This journal gathers publications from surveying practices namely Quantity Surveying, Property Surveying, Geomatics and Land Surveying and Building Surveying. The publication of ISrJ gives opportunity to the researchers, academicians, practitioners as well as students to share their research outcomes. We have covered many topics in the last few volumes under the current editorial but there is still a vast area within these surveying practices waiting to be explored.

JOURNAL OBJECTIVES

International Surveying Research Journal (ISrJ) is an international journal dedicated to the publication of theoretical and empirical refereed articles, case studies or critical literature review in thefield of surveying research and development.

The scope of the journal covers development and application of the surveying practices globally. The purpose of the **International Surveying Research Journal (ISrJ):**

- To provide a unique international forum for new research findings in the surveying research.
- To reflects recent development and application of surveying practices.
- To encourage knowledge sharing among researchers, academics, and practitioners.
- To keep abreast with new technology developments in the surveying fields.
- To stimulate research in the various surveying disciplines.

EDITORIAL BOARD

Editor's Message

Welcome to International Surveyors Journal (ISrJ) Vol. 13, Issue No. 2 for February 2024 for the Royal Institution of Surveyors Malaysia (RISM). This journal gathers publications from surveying practices namely Quantity Surveying, Property Surveying, Geomatics and Land Surveying and Building Surveying. The publication of ISrJ gives opportunity to the researchers, academicians, practitioners as well as students to share their research outcomes. We have covered many topics in the last few volumes under the current editorial but there is still a vast area within these surveying practices waiting to be explored. This particular issue consists of five (5) selected papers reviewed by the editorial committee and international experts on current topics which include Hotspot Mapping of Traffic Congestion based on Big Data Platform: Kuala Lumpur,Taxonomy Of Circular Business Models: A Critical Review, Enhancing BQS Proficiency: Insights from Taylor's BQS Students on The Significance of Internship Learning Experiences for Knowledge, Skill, and Exposure, Integrating Virtual Reality and Building Information Modeling in Quantity Surveying Curriculum Courses and The Precision Volume Estimation of Water Tanks Through UAV-based 3D Structural Modeling. We wish to extend our appreciation to all our contributors who have sent articles to date and we will try to include in future issues of ISrJ.

Do drop a message and request if there are specific surveying topics of particular interest. Thank you for the readership and hope it is beneficial to all.

Sr Hj. Ahmad Suhaimi Abdul Majid
Advisory Editor,
February 2024

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Hotspot Mapping of Traffic Congestion based on Big Data Platform: Kuala Lumpur

Ainon Nisa Othman, Maisarah Abdul Halim and Anas Sayuti Mukhtar

Abstract

Traffic congestion is a pervasive problem in high-density areas, and hotspot mapping is a suitable technique for modeling its occurrence. In this study, we used two different techniques, IDW (inverse distance weighting) and Kernel Density, to analyze and compare the patterns of traffic congestion hotspots. Data from the ArcGIS online platform were used, including information on the location of congestion and its severity. We obtained hotspot graphics using two methods in the ArcGIS software, which allowed us to identify the areas and roads most affected by traffic congestion at different temporal scales. To further analyze the data, we classified the hotspots into different traffic conditions, from heavy traffic to lower congestion. We also performed an accuracy assessment to determine the reliability of the two techniques in comparison to real data from the ArcGIS online platform. Our results provide valuable insights into the patterns of traffic congestion in high-density areas and offer a useful tool for transportation planning and management.

1.0 Introduction

As new technology emerges in this era, it is now possible to analyze and determine the road pattern using only online data. This paper focuses on monitoring the condition of traffic congestion using big data analysis. Malaysian roads are perpetually plagued by traffic congestions (Malay Mail, 2020). Occasionally, the area has multiple road patterns on various days (Goseeko, 2021). Big data has been extensively used in a variety of applications because it is one of the primary data types that can be combined with modern technology using devices such as mobile phones (Leah Wasser, 2019). The purpose of this paper is to investigate traffic congestion locations in Kuala Lumpur using big data. The objectives of this paper are to identify congestion hotspots in Kuala Lumpur based on big data and to map them. This paper will also examine the use of GIS for data processing, analysis, and discussion of the results.

2.0 Literature Review

2.1 Big Data

Big data is one of the online platforms that contain various data using internet connection, big data can be in many platforms to publish the raw data and can be one of the techniques for sharing the data from the public information (Ieltsunlocked, 2016). There is a certain type of data that has been published in online platforms that cannot be accessed because the reason is that they only provide to the user who logs in the account and gets the permission to retrieve the data. One of the capabilities of big data is that it can provide information to make a map by compiling all the related data needed (Dempsey, 2014). Another capability of big data is used to analyze the data which are available and can be obtained easily for any kinds of information. Another capability is that big data can make collaboration work with users who are online at that time and become one of the platforms to publish the data and also helping in expanding the work into a global sharing network (Gillespie, 2022). Most of the data are from cloud-based software and the data are secure by security on protecting the privacy of data.

