CHALLENGES TO ADOPT CIRCULAR ECONOMY IN THE MALAYSIAN CONSTRUCTION INDUSTRY

ASMA'U ABDULWAHAB MUHAMMAD

FACULTY OF BUILT ENVIRONMENT

UNIVERSITY OF MALAYA

KUALA LUMPUR

2022

CHALLENGES TO ADOPT CIRCULAR ECONOMY IN THE MALAYSIAN CONSTRUCTION INDUSTRY

ASMA'U ABDULWAHAB MUHAMMAD

RESEARCH PROJECT SUBMITTED TO THE FACULTY OF BUILT ENVIRONMENT

UNIVERSITY OF MALAYA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PROJECT MANAGEMENT

FACULTY OF BUILT ENVIRONMENT

UNIVERSITY OF MALAYA

KUALA LUMPUR

2022

UNIVERSITY OF MALAYA

ORIGINAL LITERARY WORK DECLARATION

Name of Candidate: Asma'u Abdulwahab Muhammad

Matric No: BQB190015 17201123/1

Name of Degree: Master of Project Management

Title of Project Paper/Research Report/Dissertation/Thesis ("this Work"): Refer Guidelines for preparing Research Project, Dissertation and Thesis

Field of Study: Project Management

I do solemnly and sincerely declare that:

1) I am the sole author/writer of this work.
2) This Work is original.
3) Any use of any work in which copyright exists was done through fair dealing and for permitted purposes and any excerpt or extract from, or reference to or reproduction of any copyright work has been disclosed expressly and sufficiently and the title of the Work and its authorship have been acknowledged in this Work.
4) I do not have any actual knowledge, nor do I ought reasonably to know that the making of this work makes up an infringement of any copyright work;
5) I assign all and every right in the copyright to this Work to the University of Malaya (”UM”), who henceforth shall be owner of the copyright in this Work and that any reproduction or use in any form or by any means is prohibited without the written consent of UM having been first had and got.
6) I know fully that if in making this work; I have infringed any copyright whether intentionally or otherwise, I may be subject to legal action, or any other action as determined by UM.

Candidate’s Signature Date:

Subscribed and solemnly declared before,

Witness’s Signature Date:

Name:

Designation:

CHALLENGES TO ADOPT CIRCULAR ECONOMY IN THE MALAYSIAN CONSTRUCTION INDUSTRY

ABSTRACT

Circular Economy (CE) has developed as a result of increasing environmental consciousness, environmental legislation, and the need for social responsibility. In Malaysia, however, an unclear financial case were also deemed the most significant economic challenges. Another significant challenge was the construction industry's structure, which was seen as having a fragmented supply chain and a general lack of interest, awareness, and knowledge. The practises are further behind than they should be due to a dearth of research on the subject. This study aims to investigate the current awareness levels and CE-related practises in the Malaysian construction industry. The study employs a quantitative survey questionnaire and a convenience sample technique. Through the FAME database, personal contacts, and LinkedIn, 100 individuals from various aspects of the construction industry were contacted directly over the course of 40 days. There were 71 completed responses to the survey. Given the exploratory nature of the study, descriptive statistics were primarily used to analyse the data. A correlation, ANOVA, and descriptive analysis were also conducted to validate the aim. The research findings indicate that as governing bodies around the world place a greater emphasis on corporate social responsibility, organizations are becoming more aware of CE practises. The analysis also reveals some valuable CE insights. Furthermore, our findings indicate that the factors of CE are to develop strategies to eliminate the perceived risk of

contamination. In addition, and given their lack of shift, industries should develop educational and awareness campaigns to assist workers in overcoming their negative perceptions of circular economy.

CABARAN UNTUK MENGGUNA PAKAI EKONOMI PEKELILING DALAM INDUSTRI PEMBINAAN MALAYSIA

ABSTRAK

Ekonomi Pekeliling (CE) telah berkembang hasil daripada peningkatan kesedaran alam sekitar, perundangan alam sekitar, dan keperluan untuk tanggungjawab sosial. Di Malaysia, kes kewangan juga dianggap sebagai cabaran ekonomi yang paling ketara. Satu lagi cabaran penting ialah struktur industri pembinaan, yang dilihat mempunyai rantaian bekalan yang tidak selari dan kekurangan minat dalam masyarakat, kesedaran serta pengetahuan umum. Praktikalnya juga jauh ketinggalan daripada yang sepatutnya kerana kekurangan penyelidikan mengenai subjek tersebut. Kajian ini bertujuan untuk menyiasat tahap kesedaran semasa dan amalan berkaitan CE dalam industri pembinaan Malaysia. Kajian ini menggunakan soal selidik tinjauan kuantitatif dan teknik sampel mudah.Melalui pangkalan data FAME, kenalan peribadi, dan LinkedIn, 100 individu daripada pelbagai aspek industri pembinaan telah dihubungi secara langsung dalam tempoh 40 hari. Terdapat 71 jawapan yang lengkap untuk tinjauan itu. Berdasarkan sifat penerokaan kajian, statistik deskriptif digunakan terutamanya untuk menganalisis data. Satu korelasi, ANOVA, dan analisis deskriptif juga telah dijalankan untuk mengesahkan matlamat.Penemuan penyelidikan menunjukkan bahawa apabila badan pentadbir di seluruh dunia memberi penekanan yang lebih besar kepada tanggungjawab sosial korporat, organisasi menjadi lebih sedar tentang amalan CE. Analisis juga mendedahkan beberapa cerapan CE yang berharga. Tambahan pula,

penemuan kami menunjukkan bahawa faktor CE adalah untuk membangunkan strategi untuk menghapuskan risiko pencemaran. Di samping itu, berdasarkan peralihan semasa, industri harus membangunkan kempen pendidikan dan kesedaran untuk membantu pekerja mengatasi persepsi negatif mereka terhadap ekonomi pekeliling

ACKNOWLEDGEMENT

I want to thank my supervisor, SR DR. KHO MEI YE for her supervision and guidance in creating this work. Would also like to acknowledge the Faculty of Built Environment and University of Malaya for this opportunity to conduct this research. Lastly, I would like to express gratitude to my family and friends for their constant support throughout this period of this paper completion.

ABSTRACT iv

ABSTRAK vi

ACKNOWLEDGEMENT viii

LIST OF FIGURES xiv

LIST OF TABLES xv

LIST OF ABBREVIATIONS xvi

LIST OF APPENDIXES xvii

CHAPTER 1: INTRODUCTION 1

1.1 Introduction 1

1.2 Research Background 3

1.3 Problem Statement 5

1.4 Research Aims 7

1.5 Research Question 7

1.6 Research Objectives 7

1.7 Research method 7

1.8 Significant of the Research 9

1.9 Scope and Limitation of the Research 10

1.10 Organisation of the Research 11

CHAPTER 2: LITERATURE REVIEW 13

2.1 Introduction 13

2.2 Circular Economy 18

2.3 Concept of Circular Economy 25

2.4 Circular supply chain VS Linear supply chain 28

2.5 Transition Towards Circular Economy 32

2.6 Circular Economy Strategies 34

2.7 Strategies toward CE in Malaysia 35

2.7.1 Governmental Policy and Initiative 35

2.8 Barriers, Challenges, and enablers in Circular Economy 37

2.9 Summary 43

CHAPTER 3: RESEARCH METHODOLOGY 45

3.1 Introduction 45

3.2 Research design 46

3.3 Data Collection 48

3.3.1 LiteratureReview 50

3.3.2 Questionnaire 50

3.3.3 Sampling Method 53

3.4 DataAnalysis 55

3.4.1 Method of Analysis 57

3.5 Summary 57

CHAPTER 4: DATA COLLECTION AND ANALYSIS 58

4.1 Introduction 58

4.2 Mode of Data Collection 58

4.3 Data Screening 59

4.4 Questionnaires Response Rate 59

4.5 Reliability Test 60

4.6 Section A: Demographics 80

4.6.1 Job Position and Working Experience 80

4.6.2 Qualifications 82

4.6.3 Field of Profession 83

4.6.4 Level of Understanding 84

4.7 Section B: Organization Information on Awareness and Perceptions of Circular Economy. 86

4.7.1 How important is adopting circular economy principles. 86

4.7.2 The Components from The Circular Economy Generate in Respondent Organization. 88

4.8 Section C: Barriers & Challenges of the Adoption and Implementation of Strategy 89

4.8.1 The External Circular Economy Barriers and Challenges 89

4.8.2 The Internal Circular Economy Barriers and Challenges..... 91

4.8.3 Strong Motivators to Transition to a More Circular Economy Approach. 93

4.8.4 Which of this implementation strategy will improve your organization 95

4.8.5 Other 'possible strategy' to improve the implementation of circular economy 96

CHAPTER 5: DISCUSSION 98

5.1 Introduction 98

5.2 Demographic 98

5.3 Organization Information on Awareness and Perceptions of Circular Economy..... 99

5.4 Barriers & Challenges of the Adoption Circular Economy 100

5.5 Implementation of Strategy 101

CHAPTER 6: CONCLUSION 103

6.1 Summary of Study..... 103

6.2 Review on Research Aim, Objective, Methodology, and Questions 103

6.3 Summary of Findings 106

6.4 Research contribution..... 106

6.5 Research Limitation 107

6.6 Future Recommendation 108

APPENDIX A 110

REFERENCES 122

LIST OF FIGURES

Figure 1-1 Organisation Of Research 11

Figure 2-1 Cep Across Different Stages In The Construction Supply Chain (Adopted From Benachio Et Al., 2020) 16

Figure 2-2 Graphical Description Of Circular Economy, Source: Ellen Macarthur Foundation (2015) 22

Figure 2-3 Linear Vs. Circular Supply Chain, Source: (Robinson, 2016) 30

Figure 3-1 Advantages Of Convenience Sample 54

Figure 3-2 Method Of Convenience Sample 55

Figure 4-1 Represent The Qualifications Of Respondents 82

Figure 4-2 Represent The Level Of Respondent Professions 84

Figure 4-3 Anova Graph Of Respondent Level Of Understanding 85

Figure 4-4 Showing The Graphical Illustration 89

Figure 4-5 Implementation Strategy 96

LIST OF TABLES

Table 2-1 Strategies Toward Ce In Malaysia 36

Table 3-1 Represent The Reliability Test 56

Table 4-1 Represents The Rate Of Respondents 60

Table 4-2 Reliability Statistics 61

Table 4-3 Reliability Statistics By Item 61

Table 4-4 Years Of Experience 81

Table 4-5 Cumulative % Of Qualifications 82

Table 4-6 Shows The % Of Respondent Professions 83

Table 4-7 Respondent Correlation Level Of Understanding 85

Table 4-8 Result Analysis On Organization Awareness And Perspectives 87

Table 4-9 Components From The Circular Economy 89

Table 4-10 External Barriers & Challenges 91

Table 4-11 Internal Barriers And Challenges 92

Table 4-12 Strong Motivators To Transition 94

Table 4-13 Implementation Strategy 96

LIST OF ABBREVIATIONS

CE – Circular Economy

CI – Construction Industry

LIST OF APPENDIXES

APPENDIX A: Survey questionnaire

CHAPTER 1: INTRODUCTION

1.1 Introduction

Even though the construction industry is one of the largest and longest-running industries and also a major consumer of natural resources (Rahla, Mateus, & Bragança, 2021). It identifies and acknowledges the need to profoundly develop the components, processes and systematic ways to mitigate waste and increase efficiency (Kyrö, 2020). Economic growth has redoubled hugely during the last century because of the commercial and technological development inflicting increased world trade. The speed of worldwide consumption magnitude relation has increased eight times over the last decades, and it's expected that the resource use globally would increase 3 times additional till 2050 Economic growth has redoubled hugely during the last century (Hickel & Kallis, 2020). The result of growth in population and a rise within the consumption of material usage raises challenges to the environment, conjointly the} overall society, together with the inadequacy of resources. inadequacy does not simply refer to the shortage of resources, however, it also affects geopolitical, economic and ecological development(Temjanovski, Bezovski, Arsova, & Sofijanova, 2021).

The recent model of resource consumption, referred to as the linear model, follow the philosophy of take-make-consume-dispose. This model isn't property because it uses scarce resources, and it contributes to pollution of the environment. The cities are generating 1.3 billion a lot of waste every year and it'll surge to 2.2 billion tonnes by 2025(Temjanovski et al., 2021). Waste and trash hurt the whole planet,

oceans are accumulated with plastics, marine life is endangered, kingdom and life are littered with too several pollutants, persistent chemicals are inflicting varied diseases, depletion of the gas layer, heating and lowland etc. have involved the humans to require serious action against waste (Nordhaus, 2021). Handling these issues, a brand-new model is getting attention worldwide known as the Circular Economy (CE). The Circular Economy model relies on the thought of fixing the take-make-use-dispose pattern into closed-loops of fabric flows.

Closed loops of materials are doable through completely divergent functions, as i.e., maintenance, repair, reusing, refurbishing, re-manufacturing, and recycling. It essentially creates the action result between the economic development and, therefore the setting (Chang & Hsieh, 2019; Lahane, Prajapati, & Kant, 2021). Supply chains are thought to be a crucial issue for implementing the circular economy model owing to the necessity for a joint effort of suppliers and manufacturers. The cooperation and coordination between offer chain upstream and downstream are partners are essential as upstream partners get eco-friendly inputs and with downstream partners to collaborate for environmental management practices comparable to product return, utilise and recycle (Barford, Ahmad, & Sustainability, 2021; Jæger, Halse, Naz, & Rahim, 2019).

However, circular economy, to an increasing extent, is becoming notable. Countries like Malaysia, China, Germany, UK (United Kingdom), have used terms within their rules, although emphasis might vary. (Benton, Coats, & Hazell, 2015). The transition to the circular economy is not as easy as it appears from several studies

which have highlighted many obstacles and difficulties. Because of these obstacles, companies are slow to switch to the circular economy (Kirchherr et al., 2018) Some of these obstacles are the complexity of supply chains, high start-up costs, the lack of availability of development models for the circular economy and the risks of trade cooperation (Charef & Emmitt, 2021).

1.2 Research Background

Circular economy

Circular economy - this concept often goes hand in hand with resource efficiency, i.e. reducing waste and pollution to zero or negligible levels by reducing the waste that needs to be processed through increased recycling and better management (Rahla et al., 2021). It is based on the principles of the circular economy - a radically different approach to economic development that avoids waste and pollution, keeps products and materials in use, and regenerates natural systems (Gravagnuolo, Angrisano, & Fusco Girard, 2019). It requires a move away from the established cycle of manufacturing products that are used and discarded to a manufacturing technique that achieves maximum value from resources for as long as possible. Therefore, a circular economy system must improve the productivity of tools, reduce waste and pollutants, and address the problems of scarcity and volatility.(Winning, Calzadilla, Bleischwitz, & Nechifor, 2017).

With the existence of the concept of the circular economy (CE), professionals, academics and policymakers have explored the case at hand as an appropriate response to the resource-intensive sector (Massaro et al., 2021). Circular economy

has drawn the attention of political and commercial hobby as a more relatable, easier functional way and less difficult manner to exercise sustainability with the aid of representing a manner to conquer the contradiction among financial increase and environmental sustainability by transferring from the contemporary linear commercial enterprise model (take, make, use and dispose) to a round commercial enterprise model (reduce, reuse, recycle and recover) (Akanbi et al., 2018; Kylili, Fokaides, & Society, 2017). Implementing the circular economy model moves from a linear business model, where products are made from raw materials and discarded at the end of their useful life, to a circular economy model, where smart design leads to products or their parts being repaired, reused, returned and recycled (Kapoor, Jauhari, & Maheshwari, 2021).

Various definitions of the circular economic system had been developed, within large part comparable ideas derived from some of the frequently interlinked schools of thought (Massaro et al., 2021). Common factors include removing the concept of waste and maximising the value of materials. CE can, for that reason, offer an economic incentive to paintings toward sustainable goals. By purpose and design, CE can manipulate resources in a manner this is regenerative and restorative and does now no longer use up those with the aid of using retaining substances at their maximum application and value times, distinguishing among technical and organic cycles, supplying extra-economic balance through aid security(Lei, Li, Yang, Bian, & Li, 2021).

The construction industry, however, struggles to successfully and practically embrace CE practices which are efficaciously being applied in lots of different industries sectors (Guerra, Leite, & Recycling, 2021; Wijewickrama, Rameezdeen, & Chileshe, 2021). Several extraordinary standard CE frameworks have to this point been suggested, however, CE is tremendously new in its conceptualisation and implementation in the constructed industry, just a few frameworks had been detailed regarding the complicated problems of the construction industry (Corvellec, Stowell, & Johansson, 2021).

1.3 Problem Statement

One of the country's major construction players, the Construction Industry Development Board (CIDB), has emphasised the need to strengthen the awareness, knowledge of circular economy understanding in the construction industry (Agamuthu & Mehran, 2020). However, issues in providing stable development for the construction industry in circular economy, as well as a desire to create a healthy working system, have become major roadblocks, particularly in emerging nations such as Malaysia (Wijewickrama, Chileshe, Rameezdeen, & Ochoa, 2021). Much of the current thinking on circular economy has been on short- and medium-lived consumer products (Lahti, Wincent, & Parida, 2018).However, several barriers and challenges were identified as a general specification, these were: (1) user's behaviour, (2) regulatory, (3) infrastructure, (4) economy and competitive markets, and (5) supply chain. An emphasis was made on the classifications that the identified barriers and challenges have been partially identified by different authors (Cantú, Aguiñaga, & Scheel, 2021), for example (Shahbazi, Wiktorsson,

Kurdve, Jönsson, & Bjelkemyr, 2016; Sousa-Zomer, Magalhães, Zancul, Cauchick-Miguel, & Recycling, 2018; Vermunt, Negro, Verweij, Kuppens, & Hekkert, 2019). Whereas some authors identified economic barriers and organizational barriers (Shahbazi et al., 2016). Furthermore, there have been four major barriers and challenges. These were: (1) knowledge, (2) financial, (3) organisational, and (4) product and material characteristics—the latter class was supported by (Bressanelli, Adrodegari, Perona, & Saccani, 2018).

Additionally, the outbreak of the COVID-19 pandemic has transformed the lifestyle and economic activities of several countries around the world, including Malaysia (Mutuku, Hou, Chen, & Research, 2020). According to (Adams, Osmani, Thorpe, & Thornback, 2017) one of the biggest challenges, rated highly by most stakeholders, is the lack of incentives to design construction products after products after Lacy's and Rutqvist's definitions follow in the following places. their life issues. Several economic challenges were also identified as the most important, including the lack of market mechanisms to support further recovery(Adams et al., 2017). The structure of the construction sector was also seen as a significant challenge, with a fragmented supply chain and a general lack of interest, awareness, and understanding. The lack of attention for end-of-life issues at the building level, as well as the complexity of buildings, were deemed to be important challenges(Adams et al., 2017). This was like the difficulties stated in the previous paragraph, with financial, structural, and knowledge issues all being relevant.

1.4 Research Aims

This project aims to investigate the circular economy implementation in the Malaysian construction industry.

1.5 Research Question

To achieve the research aim, a research question is raised to help the research break down the broad research objective into achievable goals.

