POLITEKNIK UNGKU OMAR

INFRASTRUCTURE SUSTAINABILITY MANUAL AUGMENTED REALITY (ISMAR)

ARIFUDEEN BIN MOHD HASLIN

(01BCT20F3014)

CIVIL ENGINEERING DEPARTMENT

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A project report/thesis submitted in partial fulfilment of the requirement for the award of the Bachelor's Degree of Civil Engineering Technology

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STATEMENT OF AUTHENTICITY AND PROPRIETARY RIGHTS

INFRASTRUCTURE SUSTAINABILITY MANUAL AUGMENTED REALITY (ISMAR)

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2. I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

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APPRECIATION

In the name of Allah SWT, most gracious, most merciful, peace and blessing be upon prophet Muhammad SAW, his family and his friend selected. Firstly, I want to offer my deepest gratitude must be towards Allah because of His grace and His guidance; I can enable complete this report “Infrastructure Sustainability Manual Augmented Reality (ISMAR)”.

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Thank you.

ABSTRACT

In project planning, the key for project success indicators are time, cost, quality, and project scope. Most projects in the past struggled to fulfil those vital indicators in order to complete a project within the allocated time frame with a confined budget due to inefficient management at the time. Through developing a digital rating scheme will assist the whole project's progress and visualizing it. The Internet of Thing (IoT) application, on the other hand, makes Infrastructure Sustainability rating scheme more manageable. Therefore, the aim of this project is to develop Infrastructure Sustainability Manual using Augmented Reality (ISMAR) to provide an effective guidance and information for general information based on ISCA rating scheme. The project involves designing ISMAR using augmented reality technology (BlippAR) and Google Site. Data collection was conducted through questionnaires, and Statistical Online Software was used to analyse the data. The usability and effectiveness of the ISMAR application were tested through an online survey adapted from the Technology Acceptance Model (TAM) questionnaire, which includes variables like Perceived Ease of Use, Perceived Usefulness, Attitude Towards Using Technology, and Behavioural Intention to Use. The results of the survey indicate that ISMAR received positive feedback with a higher mean score (> 4.00), and company staff expressed their intention to use it for acquiring more information on Infrastructure Sustainability (IS) rating scheme. The paired t-test analysis suggests that ISMAR is significantly more effective in terms of usability compared to the existing method. This mean that ISMAR was more effective in term of usability compared with the existing method. Hence, Infrastructure Sustainability Manual AR (ISMAR) application help department heads, managers, assistant managers, supervisors, project managers, and executives to access information anywhere and anytime on the IS rating scheme.

ABSTRAK

Dalam perancangan projek, kunci penunjuk kejayaan projek ialah masa, kos, kualiti dan skop projek. Kebanyakan projek pada masa lalu bergelut untuk memenuhi petunjuk penting tersebut untuk menyiapkan projek dalam tempoh masa yang diperuntukkan dengan bajet terhad disebabkan pengurusan yang tidak cekap pada masa itu. Melalui pembangunan skim penarafan digital akan membantu kemajuan keseluruhan projek dan menggambarkannya. Aplikasi Internet of Thing (IoT) pula menjadikan skim penarafan Kelestarian Infrastruktur lebih mudah diurus. Oleh itu, matlamat projek ini adalah untuk membangunkan Manual Kelestarian Infrastruktur menggunakan Augmented Reality (ISMAR) untuk menyediakan panduan dan maklumat yang berkesan untuk maklumat umum berdasarkan skim penarafan ISCA. Projek ini melibatkan reka bentuk ISMAR menggunakan teknologi realiti tambahan (BlippAR) dan Tapak Google. Pengumpulan data dijalankan melalui soal selidik, dan Perisian Dalam Talian Statistik digunakan untuk menganalisis data. Kebolehgunaan dan keberkesanan aplikasi ISMAR telah diuji melalui tinjauan dalam talian yang diadaptasi daripada soal selidik Model Penerimaan Teknologi (TAM), yang merangkumi pembolehubah seperti Perceived Ease of Use, Perceived Usefulness, Sikap Terhadap Menggunakan Teknologi dan Niat Tingkah Laku untuk Menggunakan. Hasil tinjauan menunjukkan bahawa ISMAR menerima maklum balas positif dengan skor min yang lebih tinggi (> 4.00), dan kakitangan syarikat menyatakan hasrat mereka untuk menggunakannya untuk memperoleh lebih banyak maklumat mengenai skim penarafan Kelestarian Infrastruktur (IS). Analisis ujian-t berpasangan menunjukkan bahawa ISMAR adalah jauh lebih berkesan dari segi kebolehgunaan berbanding kaedah sedia ada. Ini bermakna ISMAR lebih berkesan dari segi kebolehgunaan berbanding kaedah sedia ada. Oleh itu, aplikasi Manual Kelestarian Infrastruktur AR (ISMAR) membantu ketua jabatan, pengurus, penolong pengurus, penyelia, pengurus projek dan eksekutif untuk mengakses maklumat di mana-mana dan pada bila-bila masa pada skim penarafan IS.

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LIST OF ABBREVIATION

ISMAR	Infrastructure Sustainability Manual Augmented Reality
ISCA	Infrastructure Sustainability Council of Australia
IS	Infrastructure Sustainability
PTMP	Penang Transport Master Plan
PSR	Penang South Reclamation
PSI	Penang South Island
AR	Augmented Reality
BREEAM	Building Research Establish Environmental Assessment Method
CASBEE	Comprehensive Assessment System for Built Environment Efficiency
LEED	Leadership in Energy and Environmental Design
IoT	Internet of Things
IR 4.0	The Fourth Industrial Revolution
GBI	Green Building Index

CHAPTER 1

INTRODUCTION

1.1 Introduction

One of the key barriers to continuing global economic development is maintaining economic growth while conserving the environment (Wu, Ke, Xu, Xiao, & Hu, 2018). Definitely, the old economic development strategy at the expense of the environment no longer serves society's demands (Holscher, Wittmayer, & Loorbach, 2018). Since its inception, environmental management has been hampered by dogmatic and suspicious organizations that saw it as an extra expense and time commitment rather than a potential for development. Green Management, on the other hand, has begun in the Malaysian construction sector as a method of expediting quality and product for clients that are ecologically concerned about sustainability. Various efforts and methodologies, such as trial testing some of the most advanced management tools and assessment methods, have been investigated. (Jingxiao, et al., 2021)

Green Technology refers to the development and application of products, equipment, and systems to preserve the environment and nature and minimize or reduce the negative effects of human activities. Green Technology refers to products, equipment, or systems that meet the following criteria:

i. It minimizes the degradation of environmental quality
ii. It has low or zero Greenhouse Gas emissions
iii. it is safe to use and provides a healthy and better environment for all living things
iv. Save energy and natural resources
v. Promote renewable resources

Green evaluation is being used by several businesses in Malaysia. They are working to streamline and promote the feasibility of green management in a variety of initiatives. GBI Certification has been gained by projects such as Kuala Lumpur International Airport Terminal II (KLIA2) and Sunway Resort City Development in order to reduce environmental effect and promote preservation of our mother earth. According to (Francesto, 2012), the concept of sustainability frequently refers to green businesses, such as firms that promote renewable energy or electric transportation.

The Infrastructure Sustainability Council of Australia (ISCA) seeks to promote infrastructure sustainability through the development and operation of the Infrastructure Sustainability rating scheme. ISCA created the Infrastructure Sustainability (IS) rating scheme. The IS rating scheme assesses the possible environmental, social, and economic implications of infrastructure projects and assets. It is designed for use as a guide for sustainable design, procurement, construction, and operation by stakeholders, including design, construction, and operation project team members. The IS grading methodology is still being refined.

The rating is a continuous procedure that necessitates the involvement of an IS certified rater and an in-house sustainability officer from beginning to end. If an in-house sustainability officer is not obtainable, Certified Energy can fill the position. The procedure is divided into four steps. After accepting the quotation, our IS rating assessor will walk you through each stage of the procedure. Following the design process, the IS certifier will complete the necessary certification and reports to guarantee that your project receives a 'Design Rating' as well as an 'As Built Rating.' When we reach the operation stage, our rater generates the information required for 'Operation Ratings.'

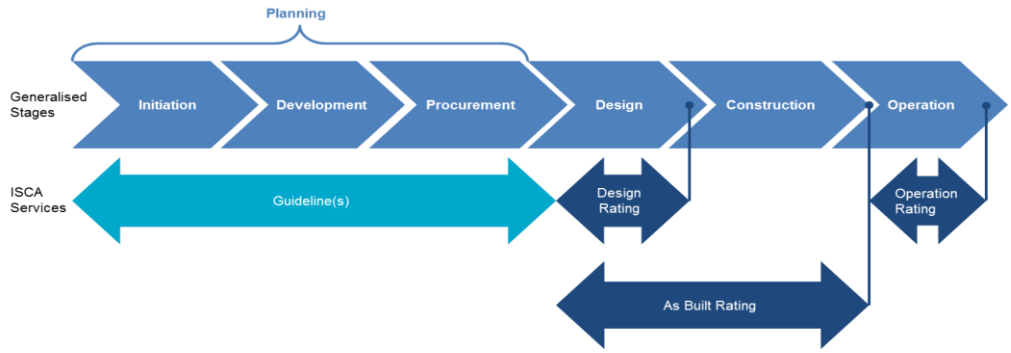


Figure 1.1 Infrastructure Lifecycle Stages

The construction sector needs to adapt to the rapidly advance of technology and smarter systems in order to keep up with the Fourth Industrial Revolution, which has been commonly discussed recently. A physical cyber system that will alter the future of construction has emerged with this Revolution. A crucial foundation for dealing with these changes is placing a strong emphasis on technology use and the requirement to improve knowledge and skills. Companies who do not adapt to this change will experience significant revenue losses, which will make it difficult to continue long-term corporate growth. Numerous aspects of life have improved thanks to digitalization, including quality, expenses, consumer experience, innovation, and revenue (F, Almada, 2017).

Internet of Things (IoT) in construction is not as far off as it looks, even though many people think the construction industry is less technologically savvy. When productivity at construction sites is a problem, it is possible to accomplish. Many initiatives tend to go beyond time and budget. Because of this, the construction sector adopts change more slowly than others. The Malaysian Internet of Things market is probably another reason why this technology is not used as much in the building sector. Another aspect contributing to the low adoption rate of Internet of Things items is their high cost. Because most Internet of Things items are pricey and rely on modern technology,

1.2 Problem Statement

Several recent studies have highlighted the significance of green management. (Rasi, Abdekhodaee, & Nagarajah, 2014) investigated how interactions between various stakeholders, such as suppliers and customers, may accelerate the general adoption and implementation of green technology. (Khan, Lodhi, Akhtar, & Khokar, 2014) examined the current worldwide scenario regarding the management of waste electric and electronic equipment (WEEE) and made policy recommendations for developing environmental solutions. Recent studies have also sought to explore what motivates organizations to embrace ISO 14001, as well as how organizations view the advantages of applying ISO 14001, which is critical to the promotion of environmental management and sustainable development (To, Yang, Chang, & Lee, 2014)

Sustainability assessments are procedures for determining, projecting, and assessing the potential effects of various projects and alternatives on the Triple Bottom Line (economy, environment, and society) (Devuyst, 2000). A useful framework for evaluating environmental performance and incorporating sustainable development into architecture and construction procedures is offered by rating systems as well. By establishing sustainable design targets and goals, creating suitable sustainable design strategies, and identifying performance measurements to direct sustainable designs and decision-making processes, they can be used as design tools (Ando, et al., 2005). Among these, rating tools for buildings first appeared more than 20 years ago in the US and UK before becoming widely used.

The most relevant are BREEAM (Building Research Establishment Environmental Assessment Method) in the UK, CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) in Japan, and LEED (Leadership in Energy and Environmental Design) in the US (LEED, 2009). Due to the increased need for resources relative to the entire sector, the building industry increased the use of these systems, especially for commercial buildings in the US. In contrast, large infrastructure assessment technologies have not been utilized all that frequently up until now. Only three score ratings Envision in the USA (Envision, 2016), CEEQUAL in the UK (CEEQUAL, 2016), and the Infrastructure Sustainability (IS) Rating scheme in Australia (ISCA, 2018) can evaluate all types and sizes of civil infrastructures, including ports, airports, highways, dams, bridges, wastewater treatment facilities,

tunnels, and railways. Several score ratings have been developed by various public and private institutions to assess highways and roads.

Whereas for the Penang South Reclamation (PSR) project, the sustainability rating systems used is the Infrastructure Sustainability Council of Australia (ISCA) based on GAMUDA BERHAD Australia recent project that achieve a score of 91% for the ISCA rating systems. When comparing these rating systems, there are similarities that sustainability issues are breakdown into several categories and assigned weightings, such as management, energy, transport, health and wellbeing, water, materials, land use and ecology, pollution, and sustainable sites, etc.

A major driving force behind this study is the lack of IoT- and IoE-based systems that are effective at capturing sustainability. Even with solutions specifically aimed at ISCA certification, this limitation still exists. Consider the effort in which a simulation for energy monitoring is establish for an ISCA based construction. Based on occupancy monitoring, efforts are made to assess the building's energy use, identify its reasons, and reduce energy consumption. Although this work and others like it bring significant advances in IoT-based monitoring and actuation, the focus is still on energy. (Abd-Elhamid & Aliaa, 2000)

Time, cost, quality, and the project's scope are the main project success indicators in project management, respectively. Due to ineffective management at the time, most projects in the past had trouble meeting those critical indicators in order to finish a project within the allotted time period with a constrained budget. Through developing a digital rating scheme will assist the whole project's progress and visualizing it. The IoT application, on the other hand, makes Infrastructure Sustainability rating scheme more manageable.

From previous research, it can be concluded that there was many research regarding Infrastructure Sustainability rating scheme that was adopt into construction project in Australia. Nonetheless, there are no digitalize Infrastructure Sustainability rating scheme manual since it was introduced in Malaysian construction industry. Therefore, this study aims to develop an Infrastructure Sustainability Manual AR (ISMAR) which will be easier to be used and assist project managers, engineers, and consultants to access information anywhere and anytime on the Infrastructure Sustainability rating scheme.

1.3 Objective of Study

The aim of this project is to provide effective guidance and information for general information based on the Infrastructure Sustainability rating scheme. The primary purpose of these guidelines is to assist project managers, engineers, and consultants to access information anywhere and anytime on the Infrastructure Sustainability rating scheme. The specified objective consists of:

i. To design Infrastructure Sustainability Manual AR (ISMAR) rating tool using augmented reality.

ii. To develop interactive Infrastructure Sustainability Manual AR (ISMAR) using BlippAR and Google site.

iii. To test the usability of Infrastructure Sustainability Manual AR (ISMAR)

1.4 Scope of Study

The scope of this study is in the southeast area of Pulau Pinang near the Kampung Permatang Damar Laut as shown in Figure. The Penang South Island (PSI) project will be a large-scale project and involve many parties to make this project successful. The Infrastructure Sustainability Manual AR (ISMAR) is a tool to help engineers, project managers and other involve parties to access the ISCA Manual. A digitalization of the IS rating scheme also will help in calculating the IS score for every party that involve in the PSR project.