2.2 Hotspot Mapping

Hotspot mapping is the one of the methods to identify the specific place or exact location (Wong, 2018). As for this paper, this method was used to find the road facing a heavy traffic congestion almost in peak hours on weekdays and weekends. By using the method, hotspot mapping can be visually interpreted not only as a hotspot area but other information such as the distance of the road facing the traffic congestion and expected time on how long the congestion will end. To develop a hotspot map, a geospatial wizard was used to process the data and identify the exact location. The results were presented in different classifications and different layers.

3.0 Methodology

This section shows the method of framework to achieve the aim and objectives of the research. The main phases include problem determination, preliminary study, data acquisition and data collection, data extraction, data processing and result. The current data of traffic congestion are retrieved from ArcGIS Online platform. About 6000 points of data are collected from the platform and used to generate the hotspot mapping.
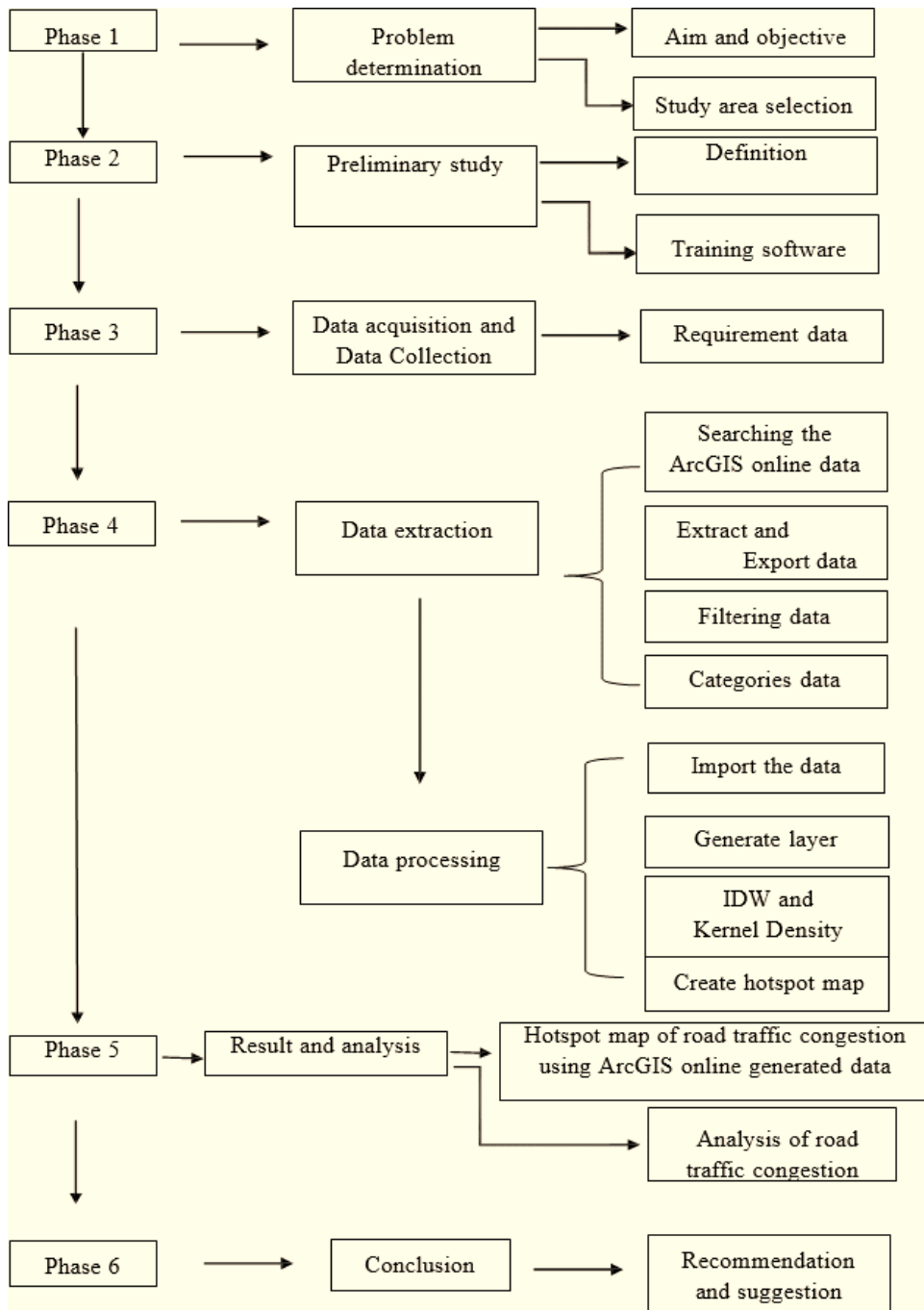