1. What are the understanding of circular economy in Malaysia construction industry?
2. What are the post articular in circular economy?
3. How to recommend the strategies for improving the adoption of circular economy?

1.6 Research Objectives

1. To identify the understanding of circular economy in Malaysia construction industry.
2. To determine the challenges in circular economy.
3. To recommend strategies for improving the adoption of circular economy in the Malaysian construction industry.

1.7 Research method

According to (Fellows & Liu, 2021) To solve the research problem or answer the research questions, the researcher must choose a methodological approach. In order

to collect and observe data, a study must have a detailed research design. (Yin, 2009) stated that: It would be beneficial to involve a thorough and exhaustive literature analysis to determine the factors that contribute to the challenges, their impact and consequences, and methods for controlling and minimising. The goal of this research is to establish a research design to examine the current development, barriers, and future potential of CE in Malaysian construction. The research findings are discussed and compared with the present literature in order to provide more insights on the present progress of CE in construction globally.

According to (Fellows & Liu, 2021; Yin, 2009) Structure and function of major parts of research project are shown in the research design, which explains how each part contributes to the research question. According to the proposed research design, the first phase in this study was to do an in-depth and comprehensive literature analysis to determine the elements that generate the issues, their impact, and repercussions, and how to regulate and minimise them. Electronic journal articles, conferences, and dissertations, as well as recommendations from the research supervisor, are among the sources for the literature review.

The next phase in this investigation was to gather enough data in order to verify the findings. This study's methodology is based on quantitative methods. Based on a careful study of the literature on this topic, a questionnaire survey was created. The questionnaire surveys were then circulated to Malaysian construction industry. The targeted respondents where persons who work in registered architectural firms, consulting firms, and government organisations in Malaysia were invited to

participate in the questionnaire survey. The data was then analysed to obtain accurate information on the issues of circular economy in Malaysia's construction industry. Finally, the findings of the circular economy research in the Malaysian construction industry led to conclusions and recommendations.

1.8 Significant of the Research

As technology and facilities advance, the world becomes more polluted. As the world's population grows and the number of industries grows exponentially. Circular economy is now a hot topic in developing countries like Malaysia, as well as in many governments and businesses around the globe. The primary goal of the circular economy model is to ensure that no resources are thrown away. The environment and the world will be cleaner and safer for humans if everything that has been used is recycled. Using a new concept, the research aims to identify and address barriers to circular economy and the ways in which these barriers can be eliminated in Malaysia construction industry. For this reason, it is important to learn about the circular economy, its enablers, and guidelines, as well as how to overcome the construction industry's barriers to the circular economy.

This study would help the construction industry to realize why the challenge of identification is important and how it can help the industry implement more transparent, improve and ease recycling. This study will help the construction industry understand why identifying challenges is important and how it can help the industry implement more transparent, improve, and another purpose of this

study is to find solutions to overcome these barriers ease recycling in a more efficient manner.

However, circular building design and construction, as well as increased recyclability and reusability, are critical in the construction industry. Between 2016 and 2025, in Europe, €107 billion will be needed to transform the current system into a circular one. As a result, by 2030, the sector is expected to reap €150 billion in financial benefits (De Jesus, Antunes, Santos, & Mendonça, 2019).

1.9 Scope and Limitation of the Research

The scope of this study will be limited to construction industry, which uses the circular economy as a primary component in its projects. At the product and component level, there is little research and widespread implementation of the circular economy in Malaysia. Research to date has focused primarily on construction and demolition waste (CDW) recycling, which has resulted in a decrease in the amount of materials reclaimed for reuse in the Malaysia (Kabirifar, Mojtahedi, Wang, & Tam, 2020; Yuan, Wang, Shi, Hao, & Management, 2021). Even though more research is needed, especially in the design stages, CDW prevention is increasingly being considered. There is a lack of research into the various aspects of material efficiency in construction, such as the design for deconstruction (DfD) and achieving the same levels of performance with less material input (Yuan et al., 2021). Buildings can be reused numerous times, despite the fact that this is not always the intention when they are constructed(Hossain, Ng, Antwi-Afari, Amor, & Reviews, 2020; Yuan et al., 2021). The aim of this paper is

to examine the level of circular economy awareness, challenges and enablers for greater adoption within the Malaysia construction sector.

1.10 Organisation of the Research

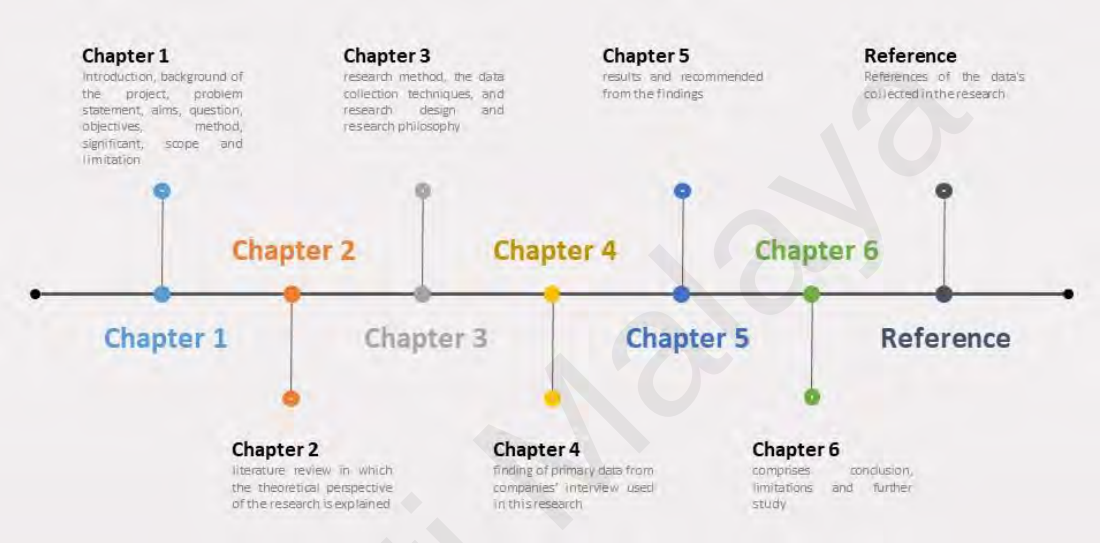


Figure 0-1 Organisation of Research

Figure 1.1 shows the organisation of the study that is divided into six chapters. The first chapter is an introduction in which the background of the study, problems, research questions aims, objectives, method, significant, scope and limitation and organisation of the study are included. The second chapter is about the literature review in which the theoretical perspective of the research is explained. The third chapter is regarding the research method, the data collection techniques, and research design and research philosophy. The fourth chapter is about finding of primary data from companies' interview used in this research. The fifth chapter is about results and recommended model. The sixth, which is the last chapter

comprises conclusion, limitations and further study and seventh chapter has references.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter will discuss the overview of the circular economy in Malaysia construction industry. The barriers and challenges, concept, and strategies of CE in Malaysia construction industry.

The primary objective of this research is to make a projection on the level of manpower awareness of circular economy in the construction sector, which if improved, could lead to an increase in the participation of labour in keeping with the expansion of the construction sector in Malaysia. After all, manpower awareness can be defined as the effort put forth to prepare an adequate quantity of workers who possess the necessary qualifications to carry out the designated tasks at the appropriate time and location (Ismail, Saukami, & Sulaiman, 2015).

Despite this, the construction sector is widely recognised as being one of the most important economic drivers in any given nation. Al Ehmad and Rahman (2017) have recently shown interest in studying the challenges faced in the construction sector in Saudi Arabia. They claim that the growth of the construction sector in the country is robust as Saudi Arabia is one of the fastest-growing countries among Middle Eastern countries in terms of the construction sector. Recently, Al Ehmad and Rahman (2017) have shown interest in studying the challenges faced in the construction sector in Saudi Arabia.

In comparison to more developed countries like Australia, Singapore, and the United Kingdom, the CE implementation in Malaysia is still in its infant stages (Altaf et al., 2022) the idea is gaining traction as a result of an increase in the awareness that businesses have regarding environmentally friendly practises (Osobajo, Oke, Omotayo, Obi, & Environment, 2020). Identified the qualities of a construction system that incorporates CE as well as the difficulties involved in applying CE in the Malaysian construction industry. The findings showed that the majority of project owners are either ignorant of CE or do not incorporate its principles into their management strategies. In addition, the majority of stakeholders, including the government, are unaware of the long-term benefits that would result from a properly implemented CE programme. An investigation was carried out by Fathoni et al. in Malaysia, a country where CE was regarded as a useful instrument.

The use of practises, in all stages of the life cycle of a building, to keep the materials as long as possible in a closed-loop, to reduce the use of new natural resources in a construction project, is the definition of the circular economy(CE) in the construction industry (CI) (Benachio, Freitas, & Tavares, 2020). According to this definition, there are two aspects that should be taken into consideration when framing the research from a CE perspective. These aspects include the stages of a construction project's life cycle and the Circular Economy Practices (CEP) that are implemented throughout these stages.

There are five stages in the building life cycle: the project design stage, manufacturing stage, construction stage, operations stage, and end of life stage (Benachio et al., 2020). However, the majority of earlier studies on the CE in the CI were centred on the EoL stage in their conceptualizations. According to (Nasir, Genovese, Acquaye, Koh, & Yamoah, 2017), the circular economy practice (CEP) is significantly attainable by implementing reverse logistics (RL), which makes it possible for salvageable materials at the end of life of a structure to re-enter the supply chain as output products of reusing, recycling, and remanufacturing. This reduces the amount of waste that is sent to landfills.

As can be seen in Figure, the construction industry (CI) is home to a substantial amount of circular economy practice (CEP). Despite the fact that each of these practises can be distinguished between different stages of the life cycle, this differentiation is not absolute (Benachio et al., 2020). The authors went on to explain that the majority of practises could be implemented during a variety of stages of the life cycle. Nevertheless, they are presented here in the stage of development (see Fig.). These practises are the actionable steps that a company ought to take in order to implement CE in their projects, they might be able to contribute to the development of CE in the CI.

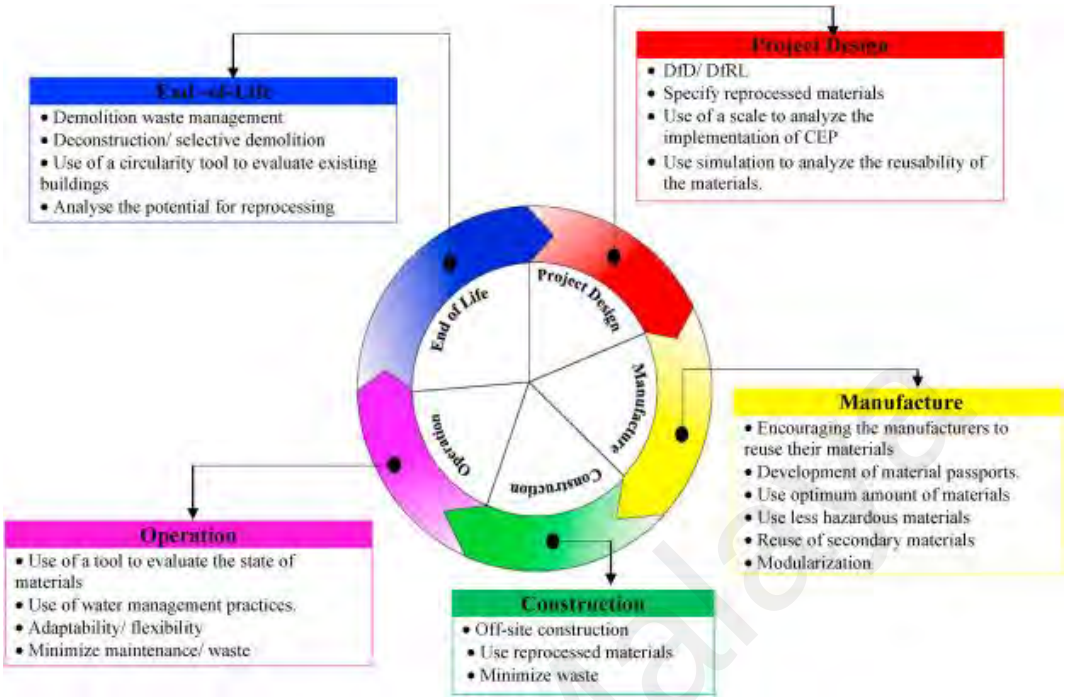


Figure 0-1 CEP across different stages in the construction supply chain (Adopted from Benachio et al., 2020)

The act of erecting a structure or putting in place an infrastructure is referred to as construction. Construction is distinct from manufacturing in that the latter typically involves the mass production of identical items without a designated purchaser, whereas construction typically takes place on-site for a client who is already known. According to Chitkara (1998), the construction industry accounts for six to nine percent of the gross domestic product in developed countries. [Citation needed] A construction project will typically begin with planning, design, and financing; it will continue until a structure, whether it be a building or something else, has been constructed and is ready for use (Halpin et al., 2017). However, in point of fact, the project continues to "live" for a good number of years and is only brought to a close when the structure is either substantially rebuilt or destroyed. One of the most significant contributors of waste to the environment is the construction industry. It

would appear that the Circular Economy could be a useful solution to the problem of reducing the negative impact that industry has on the environment. In point of fact, the construction sector was accountable for almost 30 percentage points of the total embodied energy consumption (Hong et al., 2016).

The making of decisions pertaining to the Circular Economy can take place on three different levels: the operational level, which is connected with specific parts of the production process; the tactical level, which is connected with entire processes; and the strategic level, which is connected with the entire organisation. It is possible that construction companies as well as construction projects in which a construction company is one of the stakeholders are affected by this issue.

It is possible to use pointed walnut husks as an example of a good case that fits the concept of circular economy in the construction sector on the operational level. These husks belong to the category of hard, light, and natural abrasives and are used for a variety of purposes, such as cleaning brick surfaces. Grains used in abrasive products that are produced by crushing, cleaning, and selecting walnut shells. They were considered to be abrasives that could be reused. A preliminary attempt by the international research team comprised of Pedro Nuez-Cacho, Jaroslaw Górecki, Valentn Molina-Moreno, and Francisco Corpas-Iglesias to develop a comprehensive measurement for the implementation of the circular economy in a construction company. The findings of the research were presented in a paper that was published in the year 2018 in the journal Sustainability (Nuez-Cacho et al., 2018).

The purpose of a transition in the construction industry toward the Circular Economy is to preserve, reuse, refurbish, and/or recycle the resources and materials that are used in every stage of the value chain. The majority of the new policy instruments that have been suggested by a large number of people concentrate on rules and regulations. The debris left over from construction and demolition projects is frequently recycled into an alternative to gravel. This led to a significant increase in the amount of waste that was recycled. It's possible to make the case that putting waste to use in this way amounts to downcycling, which results in a significant drop in the material's value. It is possible that waste from construction and demolition will contain hazardous substances. These substances will need to be identified and removed from the building materials before recycling can take place. This will ensure that the hazardous substances are removed from the recycling loop, which will prevent health and environmental problems in new product system loops. Waste from construction and demolition will also contain hazardous substances.

2.2 Circular Economy

Circular economy CE can also be thought of as an umbrella term, receiving inspiration from a wide range of resource management principles and environmental science theories popularised in the 1960s (Friant, Vermeulen, Salomone, & Recycling, 2020). While several CE solutions exist, and discussions about their impact are growing (Arina, Bendere, & Management, 2018), the foundation of CE can be defined by its goal of retaining value through the process of closing resource loops (Bocken, De Pauw, Bakker, Van Der Grinten, &

engineering, 2016). This concept has evolved in some academic research, with several discourses arguing CE can decrease detrimental environmental impacts, increase economic growth, and, more recently, provide good social impacts (Korhonen, Nuur, Feldmann, & Birkie, 2018). Nonetheless, some writers have demonstrated that "circular" techniques may not always have long-term effects, potentially resulting in sustainability trade-offs (Schroeder, Anggraeni, & Weber, 2019).

The circular economy concept is comprised of two distinct strands: the first is concerned with the flow of materials through an economy, while the second is concerned with the economic conditions that might result. Such a stream. These two conceptual streams date all the way back to the dawn of modern environmental science. In the 1960s and 1970s and have maintained a symbiotic relationship with it since then (Rose, 2019). In the 1940s, economic geographers used the term "industrial ecology" and the related term "industrial symbiosis" to describe the factors that determine the location of industries in order to efficiently utilise resources and avoid waste. This concept later evolved into the materials strand. According to an address by a President of the American Association for Advancement of Science, "The object of the next industrial revolution is to ensure that there will be no such thing a waste, on the basis that waste is simply some substance that we do not yet have the wit to use.... (Morseletto & Recycling, 2020; Rose, 2019).

There must be a loop back from the user to the factory in the next industrial revolution, which industry must close. If American industry were to take on the task of closing this loop, the article's original design would incorporate features that facilitate their return and remaking." (Spilhaus, 1970: 1673) Spilhaus had previously written, and perhaps more remarkable, "Ideally, the system would be completely closed." All water would be purified and reused, and all solid waste would be recycled to create new things." (Rose, 2019)dustrial economy (Turken, Geda, & Recycling, 2020) aims to bring together concepts from many scientific domains with similar aspects and characteristics under one umbrella. A few examples include the 3R principle (reduce; reuse; recycle), cleaner production, product-service systems, eco-efficiency, cradle-to-cradle design, green growth, biomimicry, natural capitalism, resilience of social-ecological systems, the concept of zero emissions and others (Eberhardt, Birkved, Birgisdottir, & Management, 2020; Foundation, 2019; Korhonen, Honkasalo, & Seppälä, 2018; Mies & Gold, 2021) CE is still in its infancy, and its development and implications are still being explored (Hossain et al., 2020) because of its interdisciplinary nature, there is no single definition of CE (Hart, Adams, Giesekam, Tingley, & Pomponi, 2019).

However, according to (Benachio et al., 2020) EMF's definition of "restorative by design" is widely cited as a primary source of CE definition. "It aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles (Foundation, 2015)." (Lacy & Rutqvist, 2016) Lacy's and Rutqvist's definitions follow in the following places, (Pomponi & Moncaster, 2017) Pommes de terre and Moncaster, (Geissdoerfer,

Savaget, Bocken, & Hultink, 2017) Geissdoerfer et al. and (Leising, Quist, & Bocken, 2018) Leising et al. respectively.

In a circular economy, there are two main components. Environmental impact reduction and business model development are two separate but intertwined goals in the first part of this project (ANDERSSON TORSTENSSON, 2016). According to the Ellen McArthur Foundation (2015), there are activities that can reduce environmental impact and provide an example of how circularity can be implemented (Foundation, 2015). The figure 2.1 illustrate the cycle of nutrient-based products and materials minimises waste and energy consumption by extending the lifespan of products, reusing and distributing them, refurbishing them, manufacturing and recycling them. And also there is a greater need to save energy in the right-blue side of the figure 2.1, which shows the industry and the circles that are inside (ANDERSSON TORSTENSSON, 2016).