This application will be a handful for public display and other parties to understand the environmental impact from the PSI project. This application also will help to gain public consent and attention on the project.

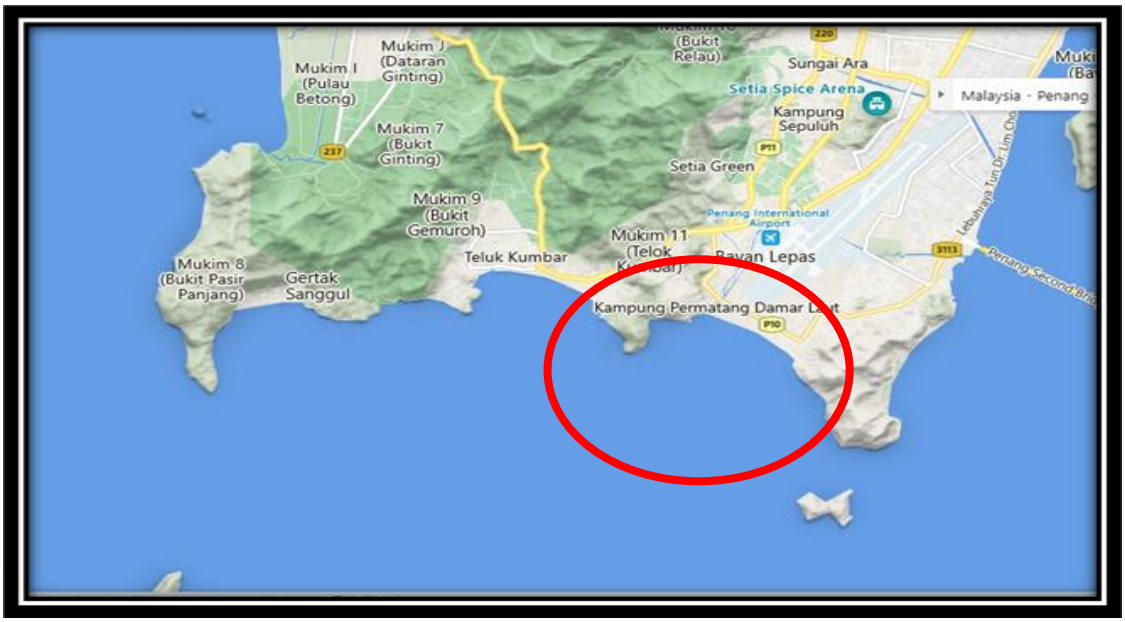


Figure 1.2 The Location of Island A for Penang South Island Project (Source Google Map, 2022)

1.5 Significant of the Study

Based on the research, Infrastructure Sustainability rating scheme is still developing and still time consuming for project managers and consultants to use ISCA effectively. To solve this problem, an Infrastructure Sustainability Manual AR (ISMAR)application will help in showing ISCA information effectively. While in the meantime will help in reducing waste by being paperless. ISCA rating tools require lots of work to rate each of the criteria with evidence and some require an Assessor to prove evidence, this application helps users to effectively calculated the score and proof evidence based on the criteria they wanted.

This will save time and prevent project delays because all tasks involving the use of IS rating scheme can be executed effectively. This is because it is easy for users to get results when carrying out work for a construction site. This will help in developing more green building and reduce pollutions from construction and buildings.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The adoption of Agenda 21 and the Kyoto Protocol in 1997 were significant historical steps toward sustainability. The green building movement in the United States emerged from a desire and need for better energy efficient and ecologically friendly construction techniques. Recent research on energy-saving construction solutions has piqued the curiosity of people all around the world (Pisello, Contana, NIcolino, & Buratti, 2014). Malaysian business looks to be getting the message, but it is definitely behind. Green management issues have been appropriately emphasized in the construction industry. However, the prevailing image of the building sector is that it contributes significantly to environmental damage, mostly through pollution. Green management is the most often discussed issue among construction industry participants today.

Sustainability in the construction and building sector may be best achieved by actively pursuing a comprehensive strategy that seeks to create a balance between the environment and the economy while retaining a healthy regard for humanity's social needs. According to (Thomson & El-Haram, 2014), sustainability action plans have a future for controlling the delivery of sustainability via project management. A sustainability action plan must be prepared from the start of the project and utilised as the foundation of project management across all phases, from planning to estates management, in order to encourage a consistent approach.

Sustainability assessments are described as the procedures of identifying, forecasting, and assessing the possible impact of various programmes and alternatives on the Triple Bottom Line (economy, environment, and society) (Devuyst, 2000). Therefore, grading systems provide a beneficial framework for evaluating environmental performance and incorporating sustainable development into architecture and construction processes. They may be used as design tools to

steer sustainable designs and decision-making processes by establishing sustainable design priorities and goals, generating suitable sustainable design techniques, and identifying performance measurements (Ando, et al., 2005).

2.2 The Infrastructure Sustainability Council of Australia (ISCA)

The Infrastructure Sustainability Council of Australia (ISCA) developed and administers the 'IS grading tool,' which is intended to be used to evaluate the sustainability of infrastructure during the design, building, and operating phases. The tool may be used for self-evaluation as well as professionally certified as 'Commended,' 'Excellent,' or 'Leading.' Users of the rating tool nominate a performance level (1, 2, or 3) that they believe they have achieved for each credit and provide supporting evidence as outlined in the tool's technical manual, taking into account specific themes within a range of social, economic, and environmental sustainability categories across each project. (ISCA, 2018)

Infrastructure sustainability is described as infrastructure that is designed, built, and operated to maximize long-term environmental, social, and economic consequences. The optimization component is critical because it represents a 'triple bottom line' approach to decision making and performance monitoring, and it encourages doing more than just minimising effects. The long-term component is especially significant since infrastructure investments frequently endure 50 to 100 years or more, and hence they must be flexible to global changes and changing societal requirements over these durations. Through the establishment and management of the Infrastructure Sustainability grading scheme, the Infrastructure Sustainability Council of Australia (ISCA) aims to promote infrastructure sustainability's created the Infrastructure Sustainability (IS) rating scheme. (Phil & Graham, 2020)

The IS grading method assesses the possible environmental, social, and economic implications of infrastructure projects and assets. It is designed for use as a guide for sustainable design, procurement, construction, and operation by stakeholders, including design, construction, and operation project team members. The IS rating methodology is still being worked on. The IS grading method was created with the help and involvement of representatives from several organisations.

ISCA and its Committees decided the presented views and opinions. An evaluation is performed, and the total rating is produced and compared to a probable degree of performance based on specified weightings included into the instrument. (Phil & Graham, 2020)

In a case study for Green Construction and Construction and Demolition Waste Management In Australia (Salman, et al., 2019) , ISCA has shown how the implications of the IS scheme have affected the management of Construction And Demolition waste in two Australian projects (Bauer, 2011). The developers of the first project, which involved upgrading two treatment plants in Queensland's Proserpine and Cannonvale, could stand to profit from the use of recycled materials, clean fill, and a decrease in raw materials and embodied carbon emissions. The second instance included a transport project in Queensland, where following IS criteria resulted in various financial advantages, including reduced costs for transportation, raw material extraction and use, recycling fees, and embodied carbon emissions. This report confirmed the project's success, which saw 90% of the inert, non-hazardous Construction and Demolition waste generated during construction recycled. (Salman, et al., 2019)

Brief overview of all important research papers, journal articles, books, websites, and other sources cited in this study has been assembled as a literature review in this chapter. This review of the literature examines material that has been published on a certain subject and during a specific time span. The goal of this literature review is to convey information in the form of a written report and to obtain a better understanding of current research and debates on a certain topic or area of study. Based on this literature review, the issue and holes in current research will be highlighted, and the study piece will then employ fresh research to fill in the gaps.

2.3 Building Research Establishment Environmental Assessment Method (BREEAM)

Building Research Establishment Environmental Assessment Method (BREEAM, 2019), first published by the Building Research Establishment (BRE) in 1990, is the world's longest-established method of assessing, rating and certifying the sustainability of buildings. More than 550,000 buildings have been 'BREEAM-certified', and over two million are registered for certification in more than 50 countries worldwide. BREEAM also has a tool which focuses on neighbourhood development.

BREEAM Com consists of forty individual assessment issues spanning five technical categories, plus a sixth category called "Innovation" for new and innovative technologies and practices. Each issue addresses a specific large-scale sustainability impact and is grouped within one of the five main technical categories: governance, land use and ecology, resources and energy, social and economic well-being and transport and movement. Governance ensures community involvement and leadership in the project, whilst land use and ecology improve biodiversity. The reduction of carbon emissions and use of natural resources is targeted by the resources and energy category. In contrast, a healthy economy, a socially cohesive community and the minimization of impact on the health and well-being of inhabitants are goals sought by the social and economic wellbeing categories. Finally, the transport and movement category aim to create a safe and efficient transportation system for people and vehicles. (BREEAM, 2019)

2.4 Comprehensive Assessment System for Built Environment Efficiency (CASBEE)

Comprehensive Assessment System for Built Environment Efficiency (CASBEE) is a green building certification scheme used in Japan. It was developed by the Japan Sustainable Building Consortium, a research group (JSBC). In 2002, the first evaluation instrument, CASBEE for offices, was introduced. Multiple assessment tools that are suited to various project scales are now included in CASBEE. The group of tools is referred to as the CASBEE family. The Japanese Ministry of Land, Infrastructure, Transport, and Tourism collaborated with leaders

from business, academia, and government on the development of CASBEE's assessment tools. The administrative office is housed within the Institute for Building Environment and Energy Conservation, and the JSBC oversees the overall management of CASBEE (IBEC). (CASBEE, 2020)

CASBEE UD evaluates two types of criteria: performance and environmental burdens. Environmental burdens comprise aspects relating to influence on the local environment, social infrastructure, and management of the local environment, whereas performance criteria cover elements like the natural environment, quality of services, and contribution to the local community.

2.5 Envision Sustainable Infrastructure Rating System

Envision was founded as a result of a strategic partnership between the Institute for Sustainable Infrastructure and the Zofnass Program for Sustainable Infrastructure at the Harvard University Graduate School of Design (ISI). In 2012, ISI released Envision Version 2.0. This planning and design guidance tool offers global sustainability indicators for all forms of infrastructure, much like its LEED-compliant building equivalent.

Envision Version 2.0 Stage 2 offers 60 sustainability credits that are composed of a series of yes/no questions structured in five categories that target important impact areas in terms of the Triple Bottom Line pillar. For projects that use cutting-edge sustainable infrastructure techniques or go above and beyond expectations, Envision awards innovation points. To evaluate performance and encourage project improvement, Envision has established five degrees of achievement: Improved (performance exceeds conventional), Enhanced (performance follows Envision principles), Superior (sustainable performance is remarkable), Conserving (performance has no effect), and Restorative (performance restores natural or social systems). According to the proportion of credentials earned, there are 4 Envision reward levels: Bronze (20–30%), Silver (30–40%), Gold (40–50%), and Platinum (above 50%).

2.6 Leadership in Energy and Environmental Design (LEED)

Leadership in Energy and Environmental Design (LEED) is a green building certification scheme that is practiced all over the world. The U.S. Green Building Council (USGBC), a non-profit organisation, created a set of grading systems for the design, construction, usage, and preservation of green buildings, towns, and houses. This is carried out as part of to encourage building owners and operators in being resourceful and ecologically responsible.

Instead of a performance measurement, LEED is a design tool that places more emphasis on energy modelling than on actual energy use. It lacks climate specificity and has been chastised for using a point system that might encourage poor design choices while making energy conservation the weakest link in the evaluation. It has also been chastised for the "LEED brain" phenomena, in which the public relations value of LEED certification promotes building growth. (LEED, 2009)

2.7 Comparison of Mainstream Sustainable Infrastructure Rating Systems and ISCA

There are notable similarities between other mainstream sustainable infrastructure rating systems and ISCA in terms of ensuring and measuring sustainability in infrastructure projects. Although they all emphasize different aspects of sustainability, the criteria that indicate whether a project is sustainable or not are hardly explained specifically. Process and result evaluations are frequently intermingled in these approaches, which also range in how they handle the various sustainability demands that emerge at different phases of the project life cycle. Furthermore, the relevance of management in the sustainability evaluation is very uneven (Watkins, 2014).

Most often, relatively common factors including GHG emissions, habitat and biodiversity preservation, pollution (air, lighting, noise, and water), energy consumption (renewable resources and efficiency), flooding risk, land usage, and more effective resource management are taken into account when analysing the environmental component. These frameworks address the social component by

addressing broad community concerns such as stakeholder participation, communication, health and well-being, and historical and cultural heritage. Other components of management include procurement, project and risk management, decision-making procedures, and rules and policies (Jose , Daniel, Badr , & Danial, 2016).

2.8 Accessibility

ISCA grants you permission to view and use the IS grading scheme solely for your own purposes. In exchange for this permission, you agree that ISCA retains all copyright and other proprietary notices, rights contained in and related to the IS rating scheme, and you agree not to sell, modify, or use the IS rating scheme for another purpose, or to replicate, display, or distribute the IS rating scheme in any way for any public or commercial purpose, including display on a website or in a networked environment. Unauthorized use of the IS rating method is illegal and violates copyright and other laws. ISCA owns all of the language, visuals, style, and other content components in the IS grading scheme, which are protected by copyright, trademark, and other laws. (ISCA, 2018)

2.9 Internet of Things (IoT)

Kelvin Ashton suggested the Internet of Things (IoT) in 1999 as a cutting-edge internet idea (K.Ashton, 2009). It is described as the capacity to link items over the internet to build a platform for doing certain activities (Al-Qaseemi, Almulhim, Almulhim, & Chaudry, 2016). It connects to the internet and everything around it to connect and communicate with one another in order to accomplish any given function via the network (Gershenfen, N, Krikorian, R, & Cohen, 2004). It is a means of allowing objects in the environment to interact with one another via internet access. The approach is carried out by always connecting everything with everyone and locations utilising the built-in wireless connection.

