fairly agrees about the statement. This questionnaire resulted that the mean value is 4.45. and based on table in the appendix shows that the respondents agreed to the statement is 100% agrees as all the results is at scale 3 to 5 and the standard deviation result at 0.68. The percentage of respondent distribution is demonstrated on Figure 4.18.

IV. I always delighted to use the CWMP on site.

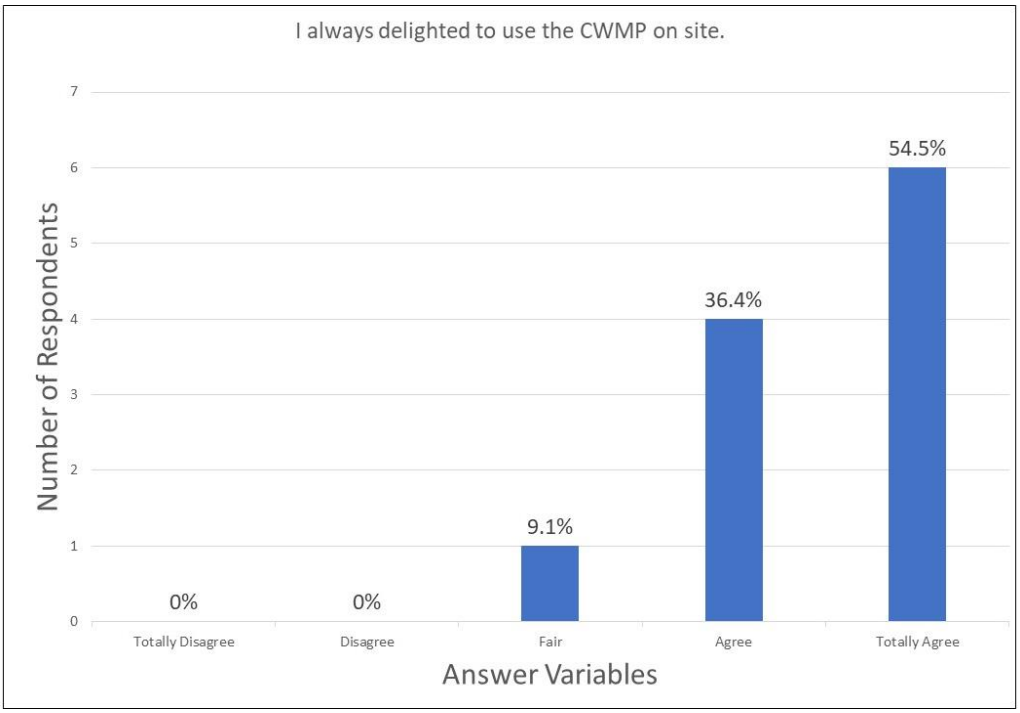


Figure 4.19: The YNJDC LEED team delighted to use CWMP.

Figure 4.19 indicates that from 11 respondents, 6 respondents are totally agreeing that the respondents delighted to use CWMP for matters regarding LEED submission while 4 respondents agrees to the statement and 1 of the respondents were fairly agrees about the statement. This questionnaire resulted that the mean value is 4.45. and based on table in the appendix shows that the respondents agreed to the statement is 100% agrees as all the results is at scale 3 to 5 and the standard deviation result at 0.69. The percentage of respondent distribution is demonstrated on Figure 4.19.

4.4 Conclusion

In conclusion, the user acceptance of a construction waste management platform (CWMP) is a critical factor in its success and effectiveness. The platform's ability to gain widespread acceptance among its intended users, including construction companies, contractors, waste management agencies, and regulatory bodies, is essential for achieving its goals of efficient waste management, sustainability, environmental protection and for YNJDC LEED accreditation goal.

Based on the analysis of user acceptance, it is evident that an effective construction waste management platform should prioritize several key factors. Firstly, it should offer a user-friendly interface that is intuitive and easy to navigate, ensuring that users can quickly understand and utilize the platform's features. Clear instructions, tooltips, and guidance should be provided to enhance user experience and minimize any learning curve associated with the platform.