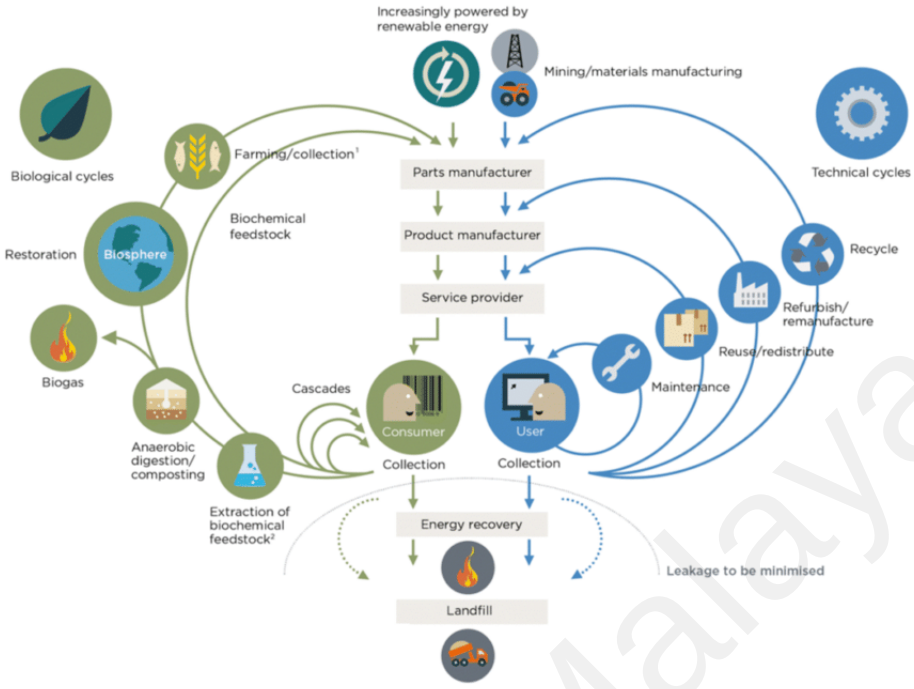


Figure 0-2 Graphical description of circular economy, Source: Ellen MacArthur Foundation (2015)

The 3R principle, which stands for reduce, reuse, and recycle, is where the circular economy's primary emphasis lies. The primary objective of the reduce strategy is to cut down on the amount of material used in the production and consumption processes. The purpose of reuse is to lengthen the amount of time that products can be used and services, and as a final option, recycling, which refers to the reuse of renewable resources once they have been exhausted. use (Ying & Jun, 2012) in the following: (Ghisellini et al., 2015). The circular economy can be broken down into two primary components. The first step is to create business models that can be used to implement the second step, which focuses on minimising the negative effects on the surrounding environment (Tortensson, 2016). The Ellen McArthur Foundation (2015) presented a model of circularity and highlighted activities that have the potential to have a smaller negative impact on the environment. Figure 2.1

depicts how the technological and biological nutrient-based product and material cycle helps to reduce waste and energy consumption. This is accomplished by extending the lifespan of products, recycling, refurbishing, and manufacturing products, as well as reusing and distributing them. Figure 2.1 shows the industry on its right side in blue, and the circles with eight inside them are the most required ones because they offer more perspectives on how to reduce energy consumption (Tortensson, 2016).

According to Zhijun and Nailing (2007), moving toward a model of circular economy requires putting a significant amount of attention on the raw materials and energy. When producing a product, the primary focus should be on minimising the negative effects on the environment that the product will have over its entire life cycle, from the very first stage of material extraction all the way through the stage of product disposal. It is necessary to have new business models in order to make the activities associated with the circular economy possible; one type of business model is known as the circular business model (Tortensson, 2016). This means pursuing and creating the opportunities for a shift from a "end-of-life" concept to Cradle-to-Cradle, from using non-renewable energy towards using renewable, from using toxic chemicals towards their elimination, and from much waste towards eliminating waste through the superior design of materials, products, systems, and also business models. Specifically, this means shifting from a "end-of-life" concept to Cradle-to-Cradle, from using non-renewable energy towards using (EMF, 2013).

All of the various theories that have been presented by many schools of thought, such as General system theory by (Von Bertanlaffy, 1950, 1968), Environmental economics by modified by pearce & Turner (1989), and Industrial ecology presented by (FROSCH, 1992)(Ghisellini et al., 2015), are included in the subfield of environmental management and also serve as the foundation for the concept of a circular economy. However, out of all of these different schools of thought, the circular economy theory is the one that is based most heavily on the concept of industrial ecology (Ghisellini et al., 2015). The concept of industrial ecology (IE) was developed in response to the prevalent view that industrial systems and the environment should be viewed and managed independently. By "industrial system" and "its impact on "the environment," we mean "industrial system" and "the environment." According to the theory of industrial ecology, an industrial system is similar to an ecosystem in that it facilitates the flow of materials, energy, and information with the help of resources and services provided by the biosphere. Consequently, IE contends that the industry and the environment cannot be considered independently of one another. There are three points of view regarding industrial ecology. The first point of view is one that takes a more in-depth look at the relationship between the industrial economy and the biosphere. The second point of view focuses on the flow of materials and energy both within and beyond the industry. The third viewpoint or pillar provides the proactive approach, which consists of technological dynamics and the transition from linear industrial systems to industrial ecosystems (Erkman, 1997). The goal of industrial ecology is to cut

down on waste by squeezing more efficiency out of our material and energy flows so that we can completely close the loop (FROSCH, 1992).

2.3 Concept of Circular Economy

Circular Economy is a concept that is receiving more and more attention (CE). By reducing resource extraction and waste streams, it may be able to help resolve the sustainability challenge and support organisations in their efforts to become more sustainable (Górka, Łuszczyk, & Thier, 2018). In order to restore natural and social capital, CE aims to redesign linear processes and flows of "materials, energy, labour, and information" into circular ones (Ratum, Sachari, & Wahjudi, 2020; Thomas, 2022).

Stahel and Braungart and McDonough revived the idea of an economy operating in a loop and discussed its impact on competitiveness, resource savings, job creation, and waste prevention in the late 1980s. A closed-loop system eliminates waste by using it as a source of energy for other processes, according to the three experts (M. Braungart & McDonough; M. J. J. o. I. A. Braungart, 2019). David Pearce, a well-known environmental economist, coined the term "Circular Economy" in the 1990s (Thomas, 2022). Cradle-to-Cradle and Biomimicry, both of which took their cues from nature, had an impact on the development of the Circular Economy concept (Meerburg et al., 2019). The concept's current lack of a common definition and simple explanation can be attributed to the various influences that have been incorporated into it over the last four decades of its existence.

However, Circular Economy aims to close material loops and treat them in two separate cycles: biological nutrients that are safe for re-entry into the biosphere because they are non-toxic and biodegradable, and technical nutrients that can be reused again and again, despite the fact that the wording of its principles may differ because of those multiple influences (M. Braungart & McDonough). This avoids the creation of waste, which is defined as "residuals... for which the generator has no further use... and of which he or she wishes to dispose," by redesigning products and processes (Ratum et al., 2020). (Re) manufacturing thus relies on renewable energy sources, such as solar power collection and processes (Ratum et al., 2020).

As economic, social, and environmental indicators of sustainable development continue to improve, attention is being drawn to the construction sector, which is both a globally emerging sector and a highly active industry in both developed and developing countries. This attention is drawing attention to the fact that the construction sector is both globally emerging and highly active (Ortiz et al., 2009). It has been established beyond a reasonable doubt that the construction activities have significant effects on the economic, social, and environmental dimensions of sustainability (Smol et al., 2015).

Kenneth Boulding brought attention to the concept of a "open economy" in 1966. This type of economy allows for unlimited input resources and output. This is in contrast to a "closed economy," in which resources are tied down and are required to remain a part of the economy for as long as possible. Although Boulding does not use the term "circular economy" in his essay "The Economics of the Coming

Spaceship Earth" (Boulding, 1966), it is commonly cited as the first expression of the "circular economy" (Allwood, 2014). The study of feedback-rich systems, particularly living systems, serves as the foundation for the circular economy. The modern understanding of the circular economy and its practical applications to economic systems evolved by incorporating various features and contributions from a variety of concepts sharing the idea of closed loops. This process resulted in a more comprehensive understanding of the circular economy and its practical applications to economic systems. Cradle to cradle, the laws of ecology, looped and performance economies, regenerative design, industrial ecology, biomimicry, and the blue economy are some of the relevant theoretical influences (Geissdoerfer et al., 2017).

In 1989, British environmental economists developed a more sophisticated model of Circular Economy (Pearce and Turner, 1990). They pointed out in the book Economics of Natural Resources and the Environment that a traditional open-ended economy was developed with no built-in tendency to recycle, which was reflected in the way that the environment was treated as a waste reservoir. They said that this was the result of treating the environment as if it were a landfill (Su et al., 2013). In the early 1990s, Tim Jackson began to compile the scientific basis for this new method of industrial production in the edited collection Clean Production Strategies that he was working on at the time (Jackson, 1993). Stahel and Reday-Mulvey (1981) presented a research report to the European Commission in 1976 titled "The Potential for Substituting Manpower for Energy." In this report, they sketched the vision of an economy in loops or a circular economy as well as its impact on job

creation, economic competitiveness, resource savings, and waste prevention. In China's 11th five-year plan, which began in 2006, the government decided to make the encouragement of CE a national policy (Zhijun and Nailing, 2007).

2.4 Circular supply chain VS Linear supply chain

The shift from a linear to a circular supply chain, from raw materials to waste to raw materials for recycling and repair, is known as the circular supply chain. It is imperative that the supply chain for modern industry move towards a circular one because the world is limited in resources. The entire reverse logistics process is required for long-term sustainability and constant expansion (Zeng & Li, 2021). The actual competition today is not between companies or industries, but between supply chains, making supply chain management a challenging concept to grasp in this day and age (Cisneros-Cabrera et al., 2021). The supply chain is the network of organisations involved in the various processes and activities that produce value and deliver it to the ultimate consumer in the form of products and services through upstream and downstream links (Kovács & Falagara Sigala, 2021). A better long-term performance for each individual company in addition to the supply chain is the goal of supply chain management, which is defined as systemic, strategic coordination of traditional business functions and tactics within a specific organisation and across businesses within it (Zeng & Li, 2021).

This digital era has put a lot of pressure on the construction industry to constantly reshape and reinventing themselves and their models. Many companies and industries around the world have embraced digital transformation as a way to stand

out from the competition (Tieto, 2017). Green supply chains, in other words, a shift from a linear economy to a circular economy, is a hot topic in many industries, especially Malaysia construction industries.

This issue primarily arises as a result of the widespread adoption of a linear economic model within the construction industry, which is predicated on the concept of "take, make, and dispose of" (EMF, 2015). The phases of this model that feature this idea to begin with the extraction of raw materials from the environment, which are then processed into becoming construction materials and assembled on the construction site in ways that cannot be deconstructed, becoming obsolete at the end of the building's life, and needing to be disposed of in landfills or incinerated along with all the waste generated throughout the entire process. In this model, the phases that feature this idea to begin with the extraction of raw materials from the environment. In this model, the phases that feature this idea begin (Mangialardo and Micelli, 2018).

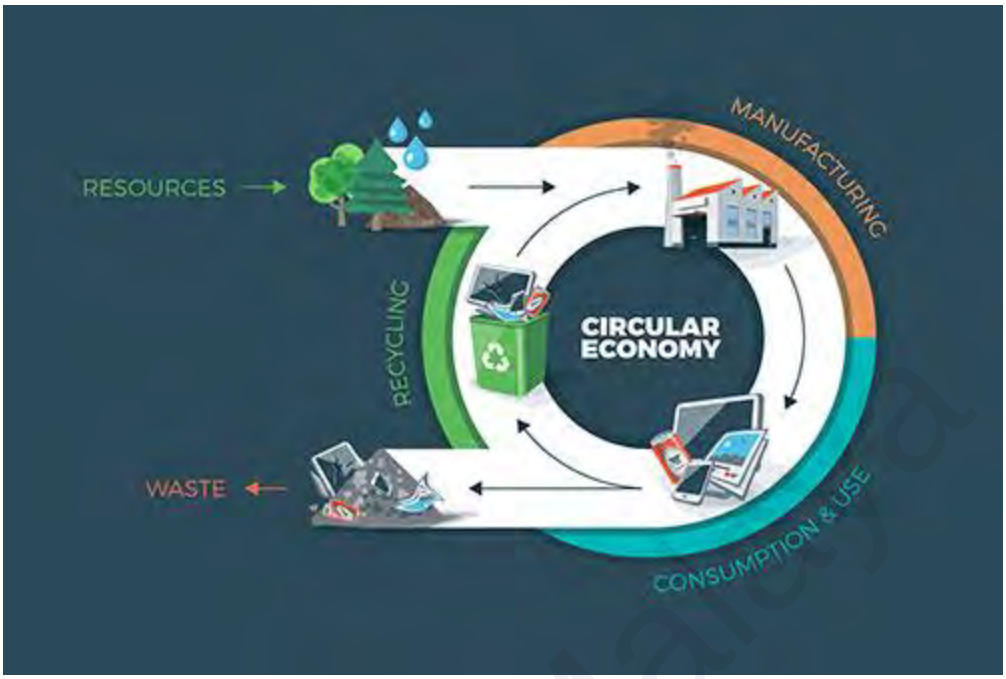


Figure 0-3 Linear vs. Circular supply chain, Source: (Robinson, 2016)

A linear supply chain and a circular supply chain are depicted in Figure 2.2, which shows the difference. The linear economy model is based on the idea of producing a product, using it, and then discarding it when the product's life cycle is complete. The circular economy concept, on the other hand, proposes minimising the use of new raw materials and all forms of waste in the material cycle in order to reduce the adverse effects on the environment. As opposed to the linear economy, in which resources are made, used and then disposed of, the circular economy maximises the value of the resources. When a product or material has reached the end of its useful life, it is possible to recover and regenerate it for future use. Because it reduces waste, generates new opportunities for growth, lessens manufacturing's negative environmental effects, and increases resource productivity enormously, a circular economy has a lot to offer (Wrap, 2018). People's attention is focused on this concept because it has numerous positive effects. Organizations and policymakers

are beginning to recognise that the linear industrial model we have all been using recently is no longer compatible with our planet's finite resources. Due to the scarcity of natural resources and high levels of waste and pollution, the linear industrial system is doing little to alleviate either of these problems (Mont et al., 2017).

According to EMF (Foundation, 2015) "take-make-dispose" is making the economy scarce, volatile, and at high price levels because of the linear approach. Although Long-term policies in Malaysia aim to improve resource efficiency and reduce environmental waste in order to achieve safe disposal and higher levels of recycling in the long run. However, the allocation of RM322.5 billion in Malaysia's 2021 budget reflects the country's rapid socio-economic growth, even though waste continues to be generated in every Malaysian municipality post-COVID-19 ((BNM), 2021). Malaysia is Asia's second-largest plastic consumer, averaging 16.78 kilogrammes of plastic per person. After Singapore and Brunei, Malaysia was the third-highest ASEAN country in 2016 in terms of waste generation per capita at 1.17 kg/capita/day, behind only Singapore and Brunei (UNEP, 2017).

In addition, Malaysia's average daily waste production increased from 38,563 tons/day to 49,670 tons/day between 2015 and 2020. Malaysia's waste recycling rate has also risen by 11.5–22% by 2020, as well ((JPSPN), 2021). With the alarming rise in average waste production, the country faces increasing pressure to reduce solid waste sent to landfills by 40% and reduce greenhouse gas emissions intensity by 45% before 2030. Additionally, at the 2015 United Nations Climate

Change Conference, Malaysia vowed to do everything in its power to live up to its Paris Agreement commitments (COP21). As a result, in accordance with the National Policy on Solid Waste Management (Negara, 2016). Due to alarming levels of natural resource consumption and environmental pollution has prompted the construction industry (CI) to embrace a significant change from a linear to a circular economy (CE) model.

2.5 Transition Towards Circular Economy

A circular economy is an industrial system that replaces the concept of "end-of-life" with restoration, use of renewable energy, getting rid of harmful and hazardous chemicals that hinder the reusing of materials, and usage of materials, products, and systems in order to reduce waste. Other components of a circular economy include: a reduction in waste, the elimination of harmful and hazardous chemicals that hinder the reusing of materials, and (EMF, 2013). The primary intention behind the circular economy's design is to cut down on waste, and its ultimate goal is to eliminate waste altogether. It focuses on reusing the consumables of the product that are biological ingredients or are non-hazardous to the environment, and these consumables have the potential to be returned to the earth and become a part of the biosphere. This is in addition to reducing the amount of waste that is produced. In light of this, the energy that is used for recycling and reusing these materials should not come from non-renewable sources such as fossil fuels, coal, or natural gas because these resources cannot be easily replenished. Instead, it should rely on renewable sources like the wind, the tides, and the sun in order to avoid becoming dependent on resources that are running out.

The term "consumer" is replaced with "user" in the context of the circular economy in order to call attention to the fact that specific machinery products should be recycled and reused after they have been used. This helps technical industries (EMF, 2013). The problems with quality, the high start-up costs, and the complexities of the supply chain are the obstacles that many businesses must overcome. The European Union has started a number of different projects, one of which is called IMS2020 and is a roadmap towards a project that will promote sustainable manufacturing. Its primary components consist of production systems that include value chains and eternal life-cycle solutions for manufacturing. Additionally, sustainable manufacturing is only implemented when the government and industries support the culture. Lifecycle considerations, which include product design, production, use, retirement, and end-of-life activities, have an impact on the sustainability of manufacturing. The production process ought to be sustainable, but not just in the sense of maintaining a predetermined level of environmental parameters. It needs to be sustainable in terms of performance and quality of both the products and the processes, as well as safety for the workers and anyone else whose lives are impacted by the manufacturing process. (Rolstadas, 2015). The cost of transitioning to any new system or idea is something that every business needs to take into consideration. Therefore, shifting toward a circular economy would result in transition costs, such as research and development, asset investment, spending on enterprise infrastructure, and subsidies. These would be the primary contributors to the high investment cost (Mckinsey & Company, 2016).

2.6 Circular Economy Strategies

In a circular economy, the various actors in the supply chain, including producers, distributors, consumers, and recyclers, are brought into harmony through various strategies and schemes. The activities of the actors further downstream in the supply chain are required to be coordinated with the decisions made by the actors further upstream. It is commendable that there is innovation at each and every stage of the supply chain and that the emphasis is not solely placed on the reduction of waste at a later stage (Vanner et al., 2014). Presented by McDonough and Braungart in 2002 in their book "Circular Economy," there are two pillars of circular economy if the concept expands beyond simply focusing on waste reduction (Vanner et al., 2014).

1. **Cardle to cardle principles:**
    - This principle states that the principles of eco-designs should be applied to all of a company's products in order for those designs to be considered successful. Product design for durability, disassembly, and refurbishment are all included in this principle. It is imperative that as few potentially hazardous and poisonous materials as possible be utilised, and that any remaining materials be of a type that can be recycled.
    - This principle focuses on the manner in which waste from consumption at the household level is converted into new products. Regenerative forms of consumption can be thought of as an example of this principle.