Furthermore, this feature enables for simple connectivity to the surrounding environment, which facilitates monitoring and management through the internet (K.Ashton, 2009). It has become nearly difficult to avoid hearing the term "Internet

of Things" (IoT) in the last several months. Particularly in the last year, there has been a great spike in interest in the Internet of Things. The Internet of Things has recently made a variety of technologies that were intended to create smart buildings possible. Whereas sustainability is generally highlighted, present IoT-based solutions primarily concentrate on monitoring and managing energy consumption and production. (C, K, & E, 2020)

The Internet of Things continues to offer a wide range of solutions for a variety of industries, particularly in the building and construction industry, where IoT is the primary force behind the smartening of homes, buildings, and cities. Interest in IoT applications for lowering and managing energy costs has recently increased. The Internet of Energy is another name for this IoT perspective that emphasises energy (IoE). It has focused on managing lighting, energy generation and storage, heating, ventilation, and air conditioning, among other building-related issues. (Abd-Elhamid & Aliaa, 2000)

2.10 The Fourth Industrial Revolution (IR 4.0)

With the introduction of the steam engine in 1760, the first industrial revolution began. The steam engine facilitated the shift from farming and feudalism to the new manufacturing process. This shift featured the use of coal as the primary energy source, with railways serving as the primary mode of transportation. In terms of employment, production value, and capital invested, textiles and steel were the main industries. With the introduction of the internal combustion engine in 1900, the second industrial revolution started. This ushered in an age of rapid industry powered by oil and electricity. The third industrial revolution began in 1960 and was marked using electronics and information technology to automate industry. Making something used to entail screwing or welding several components together.

The German government, which pioneered this future notion, backs it up by promoting industrial process automation. IR 4.0 has been formed as a phrase for the industrial development process that includes automation and data sharing, and it was originally introduced to the public as "Sectors 4.0" with the purpose of promoting IR 4.0 deployment in German manufacturing industries (Alaloul, Liew, & Zawawi, 2015). This Working Group was constituted by a diverse group of

members from many fields. The IR 4.0 workgroup developed a strategic application work plan to increase German industrial rivalry worldwide, which was incorporated into the German federal government's 2020 High-Tech Strategy.

IR 4.0 refers to the digitization, automation, and widespread use of Information and Communications Technology (ICT) in the industry. Cyber-physical systems, the Internet of Things (IoT), cloud computing, and cognitive computing are examples of these technologies.

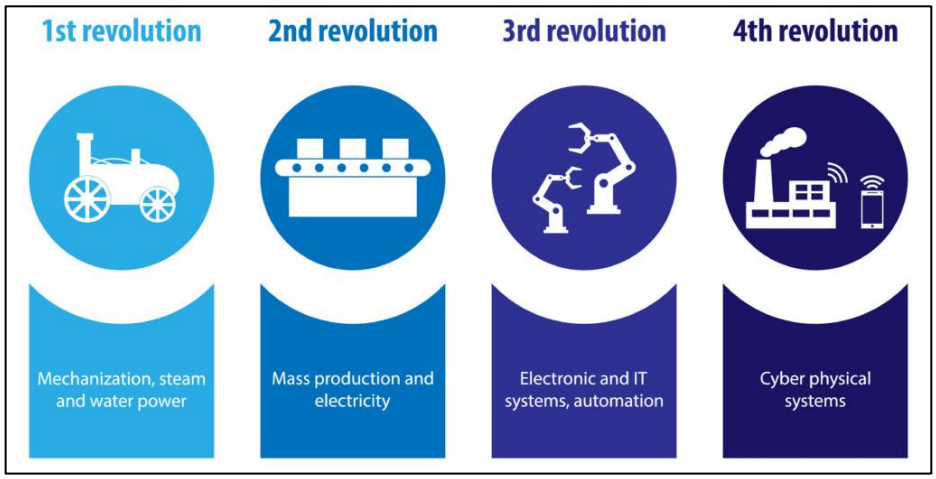


Figure 2.1 The Four Stages of Industrial Revolution

The merging of talents that blurs the differences between physical, digital, and biological scopes characterizes IR 4.0. (A.A.F.Saldivar, 2017). As seen in Figure 2.1, the core principles of IR 4.0 were initially published in 2011. It will have the same deep and irreversible impact on the industry as its three predecessors, but it will do it faster. Despite the disproportionate emphasis on the notion of IR 4.0 universality, no formal definition exists. However, it can be defined as "the integration of complex physical machinery and devices with networked sensors and software, used to predict, control, and plan for better business and societal outcomes," or "a new level of value chain organisation and management across the lifecycle of products" (N.Kudriashov, 2016).

2.11 Augmented Reality

Real and virtual items are combined using augmented reality (AR) technologies, which align them in three dimensions and enable real-time interactions (Azuma, et al., 2001). The technique positions digital items in respect to analogue objects. These digital items are made visible via an AR-capable device with a camera and a screen, such as glasses or helmets, or portable devices, such as smartphones or tablet computers (Azuma, et al., 2001). Virtual objects superimpose the physical environment in real-time (Carmigiani, et al., 2011), allowing the user to interact with them (Zhou, Duh , & Billinghurst, 2008). Given how frequently virtual reality is utilised, the general public frequently ignores augmented reality.

Augmented reality provides a lot of promise for the construction technology business in terms of educational, architectural, and field engineering operations for both students and professionals. Augmented reality is a live, virtual depiction of the actual world that may be enhanced with extra features. Augmented reality was initially employed as a kind of entertainment in the gaming business, but today architecture and engineering schools throughout the world are emphasising it for its instructional benefits (Tom, Stefan , Robert, & Payam , 2021).

Augmented reality may dramatically enhance scheduling in the construction sector due to its capacity to present a project as planned rather than as built to illustrate progress. Augmented reality and its applications in smart city infrastructure have been researched, with a focus on public transportation systems. AR technologies have been employed for shopping functions, particularly for people who are mobility impaired or physically challenged. (Rashid and colleagues, 2017)

2.12 BlippAR

Blippar, one of the UK's first digital entrepreneurs, specialises in creating and releasing augmented reality (AR) content for smartphones and the web. BlippAR's platform enables users to bring static images, objects, or physical locations to life by overlaying digital content on top of them using a smartphone or tablet. BlippAR utilizes computer vision and image recognition technologies to recognize and identify real-world objects or images. When a user scans or points their device at a recognized target, the BlippAR app or software displays relevant augmented reality content associated with that target. The AR experiences created with BlippAR can include interactive 3D models, videos, animations, games, product information, and more. It offers a range of applications across industries such as marketing, advertising, education, retail, and entertainment. Blippar specialized in augmented reality and computer vision systems for publishing, branding, and entertainment. Developers may use its platform to build and distribute cross-platform augmented reality content for mobile and web apps. Users can easily scan items, logos, and virtual content thanks to its surface tracking, image, and object identification functions. (BlippAR, 2017)

CHAPTER 3

METHODOLOGY

3.1 Introduction

A design process is the process of turning an idea into a finished product or solution. The design process requires sophisticated thinking, but it is controlled and guided by the process to provide realistic, practical solutions to the design challenge, achieving or exceeding the stated goals of the brief. One of the most significant aspects of the design process is establishing design requirements and conducting requirement analysis, which is also known as problem definition. This work is frequently conducted concurrently with a feasibility study. The method is crucial for producing many alternative ideas and includes several approaches or procedures that urge participants to think outside the box in search of a creative or new answer (Ambrose & Harris, 2010)

Throughout the engineering design process, the design requirements govern the design of the product or process being created. These include fundamentals such as functions, features, and requirements, which are determined after considering user demands. Hardware and software characteristics, maintainability, availability, and testability are examples of design criteria. Design Thinking could transform the way we work by changing how we think, approach challenges, and create products and services (Platter, Meinel, & Leifer, 2015).

3.2 Design Research

Innovation research design refers to the application of innovative approaches and methodologies in the process of conducting research. It involves utilizing creative and cutting-edge techniques to address research questions, explore new areas of inquiry, and generate novel insights. Innovation research design aims to go beyond traditional methods and to leverage advancements in technology, data collection, analysis, and interdisciplinary collaboration.

Here are some key characteristics and elements of innovation research design:

i. Novelty: Innovation research design involves introducing new and original elements into the research process. This could include novel research methods, data sources, analytical techniques, or theoretical frameworks.

ii. Interdisciplinary Approach: It often embraces an interdisciplinary perspective by integrating knowledge and expertise from different fields. By combining insights and methodologies from diverse disciplines, researchers can gain fresh perspectives and explore new research directions.

iii. Technological Advancements: Innovation research design takes advantage of advancements in technology to enhance data collection, analysis, and visualization. This could involve using state-of-the-art equipment, sensors, wearables, or leveraging emerging technologies like artificial intelligence, machine learning, or virtual reality.

iv. Data Collection Methods: Innovative research designs explore alternative or unconventional data collection methods. This could involve leveraging existing datasets, utilizing citizen science or crowdsourcing approaches, employing remote sensing or satellite imagery, or using social media data mining techniques.

v. Participatory Research: It incorporates participatory research methods to involve and empower participants in the research process. This approach recognizes the value of including stakeholders and communities as active partners in generating knowledge and finding solutions.

vi. Mixed-Methods Approaches: Innovation research design often combines qualitative and quantitative methods to provide a comprehensive understanding of complex phenomena. By using mixed methods approaches, researchers can triangulate data, gain deeper insights, and validate findings from different perspectives.

vii. Agile and Iterative Process: Innovation research design embraces an agile and iterative approach, allowing researchers to adapt and refine their methods based on emerging findings and changing research needs. This flexibility allows for

course corrections and the incorporation of new insights as the research progresses.

viii. Impact Orientation: Innovation research design emphasizes the potential impact of research findings. It aims to produce actionable knowledge that can lead to positive change, influence policies, or drive innovation in various sectors.

ix. Collaboration and Networking: It encourages collaboration and networking among researchers, experts, and stakeholders. Collaboration fosters the exchange of ideas, promotes cross-pollination of knowledge, and opens doors for joint projects or initiatives.

x. Continuous Learning and Reflection: Innovation research design involves continuous learning and reflection on the research process itself. Researchers evaluate the effectiveness of their innovative methods, identify strengths and limitations, and draw lessons for future studies.

In summary, innovation research design embraces creativity, utilizes advanced technologies and methodologies, and promotes interdisciplinary collaboration to generate new knowledge and address complex challenges. By pushing the boundaries of traditional research approaches, innovative design opens up exciting possibilities for discovery and impact.

Table 3.1 Research Design

Objective	Method	Instrument	Expected Outcome
To design Infrastructure Sustainability Manual AR (ISMAR) rating tool using augmented reality.	Design	i. ISCA v1.2 Manual	To design Infrastructure Sustainability Manual AR (ISMAR) rating tool using augmented reality.
To develop interactive Infrastructure Sustainability Manual AR (ISMAR) using BlippAR and Google site.	Develop	i. Google Site ii. BlippAR	Develop interactive Infrastructure Sustainability Manual AR (ISMAR) using BlippAR and Google site.
To test the usability of Infrastructure Sustainability Manual AR (ISMAR).	Survey	i. Quantitative ii. Questionnaire iii. Respondents iv. Google Form	Test the usability of Infrastructure Sustainability Manual AR (ISMAR).

3.3 Development of Research

Research development is a set of proactive, strategic, catalytic, and capacity-building activities that help individual faculty members, teams of researchers, and central research administrations attract extramural research funding, build relationships, and develop and implement strategies to improve institutional competitiveness. In his segment, the researcher thoroughly demonstrated how the programmed operated from start to finish. Before developing the software, a flowchart design was required to help conceptual understanding. Figure 3.2 below shows the flow of research framework.

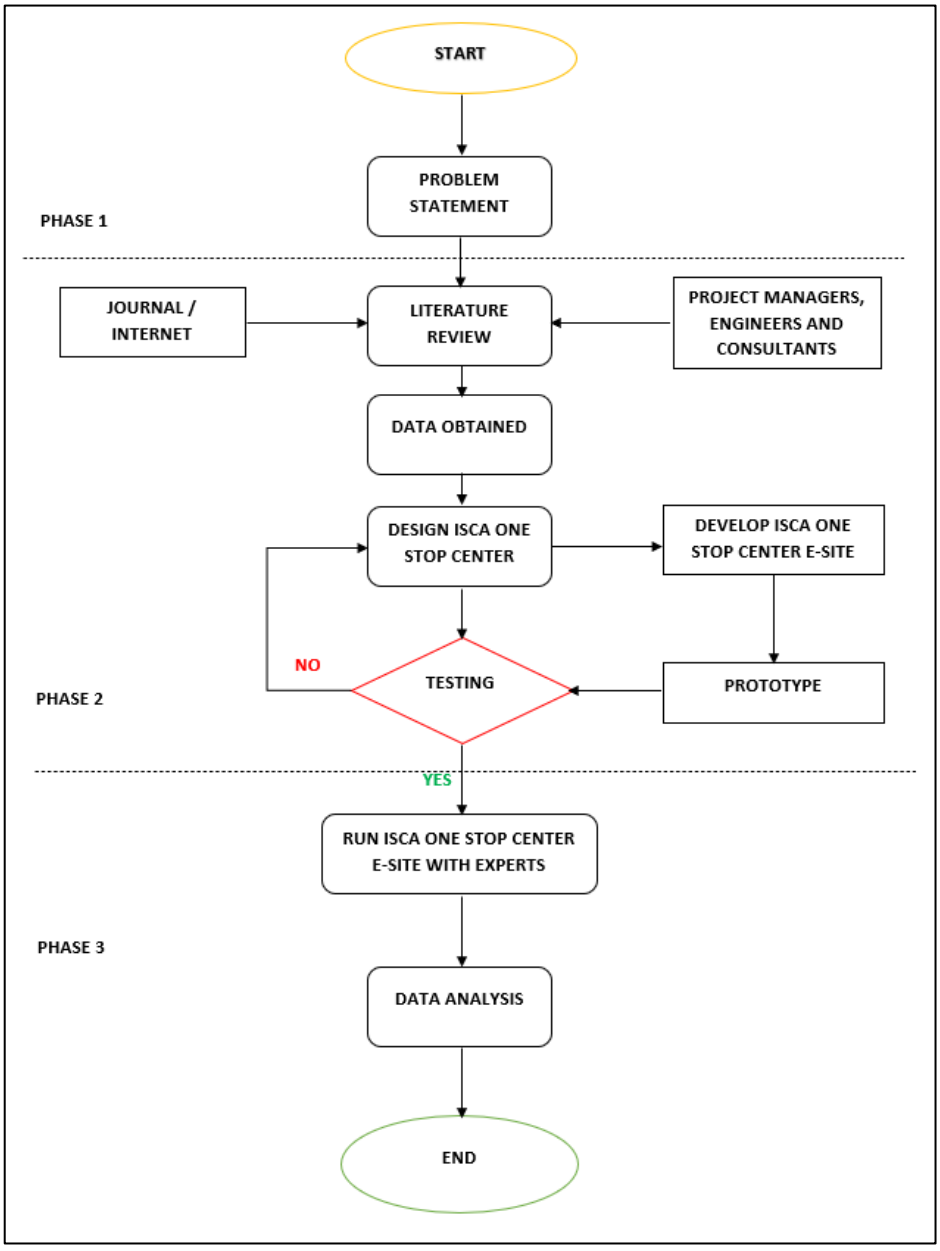


Figure 3.2 Flow of Research Framework

Figure 3.3 below shows the detail of research development for Infrastructure Sustainability Manual AR (ISMAR) e-Site.