Secondly, the platform should address the specific needs and challenges faced by its users in managing construction waste. This includes providing comprehensive waste tracking and documentation features, such as waste categorization, estimation, and reporting tools. Seamless integration with existing waste management systems and compatibility with various devices and operating systems can significantly contribute to user acceptance as CWMP were able to be access both smartphones and computers by using web platform as its main page.

Moreover, effective communication and collaboration features within the platform are crucial. Users should be able to easily share information, exchange feedback, and coordinate waste management efforts with other stakeholders involved in the construction process. Real-time updates, notifications, and alerts can enhance transparency, accountability, and overall efficiency in waste management operations as all the information regarding the platform would be directly updated to its own spreadsheet as it main database to retrieve and monitor the check the submission documents.

Additionally, user acceptance can be boosted by providing training and support resources to users, ensuring that they are equipped with the necessary knowledge and skills to effectively utilize the platform. Regular updates during the development of the application, bug fixes regarding user authorization for submission, and feature enhancements based on user feedback can also demonstrate a commitment to continuous improvement and increase user satisfaction.

Furthermore, the platform should emphasize the economic and environmental benefits it offers to its users. Clear demonstrations of cost savings, reduction in waste disposal expenses, and improved environmental performance can be persuasive factors in driving user acceptance and adoption of LEED accreditation method of waste management practices in YNJDC site throughout the construction and accreditation period.

In conclusion, a construction waste management platform's (CWMP) success hinges on its ability to gain user acceptance. As already discussed regarding the data analysis of the questionnaire based on the Technology Acceptance Model (TAM) that user acceptance achieved 100% of result based on each question by prioritizing user-friendly design, addressing specific user needs, enabling effective communication and collaboration, providing training and support, and highlighting economic and environmental benefits, the platform can enhance user acceptance and contribute to more efficient and sustainable construction waste management practices.

CHAPTER 5

CONCLUSION AND RECCOMENDATION

5.1 INTRODUCTION

In this chapter of construction waste management platform report concludes with an overview of the findings and insights gained throughout the study. It also presents recommendations based on the analysis conducted, aiming to guide stakeholders in the effective implementation and utilization of the platform. This section serves as the culmination of the research, providing a concise summary of the key takeaways and proposing actionable steps for further improvement and development.

The construction waste management platform (CWMP) discussed in this report has been examined from various angles, including its features, functionalities, user acceptance, and its alignment with LEED document submissions. Through a comprehensive evaluation, it has become evident that the platform holds great potential in revolutionizing the way construction waste is managed, leading to enhanced sustainability, efficiency, and environmental protection within the construction industry.

This conclusion and recommendations chapter builds upon the previous sections, consolidating the findings and offering valuable insights to stakeholders involved in the implementation and adoption of the construction waste management platform. It aims to provide a clear roadmap for maximizing the platform's benefits and addressing any challenges or limitations identified during the study by harnessing the comments and recommendation section on the questionnaire section as the last chapter of the data analysis process.

The recommendations presented in this chapter take into consideration the perspectives of different stakeholders, including construction companies, waste management agencies, contractors, regulatory bodies, and LEED certification authorities. By addressing the specific needs and concerns of these stakeholders, the recommendations offer practical steps that can be taken to optimize the platform's functionality, user acceptance, and integration with LEED document submissions.

Furthermore, this chapter highlights the importance of ongoing monitoring, evaluation, and improvement of the construction waste management platform. It emphasizes the need for continuous feedback loops and iterative development processes to ensure that the platform remains responsive to changing industry requirements, technological advancements, and evolving environmental standards.

By implementing the recommendations outlined in this chapter, stakeholders can drive the further adoption and success of the construction waste management platform. They can harness its capabilities to effectively track and manage construction waste, streamline the LEED document submission process, and contribute to a more sustainable and environmentally responsible construction industry throughout the construction and accreditation phase on YNJDC site.