2. **Industrial Symbiosis:**

   This principle, in its most basic form, calls for coordination between the various actors along the supply chain, such as from the producer to the distributor to the customer and, finally, among the recycler.

2.7 Strategies toward CE in Malaysia

Over 90% of solid waste is mismanaged in these low-income countries, according to a World Bank Group report (Ngan et al., 2019). As a result, one of the most cutting-edge solutions to the aforementioned problem has been to recycle, repair, and repurpose CE products instead of throwing them away. All stakeholders, including industry players, final consumers, and policymakers, must shift from traditional methods of material use to one in which the need for exploitation of primary resources and energy consumptions is minimised in order to transition to the CE (de Jong, van der Gaast, Kraak, Bergema, & Usanov, 2016).

2.7.1 Governmental Policy and Initiative

A revolutionary policy can only be implemented with the full support of the government. A holistic approach has been requested by Malaysia's Eleventh Plan for the implementation of CE in the country ((EPU)). Table 1 summarised the EPU's (Economic Planning Unit) strategies, while all stakeholders' responsibilities were also highlighted ((EPU)).

Table 0-1 Strategies toward CE in Malaysia

No	Strategy	Description
1	Packaging waste reduction and recycling	There are several ways to increase the recycling rate, including the enforcement of the Solid Waste and Public Cleansing Act (2007), a nationwide collection and recycling system, labelling packaging to make recycling easier, and extending the "no-free plastic bag day" to seven days a week.
2	Maintain a 100 percent WEEE (or e-waste) return rate in the hands of qualified individuals.	Waste Electrical and Electronic Equipment (WEEE) cannot be returned 100% of the time using traditional collection methods. According to the Solid Waste and Public Cleansing Act of 2007, consumers are responsible for delivering the specified goods to manufacturers, assemblers, importers or dealers. If necessary, WEEE can be exported to other countries with authorised facilities.
3	Hazardous waste should not be allowed to enter the biosphere	Materials that pose a danger because they exhibit at least one of four characteristics (including flammable, reactive, corrosive and toxic). Consumers are responsible for returning hazardous waste to merchants.
4	Construction waste can be recycled and repurposed as secondary building materials.	On-site waste separation and transportation to the appropriate recycling facilities are essential for construction companies. Building waste should not be dumped illegally, and those who do so should be punished.
5	keeping track of waste in the industry	Keep records of (I) the types and amounts of waste accumulated; (ii) the methods used to dispose of it; and any measures taken under the three R's principle

6	Initiate collaboration between businesses and a national waste grid.	search for valuable materials in the waste stream that could be used in another industry "Waste" information can be exchanged via a national "waste grid" being developed by the Ministry of Energy, Technology, Hijau, and Air Malaysia (KeTTHA).
7	valuing organic waste and biomass as a resource	Separate collection of organic waste at the source is necessary to treat organic waste technologies such as composting, bio-gasification, and biolique faction. High-value products can be made from agricultural biomass waste under several national policies (such as the National Biomass Strategy 2020). The Malaysian government offers incentives of up to 40% to local investors for the construction of biochemical facilities under the National Key Economic Area (NKEA).
8	Eliminating the practise of placing waste on landfills directly	Efforts have been made by the Malaysian government to curtail the widespread practise of landfilling. There is a ban on direct landfilling of redox-sensitive materials. As a result, upstream resources will be better managed (e.g., reducing, reusing or recycling.

While the government of India has implemented a favourable regulatory framework to spur the growth of CE in the country, it is also the world's sixth largest economy. According to these macro-initiatives and the corresponding regulations.

2.8 Barriers, Challenges, and enablers in Circular Economy

It is imperative for the construction industry to implement new and improved building strategies that are focused on solving the problems that arise from the

current "take-make-consume-dispose" economy model (Hong, Shen, Li, Zhang, & Zhang, 2018). CE is seen as a solution in this context because it would reduce environmental impacts while also contributing to economic growth (Yu, Yazan, Bhochhibhoya, & Volker, 2021). However, to maximise the value and use of materials throughout their lifecycle, and to minimise waste, CE is a novel regenerative system (Brown, Bocken, & Balkenende, 2020; Konietzko, Bocken, & Hultink, 2020).

The following is a breakdown of key challenges, barriers and enablers of a circular economy in Malaysia construction industry.

The concept of CE has gained acceptance in academia, government, and business. Germany, Japan, China, Europe and Malaysia are widely acknowledged for their efforts to implement CE principles through legislation at the global level (Merli, Preziosi, & Acampora, 2018). However, even though the building and construction industry is one of the most promising areas for the adoption of CE (Minunno, O'Grady, Morrison, Gruner, & Recycling, 2020), Its implementation is a difficult task that necessitates significant alterations to the industry and society as a whole, particularly in the areas of waste management and business practises (Minunno et al., 2020).

However, there is a lack of incentive to design construction products for end-of-life issues, which was ranked as the most significant challenge by all stakeholders (Cantú et al., 2021). A lack of market mechanisms to aid greater recovery, the low value of products at the end of their useful lives, and an unclear financial case were

also deemed the most significant economic challenges. Another significant challenge was the construction industry's structure, which was seen as having a fragmented supply chain and a general lack of interest, awareness, and knowledge. The lack of consideration for end-of-life issues at a building level and the complexity of buildings were also considered significant challenges in the design process (Cantú et al., 2021). In general, this was similar to the topics discussed during the breakout sessions, which included financial, structural, and knowledge issues.

For example, (Adams et al., 2017) map identified circular economy aspects onto building lifecycle stages and discuss barriers and enablers under the following seven categories in their survey of the construction industry: law making and policy; public awareness and understanding; the production of construction products (designed for end-of-life); the design and operation of buildings (designed for disassembly, adaptability etc.); the recovery of materials and products (market mechanisms); business (the financial case for CE).

In a pair of industry papers authored at least in part by Arup, whilst formal categorisation is not attempted, it is implied. In From Principles to Practices (Acharya, Boyd, & Finch, 2018), the following five 'key themes' were identified: collaboration; knowledge; policy; leadership; and finance. These are all seen as groups of potential enablers to help overcome common barriers in the sector. In The Circular Economy in the construction industry (Hart et al., 2019), enablers are put into a different set of four groups: Education, awareness & communication;

policy & regulation; technology & innovation; and collaboration. Recommendations for future action by the industry are grouped slightly differently again.

Significant challenges include a lack of awareness, interest, and knowledge. Manufacturers, on the other hand, regarded the challenges of lack of knowledge and interest as of medium importance. Although companies of all sizes believed that an awareness campaign would be an important enabler, medium and large-sized businesses believed that a lack of knowledge was a greater challenge than smaller businesses. Lack of interest, according to survey respondents with more construction experience, is a major challenge. There is a lack of clarity about what the circular economy entails, as well as apparent confusion between terms like reuse and recycling, implying that more precision is required.

The most difficult part of implementing CE remembers to take into account the materials and components and how they will be used in the end. According to Mahpour (Mahpour & recycling, 2018), the design stage of CE presents three major challenges: (I) the lack of consideration for sustainable waste management and potential reuse; (ii) uncertainty in C&D waste management; and (iii) agency and ownership issues of the end-of-life of materials. To maximise the reusability of building materials and components, (Ajayabi et al., 2019) concluded that significant alterations must be made to the configuration and interaction of various building elements and the construction system. For the concept of circular building

to work, it is necessary to find synergies between adaptability and circularity (van Stijn, Gruis, & Environment, 2020).

There were other design issues, such as the lack of incentives to use recycled materials or components that had to be overcome (Adams et al., 2017). A new challenge for product designers may be to anticipate the social, economic, and environmental challenges of CE during the design process. Consequently, designers need to address the issue of waste flows and design complexity with discarded materials (Govindan & Hasanagic, 2018). However, Singh and Ordonez argued that the end-of-life uncertainties may not affect the design process, as the use of BIM in the early design stage, the selection of modular or prefabricated components, and the integration of LCSA for multi-objective optimisation would be helpful in effectively implementing and evaluating CE for design decisions (O'Grady, Minunno, Chong, Morrison, & Recycling, 2021).

Designers, researchers, and consultants have identified the lack of end-of-life considerations during the commissioning, design, and construction of a building as a significant challenge (Benachio et al., 2020). Uncertainty about long-term user needs was cited as a major concern, with adaptability and flexibility being key factors. The importance of optimising the lifespan and the value of refurbishing to extend the life of buildings was a recurring theme, resulting in less resource consumption through increased utilisation (Benachio et al., 2020). However, the complexity of buildings was seen as a major challenge, which was addressed through modularisation and design simplification. Enablers such as a standard for

DfD design tools and guidance are critical, with designers placing a high value on these (Adams et al., 2017).

Throughout the value chain, there is a lack of interest, knowledge/skills, and engagement (suppliers, customers, and internal). An overarching barrier is the lack of interest in circularity, which can be seen as the crux of the problem and an overarching barrier: without progress on this, progress will be slow. This barrier has been mentioned by a number of authors. Some see it as a problem of delivering CE projects in a linear economy, which is difficult (Kirchherr et al., 2018).

Advanced technology, as well as technological capabilities, are critical to the successful implementation of CE principles at various levels and in various areas of construction industry. To develop the CE strategy and update production facilities and equipment, a combination of advanced technology, skills, management, finances, policy, and governance is required. (Sousa-Zomer et al., 2018) attribute their lack of enthusiasm to the high costs of participation as well as the lack of direct benefits to industries. Importing technology, according to (Heshmati, 2017), is a solution to the slow development of indigenous technology in the transition to CE. However, there is fear that such a policy may lack effect as it will be dependent on foreign experts to operate and resolve technological failures.

Innovativeness must be supported by public incentive programs in finance, technology, regulatory, and administrative support so that they can access financial and tax incentives and engage in innovative activities in order to develop and implement environmentally friendly technologies and solutions. (Murray, Skene,

& Haynes, 2017), for example, emphasise the importance of a lack of reliable data and information, a shortage of advanced technologies, weak or absent economic incentives, poor legislative enforcement, poor leadership and management of the development strategy, a lack of public awareness about the importance and promises of CE, and the lack of a comprehensive standard system for assessing CE's performance. We'll go over these and other key points in greater depth now to help remove barriers, challenges, and enablers to CE implementation.

2.9 Summary

In summary, while different perspectives have been used to identify CE barriers, only a small amount of work has been done from the perspective of the construction industry as a whole. Furthermore, previous research has primarily focused on CDW, which is a single construction life cycle stage, whereas the CE concept can be applied to all construction life cycle stages. More research is needed on the barriers that obstruct CE adoption at the industry level in the building sector from the perspective of developing countries. As a result, the goal of this study is to close the gap by identifying the major barriers to CE in the construction industry.

However, the construction industry is plagued by time and cost overruns, which limits the amount of physical infrastructure growth that can be pursued (Keng, Mansor, Ching, & Research, 2018). The Malaysian 2030 agenda requires a balance between economic stability in addition to environmental protection and social obligation. In order to keep the economy stable and find a solution to the rising costs, there are some steps that need to be taken. According to the available

research, CE is a useful economic evaluation indicator because it takes economic sustainability into account. Although there is a high rate of cost overruns in construction projects in Malaysia, where rapid development is occurring, there appears to be only a limited amount of CE implementation in the construction industry. Previous research conducted over the course of the previous decade highlighted the limited implementation of CE in comparison with developed countries (Altaf et al., 2022), the constraints from the owner's side in the implementation of CE (Altaf et al., 2022), and the unawareness of CE as an integrated part of CI (Liakos et al., 2019). As a result, the purpose of this study is to determine the level of perception that construction professionals have regarding CE and its implementation, as well as evaluate the factors that can help promote its implementation. By conducting a survey among those who work in the construction industry in Malaysia, the researchers used a quantitative method to accomplish the goal of the study. This study sheds light on the widespread misunderstanding of CE over the past ten years, as well as its significance and the potential factors that should be taken into account when implementing CE.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses and focuses on the study's research methodology. Researchers use Research Methodology to collect the information necessary to solve the research problem using scientific methods, such as data collection and data analysis techniques. According to (Saunders, Lewis, Thornhill, & Bristow, 2015) The theory of how research should be conducted is referred to as "methodology".

A literature review was carried out during the first stage of this research project in order to gain a deeper understanding of CE and its applicability in the research and construction industries at the present time. Following the completion of the literature review, evaluation questions were formulated with the purpose of determining how professionals working in the construction industry perceive CE. In addition, the factors that have been identified as having an influence on both the awareness of CE and the implementation of it in projects. During the second stage of the project, a questionnaire was developed, and a pilot study was carried out to determine the extent to which respondents understood the questionnaire. Using the software that is part of the Statistical Packages for the Social Sciences (SPSS), a descriptive analysis was performed on the data in the third and final stage. This analysis involved determining the frequency, percentages, modes, and relative importance index (RII).

This chapter focuses on the research methodology employed in this study, as well as the tools and procedures used to analyse the data in a methodical manner. This chapter will provide an overview of the overall study process method. The purpose of this chapter is to describe the research methods and design employed to conduct this study. The explanation of research design is followed by the research framework and methods in this chapter. It will also detail the data gathering method in terms of respondent selection. The conclusion is reached after taking into account the limitations and constraints observed during the research. A variety of crucial challenges that appear to represent the current condition facing the Malaysian construction sector have determined the study's scope and methodological approach.

3.2 Research design

Design research is an important part of any research project since it helps researchers to develop a structured general plan for answering the research issue. According to (Creswell & Creswell, 2017) a range of methodologies can be employed in the systematic evaluation of a target group's problems and needs for a purposeful, organised intervention programme. the research design since it best served to answer the study's questions and objectives.

This study's methodology was based on a quantitative approach. Closed-ended questions like multiple choice, ranking, and Likert-style format were used for most of these questions, allowing respondents to score the incident. Based on a review of the literature, the questionnaire survey was constructed to ask the right

questions. The questions were then prepared and presented in a clear and unambiguous way so that the targeted responders could easily understand them.

The research design is divided into two phases: the theoretical phase, which is designed to meet the first and second research objectives; and the empirical phase, which is intended to address the third research objectives. A thorough literature analysis was conducted for this phase in order to identify the challenges and enablers that the Malaysian construction sector faces while implementing the circular economy initiatives. The second phase addressed the third research objective while complementing the first and second research objectives. The goal of this phase was to figure out how the construction industry in emerging economies may take advantage of CE implementation strategies. Using a variety of methodologies, the theoretical barriers and enablers were empirically confirmed in this phase.

As a result, a quantitative approach was chosen for data collecting in order to validate the research findings and to determine how well the construction industry understands the circular economy and to assess the barriers, challenges and enablers to its wider adoption. A questionnaire survey was used to obtain data from the adequate number of respondents specified for this study. To collect data from individuals, (google form online survey) (Creswell & Creswell, 2017) Following the collection of required data, the results were analysed using statistical analysis. The analysed data were then evaluated and conclusions reached.

3.3 Data Collection

The challenges in implementing the circular economy in the Malaysian construction industry was conduct with the gathering information of two stages to present a clearer idea. The first was data collection via a direct questionnaire survey, and the second was a thorough review of the relevant literature, which began with an overview of the research topics and included case studies of several projects. The data collected during data collecting will be analysed in order to continue the research process for this study (Eti & Literacy, 2021). Data analysis is the process of examining data acquired through data collecting by applying analytical and logical reasoning to each aspect of the data (Byrd, 2021; Eti & Literacy, 2021). Essentially, after gathering all necessary and required data and materials, the researcher begins creating and writing from the theory with the goal of achieving the thesis's objective and formulating the thesis report (Byrd, 2021; Creswell & Creswell, 2017). Almost all of the theories focused on the difficulty of implementing circular economy.

The usage of a Google Form to create an online survey questionnaire utilising a quantitative technique(Creswell & Creswell, 2017). The participants' responses to each topic were scored on a five-point scale, Likert scale," with strongly agree = 5 points, agree = 4 points, neutral = 3, disagree = 2 points, strongly disagree = 1 point. The Cronbach Alpha Coefficient was used to determine the questionnaire's reliability. The materials and data in the thesis were analysed and discussed by summarising and focusing on the primary acquired information and data. For a better presentation of the results, the data can be tabulated and presented

in the form of a pie chart, bar chart, or graph. The percentage technique and statistical significance are two of the strategies utilised to analyse the data obtained for this investigation. After studying and concentrating on the responses to the thesis questions, the researcher will arrive at succinct, cohesive, and comprehensive conclusions.

However, to improve clarity, techniques that provide quantitative measurements are applied (Eti & Literacy, 2021). The primary method employed in this study to elicit replies to the research question and objectives is a non-probability sampling method which is defined as a techniques based on subjective judgement of the research and carried out by the observation, quantitative research is mostly used in this method. To achieve the study's goal, a self-administered questionnaire was developed and refined based on previous research (Eti & Literacy, 2021).

Through closed institutional (WhatsApp) groups, the questionnaire link was distributed to experienced construction personnel. This strategy took advantage of Malaysians' high Internet usage rates to help us reach out to others. After two weeks, a follow-up reminder will be sent, followed by a final reminder. The use of a Web-based survey for data collection and collation will maintain respondent confidentiality. When returning the questionnaire (Eti & Literacy, 2021), web-based methods (such as Google Forms) ensure data confidentiality and prevent other participants from seeing it. In addition, there were no questions in the survey that could be used to identify individuals.

3.3.1 Literature Review

Identifying some of the broader parameters likely to be relevant in studying circular economy is the primary concern throughout the review stage. Textbooks, institutional and statutory publications, periodicals, trade and academic journals, and seminar and conference papers were all subjected to a systematic literature review.

3.3.2 Questionnaire

The questionnaire is intended to serve as a primary tool for achieving the research's goals and objectives, as well as testing hypotheses. First, the information presented in the previous chapter assisted the researcher in broadening his or her knowledge and raising awareness of other issues that might not have been considered otherwise. Second, the circular economy experience in the public, private, and government sectors aided in the development of the questionnaire. After that, a provisional version of the questionnaire was created to cover all aspects necessary to achieve the research's goal. It was, however, also necessary to ensure that the questionnaire was accurate. As a result, a quality control process was implemented, beginning with ensuring that each objective and hypothesis had questions that corresponded to them, continuing with a practical test in which specialists were asked to fill out the questionnaire in order to assess the level of clarity, and concluding with the research supervisor's approval.

3.3.2.1 Justification of Questionnaire

A questionnaire survey is used in this study to determine the causes and effects of variation order. Aside from that, the questionnaires survey is used to identify strategic ways to identify challenges variation in Malaysia's construction industry. Questionnaire surveys were chosen because they address a geographically dispersed population and have fewer biassing errors. This is due to the fact that the interviewer's characteristics or techniques have no effect on the respondents. It also provides respondents with a high level of anonymity (Frankfort-Nachmias & Nachmias, 1996: 226).