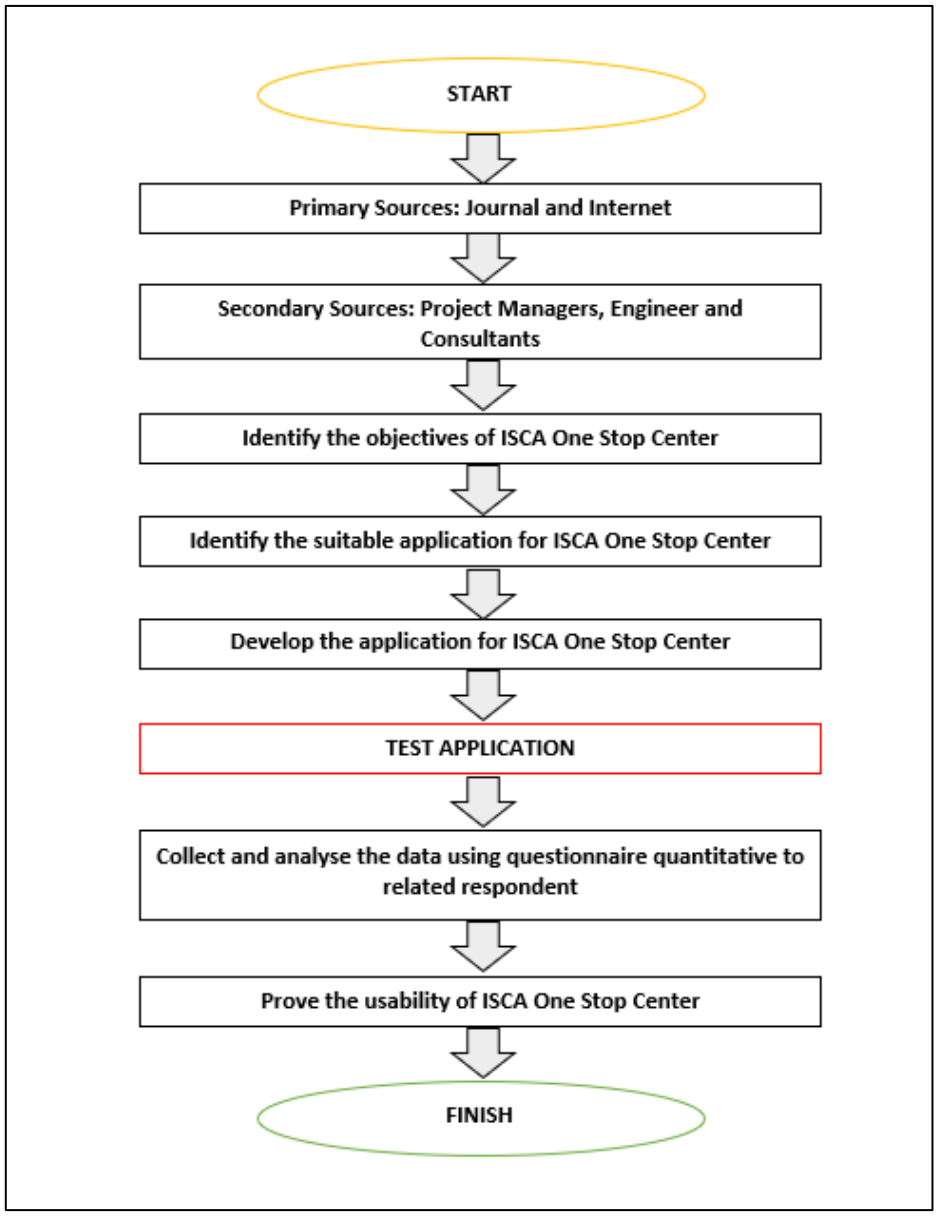
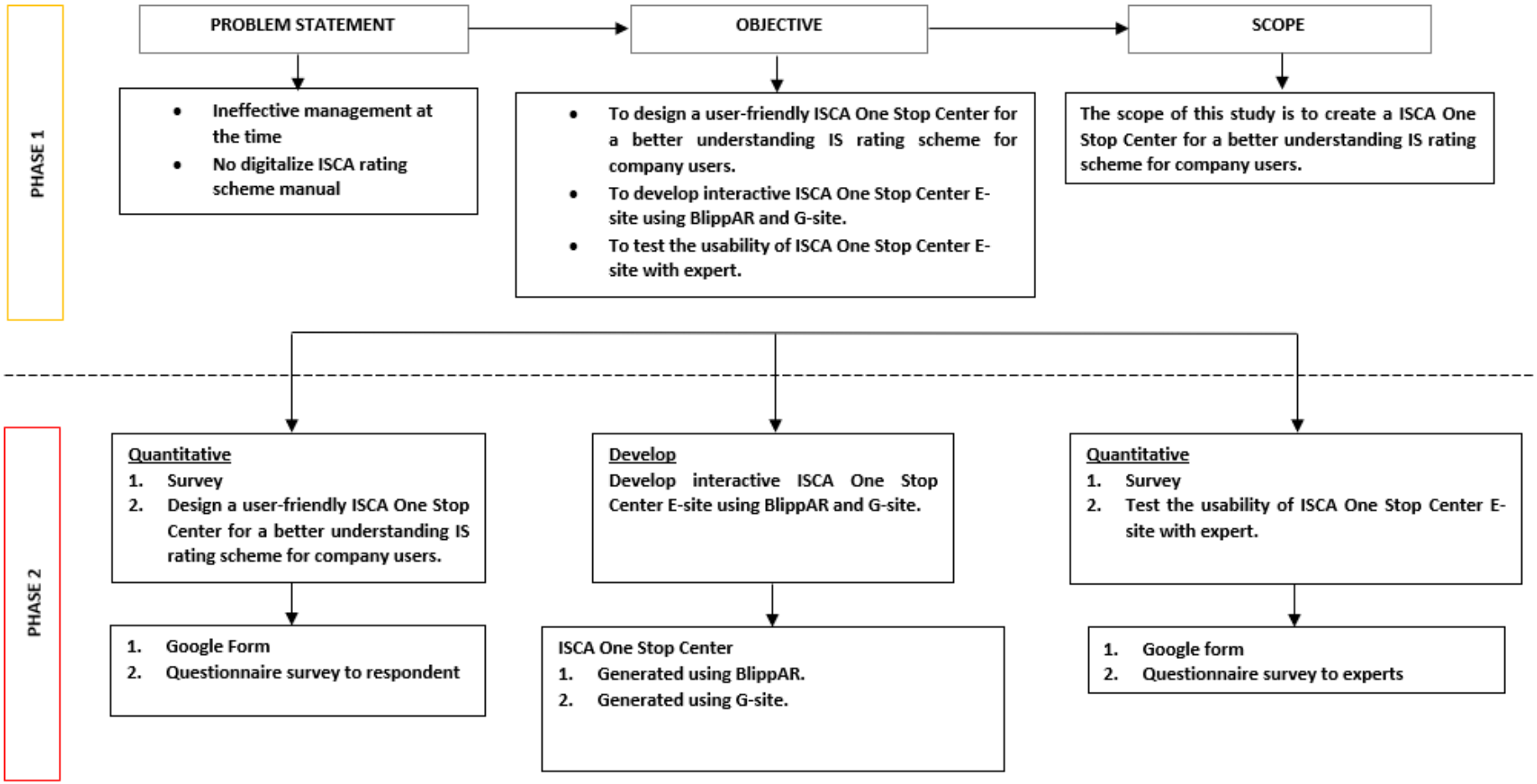


Figure 3.3 The Detail of Research Development

3.3.1 Research Flow of Methodology



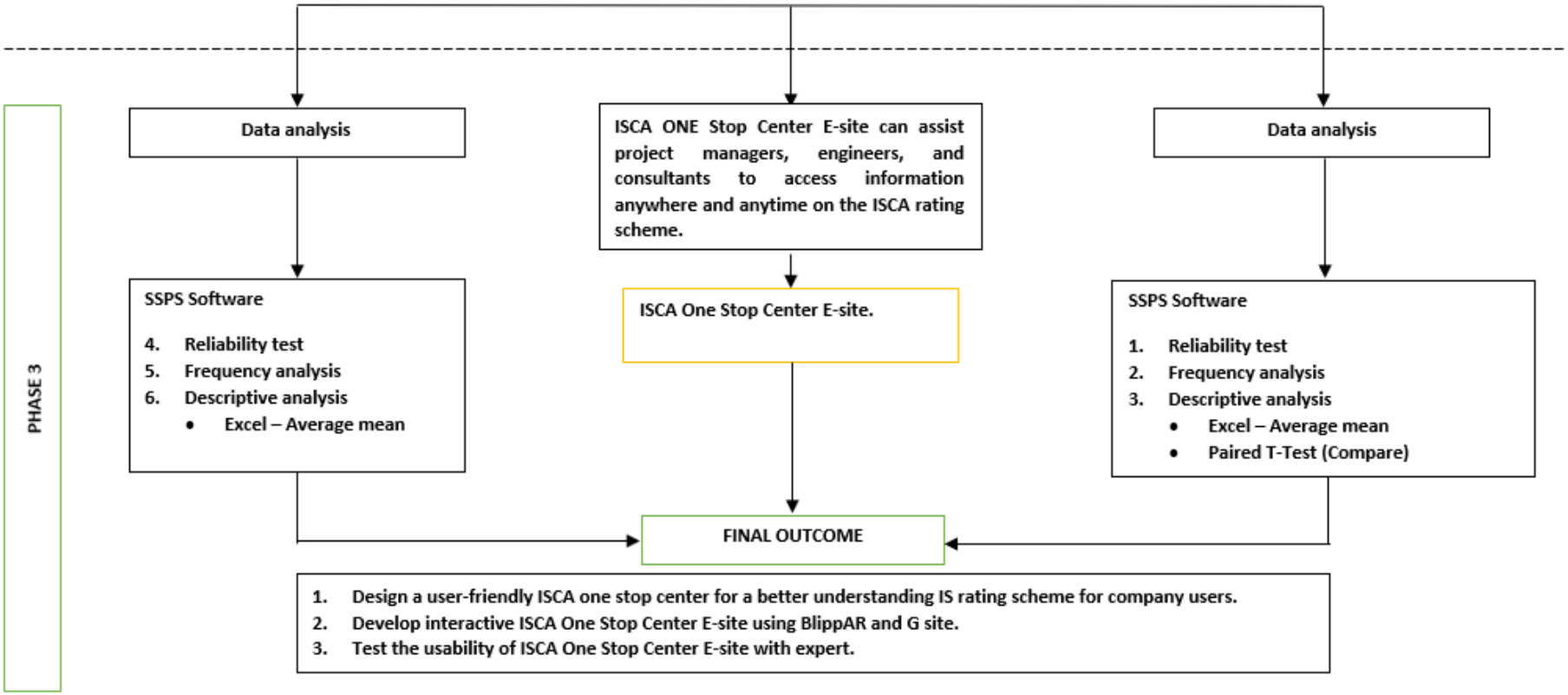


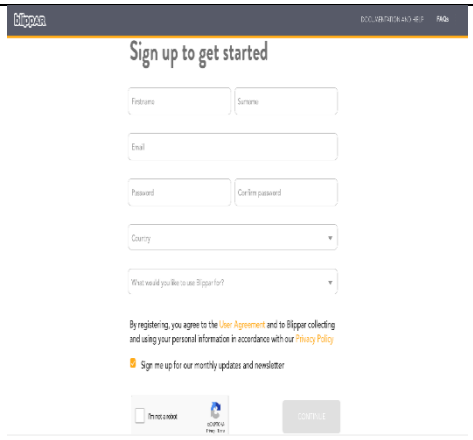
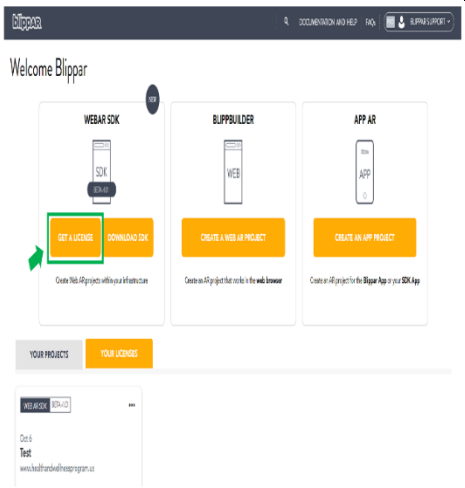
Figure 3.4 Research Flow of Methodology

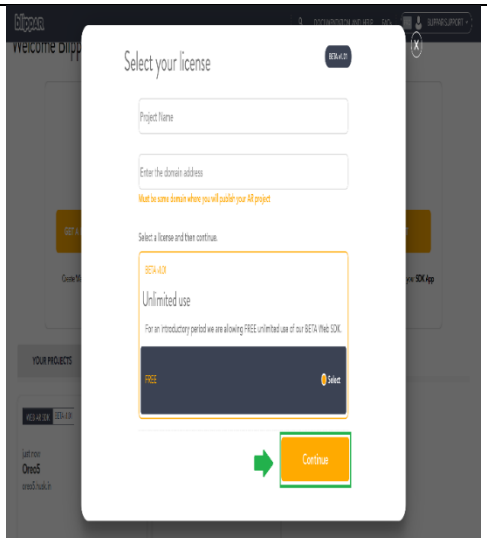
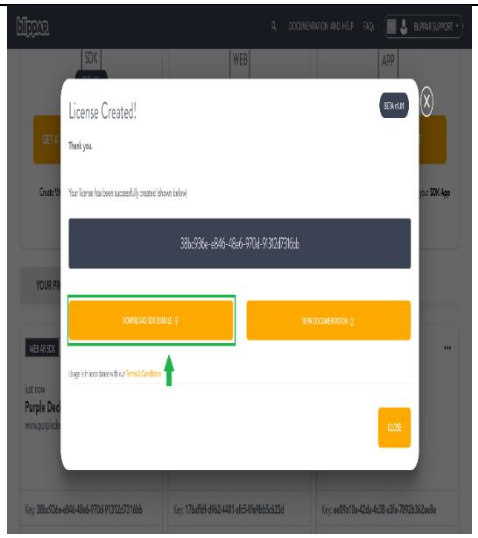
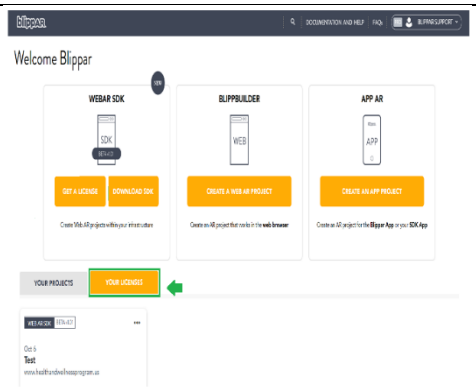
3.4 Systems Design

3.4.1 BlippBuilder

BlippBuilder is a software platform developed by Blippar, a company specializing in augmented reality (AR) technology. BlippBuilder allows users to create their own AR experiences and applications without the need for extensive coding or technical expertise. With BlippBuilder, users can design and build interactive AR content using a drag-and-drop interface. The platform provides a range of customizable templates, 3D models, animations, and interactive elements that can be easily integrated into the AR experience. BlippBuilder supports various types of AR content, such as image recognition, location-based AR, and marker-based AR. It also offers features like gesture control, social sharing, and analytics to track user engagement and behavior.