Figure 1. Flow of general methodology

3.1 Technique

Inverse Distance Weighting (IDW) is a quick deterministic interpolator. There are very few decisions to make regarding model parameters. It can be a good way to take a first look at an interpolated surface. However, there is no assessment of prediction errors, and IDW can produce "bulls' eyes" around data locations. There are no assumptions required of the data. In IDW it has a dataset where the steps in choosing the layer in source of the dataset are needed and the data field must add the field that has the valid value range that can describe the percentage or the difference between high and low range. The other technique used is Kernel Density Interpolation which is the technique where barriers is a moving window predictor that uses the shortest distance between points so that points on either side of the line barriers are connected. To provide the result, the point of location data was processed using the kernel density and then later changed the color in symbology to show the different values or classes of the hotspot map.
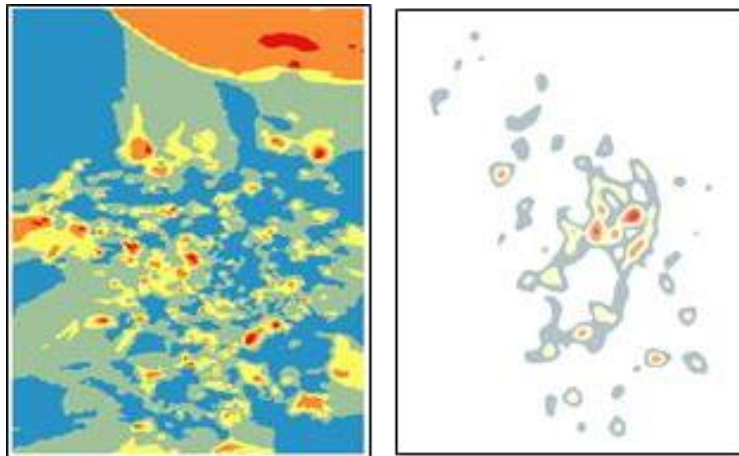
Figure 2. Example of IDW and Kernel Density

3.2 Extracting Information

To extract the information and data, platforms from open source are needed to access many types of information. The information such as time and location are the main information for this research. To extract the big data, the important elements that need to be included are the internet connection, accessibility, and the permission for the user to upload the data. This research used the cursor method to extract the data. There are five items that can be extracted namely the type of text in form of Qualitative, date of the data created and time. In the extraction process, the data type on big data online is Waze alert which needs to extract the weak data, process of filtering the importance details and added value range. The process of data filtering is needed because the data is in the form of continuous information.

3.3 Processing

ArcGIS software is used for collecting the data, analysis and map making. This process includes the export data and is converted as a layer for making maps. Data processing involved other steps such as process filters by selecting the attribute and finally adding the range value for classes. Also, data processing involved interpolation methods such as IDW and Kernel point density method, creating the hotspot map, converting by layer into vector and adding map elements.

GIS analyst is a tool which focuses on map making with more visual view and accurate expectation in providing the solution in solving a problem. It also generates maps with better design and clearly visual. Besides, it is also used in processing data to produce better results and to find new solutions. One of the main info that GIS analysts need for road traffic are location and status of road by using the user data management. GIS analysts in road traffic are focusing on user data where the data can be used as the processing information to provide solid info and the final output will be a maped in visual data from the status of the user.

3.4 Example of the Data

Table below shows an example of the data. Data such as type of jam, point and percentage are the data gain from the big data platform. The table includes how many points in each type of jam and calculate to identify the percentage for the graph analysis. Data dated 8 November 2022 were used for this research.

Table 1. Total Point and Percentage of Traffic Jam Congestion in One Day

Type of Jam	Point	Percentage %
Jam stand still traffic	3332	49
Jam heavy traffic	2498	37
Jam moderate traffic	684	10
Jam light traffic	0	0
No Info	327	5
	6841	100

4.0 Results and Analysis

Figure 3 shows the outcome from this research. It shows the predicted hotspot area in the study area and also the name of the road affected by the traffic congestion. The color represents the rate of higher and lower and the pie chart shows the percentage. The map indicates the traffic congestion in the Kuala Lumpur area.

As for the hotspot map, it shows the location of road congestion in the Kuala Lumpur area. From the analysis, it shows 49 percent road from the data given is in the jam stand still category. It follows with 37 percent and 10 percent each from jam heavy and moderate traffic. Most of the congestion roads are located at Jalan Gereja, Jalan Hang Lekiu and also Jalan Tun Perak. High-dense areas such as Jalan Ampang and Jalan P Ramlee where the roads are the main road used by almost all drivers. So as Lembah Ampang shows the area with jam stand still traffic and heavy traffic at peak hours.