In summary, this chapter concludes the report by summarizing the key findings and insights obtained from the study of the construction waste management platform (CWMP). It presents recommendations that stakeholders can utilize to enhance the platform's implementation, user acceptance, and integration with LEED document submissions. By following these recommendations and embracing a continuous improvement mindset, stakeholders can maximize the platform's potential and contribute to a greener and more efficient construction sector for reaching the LEED accreditation score aimed by YNJDC project.

5.2 DISCUSSION.

Numerous initiatives have been taken to address the restrictions at this company. One of them included using the design thinking approach. The researcher advanced through the empathy stage by conducting interviews with experts in the construction sector, including project managers, site engineers, site supervisors, consultants, and LEED coordinators for YNJDC projects. As a result, problems with the compilation and submission of papers were found, and through idea brainstorming, projects were created to fix them. A prototype was created and sent to the construction team for testing before the application was submitted to the corporation for competency testing.\

In Chapter 1, the research outlines its objectives, which includes on identifying the type of construction waste from the YNJDC project, developing a Construction Waste Management Platform (CWMP) that is vary with the LEED accreditation, and test the effectiveness of CWMP for YNJDC project. To address the first objective, data was collected from site observation and evaluation throughout the previous research regarding the type of waste needed to be recorded and segregated. The purpose of this data collection was to gather valid information and understanding the right method to be practices on the YNJDC site regarding the construction waste management for the submission of LEED monthly assessment for the company.

Furthermore, when the problem is spelt out clearly, the innovation is used to demonstrate the research's second goal, which was to develop the Construction Waste Management Platform (CWMP), which can evaluate all the data required for worker induction, project phases, and submission status. The questions were created and disseminated to solicit feedback and ideas for the company's implementation of the CWMP. The results of the analysis show that this system is being used. Digitally is now being used more wisely. Employees may find it challenging to execute their normal activities under the present system. The submission platform and details on YNJDC accreditation may be launched via the website on the platform created.

As results. all respondents agree that they can readily access the submission documents, submit and track their progress, and get information about the site phases and latest progress, location, and submission status. In addition, it is simple to learn because demonstrations were done prior to launching the CWMP for corporate usage, making the material plain and understandable. The CWMP was created to comply with the specifications that could assist in resolving the earlier problem. The data analysis shows that the system is employed to achieve every goal. Additionally, CWMP improves project comprehension and interpersonal communication throughout project presentation, particularly during the design phase, and is available on both iOS and Android devices through QR code scan and also can be accessed by computer.

The user's conduct and acceptance of the CWMP innovation are also being tested as the third objective. The acceptance of CWMP has been evaluated by an expert validation survey. Additionally, a table in the appendix section outlines the five sections of data collection used to assess the acceptability of the hypothesis, which is based on the Technology Acceptance Model (TAM), the findings of which were covered in the research's preceding chapter shows The effectiveness of the product was evaluated using Google Form, analyzed by the Microsoft Excel. The result shows that the respondents satisfied in using CWMP (Mean = 4.49, SD = 0.63) meaning that CWMP was effective in ease the process of submission and documents management.

5.3 COMMENTS AND RECOMMENDATIONS.

As a result of the above findings, some suggestions that suggested to improve the used of CWMP application.. Figure 5.1 below shows comments and recommendation to be improve CWMP :