Table 3.5 Systems Design (Augmented Reality)

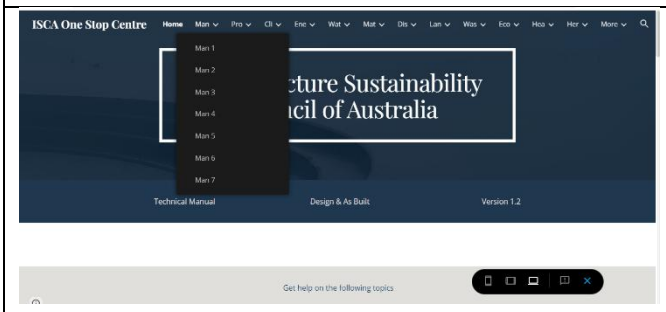
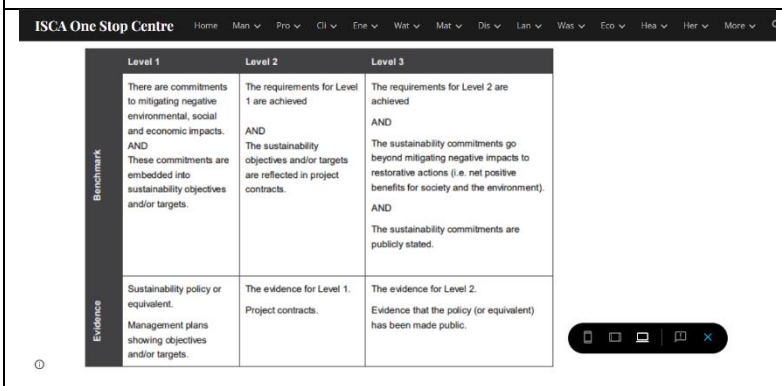
	Sign Up or Login
	Once you are logged in, under BlippBuilder select 'Get A License'

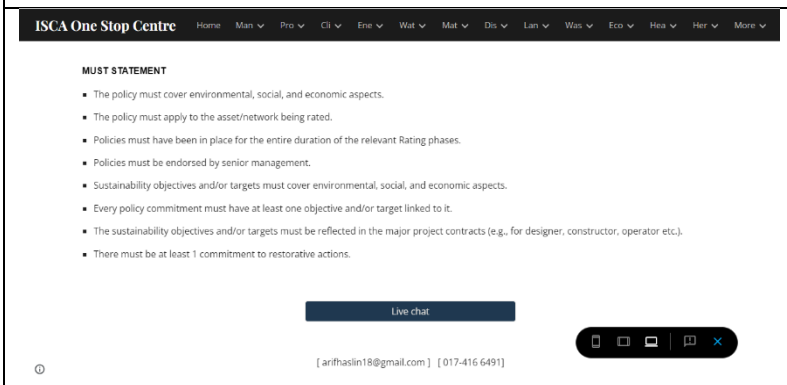
	Give your project a name and enter the domain where you will host the AR experience. BlippBuilder will always be free to get started with, and during our Beta it is free to publish with unlimited views. Click 'Continue' to generate a license key. You will need this key when you are building the AR experience, no need to write this down, as the key will be emailed to you and be available on the HUB
	Download the BlippBuilder and follow the installing the SDK
	If you need to find the license key again you can always find it (and manage other aspects of this project) under 'YOUR LICENSES' on the HUB

3.4.2 Google Sites

Google Sites is a structured wiki and web page publishing tool offered as part of Google's free, online-based Google Docs Editors suite. Google Docs, Google Sheets, Google Slides, Google Drawings, Google Forms, and Google Keep are further features of the service. Only a web application, Google Sites is only accessible online. Users of the software may collaborate in real-time with other users while creating and editing files online.

Table 3.6 Systems Design (Google Sites)

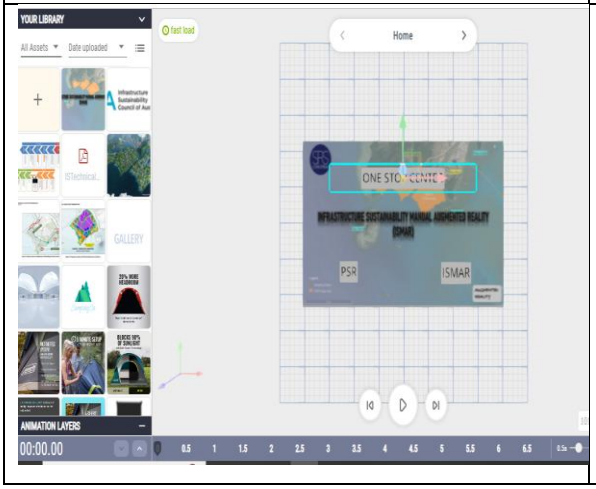
Interface	Explanation
	Home Page for Infrastructure Sustainability Manual AR (ISMAR). You can find all criteria for the rating and choose which criteria you want.
	After you click on the criteria that you choose, you will lead to the page of the criteria that you choose.
	You will be presented with the criteria requirement for each levels and the evidences needed for the criteria.

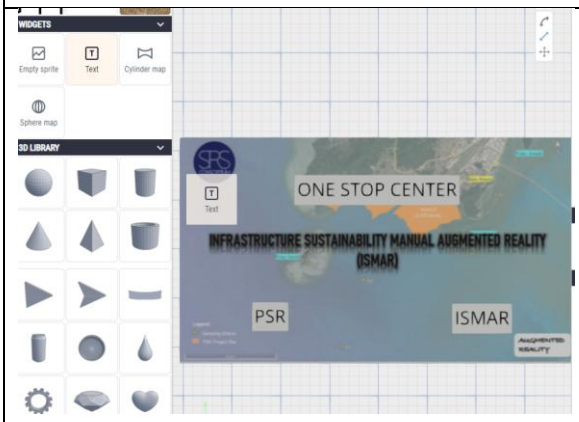
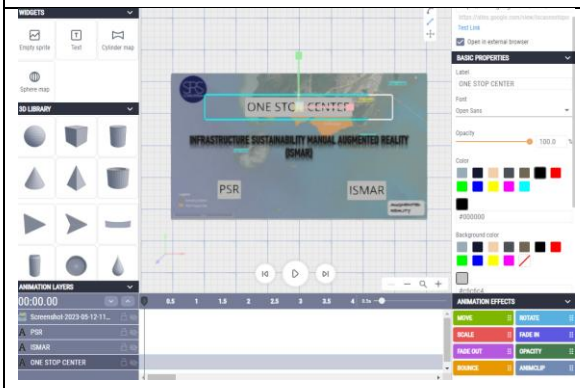
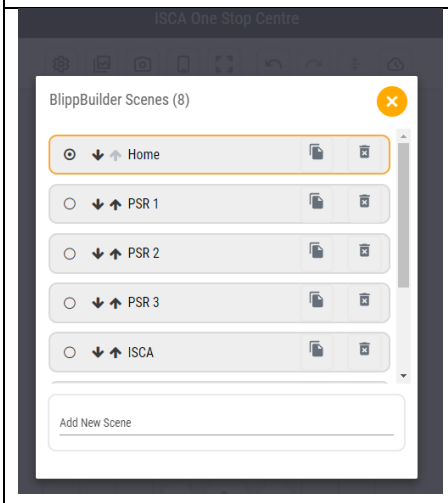
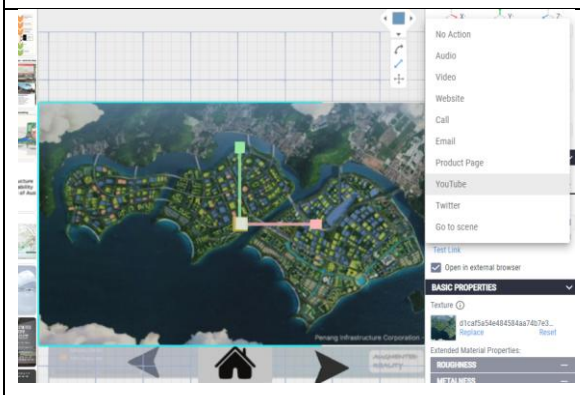
Interface	Explanation
	At the end of the criteria page, you will be presented with the Must Statement for the criteria. There is also number and email for any inquiries.

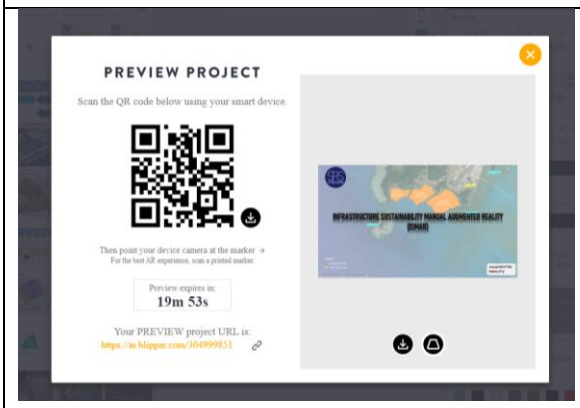
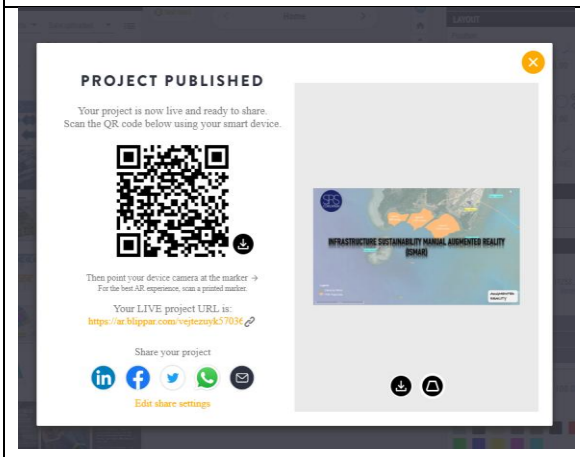
3.5 System Development

In order to guarantee the application's effectiveness, the e-site preparation application was developed phase by phase. In this part, the application has been divided into two different parts: one for administration and the other for users to utilise when working on construction assignments. The table below outlines the processes for using E-site preparation.

Table 3.7 System Development (BlippAR)

Prototype	Explanation
	Login to BlippAR and open new project. Choose the desired marker you wish to upload. It can alternatively 'Drag and Drop' your marker, marker is important to recognize your project.

Prototype	Explanation
	Click 'text' to put your desire design and interface. Put text related to your project and information.
	Edit your text and put action (on touch) on the text. You can also edit the text properties and effect to make it more interactive.
	Click the scene page to edit or add another scene. Every scene must relate to your project and repeat the previous steps to edit your scene accordingly.
	You can add or link the image with other platform such as YouTube, twitter, or other websites.

Prototype	Explanation
	You can preview your project before publishing it to make sure your content was placed accordingly.
	Publish the project once done to start use your AR.

3.6 Testing of Product

Testing an innovative product involves assessing its performance, functionality, usability, and user satisfaction to ensure it meets the desired objectives and requirements. Here are some key steps and considerations in the testing process:

i. Define Testing Objectives: Clearly define the objectives and goals of the testing phase. Identify the specific aspects and features of the innovative product that need to be evaluated.

ii. Test Planning: Develop a comprehensive test plan that outlines the testing approach, test cases, test scenarios, and success criteria. Consider factors such as target users, testing environment, resources, and timelines.

iii. Test Environment Setup: Set up the necessary infrastructure, hardware, software, and testing environments to accurately simulate real-world conditions

for testing. This may include physical testing environments, virtual environments, or a combination of both.

iv. Functional Testing: Verify that the innovative product functions as intended and meets the specified requirements. This involves testing individual features, components, and interactions to ensure they work correctly and deliver the expected outcomes.

v. Usability Testing: Evaluate the user experience and interface design of the innovative product. Gather feedback from representative users to assess ease of use, intuitiveness, efficiency, and overall user satisfaction. Usability testing may involve user interviews, surveys, observation, or usability testing sessions.

Infrastructure Sustainability Manual AR was design, developed and tested to 15 SRS Consortium Staff inclusive of Head of Department, Manager, Assistant Manager, Executive and Operational. The effectiveness of the product was obtained using online questionnaire. The questionnaire for this study was split into Section A and Section B, the two primary portions. Section A concentrated on the respondent's demographic data, while Section B concentrated on the Infrastructure Sustainability Manual AR (ISMAR) requirements. Tables 3.8 and 3.9 include an informational summary of the questions in this questionnaire.

Table 3.8 Distribution of Questionnaire Item

Section	**Aspects of evaluation**
A	Demography
B	Respondents' Opinion on Issues / Studies Conducted
C	Effectiveness of Infrastructure Sustainability Manual AR (ISMAR)

Table 3.9 Likert scale items

Scale	**Description**
1	Strongly Disagree
2	Disagree

3	Slightly Agree
4	Agree
5	Strongly Agree

3.7 Data Collection and Analysis

To evaluate the Infrastructure Sustainability Manual AR (ISMAR), data was collected from 14 SRS Consortium Sdn Bhd Berhad employees who participated in the testing. A questionnaire was adapted from the Technology Acceptance Model (TAM) by Davis, (1989), which focuses on perceived usability and simplicity of use as factors influencing the intention to use new technology.

The TAM consists of key components:

i. Perceived Usefulness (PU): Refers to the extent to which individuals believe that using a particular technology will enhance their performance or productivity.

ii. Perceived Ease of Use (PEOU): Represents the degree to which individuals perceive using the technology to be effortless.

iii. Attitude toward Using (ATU): Reflects individuals' overall positive or negative evaluation of using the technology, influenced by perceived usefulness and ease of use.

iv. Behavioral Intention to Use (BI): Represents individuals' intention to adopt and use the technology, influenced by their attitude toward using it.