This paper shows the technique and model in mapping the traffic congestion area using current data provided from a big data platform from users. The GIS technique then was performed to generate the map and provide the analysis related to the research.
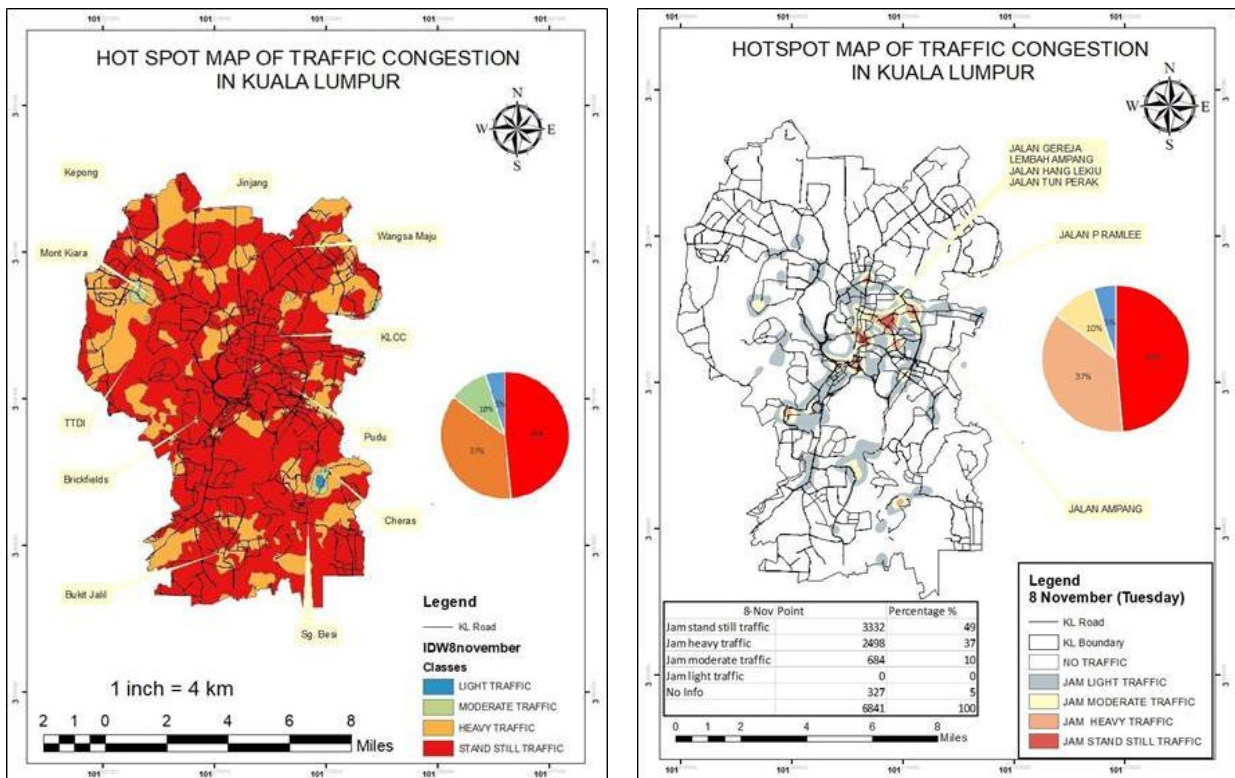
Figure 3. Hotspot Map

5.0 Conclusion

In conclusion, this study applied two hotspot mapping techniques, IDW and Kernel Density to model and analyze the patterns of traffic congestion in high-density areas using data from the ArcGIS online platform. Results showed that the two techniques provided different but complementary insights into the spatial and temporal distribution of traffic congestion hotspots. We were able to identify the areas and roads most affected by congestion and classify them into different traffic conditions. The accuracy assessment also demonstrated the reliability of the techniques used in comparison to real data. Overall, the findings of this study have significant implications for transportation planning and management, as they can help decision-makers to better understand the patterns of traffic congestion and develop effective strategies to mitigate it.