In order to evaluate the awareness level of professionals and to assess the factors that affect the understanding and implementation of CE in construction projects, a questionnaire was developed and is presented in Appendix A. The constructed questionnaire includes a total of three different sections. The first part of the questionnaire is dedicated to collecting information about the respondents' demographic profiles. In the second part of the section, includes questions about knowledge and experience with CE. Some of the questions inquire about the level of awareness and knowledge regarding CE indicated by the Likert scale as having no knowledge, very weak knowledge, weak knowledge, well knowledge, and very well awareness. A few of the questions inquire about the level of implementation if they are acquainted with CE indicated by a Likert scale ranging from very important, important, moderately important, slightly important, and not important at all. The last part of the survey inquires about the respondents' experiences with continuing education and asks them to rate its significance on a Likert scale ranging

from very important to important, important to moderately important, important to slightly important, and unimportant. In addition, the third section discusses the factors that, when combined, can help increase both awareness and the implementation of CE. On a scale from very important to not important, the Likert scale was utilised to rank the questions. Very important, important, moderately important, slightly important, and not important were the possible responses.

The majority of the survey questions on the questionnaires are closed format or forced choice. A closed or forced choice question presents respondents with a number of options from which they must choose one or more (Vaus, 1999: 86). The majority of the questions in this questionnaire survey were closed format or forced choice questions because they are easier to code and analyse. Closed format questions also allow respondents to self-classify, which prevents coders from misinterpreting what they meant. Furthermore, this type of question can prevent respondents who are less verbose or inarticulate from being discriminated against (Vaus, 1999: 87).

Multiple choice, checklists, ranking formats, and Likert-style formats are some of the most widely used approaches for closed formats questions. The questionnaires survey used Likert-style formats or rating scales formats questions to get respondents' personal thoughts and opinions. People were given statements and asked to indicate how strongly they agreed or disagreed with those statements in Likert-style formats (Vaus, 1999: 88). The respondents were asked to respond to questions in a Likert-style format because they are simple to understand and

answer. Aside from that, the responses are simple to code and quantify, and they can be analysed mathematically (LaMarca, 2011).

The questionnaire is divided into three sections. The first section looked at the participants' basic demographic information, such as their experience, and job setting(Creswell & Creswell, 2017). The warm-up questions, CE approach, and final questions were evaluated in the second and third parts.

For the purpose of this investigation, the google form platform was utilised to disseminate one hundred (100) questionnaires to the pioneers of the Malaysian construction industry in the year 2022. One month was spent collecting all of the data (from March 2022 to April 2022). Only seventy-one responses, or 71 percent, were obtained; the remaining participants were unable to provide a response to the survey. Given that the CE methodology is associated with a small number of pioneers in the building industry, the respondents were selected from each category, including academics, clients, consultants, and contractors, etc., in order to ensure that the results were representative of the industry. The academicians are included in the knowledge about CE and how it is connected with the construction industry.

3.3.3 Sampling Method

Convenience sampling is a form of non-probability sampling in which individuals are selected for sampling for no other reason than the fact that researchers find them to be "convenient" sources of data. In the methodology of probability sampling, each component of the population is assigned a specific probability that is greater than zero of being chosen in a manner that is completely

at random (Fleetwood, 2020). The method of sampling known to involve non-zero probabilities of selection is referred to as non-probability sampling. Instead, subjective methods are utilised to make the determinations regarding which components should be included in the sample. In sampling methods that do not rely on probability, the population being sampled might not be completely denned. Purposive sampling, convenience sampling, and quota sampling are the three types of non-probability sampling that are typically distinguished from one another.

Figure 0-1 Advantages of convenience sample

A form of sampling known as convenience sampling is one in which the research will make use of the primary data source(s) that are available first, even if there are additional requirements (Fleetwood, 2020). To put it another way, this method of sampling involves recruiting participants wherever you might be able to find them, typically in a location that is convenient. In the case of convenience sampling, there is no identification of inclusion criteria prior to the selection of subjects. Everyone from every subject is welcome to take part.

Figure 0-2 Method of convenience sample

This approach can be utilised in the field of business studies (construction industry etc.) in order to acquire initial primary data regarding specific issues. Some examples of such issues include the perception of the image of a particular brand or the collection of opinions of potential customers in relation to the redesign of a product(Fleetwood, 2020). When conducting pilot data collection in order to identify and address shortcomings associated with questionnaire design, the convenience sampling technique may prove to be effective. This is because the technique is used during the exploration stage of the research area.

3.4 Data Analysis

The information gathered during data collection will be used for data analysis in order to continue the study's research. Data analysis is the process of evaluating data gathered through data collection using analytical and logical thinking to examine each element of data gathered. Basically, after gathering all of

the necessary and required information and materials, the researcher begins to form and write from the theory in order to achieve the thesis's goal and formulate the thesis report. Almost all of the theories revolved around the difficulty of implementing a circular economy. The scores of the participants' responses to each item were calculated using a five-point Likert scale." The Cronbach Alpha Coefficient was used to determine the questionnaire's reliability.

Reliability:

Reliability is “whether an instrument can be interpreted consistently across different situation” (Mohajan, 2017). Reliability is the determination of the reasearc instrument consistently providing the same results.

Table 0-1 represent the reliability test

Scale	Number of items	Cronbach’s alpha
Likert scale	59	.940
Total	71	>.700

The value of Cronbach's alpha provides an estimate of the test's level of internal consistency. An estimate of the test's internal consistency can be obtained through the use of the Cronbach alpha. This surpassed the required minimum of .70 in terms of reliability to be considered acceptable (Cronbach & Shapiro, 1982).

The materials and data in the thesis were analysed and discussed by summarising and focusing on the most important information and data. For a better presentation of the result, the data can be tabulated and presented as a pie chart, bar chart, or graph. The percentage method and statistical significance are two of the

methods used to analyse the data collected for this study. Finally, the researcher will draw concise, coherent, and holistic conclusions after analysing and concentrating on the answers to the thesis questions.

3.4.1 Method of Analysis

The survey's data was analysed using descriptive statistical techniques. To organise the large body of data in a systematic, fast, and reliable manner, an advanced and accurate analysis method was required. The Statistical Package for Social Science (SPSS) computer software was chosen as the best option available for this purpose.

3.5 Summary

The focus of this study is on the challenges and deriving knowledge about the challenges in order to build a solution. The justification for using the method has been provided in this chapter and its development has been explained. The next chapter presents the data analysis and result.

CHAPTER 4: DATA COLLECTION AND ANALYSIS

4.1 Introduction

In this chapter, an analysis will be conducted based on the information that was gleaned from the questionnaires survey that was carried out earlier. The first section of the chapter is comprised of the presentation of the findings obtained from the questionnaire survey, which serves as the chapter's introduction and provides an explanation of the data screening processes that were carried out before the statistical analysis. This is then followed by a description and elaboration of the demographics of respondents, as well as a detailed discussion of the occurrence of circular economy orders in the industries of respondents. Lastly, this is followed by a summary and conclusion. The final step involved deriving the factors and impacts of circular economy, as well as recommendations regarding the strategic ways in which circular economy can be improved to a minimum, based on the responses that the respondents gave to the questionnaires survey. This step was completed based on the fact that the final step involved deriving the factors and impacts of circular economy.

4.2 Mode of Data Collection

An online Google form is used to collect the data before the screening process is finished. Once the data have been collected, they will be extracted to the SPSS software version 28. Before beginning the statistical analysis, it is necessary to carry out the data screening in order to clean the data and make it accurate,

comprehensive, and ready to be analysed. This is accomplished by cleaning the data. In particular, inferential analysis relies heavily on this process to identify and eliminate errors, outliers, and assumptions that are violated.

4.3 Data Screening

An online Google form is used to collect the data before the screening process is finished. Once the data have been collected, they will be extracted to the SPSS software version 28. Before beginning the statistical analysis, it is necessary to carry out the data screening in order to clean the data and make it accurate, comprehensive, and ready to be analysed. This is accomplished by cleaning the data. In particular, inferential analysis relies heavily on this process to identify and eliminate errors, outliers, and assumptions that are violated.

4.4 Questionnaires Response Rate

The questionnaire survey was carried out by way of an online channel, and responses were collected using an online questionnaire survey that was distributed. The documentation of the data had been gathered online so that it could be used for this research project. Overall, there were a hundred different questionnaires and surveys that were handed out. However, there were only 71 numbers of questionnaires, which corresponds to a response rate of 71% of the total questionnaire survey.

However, given that the survey was carried out solely through the use of web-based (online) surveys, a response rate of 71% is considered adequate and

satisfactory. According to Monroe and Adams (2012), there are several advantages to using online surveys; however, one of the most significant drawbacks is that response rates for online surveys are, on average, 11% lower than those for mail and phone surveys. Table 4.1 contains a tabulation of the responses broken down according to the questionnaires survey response rate. The 71 people who filled out the survey and provided their responses.

Table 0-1 represents the rate of respondents

Respondents' Feedback	Frequency	Percentage (%)
Response	71	71%
No Response	29	29%
Total	100	100%

4.5 Reliability Test

A Reliability Test was carried out to determine whether or not the research data that had been collected was reliable for the purpose of this study. The Cronbach's Alpha value was found to be greater than.7 when the variables were analysed using tables 4.2 and 4.3.

According to (Mohajan, 2017), the Cronbach's alpha is a test that is frequently utilised in the process of measuring the internal reliability, and the expected result of .70 and above implies an acceptable level. On the basis of this evidence, it is possible to reach the conclusion that the validated data response possesses an adequate degree of internal reliability for more advanced analysis.

Table 0-2 reliability statistics

Scale	Number of items	Cronbach's alpha
Likert scale	59	.940
Total	71	>.700

Table 0-3 reliability statistics by item

Reliability test Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
How well do you understand the concept of 'circular economy'?	194.44	862.147	-.095	.941
Do you consider yourself familiar with the term Circular Economy?	194.39	861.483	-.081	.941
Do you agree with the following statement . . . ? The 'circular economy' is just another word for reducing, reusing and recycling materials	194.31	832.767	.394	.939

Given that “A circular economy is an alternative to a traditional linear economy (make, use &dispose of) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life”, do you consider your company to be implementing a similar approach currently?	194.54	866.390	-.188	.942
How important is adopting circular economy principles to your organization? [Close material loops;]	194.34	856.745	.001	.941
How important is adopting circular economy principles to your organization? [Reduce; Reuse; Recycle;]	194.31	842.043	.282	.940
How important is adopting circular economy principles to your organization? [Systems thinking;]	194.34	845.780	.209	.940

How important is adopting circular economy principles to your organization? [Renewable energy use;]	194.32	845.188	.224	.940
How important is adopting circular economy principles to your organization? [Build resilience;]	194.07	858.375	-.026	.941
How important is adopting circular economy principles to your organization? [Design out waste;]	194.34	863.918	-.125	.942
How important is adopting circular economy principles to your organization? [Share resources;]	194.12	847.279	.173	.940
How important is adopting circular economy principles to your organization? [Increase exchange]	194.12	852.003	.086	.941
What do the components from the circular economy generated in your organization represent to you? [Discards to dispose of in landfill]	193.58	842.490	.200	.940
What do the components from the circular economy generated in your organization represent to you? [Materials to recycle]	193.32	838.981	.273	.940

What do the components from the circular economy generated in your organization represent to you? [Waste to incinerate]	193.76	872.943	-.246	.943
What do the components from the circular economy generated in your organization represent to you? [By-products valuable to others]	193.78	864.864	-.118	.942
What do the components from the circular economy generated in your organisation represent to you? [Hazardous materials to manage carefully]	193.37	840.514	.233	.940
AMONG THE 'EXTERNAL CIRCULAR ECONOMY BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE TO YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [lack of awareness and sense of urgency]	194.24	823.288	.500	.938

AMONG THE 'EXTERNAL CIRCULAR ECONOMY BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE TO YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Inconsistent policies and messages]	194.54	823.459	.507	.938
AMONG THE 'EXTERNAL CIRCULAR ECONOMY BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE TO YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Lack of clear pricing signals]	194.46	822.390	.617	.938

AMONG THE 'EXTERNAL CIRCULAR ECONOMY BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE TO YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Lack of consumer demand]	194.42	808.904	.692	.937
AMONG THE 'EXTERNAL CIRCULAR ECONOMY BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE TO YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Supply chain constraints]	194.53	808.633	.758	.937

AMONG THE 'EXTERNAL CIRCULAR ECONOMY BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE TO YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Thresholds in technologies and infrastructure capacity]	194.37	821.100	.646	.938
AMONG THE 'EXTERNAL CIRCULAR ECONOMY BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE TO YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Physical limitation (e.g. location / space]	194.36	821.544	.571	.938

AMONG THE 'EXTERNAL CIRCULAR ECONOMY BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE TO YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [External support and assistance]	194.51	810.668	.656	.937
AMONG THE 'EXTERNAL CIRCULAR ECONOMY BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE TO YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Incentives to invest]	194.31	810.354	.688	.937

AMONG THE 'EXTERNAL CIRCULAR ECONOMY BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE TO YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [High cost and low ROI (Return on Investment)]	194.25	815.848	.564	.938
AMONG THE 'EXTERNAL CIRCULAR ECONOMY BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE TO YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Access to capital]	194.58	820.835	.591	.938

AMONG THE 'EXTERNAL CIRCULAR ECONOMY BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE TO YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Lack of targets and benchmarks]	194.51	817.289	.643	.938
AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [High cost and low ROI (Return on Investment)]	194.20	810.199	.634	.937

AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Knowledge and expertise]	194.44	815.044	.627	.938
AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Competing priorities]	194.34	822.676	.578	.938

AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Internal capacity and resources]	194.47	814.633	.640	.938
AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Habitual behavior]	194.29	818.381	.657	.938

AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Negative attitudes and cultures]	194.36	817.026	.627	.938
AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [Lack of perception of CE as a priority due to low resources, short-term vision, and lack of time;]	194.41	808.314	.707	.937

AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [CE awareness depends on the level of education;]	194.36	814.957	.692	.937
AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [CE practices dependent on age (younger generation more familiar than senior)]	194.86	837.533	.316	.939

AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [CE transition as a long process requiring economic and educational support for its implementation;]	194.36	813.509	.674	.937
AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [lack of clear, standardized, quantitative measurement and goals for assessing the performance of a circular model]	194.46	808.287	.726	.937

AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [limited attention to end-of-life phase in current product designs]	194.49	814.737	.703	.937
AMONG THE 'INTERNAL CIRCULAR ECONOMY (CE) BARRIERS & CHALLENGES' BELOW, WHICH HAS THE MOST INFLUENCE ON YOUR ORGANISATION? Rate your response based on 1, 2, 3, 4 or 5 [higher costs for management and planning]	194.39	808.001	.758	.937
Which of the following do you think would be strong motivators to transition to a more circular economy approach? [Limited resource supply]	193.86	828.326	.479	.939

Which of the following do you think would be strong motivators to transition to a more circular economy approach? [Increasing of future profits]	193.71	824.174	.589	.938
Which of the following do you think would be strong motivators to transition to a more circular economy approach? [Sustainable business strategy]	193.90	822.886	.588	.938
Which of the following do you think would be strong motivators to transition to a more circular economy approach? [Entering new markets]	193.98	830.914	.441	.939
Which of the following do you think would be strong motivators to transition to a more circular economy approach? [Public opinion;]	194.24	842.667	.279	.940
Which of the following do you think would be strong motivators to transition to a more circular economy approach? [Energy savings]	193.95	821.601	.628	.938

Which of the following do you think would be strong motivators to transition to a more circular economy approach? [Fluctuating resource prices]	194.02	825.189	.496	.938
Which of the following do you think would be strong motivators to transition to a more circular economy approach? [Enforcements by law]	193.90	826.679	.512	.938
Which of the following do you think would be strong motivators to transition to a more circular economy approach? [Keeping up with competitors]	193.93	823.754	.559	.938
Which of the following do you think would be strong motivators to transition to a more circular economy approach? [Reduce waste]	193.73	825.546	.512	.938
Which of the following do you think would be strong motivators to transition to a more circular economy approach? [Avoid landfill]	193.88	822.899	.497	.938

Which of the following do you think would be strong motivators to transition to a more circular economy approach? [Decrease costs]	193.97	815.999	.679	.937
Which of the following do you think would be strong motivators to transition to a more circular economy approach? [increase in awareness, knowledge & performance.]	193.83	822.109	.591	.938
Which of this implementation strategy will improve your organization? [An individual company effort adoption]	194.07	823.961	.579	.938
Which of this implementation strategy will improve your organization? [A national adoption effort]	194.02	825.396	.555	.938
Which of this implementation strategy will improve your organization? [Collective effort from both government and individual company adoption]	193.90	818.610	.653	.938

4.6 Section A: Demographics

This field of study known as demographics focuses on studying the characteristics of populations. The demographics study presents the detailed profile of the respondents in this research. This profile includes the respondent's job position, working experience, and the aspect of the construction industry with which they are involved and their level of understanding.

4.6.1 Job Position and Working Experience

Table 4.4 provides the information regarding the demographic details of the respondents, which classified the respondents' job position, as well as their years of experience working in the construction industry. In general, nearly half of the respondents, who made up the majority of those who participated in the survey, held the position of project supervisor (16%) and Design team (16%). This is followed by managerial positions at 12%, project coordinator/project director positions at 7%, academia/others position at 3% and non-exclusive positions at (2%).

In terms of their working experience, the vast majority of respondents have a considerable amount of experience; however, there are a few respondents who have less than a year's worth of work experience. 28% of the total responses come from people who have been working in the construction industry for more than six years, and these people make up most of the respondents. However, the total percentage of respondents from the second highest category (4 to 6 years) and the third highest category (2 to 4 years) as well as the percentage of respondents from

1 to 2 years with a total percentage of 6%. As a result, this will contribute to an increase in the research's overall reliability.

Table 0-4 years of experience

Job Position		**Years of Experience**					
		Frequency					**Percentage (%)**
	1-2 years	2-4 years	4-6 years	Less than one year	More than 6 years	**Total**	
Academician	0	0	1	0	2	3	6%
Designing team	1	4	4	1	6	16	16%
Executive	0	1	1	0	3	5	5%
Managerial	0	1	5	1	5	12	12%
Non-Executive	0	2	0	0	0	2	2%
Project coordinator	0	1	1	1	4	7	7%
Project director	0	3	0	0	4	7	7%
Project supervisor	3	1	9	0	3	16	16%
Others	2	0	0	0	1	3	3%
Total	6	13	21	3	28	71	100
Percentage (%)	6%	13%	21%	3%	28%	71%	

4.6.2 Qualifications

The next consideration is the respondent's qualification; based on this consideration, one can obtain accurate answers regarding the respondent's skill, knowledge, and awareness. The following chart illustrates the level of expertise possessed by pioneers in their respective fields of work and guarantees the depth of their comprehension of the subject matter. And the information that they have concerning it.