TAM has been widely used to study technology adoption and acceptance in various domains. The researchers followed Krejcie & Morgan (1970) to determine the sample size, which indicated that a sample size of 14 was sufficient for a population of 15 respondents. Additionally, De Winter's simulation study (2013) showed that even very small sample sizes, such as 2, can be used without fundamental objections.

Data was collected through a Google form, providing a convenient and user-friendly platform for respondents to complete the questionnaire. The collected data was extracted from Microsoft Excel for analysis. Paired T-test analysis was performed using

statistical analysis software to compare responses before and after implementing Infrastructure Sustainability Manual AR (ISMAR). The analysis process involved extracting the data from Excel and conducting the Paired T-test analysis to assess the application's effectiveness. A paired t-test, also known as a dependent t-test or paired samples t-test, is a statistical test used to determine if there is a significant difference between the means of two related groups or conditions. It is specifically designed for situations where the same individuals or objects are measured or tested under different conditions or at different time points. Here are the key steps involved in conducting a paired t-test:

i. Hypothesis Formulation: Start by formulating the null hypothesis (H_0) and alternative hypothesis (H_1) based on the research question. The null hypothesis typically assumes that there is no significant difference between the means of the paired groups, while the alternative hypothesis suggests that there is a significant difference.

ii. Data Collection: Collect data from the paired groups or conditions of interest. Each individual or object in the sample should have measurements or observations recorded under both conditions.

iii. Calculate the Differences: Calculate the difference between the paired observations for each individual or object. This is done by subtracting the value of one condition from the corresponding value of the other condition.

iv. Compute the Mean Difference: Calculate the mean of the differences. This provides an estimate of the average difference between the paired groups.

v. Calculate the Standard Deviation: Calculate the standard deviation of the differences. This measures the variability or spread of the differences between the paired groups.

vi. Compute the t-value: Calculate the t-value using the formula: t = (mean difference) / (standard deviation / sqrt(sample size)). The t-value measures the difference between the means in terms of standard deviations.

vii. Determine the Degrees of Freedom: Degrees of freedom (df) are calculated as the sample size minus 1 (df = n - 1), where n is the number of paired observations.

viii. Determine the Critical Value: Determine the critical value of t based on the desired significance level (α) and the degrees of freedom. This critical value is obtained from a t-distribution table or statistical software.

ix. Compare the t-value and Critical Value: Compare the calculated t-value to the critical value. If the calculated t-value is greater than the critical value, there is evidence to reject the null hypothesis and conclude that there is a significant difference between the means of the paired groups.

x. Interpret the Results: Based on the comparison of the t-value and critical value, interpret the results in the context of the research question. Report whether there is a significant difference between the means and the direction of the difference (i.e., which group has a higher mean).

It's important to note that assumptions should be checked before conducting a paired t-test, including normality of the differences and homogeneity of variances. If these assumptions are violated, alternative non-parametric tests may be considered. The paired t-test is commonly used in various fields, such as medicine, psychology, social sciences, and engineering, to compare the effectiveness of interventions, evaluate the impact of treatments, or assess the differences before and after an intervention within the same group of individuals or objects. This methodology aims to gather valuable insights into the usability and acceptance of the application. The questionnaire served as a crucial tool for data collection, capturing participants' perceptions and acceptance of the new technology.

The process of gathering, measuring, and analysing precise insights for research using accepted, established methods was known as data collection. A researcher can assess their hypothesis using the data that they have gathered. Regarding the subject of study, gathering data is typically the first and most crucial phase in the research process. Depending on the type of data needed, various research disciplines require different approaches to data gathering. There are several ways to gather information when doing research. The study question stated the data-gathering techniques the researcher uses. Surveys, interviews, testing, physiological assessments, observations, reviews of previous records, and gathering biological samples are a few examples of data collection techniques. This study will be conducted at SRS Consortium Sdn Bhd Berhad under the management of the PSR project because they will use this digital IS rating scheme for

the PSI project. Data for this experiment were gathered by the researchers using the questionnaire. Data may be gathered via a google form. The questionnaire was a helpful instrument for data collecting when researchers were aware of the requirements of the study. The respondents get the survey by sending them the URLs of the Google forms.

3.8 Conclusion

The conclusion that this chapter observes the methodologies for data collecting and information in the study follows from the discussion of those methods in this chapter. The results will be determined by analysing the data that has been collected. This chapter also mentions the setting, the respondents, the research methodology, the analysis of the data, and the work carried out during the review process.

The utilisation of digital technology is better than it used to before. Digital technology is being used more efficiently. The existing structure could pose difficulties for each department to find the criteria and requirements for each assessment to apply the rating scheme. In term of adaptability, this website may be used for needed findings for any project at any time since it is straightforward for users to grasp and refer.

Eventually, this turned into a benefit for all departments, allowing them to rapidly refer to the materials utilised without needing to ask the other department to find the requirement in other criteria.

Aside from that, the approaches to be taken will be outlined based solely on the challenges at hand, along with the choice of suitable systems when they are used and applicable to the site. This is based on currently available references, including articles, papers, interviews, personal experiences, and other relevant data. The process path that will be used for this project and applied to the working environment on location will be attached after this chapter.

CHAPTER 4

DATA AND ANALYSIS

4.1 Introduction

In this chapter, the researcher should have an overview of what the project's expected outcome would be. Researchers thoroughly examined what data will be produced throughout the project's execution as one of the pre-project planning responsibilities. By using the quantitative method, a questionnaire was distributed to 30 respondents. The feedback from the respondents was process using Excel and the results was analysis using a paired t-test to find 2 dependent means. The E-Site application is expected capable of achieving the following objectives.

i. To design Infrastructure Sustainability Manual AR (ISMAR) rating tool using augmented reality.

ii. To develop interactive Infrastructure Sustainability Manual AR (ISMAR)using BlippAR and Google site.

iii. To test the usability of Infrastructure Sustainability Manual AR (ISMAR) E-site.

4.2 Design ISMAR Using Augmented Reality

BlippAR Application aimed to ease human operations by moving from traditional methods (forms) to real-time updates in mobile devices. Engineers and project managers used to collect all project information on scraps of paper. A serious lack of planning is one of the most typical challenges that contractors confront when commencing on a site preparation project. Project delays and lost productivity can result from poor site management (K. Pickavance, 2000).

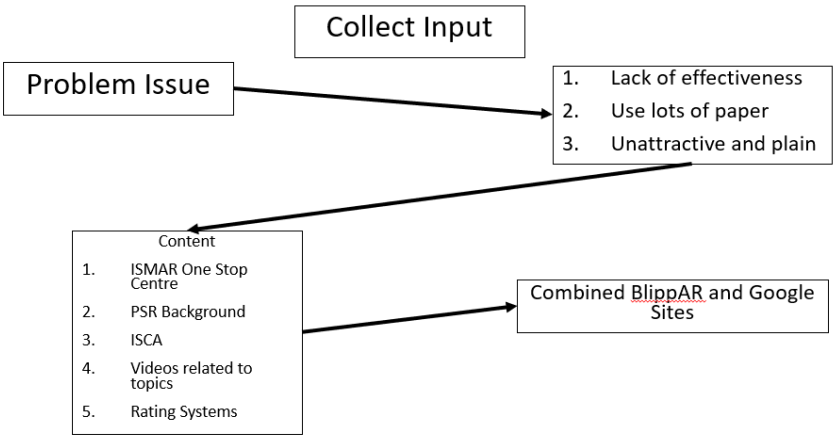


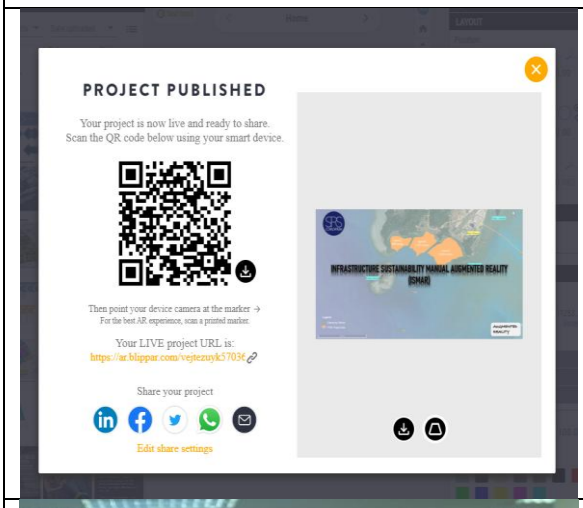
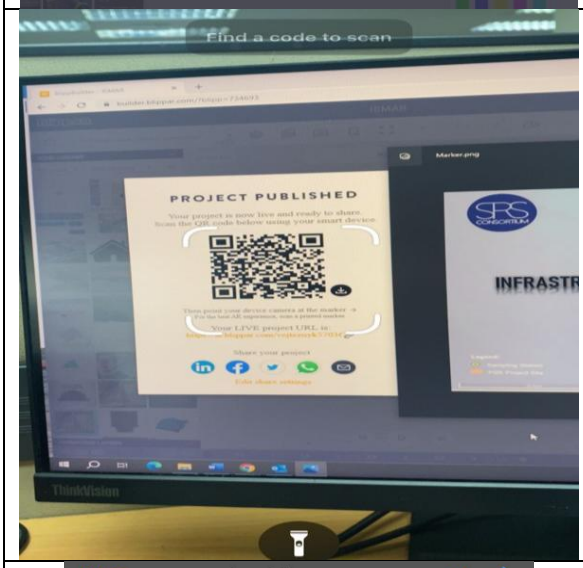
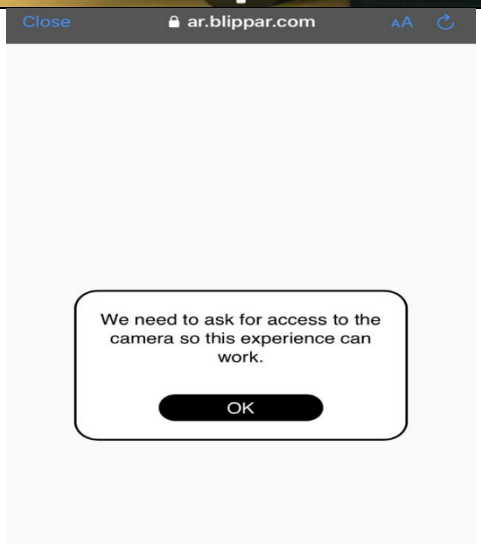
Figure 4. 1 Flowchart of Design ISMAR

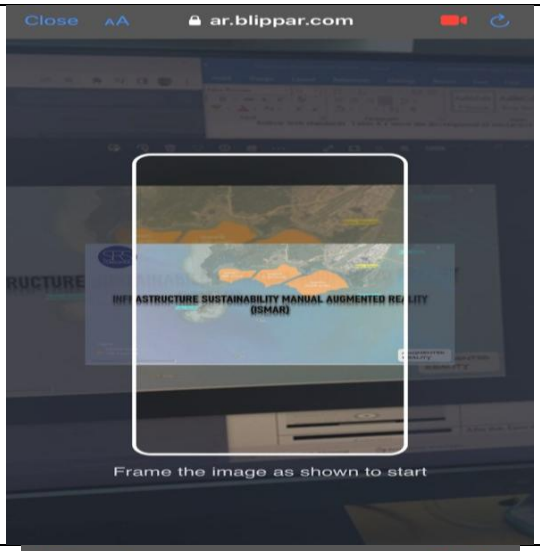
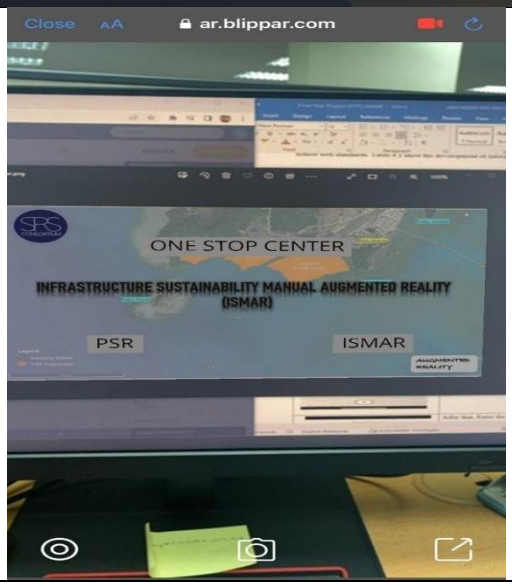
This application will also allow head of departments, managers, assistant manager, executive, and other interested parties to acquire information on infrastructure sustainability criteria and requirements. Furthermore, this application can be used to attracted public to support and give fellowship to the project.