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TAXONOMY OF CIRCULAR BUSINESS MODELS:
A CRITICAL REVIEW

Nurul Sakina Mokhtar Azizi & Zahirah Azizi

Abstract

The circular business model is proposed as a sustainable strategy to reduce carbon emissions and waste through resource efficiency. Companies across various industries adopt different approaches in establishing circular business models, resulting in a lack of clarity on the definition of a circular business model due to the absence of guidelines for its practical implementation. Furthermore, prior research has identified distinctive characteristics of circular business models, resulting in a lack of clarity regarding the comprehensive understanding of these characteristics. In addition, there are also unclear examples demonstrating the practical implementation of these characteristics which hinders organisations from emulating exemplary approaches. Hence, the paper aims to establish the characteristics of a circular business model and explore the many practices that organisations in various industries use to implement them. This is critical for providing a guideline for organisations wanting to develop a circular business model due to the different approaches to implementing circular business models in practice. Based on specified keywords, four databases were utilised to perform a systematic literature review of research publications on the subject of circular business models. Out of the 240 articles retrieved, 56 were included in the analysis to investigate the current understanding of circular business models and develop a taxonomy of circular business model characteristics. The study established six categories of circular business model characteristics namely, extending, dematerialising, cycling, bridging, intensifying, and narrowing. Practices such as integrating smart design solutions in buildings and infrastructure, changing product materials in the supply chain, introducing a used item marketplace and robust return policies, offering service contract leasing, and redesigning products to be fully recyclable are some examples of how circular business model principles are applied. This paper enhances the body of knowledge by presenting practical examples implemented by organisations for each characteristic of a circular business model.

1.0 Introduction

Over the last decade, the idea of a circular economy has gained traction in both academia and business around the world, and it is regarded as a significant and emerging area of study (Brennan et al., 2015; Geissdoerfer et al., 2017). A circular economy system necessitates the creation and adoption of business models focused on using as little capital as possible for as long as possible whilst maximising value. Its restorative and regenerative system attempts to prolong the life of products, close energy loops, and limit material resources in order to maximise benefit to a diverse set of stakeholders and customers while minimising environmental effects and social costs (Marina et al, 2018; Board of Innovation, 2020). This moves away from the traditional linear business model and requires organisations to reconsider their investment strategies and service offerings (Rashid et al., 2013). As a result, there has been a surge of interest in research on circular business models (CBM) in the last five years (Geissdoerfer et al., 2020)). The introduction of circular business models (CBM) could aid in the achievement of the Sustainable Development Goals and the creation of a sustainable economy for future generations. Numerous industries are committed to reduce their carbon footprint including agriculture, automotive, construction, retail, hospitality, and industrial technology believing that it not only benefits the environment, but also adds economic and social value to their businesses through innovative business solutions. (Morgan, 2019). However, how the circular business model is implemented within their business is unknown. While the concept has been around since the 1950s, there is limited evidence of circular business models in practice. This may be attributed to a lack of consistency in the literature on circular business models, as well as a lack of common framework to clarify how they are applied in practice (Pieroni et al., 2019a; Rosa et al., 2019).

Attempts to reduce carbon emissions within an organisation are often fragmented and do not involve the entire process in a circular business model. For instance, there are companies that focused solely on the construction phase through dematerialization and recycling, whereas the entire operation and use phase was overlooked (Gamuda Berhad, 2021; NCC, 2019; LafargeHolcim, 2020). On the contrary, there are also cases where companies focused only at the operational phase through the use of renewable energy to operate their facilities but other phases were neglected (The Walt Disney Company, 2020; Carlsberg Group, 2021; Starbucks Coffee Company, 2020; Legosz, 2020). As a result, the adoption of the circular business models by most organisations are not holistic in all areas but only in certain processes.

Furthermore, even carbon emission assessment methods focus exclusively on the operational phase of a project, rather than the entire process, which frequently overlooks the manufacturing phase. The Royal Institute of Chartered Surveyors (RICS) reported that carbon emissions are

assessed primarily in the use phase (80%) and only 20% in the manufacturing phase (RICS, 2012). Other examples can be found in the current green building rating tools, such as BREEAM in the United Kingdom, LEEDS in the United States, Greenstar in Australia, Green Building Index in Malaysia and BCA Green Mark Scheme in Singapore where the production of buildings is also primarily evaluated during the use phase, rather than during the manufacturing process (Doan et al., 2017; Shan & Hwang, 2018; Zhang et al., 2019). Therefore, the fragmented approach to carbon emission reduction can be addressed through the appropriate adoption of a circular business model, which takes into account the complete life cycle of a project, including manufacturing, transportation, construction, operation, and end-of-life phase.

The lack of clarity regarding the characteristics of circular businesses and the variety of approaches to circular business make it challenging to assess its carbon emission impact. Even though there exists several national and international guidelines that touches some aspects of circular business models. However, these guidelines vary greatly, making it difficult to extract the key characteristics of circular business models. For example, a national UK guideline can be seen through the UK Economy Package (Gov UK., 2020) where it concentrates on waste management as opposed to an international guideline such as the EU Action Plan (Shahbazi & Jönbrink, 2020) where it focuses exclusively on the production of circular products. In addition, the EU Action Plan nor does the UK Economy Package take into account important aspects of the circular business model, such as the integration of long-term service-oriented approach with product users, as proposed by Kuik et al., (2023) and Rosa et al., (2019).