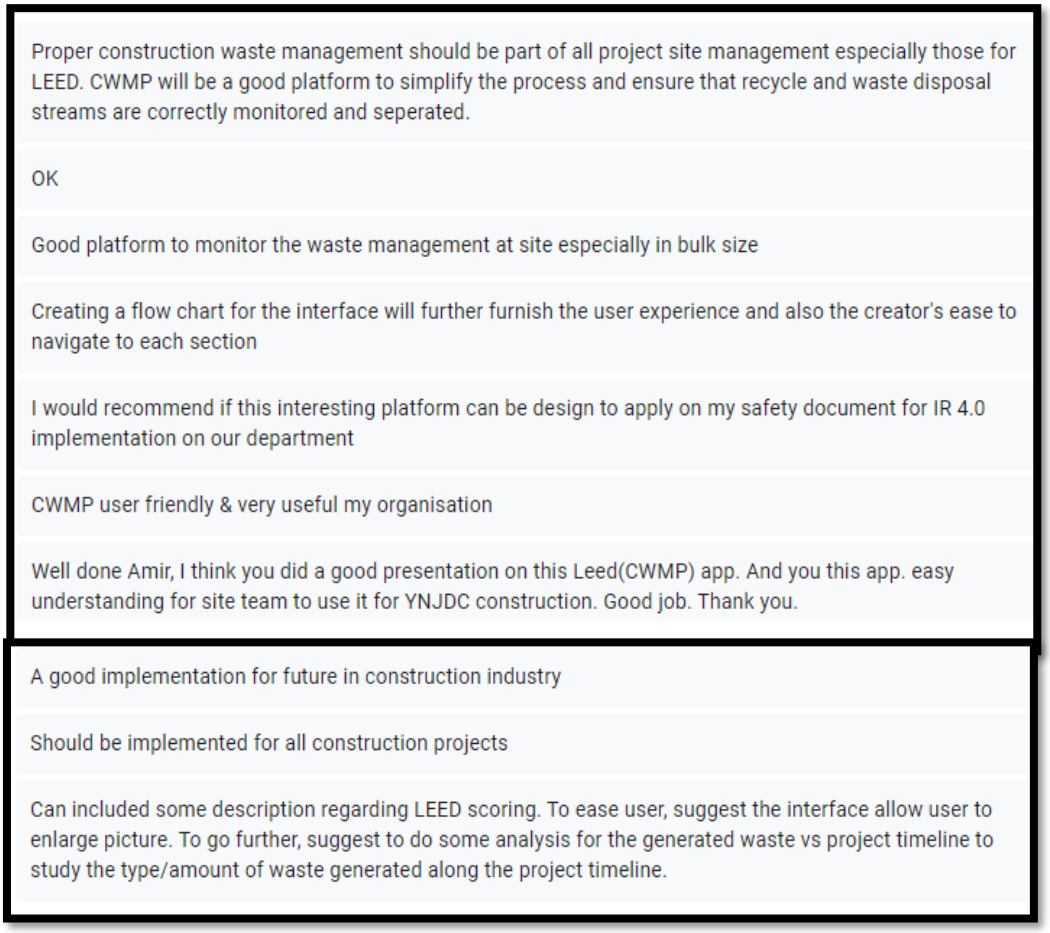


Figure 5.1: Respondent Comments and Recommendations

Based on the recommendation stated above on figure 5.1, the respondents preferred that the application creates or demonstrates the charts for the user interface for better explanation about the destination of each user as the user were divided into two sectors which is the authorized user which has been approved for the submission and the visitor for the application for presentation and safety induction purposes. Moreover, the respondents recommends that the application can include additional description regarding the LEED scoring method guidance and the recommendation will be useful for the development of CWMP. Moreover, future improvements are suggested by the respondent that the picture displayed be able to be enlarge for better view and provides analysis for the generated waste vs project timeline to study the current and remaining amount of waste generated along the project timeline.

5.4 CONCLUSION.

In conclusion, the implementation of a construction waste management platform can greatly facilitate and streamline the process of LEED document submissions related to waste management. The platform's integration with LEED requirements and its ability to effectively track, document, and report construction waste can significantly enhance the efficiency and accuracy of LEED certification processes.

By utilizing a construction waste management platform, project teams can easily capture and record waste generation data throughout the construction lifecycle. This includes information on waste types, quantities, and disposal methods, as well as any recycling or diversion efforts. The platform can automate the collection and organization of this data, ensuring its accuracy and reliability for LEED document submissions.