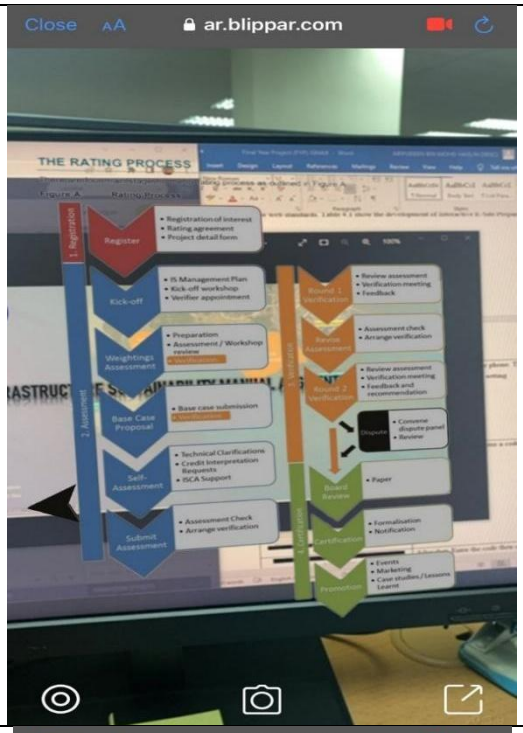
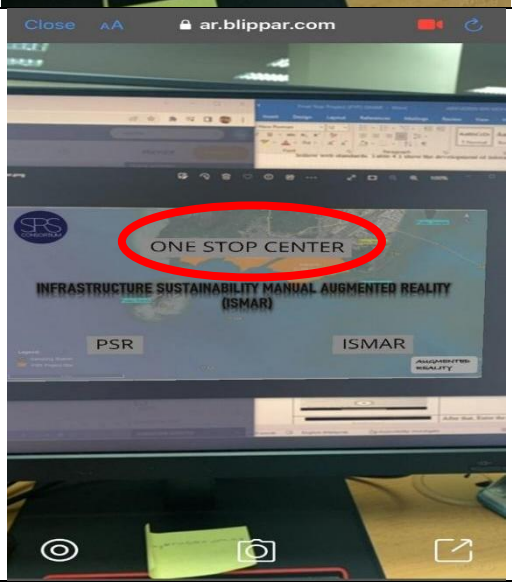
4.3 Develop ISMAR Using Augmented Reality

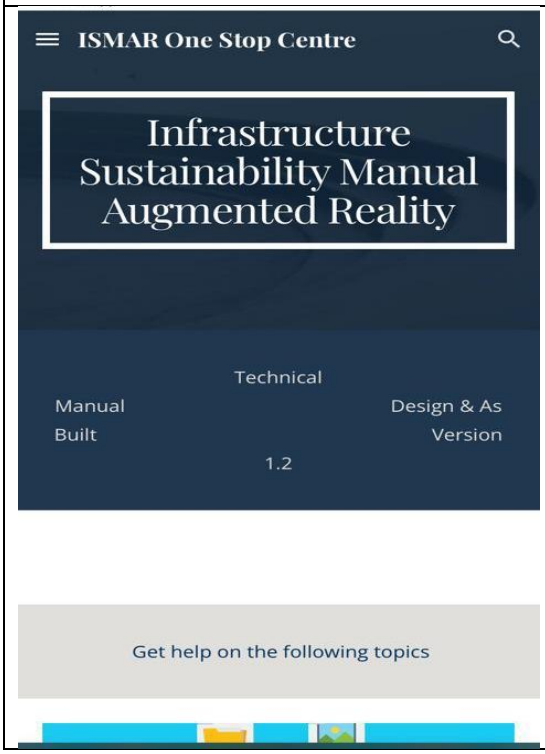
The Blippar BlippBuilderis a software toolkit that enables creating and utilisation of augmented reality experiences on mobile web browsers. Using WebGL-based 3D material and/or operable HTML components with the BlippBuilderand A-Frame or PlayCanvas, it is simple to create AR experiences that interact realistically with objects and environments. In order to locate and fix an object on any surface, it also uses the device's motion sensors. The BlippBuilderenables developers to produce augmented reality content on the web. Whereas augmented reality makes it possible to render things that are virtual in the physical environment, BlippBuildermakes it possible to precisely place and track such objects to provide an immersive online experience. It is compatible with HTML and WebGL, two web content standards that handle 2D and 3D graphics. By leveraging numerous JavaScript-based library and framework elements in AR apps (Chrome, Safari, etc.), it may build augmented reality on mobile web browsers that follow web standards. Table 4.1 show the development of Infrastructure Sustainability Manual AR (ISMAR)

Table 4.2 Systems Development

Prototype	Explanation
	Publish your project to get the QR code linked to your project.
	Open your cam scanner to scan the QR code published.
	After that, you will need to allow BlippAR to access your camera and motion sensor.

Prototype	Explanation
	Hold your camera steadily and scan your marker photo using camera. Make sure to place the marker accordingly.
	Success to access BlippAR. Able to access all information that had be upload on BlippAR

Prototype	Explanation
	For the content page that had a few options, for example, rating process, PSR infrastructure sustainability projects, and ISCA
	If you need to use the manual, click on the ‘ONE STOP CENTER’ words.

Prototype	Explanation
	Then, it will take users to the documentation that has been linked.

4.4 Test the Effectiveness of ISMAR Using Augmented Reality

The questionnaire used was altered from (Davis, 1989) Technology Acceptance Model. One of the most popular models of technology adoption is the Technology adoption Model (Davis, 1989), it focuses on the two key factors—perceived usability and ease of use—that determine an individual's interest for adopting new technology. The TAM aspects being assessed in this study are Perceived Ease of Use, Perceived Usefulness, Attitude Towards Using Technology, and Behavioural Intention to Use. Using the (Krejcie & Morgan, 1970), the samples of 14 respondents would be sufficient for the population of 15 samples. The simulation research conducted by (Winter, 2019) proven that using a regular t-test with exceedingly small sample sizes is not always wrong. He stated that even a sample size of two posed no problems.

This study presents the results of a questionnaire that was given to respondents, together with head of department, managers, engineers, executive, assistant managers, and others, to find out the need for Infrastructure Sustainability Manual AR (ISMAR) for the Penang South Island (PSI) project. This questionnaire consists of 5 sections in total. Information about demographics is included in Section 1. Issues relating to the manual technique are covered in Section 2,3,4 and 5. Through using a Google Form,

the Risk & Opportunity Team, Approval Management, Environment & Health Team, and Project Management Team have distributed this questionnaire to 14 responders. Section 1 is a demographic data section that includes four questions regarding the respondent's backgrounds. The respondents of pre and post questionnaire was the same.

This research included 64.3% male respondents and 35.7% female respondents. The percentage indicates that male respondents outnumber female respondents by a significant amount. Most men dominate the responses at the SRS Consortium Sdn Bhd main office because most of them are directly involved in the IS rating scheme. The age group of age 26 to 35 years old is the largest number of respondents with 5 people covering up to 35.7%. For the age 25 years and below they are the lowest which is 7.1 % or 1 respondent only. The numbers are same for the 46 years old and above and 36 – 45 which they are the remaining 28.6 % or 4 respondents each to complete the survey.

The respondents with below 2 years working experience are covering only 7.1 % which is 1 respondent. Secondly are the respondents with 2 – 5 years working experience, with 2 respondents covering up 14.3% of the survey. Respondents with 10 years and above manage to get 5 respondents with percentage of 35.7%. The respondents with 6 – 10 years of experience are covering most of the survey with 6 respondents or 42.9%.

Positions in the SRS Consortium office, which comprises Head of Department, Manager, Assistant Manager, Officer, Executive, Operation, and Others. Assistant Manager and Officer have the most respondents which are 6 respondents which is 42.9 %. The respondent for Executive and Operation come with a total of 4 respondents or 28.6%. Head of Department and Manager also come with the same numbers of 4 respondents or 28.6%. Lastly there was no respondents for Others.

Table 4.3 Respondents Background

	Gender	No of respondents	Percentage (%)
1	Male	9	64.3
2	Female	5	35.7
	Age	No of respondents	Percentage (%)
1	< 25	1	7.1
2	26 - 35	5	35.7
3	36 – 45	4	28.6
4	> 46	4	28.6
	Work Experience	No of respondents	Percentage (%)
1	< 2 years	1	7.1
2	2 – 5 years	2	14.3
3	> 10 years	6	42.9
4	6 – 10 years	5	35.7
	Position / Post	No of respondents	Percentage (%)
1	Head of Department/ Manager	4	28.6
2	Assistant Manager/ Officer	6	42.9
3	Executive/ Operation	4	28.6
4	Other	0	0.0

The following section focused on the issues with the previous regular method. On a scale from 5 to 1, respondents were prompted to pick the relevant scores. The following scoring system was used:

i. Strongly agree - 5
ii. Agree - 4
iii. Natural - 3
iv. Disagree - 2
v. Disagree strongly – 1

Section 2-5 of the Pre- questionnaire included questions about respondents' attitudes toward the existing method of site preparation. Table 4.3 below contains the data for Section 2-5 of the Pre- questionnaire. Section 1(P.U 1) through 4(P.U 4) collected information on the perceived effectiveness of the existing traditional procedure.

According to the findings, half of the respondents believe that the present traditional strategy is ineffective. In response to Section 1 (P.U 1), 28.6% of respondents disagree with the existing customary procedure, while 71.4% strongly disagreeing. For Section 1 (P.U 2), 42.9% of respondents disagree and 57.1% strongly disagreeing. In response to Section 1 (P.U 3), 42.9% of respondents disagree and 57.1% strongly disagreeing. Finally, for Section 1 (P.U 4), 35.7% of respondents disagree while 64.3% strongly disagreeing with the existing method being convenient. This demonstrates that the current standard method is less effective.

Section 2(P.E.U 1) to 2(P.E.U 4) collected information on the existing method's perceived ease of use. According to the findings, most respondents believe that the present traditional strategy is less effective. For Section 2(P.E.U 1), 42.9% of respondents disagree and 57.1% strongly disagreeing with the existing technic was simple to use. For Section 2 (P.E.U 2), 42.9% of respondents disagree and 57.1% strongly disagreeing that their contact with the existing technique was simple and straightforward. For Section 2 (P.E.U 3), half of respondents disagree and strongly disagreeing that the job would be simple to handle using the Existing method. Finally, for Section 2 (P.E.U 4), 57.1% of respondents disagree and 42.9% strongly disagreeing that it would be simple to learn to use the existing technique.

Section 3(I.U 1) through 3(I.U 3) collected information on the intention to employ the existing conventional approach. According to the findings, most respondents believe that the present traditional strategy is less effective. In response to Section 3 (I.U 1), 57.1% of respondents disagree and 42.9% strongly disagreeing they will use current method while working. For Section 3 (I.U 2), which is whether the user will utilise the existing method frequently, 57.1% of respondents disagree and 42.9% strongly disagreeing they will use the existing method frequently. Finally, on Section 3 (I.U 3), half of the respondents disagree and strongly disagreeing they do not intend to find other method. This shows that some people are looking for other options and have little intention of adopting the current approach because of its difficulties.

Section 4(A.U 1) to 4(A.U 4) gave information on the current conventional method's actual application. In accordance with the results, the majority of respondents indicated that the current conventional method is insufficient for practical use. For Section 4 (A.U 1), Work is more convincing with the existing method, half of the respondents disagree and strongly disagreeing with the existing conventional way. Section 4 (A.U 2), 57.1%

of respondents disagree and 42.9% strongly disagreeing that implementing current techniques is easy for them. In response to Section 4 (A.U 3), 57.1% of respondents disagree and 42.9% strongly disagreeing the existing method is comfortable to use. Finally, 64.3% of respondents disagree and 35.7% strongly disagreeing that they keenly await the components of work that consider using existing methods in Section 4 (A.U 4). This indicates that the existing conventional method is not suitable for practical application, and therefore another alternative method is essential to prepare the Infrastructure Sustainability requirement for IS rating scheme.

Table 4.4 Existing Method Survey Data

No.	**Survey to identify effectiveness of Existing method on Project management at a construction site.**	**Strongly Agree**	**Agree**	**Natural**	**Disagree**	**Strongly Disagree**
		(5)	**(4)**	**(3)**	**(2)**	**(1)**
1	Using existing method would enhance my effectiveness in work (P.U 1)	0.0%	0.0%	0.0%	28.6%	71.4%
1	Using the existing method would improve my performance in work (P.U 2)	0.0%	0.0%	0.0%	42.9%	57.1%
1	Using existing method would increase my productivity (P.U 3)	0.0%	0.0%	0.0%	42.9%	57.1%
1	I found the existing method useful (P.U 4)	0.0%	0.0%	0.0%	35.7%	64.3%
2	The current technique was simple for me to use. (P.E 1)	0.0%	0.0%	0.0%	42.9%	57.1%
2	My contact with the Existing technique was simple and straightforward (P.E 2)	0.0%	0.0%	0.0%	42.9%	57.1%
2	It would be simple for me to handle my job if I used the Existing method. (P.E 3)	0.0%	0.0%	0.0%	50.0%	50.0%

No.	Survey to identify effectiveness of Existing method on Project management at a construction site.	Strongly Agree (5)	Agree (4)	Natural (3)	Disagree (2)	Strongly Disagree (1)
2	It would be simple for me to learn to use the existing technique (P.E 4)	0.0%	0.0%	0.0%	57.1%	42.9%
3	I will use current method while working. (I.U 1)	0.0%	0.0%	0.0%	57.1%	42.9%
3	I will use Existing method often. (I.U 2)	0.0%	0.0%	0.0%	57.1%	42.9%
3	I do not intend to find other method. (I.U 3)	0.0%	0.0%	0.0%	50.0%	50.0%
4	Work is more convincing with the existing method. (A.U 1)	0.0%	0.0%	0.0%	50.0%	50.0%
4	Implementing current techniques is easy for me. (A.U 2)	0.0%	0.0%	0.0%	57.1%	42.9%
4	It is comfortable to use the existing method. (A.U 3)	0.0%	0.0%	0.0%	57.1%	42.9%
4	I keenly await the components of my work that consider me to use existing methods. (A.U4)	0.0%	0.0%	0.0%	64.3%	35.7%

Section 2-5 of the Post – questionnaire consisted of questions concerning respondents' experience with applying the One Stop Centre to acquire information on the specifics of the infrastructure sustainability rating scheme. Table 4.4 below contains the data for Section 2-5 of the Post – questionnaire. Questions 1(P.U 1) through 1(P.U 4) collect data on the perceived usefulness of applying the One Stop Centre to collect information on the specifics of the infrastructure sustainability rating scheme. The results of the survey imply that a large percentage of respondents think that the One Stop Centre is handy in acquiring information on the specifics of the infrastructure sustainability rating scheme.

In response to question 1 (P.U. 1), 64.3% of respondents agree and 35.7% of respondents strongly agree that the E-Site approach would increase their ability to perform their jobs. The next question (P.U. 2) asks if applying a One Stop Centre will improve users' performance at work, and 57.1% of respondents agree and 42.9% of respondents strongly agree. In response to P.U. 3, question 1, 71.4% of respondents agree and 28.6% of respondents strongly agree that implementing a One Stop Centre will increase their productivity. Finally, question 1 (P.U. 4), 64.3% of respondents agree and 35.7% of respondents strongly agree that it was convenient to them. This shows how One Stop Centre may be used to acquire information on the specifics of the infrastructure sustainability rating scheme.

Data on the perceived usability of the the Infrastructure Sustainability Manual AR (ISMAR) on the project can be found in questions 2(P.E.U. 1) to 2(P.E.U. 4). The findings indicate that a huge proportion of respondents think the current approach is less effective. In relation to question 2 (P.E.U. 1), 64.3% of respondents agree and 35.7% of respondents strongly agree that it was easy for them to use. The results for question 2 (P.E.U. 2), which asked respondents if using an E-site would be straightforward for users to learn, 57.1% of respondents agree and 42.9% of respondents strongly agree. In response to question 2 (P.E.U. 3), 64.3% of respondents agree and 35.7% of respondents strongly agree it would be simple for them to handle their job using Infrastructure Sustainability Manual AR (ISMAR). Finally, question 2 (P.E.U. 4), 57.1% of respondents agree and 42.9% of respondents strongly agree that it would be simple for them to learn to use Infrastructure Sustainability Manual AR (ISMAR).

Questions 3 (I.U 1) through 3 (I.U 3) provided data regarding the intention of using the E-Site to enable visitors to easily get information on the project's specifics and methodology. The results show that most respondents think the current method is less useful. In accordance to question 3 (I.U. 1), 71.4% of respondents agree and 28.6% of respondents strongly agree that they would utilise the Infrastructure Sustainability Manual AR (ISMAR) while at work. Following that, in response to question 3 (I.U. 2), 71.4% of respondents agree and 28.6% of respondents strongly agree that they would use the E-site regularly. For the last question (I.U. 3), A total of 71.4% of respondents agree and 28.6% of respondents strongly agree that they do not plan to use any other way than the Infrastructure Sustainability Manual AR (ISMAR).