Table 0-5 cumulative % of qualifications

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Associate degree	7	9.9	9.9	9.9
	Bachelor's degree	22	31.0	31.0	40.8
	diploma or advance diploma	9	12.7	12.7	53.5
	Doctorate degree	3	4.2	4.2	57.7
	Master's degree	19	26.8	26.8	84.5
	No schooling completed	1	1.4	1.4	85.9
	Professional degree	10	14.1	14.1	100.0
	Total	71	100.0	100.0	

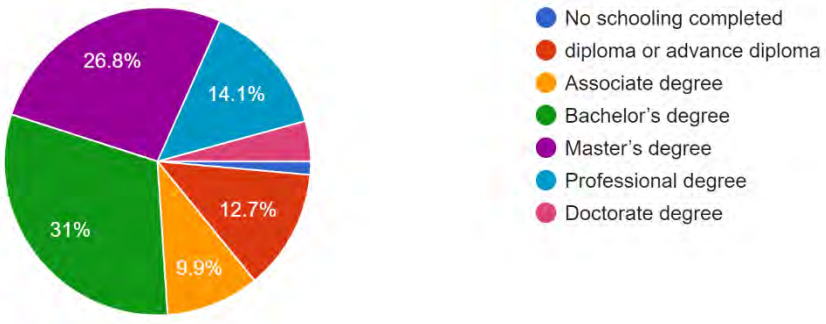


Figure 0-1 represent the qualifications of respondents

The data for all 71 respondents can be seen in their entirety in the figure 4.1 that was just presented. The highest percentage of respondents, 31.0%, or 22 of them, have a degree. Those with a master's degree come in second with 26.8%, then those with a professional degree with 14.1%, and finally those with a diploma level response come in third with 12.7%, or 9 of them. 19 of the respondents held master's degrees, 10 held doctoral degrees, and 9.9% had associate degrees. As a connection to familiarity with and comprehension of interface management, level education is regarded as a priority in the process of bolstering the data that has been analysed.

4.6.3 Field of Profession

For the purpose of obtaining accurate data based on a professional's responsibilities, knowledge, and specialisation in the performance of their duties or duties, it is important to be familiar with the relevant professional fields. It is essential to conduct this analysis so that accurate measurements can be taken of their perceptions regarding the implementation of circular economy in the construction industry.

Table 0-6 shows the % of respondent professions

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Architect	15	21.1	21.1	21.1
	Consulting Engineer	10	14.1	14.1	35.2
	Developer/Client	5	7.0	7.0	42.3
	Government Agencies	3	4.2	4.2	46.5
	Main Contractor	17	23.9	23.9	70.4
	Others	1	1.4	1.4	71.8
	Real Estate	14	19.7	19.7	91.5

	Subcontractor	5	7.0	7.0	98.6
	Vendors/Supplier/Solution Providers	1	1.4	1.4	100.0
	Total	71	100.0	100.0	

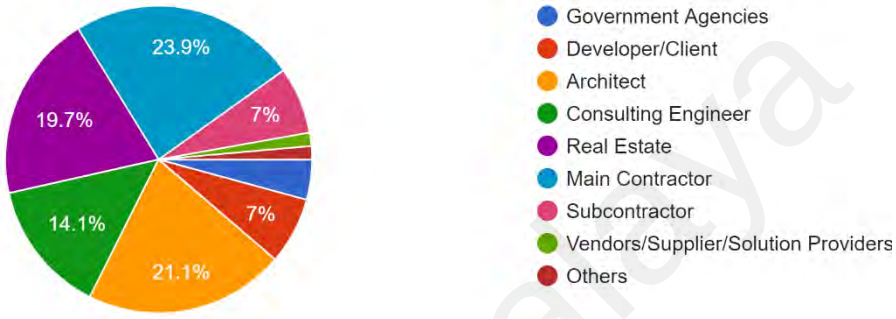


Figure 0-2 represent the level of respondent professions

4.6.4 Level of Understanding

Correlation and ANOVA between level of understanding and how well is the respondent familiar with circular economy

The relation between the scale of the respondents' level of understanding in circular economy and how well they are familiar with circular economy are likely to occur in neutral level, an ANOVA graph analysed and tabulated in Table 4.7. From the data obtained, the sig value is below .005 which is <.001. and that makes it statistically significant. The data obtained revealed high familiarity of circular economy. On the other hand, less understanding and involvement numbers of variation.

Table 0-7 respondent correlation level of understanding

Correlations			
		How well do you understand the concept of 'circular economy'?	Do you consider yourself familiar with the term Circular Economy?
How well do you understand the concept of 'circular economy'?	Pearson Correlation	1	.582**
	Sig. (2-tailed)		<.001
	N	71	71
Do you consider yourself familiar with the term Circular Economy?	Pearson Correlation	.582**	1
	Sig. (2-tailed)	<.001	
	N	71	71
**. Correlation is significant at the 0.01 level (2-tailed).			

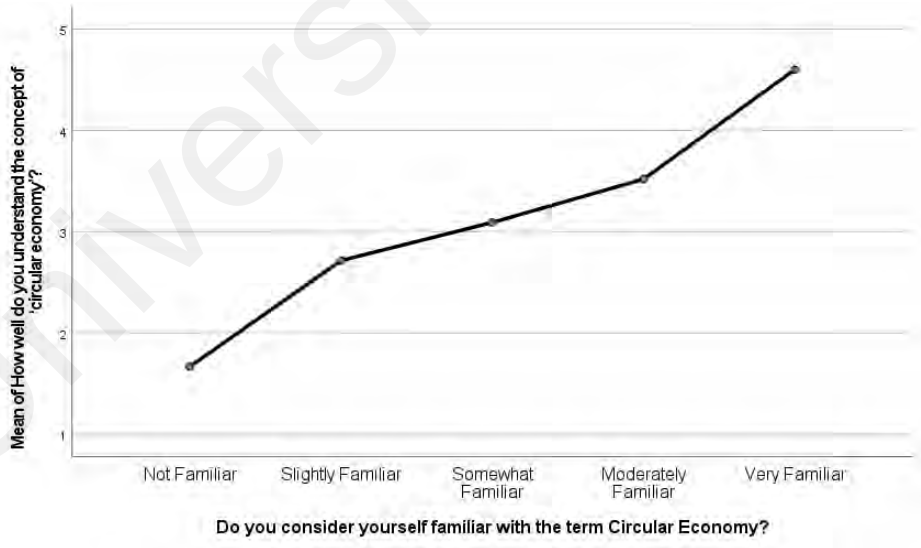


Figure 0-3 ANOVA graph of respondent level of understanding

4.7 Section B: Organization Information on Awareness and Perceptions of Circular Economy.

4.7.1 How important is adopting circular economy principles.

Using descriptive analysis table 4.8 shows the result of the mean and standard deviation for 8 elements on the status of organization awareness and perspectives on circular economy by the pioneers of Malaysia construction industry. The first element pointed out that majority of the respondent agree that it is moderately important their organization should adopt the concept of circular economy principle to close material loops in structured project and framework for the team to utilize during the project execution stage (M=3.27, SD=1.028).

For element 2, the findings indicated that the respondent's organisation believes that the adoption of "Reduce," "Reuse," and "Recycle" in organisation practise and execution in projects is an important practise level (M = 3.34, SD =.894). Next, with regard to element 3, the respondent is leaning toward agreement that their organisation must start or continue the systemic thinking and acquire the necessary expertise to assist the project team and the organisation as a whole in carrying out the circular economy exercise (M=3.23, SD=.944).

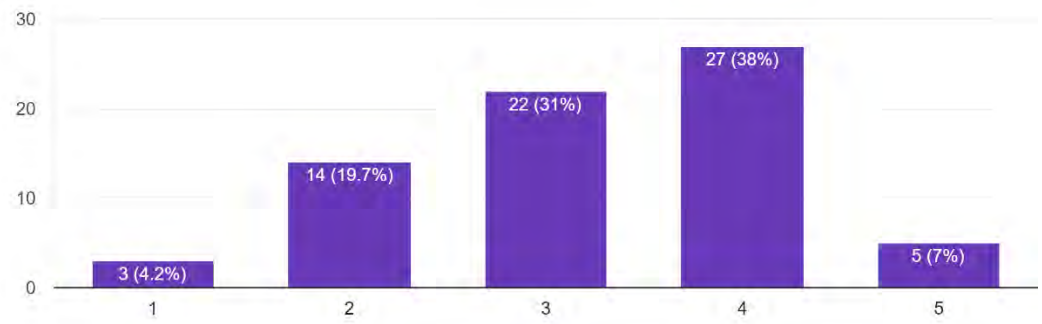
Next, with regard to element 3, the respondent is leaning toward agreement that their organisation must start or continue the systemic thinking and acquire the necessary expertise to assist the project team and the organisation as a whole in carrying out the circular economy exercise (M=3.23, SD=.944). Following that, Element 4 demonstrated that the respondent had a tendency to agree that the use of

renewable energy in their organisation needs to be placed in the necessary requirement for project teams and the construction industry as a whole (M = 3.32, SD =.922).

In addition, Element 5 demonstrated that the organisation should build resilience, Element 6 designed out waste, Element 7 shared resources, and Element 8 increased exchange, all of which agree that the organisation should be aware of different practises in the construction industry for the importance of improvement and the project life cycle.

Table 0-8 result analysis on organization awareness and perspectives

	Descriptive Statistics					
Element number	Organization information on awareness &perception	N	Minimum	Maximum	Mean	Std. Deviation
1	[Close material loops;]	71	1	5	3.27	1.028
2	[Reduce; Reuse; Recycle;]	71	2	5	3.34	.894
3	[Systems thinking	71	2	5	3.23	.944
4	[Renewable energy use;]	71	1	5	3.32	.922
5	[Build resilience;]	71	1	5	3.51	.876
6	[Design out waste;]	71	1	5	3.28	.944
7	[Share resources;]	71	1	5	3.52	.969
8	[Increase exchange]	71	1	5	3.48	.954
	Valid N (listwise)	71				



4.7.2 The Components from The Circular Economy Generate in Respondent Organization.

Table 4.9 displays the results of the survey question asked of respondents regarding the presence or absence of a component of circular economy in their respective organisations, along with the corresponding Likert scale responses of Always, Very Frequently, Occasionally, Rarely, Very Rarely, and Never. On the other hand, based on the information that was gathered, Element 1 demonstrates that there is an occasional instance of the practise of discards being disposed of in landfills (M = 4.00, SD =1.207). According to the outcome of element 2, where the M value is 4.27 and the SD value is 1.146, very common materials to recycle are occasionally taken into consideration.

According to the findings of Element 3, the majority of respondents have a favourable attitude toward the practise of incinerating waste in the construction industry, which is an essential part of a circular economy (M = 3.85, SD =1.117). The significance of by-products that are valuable to others, which is element 4, and hazardous materials that need to be managed, which is element 5, appears to come up quite frequently in the responses.

Table 0-9 components from the circular economy

Element number		N	Minimum	Maximum	Mean	Std. Deviation
1	[Discards to dispose of in landfill]	71	1	6	4.00	1.207
2	[Materials to recycle]	71	1	6	4.27	1.146
3	[Waste to incinerate]	71	1	6	3.85	1.117
4	[By-products valuable to others]	71	1	6	3.87	1.230
5	[Hazardous materials to manage carefully]	71	1	6	4.23	1.198
	Valid N (listwise)	71				

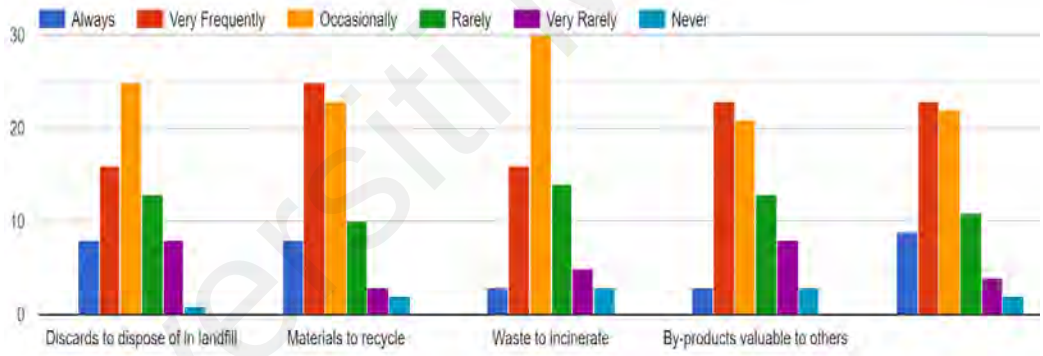


Figure 0-4 showing the graphical illustration

4.8 Section C: Barriers & Challenges of the Adoption and Implementation of Strategy.

4.8.1 The External Circular Economy Barriers and Challenges

The result of the output that was generated can be seen in table 4.10, which can be found below. It was mentioned that the majority of the variables were rated

on a five-point Likert scale, with 5 strongly agree, 4 agree, 3 neutral, 2 disagree, and 1 strongly disagree. It is clear to see from the scale that the percentages for the question lack of awareness and sense of urgency that organisation frequently encountered on the external barrier and challenges is 32.4% agreed as one of the highest factors contributing to the challenges. This is one of the highest factors contributing to the challenges. The next barrier is inconsistent policies and messages, with a percentage of 32.4% being considered as neutral level, which still counts as not suitable and is one of the challenges. absence of transparent pricing. Pricing is one of the most important aspects of the industry for the construction sector. 43.7% of respondents were agnostic regarding the lack of a clear price.

Nevertheless, the next obstacle is based on the demand from customers. In addition to this, it took no stance on the table and contributed 31.0%. It was found that one of the barriers to the adoption of circular economy in the construction industry was supply chain constraints, thresholds in technologies and infrastructure capacity, a lack of external support and assistance, a lack of access to capital, and also a lack of targets and benchmarks. This percentage, 36.6%, was found to fall under the same category as one of the barriers. As a percentage, 35.2% of people reported that their experience with physical limitations (such as location or space) was neutral. Nevertheless, high costs and a low ROI (return on investment) were reported to be one of the most important and strongly agreed-upon factors by 33.8% of respondents, along with access to capital, which was mentioned by 36.6% of respondents.

Table 0-10 External barriers & challenges

External barriers & challenges	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
lack of awareness and sense of urgency	5.6%	25.4%	21.1%	32.4%	15.5%
Inconsistent policies and messages	7.0%	26.8%	32.4%	22.5%	11.3%
Lack of clear pricing signals	4.2%	22.5%	43.7%	21.1%	8.5%
Lack of consumer demand	9.9%	25.4%	31.0%	18.3%	15.5%
Supply chain constraints	5.6%	26.8%	40.8%	12.7%	14.1%
Thresholds in technologies and infrastructure capacity	2.8%	23.9%	29.6%	36.6%	7.0%
Physical limitation (e.g. location / space)	2.8%	26.8%	35.2%	22.5%	12.7%
External support and assistance	8.5%	23.9%	36.6%	15.5%	15.5%
Incentives to invest	2.8%	32.4%	28.2%	18.3%	18.3%
High cost and low ROI (Return on Investment)	7.0%	22.5%	14.1%	22.5%	33.8%
Access to capital	5.6%	31.0%	18.3%	36.6%	8.5%
Lack of targets and benchmarks	5.6%	26.8%	36.6%	21.1%	9.9%

4.8.2 The Internal Circular Economy Barriers and Challenges.

There is an inadequate awareness level within the internal barrier of the organisation, as shown in table 4.11, as well as a lack of perception of CE as a priority due to low resources, short-term vision, and lack of time with regards to higher costs for management and planning strongly agree with percentage of 36.6%. This is one of the factors that is holding back the adoption of internal circular economy.

It also demonstrated that the highest percentage was from of the CE practises dependent on age (younger generations are more familiar than senior generations), which is 44.3% and result to be neutral. This was shown to be the case. Not having adequate resources awareness, knowledge, and expertise on the benefits that can be achieved by implementing circular economy practises in order to achieve growth in the industry are all necessary. The results that were gathered from the CE transition, which was a lengthy process that required financial and educational support for its implementation, showed further that the implement is neutral with the percentage of 33.8% having sufficient knowledge with regards to circular economy processes to be utilised during the execution phase as well as the associated tools and techniques to be adopted in mitigating the uncertainty that may potentially jeopardise the project from meeting its intended goals. 35.2% of respondents said they strongly disagreed with the statement that current product designs pay limited attention to the end-of-life phase, and overall, in all higher costs for management and planning resulted in respondents strongly agreeing with the statement, which is one of the major factors.

Table 0-11 Internal barriers and challenges

Internal barriers and challenges	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
High cost and low ROI (Return on Investment)	7.4%	25.0%	17.6%	30.9%	19.1%
Knowledge and expertise	7.4%	26.5%	25.0%	29.4%	11.8%
Competing priorities	5.9%	22.1%	11.8%	20.6%	39.7%
Internal capacity and resources	11.6%	20.3%	33.3%	21.7%	13.0%
Habitual behavior	1.4%	24.6%	33.3%	29.0%	11.6%

Negative attitudes and cultures	4.3%	28.6%	20.0%	32.9%	14.3%
Lack of perception of CE as a priority due to low resources, short-term vision, and lack of time	7.0%	25.4%	14.1%	19.7%	33.8%
CE awareness depends on the level of education;	1.4%	29.6%	14.1%	21.1%	33.8%
CE practices dependent on age (younger generation more familiar than senior)	11.4%	28.6%	44.3%	10.0%	5.7%
CE transition as a long process requiring economic and educational support for its implementation	2.8%	31.0%	33.8%	18.3%	14.1%
lack of clear, standardized, quantitative measurement and goals for assessing the performance of a circular model	5.6%	31.0%	28.2%	22.5%	12.7%
limited attention to end-of-life phase in current product designs	1.4%	35.2%	32.4%	21.1%	9.9%
higher costs for management and planning	4.2%	28.2%	15.5%	15.5%	36.6%

4.8.3 Strong Motivators to Transition to a More Circular Economy Approach.

According to the findings, only 42.3% of respondents indicated that a national adoption effort is very important in order to have a strong motivator in the process of transitioning to an approach based on a circular economy. whereas the opinion of the public is also important because they are going to be the customer.

Nevertheless, the result demonstrates that 39.4% of the general public's opinion is relevant. 38% of sustainable business, which is very important in this regard, 38% of waste reduction, which is one of the fundamental principles of circular economy, and an individual company effort adoption was shown in the result as an important component of the transition. And then after that came 36.6% of both keeping up with competitors' projects and avoiding landfill, both of which are additional factors that need to be taken seriously. And whatever law is enforced to be followed by the government in order to govern the country was also found to be important as 35.2% of the total in the results.

Utilization of collective effort from both the government and individual company adoption from the results was found to be a moderately important factor with the percentage of 36.6%, while fluctuations in resource prices were also found to be a moderately important factor with the value of 35.2%. Based on the findings, it is clear that each of the aforementioned considerations for the transition to a circular economy plays a significant part in the overall strategy.