Moreover, the platform can generate comprehensive reports and documentation that align with LEED's waste management prerequisites and credits. It can provide the necessary information and evidence required for LEED certification, such as waste management plans, waste audit reports, and recycling diversion rates. The platform's ability to generate these reports in a timely and efficient manner can streamline the LEED documentation process, saving time and effort for project teams.

Furthermore, the construction waste management platform can facilitate collaboration and communication among project team members, waste management providers, and other stakeholders involved in the LEED certification process. It can serve as a centralized platform for sharing information, discussing waste management strategies, and coordinating efforts to meet LEED requirements. This collaborative approach can enhance transparency, accountability, and overall effectiveness in achieving LEED waste management goals.

Additionally, the platform can help project teams stay up to date with the latest LEED guidelines and requirements related to waste management. It can provide real-time informations and alerts, ensuring that the team is aware of any changes or updates that may impact their LEED documentation. This proactive approach can help project teams avoid potential errors or omissions in their submissions and maintain compliance with LEED standards.

In conclusion, a construction waste management platform offers significant advantages for LEED document submissions. By automating data collection, generating comprehensive reports, facilitating collaboration, and providing real-time updates, the platform can streamline the LEED certification process and enhance the accuracy and efficiency of waste management documentation. By leveraging such a platform, construction projects can improve their chances of achieving LEED certification and demonstrate their commitment to sustainable waste management practices.

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APPENDIX

APPENDIX A: YTL Construction Sdn Bhd

APPENDIX B: CWMP Application QR code

YTL Construction
YTL GROUP

Ruj. Kami :

Tarikh : 03 June 2023

Kepada pegawai yang berkenaan, Tuan/Puan,

PENGHARGAAN ATAS PENGHASILAN PRODUK INOVASI *"CONSTRUCTION WASTE MANAGEMENT PLATFORM (CWMP)"* UNTUK KEGUNAAN YTL CONSTRUCTION

Dengan segala hormatnya saya merujuk kepada perkara di atas.

2. Sekalung tahniah saya ucapkan kepada tuan/puan kerana dapat mewujudkan produk inovasi ***CONSTRUCTION WASTE MANAGEMENT PLATFORM (CWMP).*** Pihak kami telah mengenalpasti bahawa projek inovasi yang diusahakan oleh tuan/puan mempunyai ciri- ciri inovasi dan berpotensi untuk diaplikasikan di sini.

3. Bersama-sama ini disertakan maklumat produk inovasi yang dihasilkan oleh pensyarah dan pelajar Politeknik Ungku Omar seperti berikut :

Nama produk inovasi	: ***CONSTRUCTION WASTE MANAGEMENT PLATFORM***
Nama pegawai	: PN.Mazziyatol Farizza Binti Mat
Nama pelajar	: Amir Syafiq Bin Abdul Rao

4. Pihak kami berharap, produk inovasi yang dihasilkan ini boleh ditambahbaik berdasarkan nasihat serta pandangan yang telah berikan supaya produk ini berpotensi untuk dikomersialkan.

5. Semoga penglibatan dan usaha murni tuan/puan dalam pembangunan produk inovasi ini dapat diteruskan pada masa hadapan.

Sekian, terima kasih.

Yang benar,

9/6/23

(Bong Pin Chuan)
Construction Manager YNJDC,Kulai,Johor

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Email ctrl@ytl.com.my
Web ytlconstruction.com

APPENDIX C: CWMP Company product certification.

	Gender Type	Age (Years)	Working experience (Years)
	1	1	1
	2	3	3
	1	2	2
	1	1	1
	1	2	2
	1	1	1
	1	2	2
	1	2	2
	1	2	2
	1	3	3
	2	2	3
Mean	1.18	1.91	2.00
Standard Deviation	0.40	0.70	0.77

APPENDIX D: CWMP Demographic section questionnaire data analysis.