Prior research on systematic literature review around the topic of circular business model attempted to establish its characteristics. However, the results revealed divergent findings. For example, Geissdoeffer et al., (2020) proposes that in a circular business model it should have four characteristics which are cycling, extending, intensifying and dematerialising. However, Kuik et al., (2023) proposed six characteristics of a circular business model which are extending, long term service oriented, use of renewable energy and bio based materials, resource recovery, collaborative consumption. Whereas Rosa et al., (2019) proposed eight characteristics in a circular business model which are designed for circularity, resource efficiency, product-service systems, closed loop supply chains, collaboration and partnerships, leveraging digital technologies, adoption of life cycle thinking and value creation. Lewandowski, (2016) on the other hand, proposed nine characteristics of a circular business model which are resource efficiency, product life extension, closed loop system, value retention, eco design and innovation, collaborative ecosystems, customer centricity, transparency and traceability, and regenerative practices. While there may be overlapping traits, the overall characteristics of a circular business model remain unclear. The proposed characteristics are broad and do not specifically address the

needs of the construction or manufacturing industries, but rather encompass a wide range of businesses. Hence,there is a need to establish the characteristics of a circular business model to provide a comprehensive view of circular business models. In addition it is imperative to explore the practices that organisations in various industries have implemented so that organisations can emulate exemplary approach. This would enhance the understanding of what a circular business model entails.

2.0 Background

This section describes the background of the circular business model. It begins by describing the principles of circular economy and an introduction on the overview available guidelines that relates with circular business model

2.1 Circular Economy

The concept of circular economy was first introduced by Boulding (1966), who proposed the idea of prolonging the lifespan of products by keeping them in use for as long as possible. A widely accepted definition of the circular economy, as proposed by Kirchherr et al., (2017) describes it as an economic system of a business model that replaces the concept of end-of-life with the reduction, reuse, recycling, and recovery of materials in the production, distribution, and consumption processes. This system operates at both micro-level (individual products, companies, and consumers) and macro-level (cities, regions, nations, and beyond) with the goal of achieving sustainable development. The circular economy seeks to establish a balance between the economy and the environment, while also considering the social equity aspects for the benefit of current and future generations.

2.2 Available framework on concepts of circular business model

Table 1.0 depicts the list of frameworks that touches on the concept of circular business model. Each framework has its own key characteristics on how the circular economy principle can be applied. There are a total of nine frameworks. The EU Action plan prioritises the integration of circularity factors into the earliest stages of product design (Shahbazi & Jönbrink, 2020b). The promotion of product value intensification aims to achieve circular product design that meets eco-design requirements and enables the closing of resource loops. The framework of the Circular Strategy Scanner (Blomsma et al., 2019) presents categorization of circular strategies.``Rethink and Reconfigure" strategies are presented, which focus on reinventing company models and reconfiguring ways to propose, develop, capture, and distribute value to customers. "Reinvent" focuses on shifting paradigms by selling services rather than tangible goods. "Restore, reduce, and avoid" focuses on raw material usage, manufacturing efficiency, logistics, and packaging during the production stage. "Recirculate'' closes the resource loop by recycling and remanufacturing parts and components and cascading materials for future use. Four Value Creation Bases (Guldmann, 2017) is a value creation framework comprising four concepts. 1. Inner circle power: Keep things running for a long time. 2. The power of circling longer: Keep products in consecutive cycles and boost new product energy performance. 3. The power of cascaded use: Diversify product functions, share and reuse it. 4. The power of the clean circle: the use of uncontaminated materials and the eco-design concept. Macarthur (2015) proposed ReSOLVE Framework where it means Regenerate, Share, Optimise, Loop, Virtualize and Exchange. Regenerate means reclaiming and retaining the biosphere with renewable resources. Share action aims to diversify usability of products by sharing them with different users for different purposes. Optimise action aims at intensifying product's efficiency and eliminating waste from the production process. Loop action focuses on closing the loop of the supply chain through remanufacturing and recycling or anaerobic digestion.

Mentink (2014) developed a circular business model innovation where it approaches a problem through questions such as Value propositions (What): Produce long lasting products, reverse logistics system, Activities, processes, resources and capabilities (How): Use recycled materials, maintain relationship of companies with end-users, insure closed-loop Revenue models (Why): Sell product-based services and Customers interfaces (Who): Change of customers habits, Target new customers. Circular Business Model principles by Laubscher & Marinelli (2014) proposed six key areas which are sales model where it should be product service system, maximise product quality, keep track of products, components, and materials, maximise uses of recycled materials, building partnerships and developing employees' capabilities.

Table 1.0 shows that there are similarities in how these frameworks outline circular business models. In the first column, there is a common theme drawn that emphasises the importance of products being durable, longevity, and remaining on the market for as long as possible. The second common characteristic throughout the nine frameworks is the incorporation of a product service system within the organisation to ensure a continuous business cycle with consumers. However, only the EU Action plan did not emphasise this aspect. As for the third common theme, the frameworks appear to emphasise on the importance of ensuring that the products are continued to be used in any forms such as recycle, repurpose, and restore, in order to reduce waste.