Table 0-12 Strong Motivators to Transition

	Not Important	Slightly Important	Moderately Important	Important	Very Important
[Limited resource supply]	0.0%	16.9%	26.8%	32.4%	23.9%
[Increasing of future profits]	0.0%	9.9%	31.0%	31.0%	28.2%
[Sustainable business strategy]	2.8%	9.9%	29.6%	38.0%	19.7%
[Entering new markets]	1.4%	12.7%	35.2%	32.4%	18.3%

[Public opinion;]	1.4%	15.5%	36.6%	39.4%	7.0%
[Energy savings]	0.0%	14.1%	33.8%	31.0%	21.1%
[Fluctuating resource prices]	4.2%	11.3%	35.2%	26.8%	22.5%
[Enforcements by law]	2.8%	9.9%	31.0%	35.2%	21.1%
[Keeping up with competitors]	1.4%	12.7%	29.6%	36.6%	19.7%
[Reduce waste]	5.6%	2.8%	28.2%	38.0%	25.4%
[Avoid landfill]	5.6%	8.5%	23.9%	36.6%	25.4%
[Decrease costs]	1.4%	12.7%	36.6%	28.2%	21.1%
[increase in awareness, knowledge & performance.]	2.8%	9.9%	33.8%	26.8%	26.8%
[An individual company effort adoption]	4.2%	9.9%	32.4%	38.0%	15.5%
[A national adoption effort]	2.8%	14.1%	25.4%	42.3%	15.5%
[Collective effort from both government and individual company adoption]	0.0%	11.3%	36.6%	23.9%	28.2%

4.8.4 Which of this implementation strategy will improve your organization

According to the findings presented in table 4.13 using the Likert scale of Not Important, Slightly Important, Moderately Important, Important, and Very Important to demonstrate a more appropriate adoption and also shown in figure 4.5, it is stated that the majority of the percentages come from the adoption of individual effort, as well as the adoption of national effort, which appears to be both 38.0% and 42.3%.

Table 0-13 implementation strategy

	An individual company effort adoption	A national adoption effort	Collective effort from both government and individual company adoption
Not Important	4.2%	2.8%	0.0%
Slightly Important	9.9%	14.1%	11.3%
Moderately Important	32.4%	25.4%	36.6%
Important	38.0%	42.3%	23.9%
Very Important	15.5%	15.5%	28.2%

Figure 0-5 implementation strategy

4.8.5 Other 'possible strategy' to improve the implementation of circular economy

In addition to the strategy for its implementation, a few pieces of feedback were provided on a strategy to adopt the practice of circular economy in the Malaysian construction industry. One of these pieces of feedback stated that

national level awareness programs, subsidies, and incentives should be implemented. In the short term, the government needs to take the lead in directing the respective industries to enforce it, but in the long term, it needs to develop it into organizational culture and self-regulation. Additionally, another respondent argues that collaborative efforts from governments as well as individual businesses could be of great assistance in improving the implementation of circular economy. However, another respondent also stated that the most effective method of promoting the circular economy is to extend the product life cycle by using durable materials and making long-life products that can be repaired and that are reused at the end of their life cycle. This was stated as the most efficient way to promote the circular economy. Make sure that no harmful substances are used in the production of materials because this will prevent recirculation from occurring, which will result in the materials becoming hazardous waste or being burned. Prepare the materials to be reused in the future by planning and developing them in advance. Increase your level of collaboration with the various businesses that are a part of the supply chain and learn more about the circular economy together. Several other respondents brought up the idea of informing the employees of the significance of the matter and instituting stringent regulations. The initiatives taken by Top Management to ensure that the company's vision is effectively implemented. Instruction in the information and comprehension required by design regulations.

CHAPTER 5: DISCUSSION

5.1 Introduction

In this chapter discussion is going to be made in this section with reference to the results that were obtained from the survey, and it's going to correlate with studies that have been carried out in the past. This will make it possible to identify barriers and challenges in order to find solutions to the proposed research question that was presented earlier in chapter 1.

No	Question
1	What are the understanding of circular economy in Malaysia construction industry?
2	What are the post articular in circular economy?
3	How to recommend the strategies for improving the adoption of circular economy?

5.2 Demographic

It is clear from the findings of the survey that the respondents come from a variety of professional backgrounds. The project supervisors and design team members make up a significant proportion of the respondents, in contrast to the findings of the earlier study, which focused primarily on the feedback provided by design teams (architects). It is possible to draw the conclusion that, in comparison to earlier times, now that information is easily accessible and in a more developed form, more people are willing to understand and learn more about circular economy in the construction industry. It is also possible to observe that the majority of respondents

are members of the working class and are well-oriented in terms of their working experience and a sound qualification. According to the respondent, one can observe that despite having a well-oriented education and experience, one can still be considered a novice in the practise of circular in the construction industry. This can be seen as a potential issue. The findings demonstrate that merely being familiar with the concept of a circular economy is not the same as understanding it. It has come to my attention that a relatively high percentage of people are familiar with the method, but they do not fully comprehend how it operates.

5.3 Organization Information on Awareness and Perceptions of Circular Economy.

In order to determine the understanding of circular economy in Malaysia construction industry from the first objectives. This section discusses on the status of awareness towards circular economy in Malaysia construction industry pioneers. The results shows that 38% of the respondents to some degree had indicated a level of awareness. Moreover, the input from the responses obtained are based on the view of 71 respondents on the scale of 100% having bachelor degree as 31% and masters as 26.8% which form the most input toward the consolidated data. This reflects the understanding of the construction industry pioneers as well as the organization that they are currently serving.

Nuez-Cacho et al. (2018) developed the first comprehensive evaluation system, which is beneficial for entities involved in construction projects that are carried out in accordance with the requirements of the Circular Economy. Their significant

contribution was a plan for the various dimensions that make up the scale. Management of energy, water, and waste, as well as adherence to the principles of the 3Rs, are the most important factors to consider when evaluating the degree to which the circular economy has been incorporated into the building and construction sector (Reduce-Reuse-Recycle). Emissions, Material, and Transition of CE are said to be the three most important aspects, according to the authors. On the other hand, we are able to entertain the possibility that the involvement is either unimportant or non-existent given the findings of the investigation. The survey found that the construction industry in Malaysia has a long way to go in terms of gaining awareness. The majority of respondents are not familiar with the concept of circular economy, and it is not being practised in an effective manner.

5.4 Barriers & Challenges of the Adoption Circular Economy

In order to ascertain the post articular in CE, information regarding the hurdles and problems in CE was obtained in respect to the second purpose. Knowing the obstacles in CE in terms of finances, expertise, awareness, and a host of other factors was crucial for this surgery. This is supported by survey findings on barriers and challenges that are both internal and external, with the vast majority of participants admitting that there is a lack of awareness and urgency, as well as a lack of knowledge and ability.

However, considering the other factors and also supporting the findings. According to (Altaf et al., 2022) also stated that, the saturation of markets for recycled construction materials can become a crucial factor if there is an increase in the

distance between project sites and recycling facilities. This is due to the fact that an increase in the distance between project sites and recycling facilities It's possible that the advantages of recycling could be nullified by certain constraints, such as location or space. According to the findings of the study, further increases in recycling activities are contingent upon the existence of a market (consumer demand) for recycled materials, regional recycling capacities (External support and assistance), total energy used to recycle, as well as the knowledge of the workers, expertise, and perception of CE as a priority due to low resources and short-term vision.

At Malaysian construction sites, the vast majority of pioneers in the construction industry do not practise source separation, source reduction, reuse, or recycling (Esa, Halog, Rigamonti, & Recycling, 2017). The findings of the study indicated that several of the most significant factors affecting the performance of the circular economy include construction-related education among employees, experience expertise in construction works, source reduction measures, and so on.

5.5 Implementation of Strategy

The perspectives of CE are expansive and alluring. Fundamental to advancing circular economy (CE) in Malaysia is a general increase in knowledge of the theoretical and practical framework of CE, as well as the monitoring of the currently existing in construction at the strategy, component, and level. The most important aspect, i.e., the one that appears to still require improvement, is the knowledge, understanding, and awareness of every aspect of circular economy, as

stated by several respondents on the Other 'possible strategy' to improve the implementation of circular economy and in correspondent to the last objective to recommend strategies for improving the adoption of circular economy in the Malaysian construction industry. However, there is a need to further investigate, in particular, the role played by the government agency associated to the Malaysian construction industry in order to enhance the training system already in place. Recommending better management, and initiatives taken by top management to ensure that the company's vision is effectively implemented. Last but not least, provide an economic incentive to work toward sustainable aims. The majority of those surveyed agreed with the needs of the government agencies within the Malaysian construction industry.

Literature demonstrates that the same factor is significant in other nations. The application of the idea of a circular economy, which is still in its infant stage, has primarily been restricted to the construction industry so far. According to the available research, there has been relatively little done on CE from a systems perspective and how to enable materials to maintain high values.

CHAPTER 6: CONCLUSION

6.1 Summary of Study

The most important part of this research was the conclusion that the level of knowledge and understanding regarding the CE was about the same as it had been before from the survey of the literature review. Overall, the findings of this study lend credence to the proposition that the construction industry urgently requires adopting a practise that is less linear and more circular in orientation. The CE concept is adaptable enough to be utilised as a method in the construction and construction sector. By investigating the various ways in which the CE idea can be incorporated at various stages of the building process, this study paves the way for further investigation in the future.

6.2 Review on Research Aim, Objective, Methodology, and Questions

This study is aimed to investigate the circular economy implementation in the Malaysian construction industry by providing the necessary recommendation for construction industry improvement towards the circular economy practices in the Malaysia construction industry.

3 objectives were crafted by researcher for the purpose of this study. Research question was utilized as a guide to address the identified research objective in accomplishing the research aim. The result from distributed online questionnaire has provided the answer in achieving this Research Objective.

Table 0-1Data Collection and analysis utilized to achieved Research Objective

No	Research Objectives	Data Collection and analysis
1	To identify the understanding of circular economy in Malaysia construction industry.	i. Literature Review ii. Questionnaire Survey (SPSS)
2	To determine the challenges in circular economy.	i. Literature Review ii. Questionnaire Survey (SPSS)
3	To recommend strategies for improving the adoption of circular economy in the Malaysian construction industry.	i. Questionnaire Survey (Content Analysis & SPSS) ii. Output from RO1 and RO2

RO1- To identify the understanding of circular economy in Malaysia construction industry.	RQ1- What are the understanding of circular economy in Malaysia construction industry?

On the first Research Objective, the status of Circular economy implementation was explored by focussing on 2 main aspect which covers the organization as well as the pioneers' awareness towards the circular economy practices. Under the organization, investigation was conducted through 5 main element which are the component circular economy generated to their organisation. Meanwhile on the pioneers, 3 elements were assessed which are the importance in adopting circular economy principles. Subsequently, further investigation was made to gauge the understanding and awareness of respondents on the benefit in applying circular economy practices.

RO2- To determine the challenges in circular economy.	RQ2- What are the post articular in circular economy?

For the second Research Objective, it was reviewed through literature review produced by scholar as well as in reference to the questionnaire. The circular economy process adopted by this study for purpose of questionnaire distribution was focusing on 2 main process which are the internal and external barriers and challenges of circular economy adoption. Under the assessment further question were embedded to determine the assessment method utilization. The availability circular economy technique were reviewed based on literature produced by scholars.

RO3- To recommend strategies for improving the adoption of circular economy in the Malaysian construction industry.	RQ3- How to recommend the strategies for improving the adoption of circular economy?

Subsequently for the Research Objective 3 and Research Question 3, the limitation and barriers faced by the construction industry from implementing a circular economy were identified based on the guidance from identified literature review. From the identified gap under section 5.3 and 5.4, the researcher was able to formulate 3 recommendations for consideration towards Malaysia construction Industry which are the highlighting on the role of government agency to enhance training and capability program specifically for constructions industry pioneers in the Malaysia, recommendation for a more proper management, initiatives taken by top Management to ensure that the company's vision is effectively implemented and lastly an economic incentive to paintings toward sustainable goa offer an economic incentive to paintings toward sustainable goals.

6.3 Summary of Findings

The findings of this study provide valuable insights into the acceptance, awareness, and understanding of circular economy and what it is in the construction industry in Malaysia. Better strategies for being able to meet the demand of the market won't be able to be developed until the industry has a complete understanding of the awareness and acceptance of the circular economy on the part of consumers. Companies that follow sustainable business strategies should engage consumers through awareness-raising communication campaigns and education on the consumption of circular economy products and services. They should also provide consumers with adequate information about recycled products and the characteristics of those products. In a similar vein, businesses should work to ensure the safety of their products by presenting objective proofs of the harmlessness of recycled goods and developing strategies to remove the possibility of their goods being mistakenly thought to be contaminated. In addition, and taking into account their limited influence, organisations should also develop educational and awareness campaigns in order to assist employees in improving their negative perceptions of the circular economy.

6.4 Research contribution

The perspectives of CE are huge and appealing. The study provides an insight on what is the actual challenges in the implementation status of circular economy in Malaysia construction industry. The outcome from the first and second research

objective were utilized for gap identification in determining the recommendation for Malaysia construction Industry to enhance the current challenges practices during execution phase of circular economy.

An overall increase of knowledge of theoretical and practical framework of circular economy, CE, as well as the monitoring of the presently existing construction projects at the different levels are fundamental for advancing CE progresses in Malaysia. The most important aspect, i.e., the one that still seems to need improvement, is the knowledge and awareness of Malaysia construction industry, because of the important role devoted to construction industry responsibility in Malaysia policies.

Having the knowledge of how circular economy is being implemented would assist the construction industry in crafting methods to further enhance the effectiveness of circular economy. This also indirectly support the capability and development and Malaysian Government initiative in transforming Malaysia and meeting the future demands of the economy. This study also provides a reference for other future studies pertaining to circular economy in the Malaysia construction Industry.

6.5 Research Limitation

The construction industry in Malaysia is the primary focus of this study, specifically looking at their understanding and awareness of the circular economy. As a result, only the Malaysian construction industry might benefit from using these data as a point of reference.

In addition, another limiting factor can be attributed to the general approach that was taken with the survey. In this case, the limitation of the result outcome for the construction industry was to acquire as many respondents as possible to participate in the survey within a limited amount of time. This presented a challenge. Due to the limited amount of time available, we were only able to collect quite a number of responses to validate the findings of the research. However, the survey was conducted using the non-probability method, the convenience sampling method, which have the most prefund understanding and broadly comprehensive indicative and enlightening as most of the key findings conformed to the delineation of the literature review.

6.6 Future Recommendation

This study, like all others, is based on the findings of a small sample of 71 survey responses from various aspects of the construction industry. In addition, the majority of responses come from the design team and project manager. Future research studies should therefore aim to collect a greater number of responses in order to generalise the findings across the sector and expand their geographic scope. Additionally, the collection of data from industries other than the construction industry would aid businesses in understanding the complexities and benefits of CE implementation. Quantitative survey-based methods, literature reviews from the past, and the application of statistical analysis techniques can further bolster the credibility of the findings. CE can be argued to be one of the most important emerging fields in the world and to provide researchers and businesses with numerous opportunities. As a result, this study can serve as a foundation for future

researchers who may look for ways to advance this field, thereby assisting the construction industry in achieving improved performance while maintaining an environmentally-responsible mindset –a much-needed concept in the modern world.

APPENDIX A

Questionnaire on the Circular Economy's implementation

Dear respondents,

Thank you for taking the time to complete the following survey. we appreciate the information you share, as it helps us learn more about what the construction industries are doing to protect natural resources while creating value and revenue.

One of the country's major construction players, Construction Industry Development Board (CIDB), has emphasised the need to strengthen the awareness, knowledge of circular economy understanding in the construction industry. However, some of the factors that affect the proper adoption of circular economy are financial, structural, and knowledge. Hence this research is intended to investigate the challenges of circular economy in Malaysian Construction Industry.

The questionnaire is to be completed by participants in the Malaysian Construction Industry. The survey process is anticipated to only take ten (10) to fifteen (15) minutes of your attention and response. Thank you.

The outcome of the study will assist in developing strategies that will be beneficial for the rapid adoption of circular economy in the Malaysian Construction Industry. Your kind response and feedback towards this survey will be very much appreciated. Thank you in advance for your participation.

PART A: GENERAL PERSONAL INFORMATION

1. How long have you worked for?

   ☐ Less than one year

   ☐ 1-2 years

   ☐ 2-4 years

   ☐ 4-6 years

   ☐ More than 6 years

2. What is the highest level of school you have completed? If currently enrolled, highest degree received.

   ☐ No schooling completed

   ☐ diploma or advance diploma

   ☐ Associate degree

   ☐ Bachelor's degree

   ☐ Master's degree

   ☐ Professional degree

   ☐ Doctorate degree

3. What aspect of the construction industry does your organisation represent?

   ☐ Government Agencies

   ☐ Developer/Client

   ☐ Architect

   ☐ Consulting Engineer

   ☐ Real Estate

   ☐ Main Contractor

☐ Subcontractor

☐ Vendors/Supplier/Solution Providers

☐ Others

4. What is your role in the organisation (hierarchy level)?

☐ Executive

☐ Managerial

☐ Project director

☐ Designing team

☐ Project supervisor

☐ Project Coordinator

☐ Consultant/Advisor

☐ Academician

☐ Non-Executive

☐ Others

5. How well do you understand the concept of 'circular economy'?

☐ Never heard of it (1)

☐ Very well (2)

PART B: ORGANISATION INFORMATION ON CIRCULAR ECONOMY AWARENESS, PERCEPTION & IMPLEMENTATION.

6. Do you consider yourself familiar with the term Circular Economy?

☐ Not Familiar (1)

☐ very familiar (2)

7. Do you agree with the following statement . . . ? The ‘circular economy’ is just another word for reducing, reusing, and recycling materials

   ☐ Strongly Disagree

   ☐ Disagree

   ☐ Neutral

   ☐ Agree

8. Strongly Agree Given that “A circular economy is an alternative to a traditional linear economy (make, use &dispose of) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life”, do you consider your company to be implementing a similar approach currently?

   ☐ Never (1)

   ☐ Always (5)

9. How important is adopting circular economy principles to your organisation? (Very Important, Important, Moderately Important, Slightly Important, Not Important)

	Very important	important	Moderately important	Slightly important	Not important
Close material loops.					

Reduce; Reuse; Recycle.					
Systems thinking.					
Renewable energy use.					
Build resilience.					
Design out waste.					
Share resources.					
Increase exchange					

10. What do the components from the circular economy generated in your organisation represent to you? (Always, Very Frequently, Occasionally, Rarely, Very Rarely, Never).

	Always	Very frequently	Rarely	Very rarely	Never
Discards to dispose of in landfill					

Materials to recycle					
Waste to incinerate					
By-products valuable to others					
Hazardous materials to manage carefully.					

PART C: BARRIERS & CHALLENGES OF THE ADOPTION AND IMPLEMENTATION OF CIRCULAR ECONOMY

11. Among the 'external circular economy barriers & challenges' below, which has the most influence on your organisation? Rate your response based on Strongly Disagree, Disagree, Neutral, Agree or Strongly Agree

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
lack of awareness and sense of urgency					

Inconsistent policies and messages					
Lack of clear pricing signals					
Lack of consumer demand					
Supply chain constraints					
Thresholds in technologies and infrastructure capacity					
Physical limitation (e.g., location / space					
External support and assistance					
Incentives to invest					
High cost and low ROI					

(Return on Investment)					
Access to capital					
Lack of targets and benchmarks					

12. Among the 'internal circular economy (CE) barriers & challenges' below, which has the most influence on your organisation? Rate your response based on Strongly Disagree, Disagree, Neutral, Agree or Strongly Agree

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
High cost and low ROI (Return on Investment)					
Knowledge and expertise					
Competing priorities					
Internal capacity and resources					
Habitual behavior					

Negative attitudes and cultures					
Lack of perception of CE as a priority due to low resources, short-term vision, and lack of time. (e.g., location / space					
CE awareness depends on the level of education.					
CE practices dependent on age (younger generation more familiar than senior)					
CE transition as a long process requiring economic and educational support for its implementation.)					
lack of clear, standardized, quantitative measurement					

and goals for assessing the performance of a circular model					
limited attention to end-of-life phase in current product designs					
higher costs for management and planning					

13. Which of the following do you think would be strong motivators to transition to a more circular economy approach? (Very Important, Important, Moderately Important, Slightly Important, Not Important)

	Very important	important	Moderately important	Slightly important	Not important
Limited resource supply					
Increasing of future profits					
Sustainable business strategy					

Entering new markets					
Public opinion.					
Energy savings					
Fluctuating resource prices					
Enforcements by law					
Keeping up with competitors					
Reduce waste					
Avoid landfill					
Decrease costs					
increase in awareness, knowledge & performance.					