Information on the usage of the Infrastructure Sustainability Manual AR (ISMAR) on the project was provided in questions 4 (A.U 1) through 4 (A.U 4). The findings show that most respondents think the Infrastructure Sustainability Manual AR (ISMAR) is suitable for practical usage. In response to question 4 (A.U 1), 64.3% of respondents agree and 35.7% of respondents strongly agree that the Infrastructure Sustainability Manual AR (ISMAR)'s work is more convincing. In response to question 4 (A.U. 2), 64.3% of respondents agree and 35.7% of respondents strongly agree think it will be simpler for them to implement Infrastructure Sustainability Manual AR (ISMAR). Then, for question 4 (A.U. 3), 64.3% of respondents agree and 35.7% of respondents strongly agree that using the Infrastructure Sustainability Manual AR (ISMAR) is comfortable. Finally, 57.1% of respondents agree and 42.9% of respondents strongly agree to look forward to those aspects of job that require to use Infrastructure Sustainability Manual AR (ISMAR) for question 4 (A.U 4).

Table 4.5 Feedback after using ISMAR

No.	**Survey to identify effectiveness of E-Site on Project management at a construction site.**	**Strongly Agree (5)**	**Agree (4)**	**Natural (3)**	**Disagree (2)**	**Strongly Disagree (1)**
1	Infrastructure Sustainability Manual AR (ISMAR) would increase the effectiveness in work. (P.U 1)	35.7%	64.3%	0.0%	0.0%	0.0%
1	Infrastructure Sustainability Manual AR (ISMAR) would increase finishing the task. (P.U 2)	42.9%	57.1%	0.0%%	0.0%	0.0%
1	The productivity would improve if I used the Infrastructure Sustainability Manual AR (ISMAR). (P.U 3)	71.4%	28.6%	0.0%	0.0%	0.0%
1	Infrastructure Sustainability Manual AR (ISMAR) was convenient to me. (P.U 4)	35.7%	64.3%	0.0%	0.0%	0.0%
2	Infrastructure Sustainability Manual AR (ISMAR) was simple for me to use. (P.E 1)	35.7%	64.3%	0.0%	0.0%	0.0%
2	My contact with Infrastructure Sustainability Manual AR (ISMAR) was simple and straightforward. (P.E 2)	42.9%	57.1%	0.0%	0.0%	0.0%
2	My contact with Infrastructure Sustainability Manual AR (ISMAR) was simple and straightforward. (P.E 3)	35.7%	64.3%	0.0%	0.0%	0.0%
2	It would be simple for me to learn to use Infrastructure	42.9%	57.1%	0.0%	0.0%	0.0%

No.	Survey to identify effectiveness of E-Site on Project management at a construction site.	Strongly Agree (5)	Agree (4)	Natural (3)	Disagree (2)	Strongly Disagree (1)
	Sustainability Manual AR (ISMAR). (P.E 4)					
3	I will use Infrastructure Sustainability Manual AR (ISMAR) while working. (I.U 1)	71.4%	28.6%	0.0%	0.0%	0.0%
3	I will use the Infrastructure Sustainability Manual AR (ISMAR) frequently. (I.U 2)	71.4%	28.6%	0.0%	0.0%	0.0%
3	I do not intend to find method other than Infrastructure Sustainability Manual AR (ISMAR). (I.U 3)	71.4%	28.6%	0.0%	0.0%	0.0%
4	Work is more convincing with the Infrastructure Sustainability Manual AR (ISMAR). (A.U 1)	35.7%	64.3%	0.0%	0.0%	0.0%
4	Implementing Infrastructure Sustainability Manual AR (ISMAR) is easy for me. (A.U 2)	35.7%	64.3%	0.0%	0.0%	0.0%
4	It is comfortable to use the Infrastructure Sustainability Manual AR (ISMAR). (A.U 3)	35.7%	64.3%	0.0%	0.0%	0.0%
4	I look forward to those aspects of my job that require me to use Infrastructure Sustainability Manual AR (ISMAR). (A.U 4)	42.9%	57.1%	0.0%	0.0%	0.0%

Table 4.5 shows respondent level of usability toward using existing method whereby analysis shows for all variables tested the mean score were less than 3.00 meaning that the usability level of existing method was low. Whilst Table 4.6 shows respondent level of usability toward using Infrastructure Sustainability Manual AR (ISMAR) whereby analysis shows for all variables tested the mean score were more than 4.00 meaning that the usage of Infrastructure Sustainability Manual AR (ISMAR) much easier compare with the existing method.

Table 4.6 Usability Level of existing method among respondents

Variables	Mean	Interpretation
Perceived Ease of Use	1.40	Low
Perceived Usefulness	1.50	Low
Attitude Towards Using Technology	1.50	Low
Behavioral Intention to Use	1.60	Low

Table 4.7 Usability Level of ISMAR among respondents

Variables	Mean	Interpretation
Perceived Ease of Use	4.40	High
Perceived Usefulness	4.40	High
Attitude Towards Using Technology	4.30	High
Behavioural Intention to Use	4.40	High

In order to evaluate the effectiveness of Infrastructure Sustainability Manual AR (ISMAR) in the project, a paired sample t test was performed. Results as shown in Table 4, respondent preferred using Infrastructure Sustainability Manual AR (ISMAR) whereby all variable measured, Perceived Ease of Use (Mean = 4.40), Perceived Usefulness (Mean = 4.40), Attitude Towards Using Technology (Mean = 4.30) and Behavioural Intention to Use (Mean = 4.40) were higher compared with existing method, Perceived Ease of Use (Mean = 1.40), Perceived Usefulness (Mean = 1.50), Attitude Towards Using Technology (Mean = 1.50) and Behavioural Intention to Use (Mean = 1.60). A paired sample t-test found this difference to be significant for all variables being measured, the value of t of Perceived Ease of Use is 21.33 and the value

of p is < .00001. The result is significant at p < .05. The value of t of Perceived Usefulness is 19.01 and value of p is < .00001. The result is significant at p < .05. The value of t of Attitude Towards Using Technology is 17.98 and the value of p is < .00001. The result is significant at p < .05. The value of t of Behavioural Intention to Use is 14.67 and the value of p is < .00001. The result is significant at p < .05. This suggests that using Infrastructure Sustainability Manual AR (ISMAR) was much easier and resourceful compared with existing method. This mean that Infrastructure Sustainability Manual AR (ISMAR) was more effective compare with the existing method.

Table 4.8 Paired Sample T-Test

Pair	Paired Different	t	Significant (two tailed)
	Mean		
Perceived Ease of Use - Existing Method	3.00	21.33	.000
Perceived Usefulness - Existing Method	2.90	19.01	.000
Attitude Towards Using Technology- Existing Method	2.80	17.98	.000
Behavioural Intention to Use- Existing Method	2.80	14.67	.000

4.5 CONCLUSION

Sustainable ratings seek to evaluate a company's economic, environmental, and social performance. A well-balanced firm provides three crucial insight factors into its capacity to capitalize on opportunities and control risks throughout the medium to long term. In addition to enhancing reputation and minimizing the possible effects of stricter regulation and standards, awareness of emerging environmental and social requirements may aid in identifying opportunities for new goods. Moreover, to being more appealing to employees, sustainable businesses also encourage innovation and the retention of critical knowledge.

Therefore, it was determined that respondents from SRS Consortium Sdn Bhd employees including department heads, managers, assistant managers, supervisors, project managers, and executives agreed that the Infrastructure Sustainability Manual AR (ISMAR) system is superior to the current approach. As of right now, paper is still being utilised for references and submissions. This approach was dated and challenging to use. The Infrastructure Sustainability Manual AR (ISMAR) was praised for having a higher mean (> 4.00), and they intend to use it to acquire more about the infrastructure sustainability rating scheme. The Social Science Statistics online website's analysis of the paired t-test was used to assess the efficiency of the Infrastructure Sustainability Manual AR (ISMAR). The outcome demonstrates that the Infrastructure Sustainability Manual AR (ISMAR) differs significantly from the current approach. This indicates that, in comparison to the current system, Infrastructure Sustainability Manual AR (ISMAR) was more efficient and user-friendly.

CHAPTER 5

DISCUSSION, CONCLUSION AND SUGGESTION

5.1 INTRODUCTION

The research project had been analysed and the conclusions drawn from previous chapters were summarised. At the conclusion of the chapter, a few suggestions for more research were provided. It was established from the findings in the previous chapter that the Infrastructure Sustainability Manual AR (ISMAR) is suitable to be use inside the firm and, consequently, for implementation throughout the whole construction industry. A system that characterises "sustainability" and brings together project issues and solutions within the context of sustainability is provided by sustainability rating systems, which also give standards and measurements that enhance collaboration. An efficient, long-lasting, and robust project is frequently the consequence of a green rating system. Implementing a sustainability framework can lead to opportunities for tax incentives, long-term operational cost savings, and an improvement in waste and energy costs.

Studies reveal that a lack of preparation is one of the most common mistakes made during the planning phase. An e-site information system can help project managers and other departments to acquire more about the details of the infrastructure sustainability rating scheme in order to solve this problem. Construction technology offers a variety of intriguing opportunities for the construction industry's digital transformation, from obtaining a competitive edge to improving working conditions for employees and reducing carbon emissions. The study predicts that the future of the construction industry will see digitalization technology become a necessity rather than an option for all corporate enterprises.

5.2 DISCUSSION

The challenges that exist at this firm have been discussed through several attempts. One of these included applying the design thinking method. By interviewing construction industry professionals such as the project managers department, environment department, approval department, and clients, the researcher progressed through the empathy stage. Therefore, difficulties were identified, and projects were developed to address them through idea brainstorming.

Surveys have been designed based on two ideal phases: before and after using the application. One (1) questionnaire had a few questions meant to generate feedback and ideas on the current conventional method to acquire more about the details of the infrastructure sustainability rating scheme. The questions in Questionnaire 2 are intended to produce comments and suggestions on the application. The analysis's findings indicate that this digital is being used better than it was previously. More effective use is being made of digital. Under the current system, employees might find it challenging to complete their routine tasks. This website may be used for any project at any time since it is easy for users to understand and apply.

According to the questionnaire feedback, respondent level of usability toward utilizing current method, whereby analysis shows that the mean score for all variables examined was less than 3.00, indicating that the usability level of existing method was low. While the feedback demonstrates respondent usability toward utilizing Infrastructure Sustainability Manual AR (ISMAR), research shows that the mean score for all variables examined was greater than 4.00, implying that using Infrastructure Sustainability Manual AR (ISMAR) is significantly easier than the present approach. A paired sample t test was used to assess the performance of Infrastructure Sustainability Manual AR (ISMAR) in the project. According to the findings in Table 4, respondents preferred using Infrastructure Sustainability Manual AR (ISMAR), with all variables measured Perceived Ease of Use (Mean = 4.40), Perceived Usefulness (Mean = 4.40), Attitude Towards Using Technology (Mean = 4.30) and Behavioral Intention to Use (Mean = 4.40) being significantly higher than the existing method. Perceived Ease of Use (Mean = 1.40), Perceived Usefulness (Mean = 1.40), Attitude Towards Using Technology (Mean = 1.50), and Behavioral Intention to Use (Mean = 1.60).

A paired sample t-test revealed that this difference was significant for all variables studied. The value of t for Perceived Ease of Use is 21.33 and the value of p is < .00001, the result is significant at p .05. Perceived Usefulness is 19.01 and value of p is < .00001, and the result is also significant at p .05. Attitude Towards Using Technology has a t value of 17.98 and the value of p is < .00001, and the result is significant at p .05. Behavioral Intention to Use has a t value of 14.67 and the value of p is < .00001, at p .05. The result is significant. It follows that using Infrastructure Sustainability Manual AR (ISMAR) was much simpler and more creative than the previous method. Therefore, Infrastructure Sustainability Manual AR (ISMAR) was more effective than the previous method.

5.3 RECOMMENDATION

In context of the previously stated findings, the researcher would like to make several recommendations that may be used as a road map or as a plan of action for increasing the use of the Infrastructure Sustainability Manual AR (ISMAR). Penang South Reclamation is the project's current focus. This indicates that just the data necessary for this project may be accessed by this program. Therefore, it would be highly beneficial for many parties if the application could include a variety of other efforts put out by the organization.

In addition, tools other than the BlippAR Builder can be used to develop the E-Site application. Applications may be made using programs like Dalux Viewer, Pair 3D, Smart Reality, and Storyboard VR. All the platforms mentioned can be used by users to create applications. Each platform is easy to use and is offered without charge. While creating the program, users may also pick up new skills like coding and blockchain.

The Infrastructure Sustainability Manual AR (ISMAR) helps in the reduction of time taken to access the information on the specifics of the infrastructure sustainability rating scheme. The technology of a business can therefore persuades more individuals to adopt its services. If this technology is used in the company, Malaysia may be able to compete favourably with other industrialized countries. Technologies used in the building industry can benefit a nation's economy.

5.3 CONCLUSION

The result showed that respondents which consist of employees of SRS Consortium Sdn Bhd Sdn Bhd employees consisting of engineer, site supervisor, project manager agreed that the Infrastructure Sustainability Manual AR (ISMAR) system is more effective compared to existing method. The current method that has been used on site is they use paper as their reference and submission. This method was obsolete and hard to manage. Higher mean (> 4.00) was agreed with Infrastructure Sustainability Manual AR (ISMAR) easy to use and they have the intention to use it to gain information about the infrastructure sustainability rating scheme. The effectiveness of the Infrastructure Sustainability Manual AR (ISMAR) was evaluated using paired t-test, analysed by Social Science Statistics online website. The result shows that Infrastructure Sustainability Manual AR (ISMAR) has a significant difference compared with existing method. This meant that Infrastructure Sustainability Manual AR (ISMAR) was more effective and easier to use compared with the existing method. This product was highly recommended to be used to acquire more about the infrastructure sustainability rating scheme.

Furthermore, this Infrastructure Sustainability Manual AR (ISMAR) can be accessed as a mobile application, which will also benefit the user and be ready and easy to use by all employees. The researcher's conclusion is that technology in the construction business is vital for producing the best quality and product for the project. The use of Infrastructure Sustainability Manual AR (ISMAR) can reduce the expense of paper, save time, and help the organization become more systematic. As a result, the use of technology in the organization might help induce more customers to use the company's services. Using technology to manage building activities may also help Malaysia catch up with other successful countries across the world. Technology in the construction sector is critical to a country's economic growth.

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