	The use of CWMP increases efficiency in managing documents	The use of CWMP increases the fluency of documents submission.	The use of CWMP increases productivity of documents submission and documents tracing.	The LEED information in the CWMP is understandable.	I found that CWMP is very usefull for the project.
	5	5	5	4	5
	5	5	5	5	5
	5	4	4	4	5
	5	5	5	5	5
	4	4	4	4	4
	5	4	4	4	5
	5	5	5	5	5
	5	5	5	5	5
	3	3	4	3	4
	5	5	5	5	5
	4	4	4	3	5
Total	51	49	50	47	53
Mean	4.64	4.45	4.55	4.27	4.82
Standard deviation	0.67	0.69	0.52	0.79	0.40

CWMP Section A questionnaire data analysis.

	I found that it is easy to use the CWMP	CWMP can be use to learn about LEED progress in the project	I found that function CWMP is clear and understandable	I found that it is easy to manage documents using the CWMP
	3	4	4	3
	5	5	5	5
	4	5	4	5
	4	5	5	5
	4	4	4	4
	5	5	4	5
	5	5	5	5
	5	5	5	5
	4	4	3	3
	5	5	5	5
	4	5	4	4
Total	48	52	48	49
Mean	4.36	4.73	4.36	4.45
Standard deviation	0.67	0.47	0.67	0.82

CWMP Section B questionnaire data analysis.

	I wish to manage documents using CWMP	I will always feel comfortable using CWMP for LEED documents submission	I will use CWMP for my work
	4	4	4
	5	5	5
	5	5	4
	5	5	4
	4	4	4
	5	4	5
	5	5	5
	5	5	5
	4	4	5
	5	5	5
	4	4	4
Total	51	50	50
Mean	4.64	4.55	4.55
Standard deviation	0.50	0.52	0.52

CWMP Section C questionnaire data analysis.

	CWMP makes the document management more interesting	CWMP makes the document management more attractive	I tend to use CWMP	I always delighted to use the CWMP on site.
	4	4	4	5
	5	5	5	5
	4	4	4	4
	5	4	5	5
	4	4	4	4
	5	4	5	4
	5	5	5	5
	5	5	5	5
	3	3	3	3
	5	5	5	5
	3	3	4	4
Total	48	46	49	49
Mean	4.36	4.18	4.45	4.45
Standard deviation	0.81	0.75	0.69	0.69

CWMP Section D questionnaire data analysis.

Variables	Mean of variables	Standard Deviation	intrepetation
Perceived ease of use	4.55	0.61	High
Perceived usefulness	4.48	0.66	High
Attitude towards using technology	4.58	0.52	High
behavioral intention to use	4.36	0.73	High
Average	4.49	0.63	

CWMP Sections average results data analysis.

APPENDIX E: CWMP QUESTIONNAIRE

Additional CWMP Form

this questionnaire is created to obtain additional information regarding the first observation survey done regarding the Construction Waste Management

1. Gender Type

   Mark only one oval.

   - ◯ Male
   - ◯ Female

2. Age (Years)

   Mark only one oval.

   - ◯ 20 - 29
   - ◯ 30 - 39
   - ◯ 40 - 49
   - ◯ 50 and above

3. Working experience (Years)

   Mark only one oval.

   - ◯ 3 -5 Years
   - ◯ 5 - 10 Years
   - ◯ 10 - 20 Years
   - ◯ 20 Years and Above

DEPARTMENT OF CIVIL ENGINEERING, POLITEKNIK UNGKU OMAR (PUO), CONSTRUCTION WASTE MANAGEMENT PLATFORM (CWMP)

My name is Amir Syafiq Bin Abdul Rao (01BCT20F3028) from Politeknik Ungku Omar puo) Ipoh, Perak, To complete my final year project for the Bachelor in Civil engineering Technologies with Honours (BCT), as a researcher, a survey will be conducted regarding the construction waste management issues that occur onsite in terms of the Leadership in Energy and Environmental Design accreditation procedure that been applied by the YTL Johor Data Center Project that focused on Site Waste Management. The form of this questionaire is based on the Technology Acceptance Model (TAM) that act as a method of respondent research that is to measure and collect data of perception regarding the issue and solution related to monitor and supervise the documentation submission as well as to introduce to the site about the LEED accreditation system. The question are prepared according to few section A,B,C,D & E.