14. Which of this implementation strategy will improve your organisation? (Very Important, Important, Moderately Important, Slightly Important, Not Important)

	Very important	important	Moderately important	Slightly important	Not important
An individual company effort adoption					
A national adoption effort					
Collective effort from both government and individual company adoption					

15. Besides the above strategy mentioned, what are other 'possible strategy' to improve the implementation of circular economy in your organisation?

_____
_____
_____

REFERENCES

(BNM), B. N. M. (2021).

(EPU), E. P. U. *The national SCP Blueprint 20162030, 2016, Putrajaya, Malaysia*.

(EPU), E. P. U. Eleventh Malaysia plan 2016–2020.

(JPSPN), J. P. S. P. N. (2021). Solid Waste Management Lab 2015 Report.

Acharya, D., Boyd, R., & Finch, O. J. A., Ellen MacArthur Foundation. (2018). From Principles to Practices: First steps towards a circular built environment.

Adams, K. T., Osmani, M., Thorpe, T., & Thornback, J. (2017). *Circular economy in construction: current awareness, challenges and enablers.* Paper presented at the Proceedings of the Institution of Civil Engineers-Waste and Resource Management.

Agamuthu, P., & Mehran, S. (2020). Circular economy in Malaysia. In *Circular Economy: Global Perspective* (pp. 241-268): Springer.

Ajayabi, A., Chen, H.-M., Zhou, K., Hopkinson, P., Wang, Y., & Lam, D. (2019). *REBUILD: Regenerative buildings and construction systems for a circular economy.* Paper presented at the IOP Conference Series: Earth and Environmental Science.

Akanbi, L. A., Oyedele, L. O., Akinade, O. O., Ajayi, A. O., Delgado, M. D., Bilal, M., . . . Recycling. (2018). Salvaging building materials in a circular economy: A BIM-based whole-life performance estimator. *129*, 175-186.

Altaf, M., Alalaoul, W. S., Musarat, M. A., Hussain, A., Saad, S., Rabbani, M. B. A., & Ammad, S. J. A. S. E. J. (2022). Evaluating the awareness and implementation level of LCCA in the construction industry of Malaysia. *13*(5), 101686.

ANDERSSON TORSTENSSON, L. (2016). Internal barriers for moving towards circularity-An industrial perspective. In.

Arina, D., Bendere, R. J. E. R., Engineering, & Management. (2018). Waste as energy source in EU action plan for the circular economy. *74*(1), 43-49.

Barford, A., Ahmad, S. R. J. C. E., & Sustainability. (2021). A call for a socially restorative circular economy: waste pickers in the recycled plastics supply chain. 1-22.

Benachio, G. L. F., Freitas, M. d. C. D., & Tavares, S. F. J. J. o. C. P. (2020). Circular economy in the construction industry: A systematic literature review. *260*, 121046.

Benton, D., Coats, E., & Hazell, J. J. G. A., London. (2015). A circular economy for smart devices: Opportunities in the US, UK and India.

Bocken, N. M., De Pauw, I., Bakker, C., Van Der Grinten, B. J. J. o. i., & engineering, p. (2016). Product design and business model strategies for a circular economy. *33*(5), 308-320.

Braungart, M., & McDonough, W. Social Justice Entrepreneurship Resources.

Braungart, M. J. J. o. I. A. (2019). THE CRADLE TO CRADLE MOVEMENT. *73*(1), 299-304.

Bressanelli, G., Adrodegari, F., Perona, M., & Saccani, N. (2018). Exploring How Usage-Focused Business Models Enable Circular Economy through Digital Technologies. *Sustainability, 10*(3), 639. doi:10.3390/su10030639

Brown, P., Bocken, N., & Balkenende, R. J. S. (2020). How do companies collaborate for circular oriented innovation? *, 12*(4), 1648.

Byrd, R. (2021). Qualitative research methods.

Cantú, A., Aguiñaga, E., & Scheel, C. (2021). Learning from Failure and Success: The Challenges for Circular Economy Implementation in SMEs in an Emerging Economy. *Sustainability, 13*(3), 1529. doi:10.3390/su13031529

Chang, Y.-T., & Hsieh, S.-H. (2019). A Preliminary Case Study on Circular Economy in Taiwan's Construction. *IOP Conference Series: Earth and Environmental Science, 225*, 012069. doi:10.1088/1755-1315/225/1/012069

Charef, R., & Emmitt, S. J. J. o. c. p. (2021). Uses of building information modelling for overcoming barriers to a circular economy. *285*, 124854.

Cisneros-Cabrera, S., Pishchulov, G., Sampaio, P., Mehandjiev, N., Liu, Z., & Kununka, S. J. C. i. I. (2021). An approach and decision support tool for forming Industry 4.0 supply chain collaborations. *125*, 103391.

Corvellec, H., Stowell, A. F., & Johansson, N. J. J. o. I. E. (2021). Critiques of the circular economy.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*: Sage publications.

Cronbach, L. J., & Shapiro, K. (1982). *Designing evaluations of educational and social programs*: Jossey-Bass.

De Jesus, A., Antunes, P., Santos, R., & Mendonça, S. J. J. o. C. P. (2019). Eco-innovation pathways to a circular economy: Envisioning priorities through a Delphi approach. *228*, 1494-1513.

de Jong, S., van der Gaast, M., Kraak, J., Bergema, R., & Usanov, A. (2016). *The circular economy and developing countries: a data analysis of the impact of a circular economy on resource-dependent developing nations*: The Hague Centre for Strategic Studies.

Eberhardt, L. C. M., Birkved, M., Birgisdottir, H. J. A. E., & Management, D. (2020). Building design and construction strategies for a circular economy. 1-21.

Esa, M. R., Halog, A., Rigamonti, L. J. R., Conservation, & Recycling. (2017). Strategies for minimizing construction and demolition wastes in Malaysia. *120*, 219-229.

Eti, S. J. R. A. o. P. F., & Literacy, I. F. (2021). The use of quantitative methods in investment decisions: a literature review. 1-20.

Fellows, R. F., & Liu, A. M. (2021). *Research methods for construction*: John Wiley & Sons.

Fleetwood, D. J. Q. P. (2020). Non-Probability Sampling: Definition, types, Examples, and advantages.

Foundation, E. M. (2015). Towards a circular economy: Business rationale for an accelerated transition. In: Ellen MacArthur Foundation Cowes.

Foundation, E. M. (2019). Circular Economy Schools of Thought.

Friant, M. C., Vermeulen, W. J., Salomone, R. J. R., Conservation, & Recycling. (2020). A typology of circular economy discourses: Navigating the diverse visions of a contested paradigm. *161*, 104917.

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. J. J. o. c. p. (2017). The Circular Economy–A new sustainability paradigm? *, 143*, 757-768.

Górka, K., Łuszczyk, M., & Thier, A. J. B. R. A. i. p. (2018). The Impact of a Circular Economy on Sustainable Development. (4 (54)), 7-14.

Govindan, K., & Hasanagic, M. J. I. J. o. P. R. (2018). A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective. *56*(1-2), 278-311.

Gravagnuolo, A., Angrisano, M., & Fusco Girard, L. (2019). Circular Economy Strategies in Eight Historic Port Cities: Criteria and Indicators Towards a Circular City Assessment Framework. *Sustainability, 11*(13), 3512. doi:10.3390/su11133512

Guerra, B. C., Leite, F. J. R., Conservation, & Recycling. (2021). Circular economy in the construction industry: An overview of United States stakeholders' awareness, major challenges, and enablers. *170*, 105617.

Hart, J., Adams, K., Giesekam, J., Tingley, D. D., & Pomponi, F. J. P. C. (2019). Barriers and drivers in a circular economy: the case of the built environment. *80*, 619-624.

Heshmati, A. J. I. J. o. G. E. (2017). A Review of the Circular Economy and its Implementation. *11*(3-4), 251-288.

Hickel, J., & Kallis, G. J. N. p. e. (2020). Is green growth possible? *, 25*(4), 469-486.

Hong, J., Shen, G. Q., Li, Z., Zhang, B., & Zhang, W. J. J. o. c. p. (2018). Barriers to promoting prefabricated construction in China: A cost–benefit analysis. *172*, 649-660.

Hossain, M. U., Ng, S. T., Antwi-Afari, P., Amor, B. J. R., & Reviews, S. E. (2020). Circular economy and the construction industry: Existing trends, challenges and prospective framework for sustainable construction. *130*, 109948.

Jæger, B., Halse, L. L., Naz, F., & Rahim, K. K. (2019). *Towards circular economy in manufacturing: identification of barriers seen by Norwegian manufacturing companies*.

Kabirifar, K., Mojtahedi, M., Wang, C., & Tam, V. W. J. J. o. C. P. (2020). Construction and demolition waste management contributing factors coupled with reduce, reuse, and recycle strategies for effective waste management: A review. *263*, 121265.

Kapoor, N., Jauhari, S., & Maheshwari, D. (2021). Policies for Promoting the Circular Economy in India. In *Examining the Intersection of Circular Economy, Forestry, and International Trade* (pp. 68-82): IGI Global.

Keng, T. C., Mansor, N., Ching, Y. K. J. G. B., & Research, M. (2018). An Exploration of Cost Overrun in Building Construction Projects. *10*(3).

Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., & Hekkert, M. J. E. E. (2018). Barriers to the circular economy: Evidence from the European Union (EU). *150*, 264-272.

Konietzko, J., Bocken, N., & Hultink, E. J. J. S. (2020). A tool to analyze, ideate and develop circular innovation ecosystems. *12*(1), 417.

Korhonen, J., Honkasalo, A., & Seppälä, J. J. E. e. (2018). Circular economy: the concept and its limitations. *143*, 37-46.

Korhonen, J., Nuur, C., Feldmann, A., & Birkie, S. E. J. J. o. c. p. (2018). Circular economy as an essentially contested concept. *175*, 544-552.

Kovács, G., & Falagara Sigala, I. J. J. o. S. C. M. (2021). Lessons learned from humanitarian logistics to manage supply chain disruptions. *57*(1), 41-49.

Kylili, A., Fokaides, P. A. J. S. C., & Society. (2017). Policy trends for the sustainability assessment of construction materials: A review. *35*, 280-288.

Kyrö, R. (2020). *Share, Preserve, Adapt, Rethink–a focused framework for circular economy.* Paper presented at the IOP Conference Series: Earth and Environmental Science.

Lacy, P., & Rutqvist, J. (2016). *Waste to wealth: The circular economy advantage*: Springer.

Lahane, S., Prajapati, H., & Kant, R. J. M. o. E. Q. A. I. J. (2021). Emergence of circular economy research: a systematic literature review.

Lahti, T., Wincent, J., & Parida, V. J. S. (2018). A definition and theoretical review of the circular economy, value creation, and sustainable business models: where are we now and where should research move in the future? *, 10*(8), 2799.

Lei, H., Li, L., Yang, W., Bian, Y., & Li, C.-Q. J. J. o. B. E. (2021). An analytical review on application of life cycle assessment in circular economy for built environment. 103374.

Leising, E., Quist, J., & Bocken, N. J. J. o. C. p. (2018). Circular Economy in the building sector: Three cases and a collaboration tool. *176*, 976-989.

Liakos, N., Kumar, V., Pongsakornrungsilp, S., Garza-Reyes, J. A., Gupta, B., & Pongsakornrungsilp, P. (2019). Understanding circular economy awareness and practices in manufacturing firms. *Journal of Enterprise Information Management, 32*(4), 563-584. doi:10.1108/JEIM-02-2019-0058

Mahpour, A. J. R., conservation, & recycling. (2018). Prioritizing barriers to adopt circular economy in construction and demolition waste management. *134*, 216-227.

Massaro, M., Secinaro, S., Dal Mas, F., Brescia, V., Calandra, D. J. B. S., & Environment, t. (2021). Industry 4.0 and circular economy: An exploratory analysis of academic and practitioners' perspectives. *30*(2), 1213-1231.

Meerburg, P. D., Green, D., Abidi, M., Amin, M. A., Adshead, P., Ahmed, Z., . . . Ávila, S. J. a. p. a. (2019). Primordial non-gaussianity.

Merli, R., Preziosi, M., & Acampora, A. J. J. o. C. P. (2018). How do scholars approach the circular economy? A systematic literature review. *178*, 703-722.

Mies, A., & Gold, S. J. J. o. C. P. (2021). Mapping the social dimension of the circular economy. *321*, 128960.

Minunno, R., O'Grady, T., Morrison, G. M., Gruner, R. L. J. R., Conservation, & Recycling. (2020). Exploring environmental benefits of reuse and recycle practices: A circular economy case study of a modular building. *160*, 104855.

Mohajan, H. K. J. A. o. S. H. U. E. S. (2017). Two criteria for good measurements in research: Validity and reliability. *17*(4), 59-82.

Morseletto, P. J. R., Conservation, & Recycling. (2020). Targets for a circular economy. *153*, 104553.

Murray, A., Skene, K., & Haynes, K. J. J. o. b. e. (2017). The circular economy: an interdisciplinary exploration of the concept and application in a global context. *140*(3), 369-380.

Mutuku, J. K., Hou, W.-C., Chen, W.-H. J. A., & Research, A. Q. (2020). An overview of experiments and numerical simulations on airflow and aerosols deposition in human airways and the role of bioaerosol motion in COVID-19 transmission. *20*(6), 1172-1196.

Nasir, M. H. A., Genovese, A., Acquaye, A. A., Koh, S., & Yamoah, F. J. I. J. o. P. E. (2017). Comparing linear and circular supply chains: A case study from the construction industry. *183*, 443-457.

Negara, D. P. S. P. (2016). Pindaan 2016.

Ngan, S. L., How, B. S., Teng, S. Y., Promentilla, M. A. B., Yatim, P., Er, A. C., . . . reviews, s. e. (2019). Prioritization of sustainability indicators for promoting the circular economy: The case of developing countries. *111*, 314-331.

Nordhaus, W. D. (2021). 8 Green Economics and Concepts of Sustainability. In *The Spirit of Green* (pp. 73-82): Princeton University Press.

O'Grady, T., Minunno, R., Chong, H.-Y., Morrison, G. M. J. R., Conservation, & Recycling. (2021). Design for disassembly, deconstruction and resilience: A circular economy index for the built environment. *175*, 105847.

Osobajo, O. A., Oke, A., Omotayo, T., Obi, L. I. J. S., & Environment, S. B. (2020). A systematic review of circular economy research in the construction industry.

Pomponi, F., & Moncaster, A. J. J. o. c. p. (2017). Circular economy for the built environment: A research framework. *143*, 710-718.

Rahla, K. M., Mateus, R., & Bragança, L. J. A. S. I. (2021). Implementing Circular Economy Strategies in Buildings—From Theory to Practice. *4*(2), 26.

Ratum, A. P., Sachari, A., & Wahjudi, D. J. e.-P. P. I. B. (2020). A Review on Circular Design Guideliness by Ideo and Ellen Macarthur Foundation. *1*(1).

Rose, C. (2019). *Systems for reuse, repurposing and upcycling of existing building components.* UCL (University College London),

Saunders, M. N., Lewis, P., Thornhill, A., & Bristow, A. (2015). Understanding research philosophy and approaches to theory development.

Schroeder, P., Anggraeni, K., & Weber, U. J. J. o. I. E. (2019). The relevance of circular economy practices to the sustainable development goals. *23*(1), 77-95.

Shahbazi, S., Wiktorsson, M., Kurdve, M., Jönsson, C., & Bjelkemyr, M. J. J. o. C. P. (2016). Material efficiency in manufacturing: Swedish evidence on potential, barriers and strategies. *127*, 438-450.

Sousa-Zomer, T. T., Magalhães, L., Zancul, E., Cauchick-Miguel, P. A. J. R., Conservation, & Recycling. (2018). Exploring the challenges for circular business implementation in manufacturing companies: An empirical investigation of a pay-per-use service provider. *135*, 3-13.

Temjanovski, R., Bezovski, Z., Arsova, M., & Sofijanova, E. J. J. o. E. (2021). Circular Economy, resources and environmental metabolism. *6*(2), 22-36.

Thomas, N. J. (2022). In Search of Morphogenetic Mechanisms to Transform Marketing Systems from Linear to Circular Structural Arrangements. In *Corporate Responsibility, Sustainability and Markets* (pp. 163-184): Springer.

Turken, N., Geda, A. J. R., Conservation, & Recycling. (2020). Supply chain implications of industrial symbiosis: A review and avenues for future research. *161*, 104974.

UNEP. (2017). United Nations Environment Programme, Summary Report: Waste Management in ASEAN Countries.

van Stijn, A., Gruis, V. J. S., & Environment, S. B. (2020). Towards a circular built environment: An integral design tool for circular building components.

Vermunt, D., Negro, S., Verweij, P., Kuppens, D., & Hekkert, M. J. J. o. C. P. (2019). Exploring barriers to implementing different circular business models. *222*, 891-902.

Wijewickrama, M., Chileshe, N., Rameezdeen, R., & Ochoa, J. J. (2021). *The Role of Government towards a Circular Economy in the Construction Industry: A Systematic Literature Review.* Paper presented at the Proceedings of the 2nd World Conference on Waste Management.

Wijewickrama, M., Rameezdeen, R., & Chileshe, N. J. J. o. C. P. (2021). Information brokerage for circular economy in the construction industry: A systematic literature review. 127938.

Winning, M., Calzadilla, A., Bleischwitz, R., & Nechifor, V. (2017). Towards a circular economy: insights based on the development of the global ENGAGE-materials model and evidence for the iron and steel industry. *International Economics and Economic Policy, 14*(3), 383-407. doi:10.1007/s10368-017-0385-3

Yin, R. K. (2009). *Case study research: Design and methods* (Vol. 5): sage.

Yu, Y., Yazan, D. M., Bhochhibhoya, S., & Volker, L. J. J. o. C. P. (2021). Towards Circular Economy through Industrial Symbiosis in the Dutch construction industry: A case of recycled concrete aggregates. *293*, 126083.

Yuan, H., Wang, Z., Shi, Y., Hao, J. J. J. o. E. P., & Management. (2021). A dissipative structure theory-based investigation of a construction and demolition waste minimization system in China. 1-27.

Zeng, X., & Li, J. J. I. (2021). Emerging anthropogenic circularity science: principles, practices, and challenges. 102237.