Table 1.0 The similarities in how these frameworks outline circular business models.

| No	Framework	Spectrum of Circular Business Model								References
		DURABLE	PRODUCT SERVICE	CONTINUUITY IN USES						
1	EU Action Plan	Longetivity of products								(Shahbazi & Jonbrink, 2020)
2	Circular Strategy Scanner	Rethink and Reconfigure	Reiinvent	"Restore, reduce, and avoid	"Recirculate					(Blomsma, 2019)
3	Four Value Creation Bases	Inner circle power: Keep things running for a long time	The power of circling longer: Keep products in consecutive cycles and boost new product energy performance.	The power of cascaded use: Diversify product functions, share and reuse it.	The power of the clean circle: the use of uncontaminated materials and the eco-design concept					(Guldmann, 2017)
4	ReSOLVE Framework	Regenerate	Share	Optimize	Loop	Virtualize	Exchange			(Macarthur, 2015)
5	Circular Business Model Innovation (CBMI)	Value propositions (What): Produce long lasting products, reverse logistics system,	Activities, processes, resources, and capabilities (How): Use recycled materials, maintain relationship of companies with end-users, insure closed-loop	Revenue models (Why): Sell product-based services				Customers interfaces (Who): Change of customers habits, Target new customers		(Mentink, 2014)
6	Circular business model principles	Product design/material composition: Maximize products' quality	Sales model: Product-service system (PSS)		Supply loops: Maximize use of recycled materials to gain excess value from products		IT/data management: Keep track of components, and materials	Strategic sourcing for own operations: : Build partnership and relationship with	HR/Incentives: Develop employees' capabilities	(Laubscher & Marinelli, 2014)
7	Principles strategies to future circular material chains	Accumulate tomorrow's valuable resources	Move from ownership to functionality	Utilise technologies to improve the efficiency of manufacturing process	Substitute inputs with renewable, recyclable inputs			building relationships with customers and partnership		(Roos,2014)
8	Business Model Canvas Value network	Develop a durable product that requires minimal resources and can be disassembled and recovered.	Offers product-service system	Implement reverse supply chain activities				High degree of cooperation with actors of supply chain		(Urbinati et al., 2017)
9	Circular Economy Package (CEP)	Making Things Last	Beyond Recycling	Resource and Waste Strategy (RWS)		Environment Strategy				(Gov UK, 2020)
		9	8	7	5	2	2	4	1	

3.0 Research Method

The research methodology employed in this paper is using a systematic literature review following the PRISMA framework. PRISMA framework in systematic literature review proposed four phases in the process of selecting the final number of materials to be reviewed. The four phases are identification, screening, eligibility and inclusion criteria. Figure 1.0 shows how the final articles were selected.
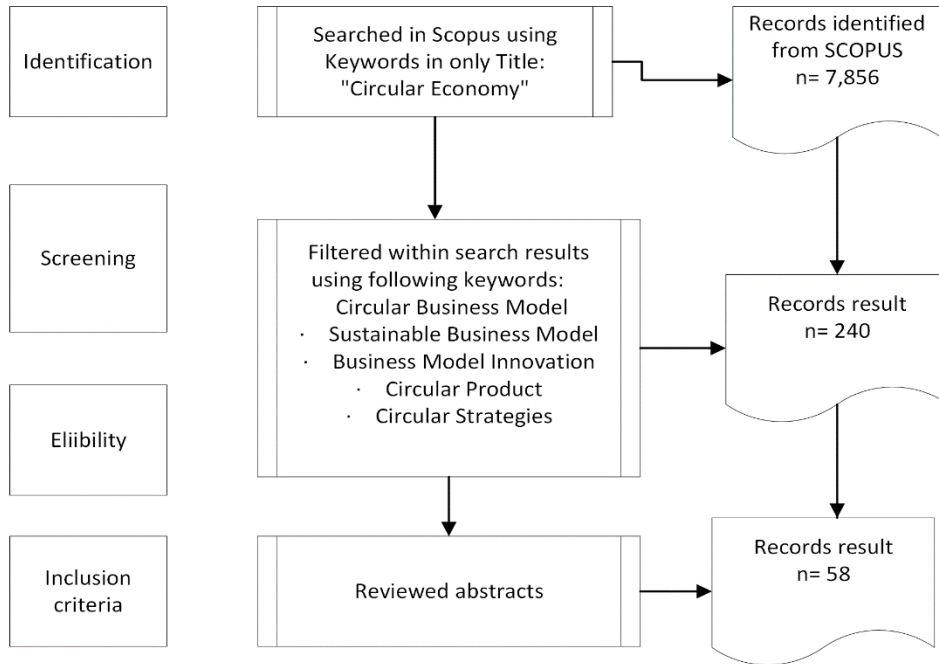
Scopus search engine database was used to search for articles. The initial search began with keywords on "circular economy" which resulted in 7856 articles. Subsequently, the following keywords such as "Circular Business Model'', "Sustainable Business Model", "Business Model Innovation", "Circular Product", and" Circular Strategies" were used to search within the initial searched results. This process resulted in 240 papers. Out of the 240 papers, abstracts were screened and resulted in 58 articles.