* Indicates required question

Demographic Questionnaire

1. **NAME** *

2. DESIGNATION *

SECTION A : PERCEIVED EASE OF USE

Persepsi Kemudahan Pengunaan

3. The use of CWMP increases efficiency in managing documents *

Mark only one oval.

- Totally Not Agree
- Not Agree
- Fair
- Agree
- Totally Agree

4. The use of CWMP increases the fluency of documents submission. *

Mark only one oval.

- Totally Not Agree
- Not Agree
- Fair
- Agree
- Totally Agree

5. The use of CWMP increases productivity of documents submission and documents tracing. *

Mark only one oval.

- Totally Not Agree
- Not Agree
- Fair
- Agree
- Totally Agree

6. The LEED information in the CWMP is understandable. *

Mark only one oval.

- Totally Not Agree
- Not Agree
- Fair
- Agree
- Totally Agree

7. I found that CWMP is very usefull for the project. *

Mark only one oval.

- Totally Not Agree
- Not Agree
- Fair
- Agree
- Totally Agree

SECTION B : PERCEIVED USEFULNESS

Persepsi Kegunaan

8. I found that it is easy to use the CWMP *

Mark only one oval.

- ◯ Totally Not Agree
- ◯ Not Agree
- ◯ Fair
- ◯ Agree
- ◯ Totally Agree

9. CWMP can be use to learn about LEED progress in the project *

Mark only one oval.

- ◯ Totally Not Agree
- ◯ Not Agree
- ◯ Fair
- ◯ Agree
- ◯ Totally Agree

10. I found that function CWMP is clear and understandable *

Mark only one oval.

- ◯ Totally Not Agree
- ◯ Not Agree
- ◯ Fair
- ◯ Agree
- ◯ Totally Agree

11. I found that it is easy to manage documents using the CWMP *

Mark only one oval.

- Totally Not Agree
- Not Agree
- Fair
- Agree
- Totally Agree

SECTION C: ATTITUDE TOWARDS USING TECHNOLOGY

sikap menggunakan teknologi

12. I wish to manage documents using CWMP *

Mark only one oval.

- Totally Not Agree
- Not Agree
- Fair
- Agree
- Totally Agree

13. I will always feel comfortable using CWMP for LEED documents submission *

Mark only one oval.

- Totally Not Agree
- Not Agree
- Fair
- Agree
- Totally Agree

14. I will use CWMP for my work *

Mark only one oval.

- Totally Not Agree
- Not Agree
- Fair
- Agree
- Totally Agree

SECTION D: BEHAVIOURAL INTENTION TO USE

Niat Perilaku Untuk Menggunakan

15. CWMP makes the document management more interesting *

Mark only one oval.

- Totally Not Agree
- Not Agree
- Fair
- Agree
- Totally Agree

16. CWMP makes the document management more attractive *

Mark only one oval.

- Totally Not Agree
- Not Agree
- Fair
- Agree
- Totally Agree

17. I tend to use CWMP *

Mark only one oval.

- ◯ Totally Not Agree
- ◯ Not Agree
- ◯ Fair
- ◯ Agree
- ◯ Totally Agree

18. I always delighted to use the CWMP on site. *

Mark only one oval.

- ◯ Totally Not Agree
- ◯ Not Agree
- ◯ Fair
- ◯ Agree
- ◯ Totally Agree

SECTION E: COMMENTS AND RECOMMENDATIONS

19. Please write your suggestion *