Articles spanning the years 2014 to 2021 were examined to demonstrate the historical evolution of changes in the characteristics of the circular business model. This is because the articles published between the 1950s and up until 2013 did not directly address circular business models, but rather focused on individual practices, and thus were not included in this study. Mostaghel & Oghazi (2017) asserted that the concept of circular business existed in the 1950s, but little evidence was found to explain what practices were considered circular in an organisation.

Number of Articles
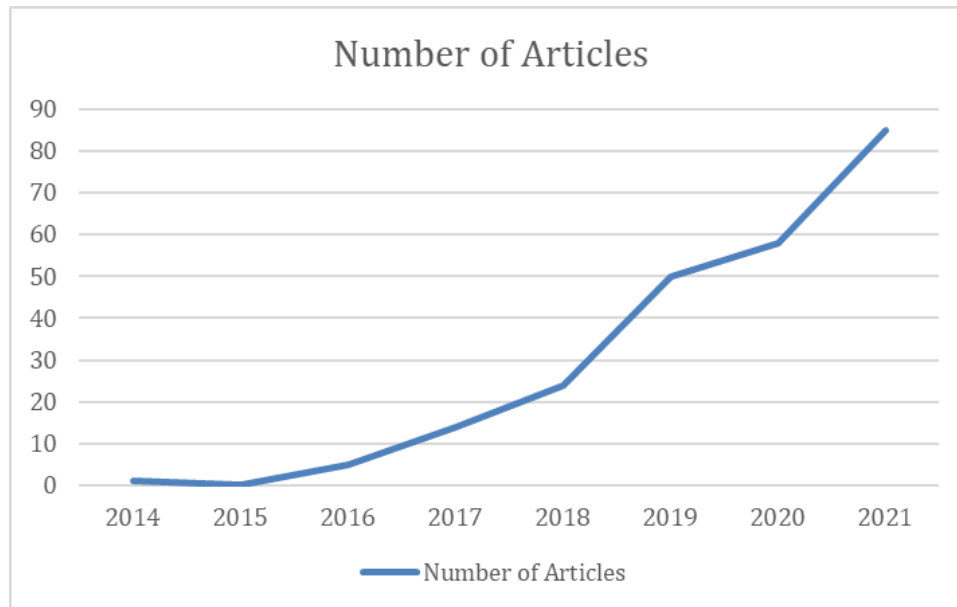
Only between the 1970s and 1990s did evidence of a circular approach in an organisation emerge, demonstrating some practices that were not previously recognized as circular but are now considered to be characteristics of the circular business model. For example, Commoner (1971) and Graedel and Allenby (1995) introduced the laws of ecology, which emphasize the importance of building an environment that promotes the transcendence of sustainable business. Another example is Stahel and Reday (1976), who demonstrate how to incorporate waste prevention and dematerialization strategies into a business organisation. Additional examples of circular approaches began to emerge, such as renting products rather than selling (Stahel, 1982) and producing regenerative design of the product (Lyle, 1994). As shown in the examples, the circular approach is secular rather than holistic in nature, with each organisation adopting a unique circular approach to their business. Between 2000 and 2015, the term 'circular business model' was first used in 2006 by Schewager and Moser (2006), who examined various types of circular value creation business models but did not provide an introduction to the characteristics of circular business models through examples of organisational practices. It was not until 2013 that an explanation for the characteristics of business models was discovered through the article by Ellen Macarthur Foundation (EMF, 2013).

Thematic analysis was used to synthesise and analyse the data from the sample of articles. All 58 articles were reviewed to extract the explanation of the characteristics of the circular business model. Similar themes were then classified into different main categories as proposed by Castleberry & Nolen (2018), where the researcher can extract and study all of the data linked with

that category from the dataset. Additionally, examples of organisational practices were extracted from organisational publications to help elucidate the taxonomy of circular business models.

4.0 Results and Discussion

4.1 Characteristics of Circular Business Model

It is evident from the analysis of the data that the quantity of articles pertaining to the attributes of circular business models has increased substantially from 2014 to the present. With the exception of 2015, a year in which no articles were identified as contributing to the subject matter of this paper, the number of studies conducted increased every other year, with the most recent year witnessing a substantial surge of 46.6%, from 58 articles in 2020 to 85 articles in 2021. It is evident that this research topic is still in its nascent stages, with much more yet to be uncovered.
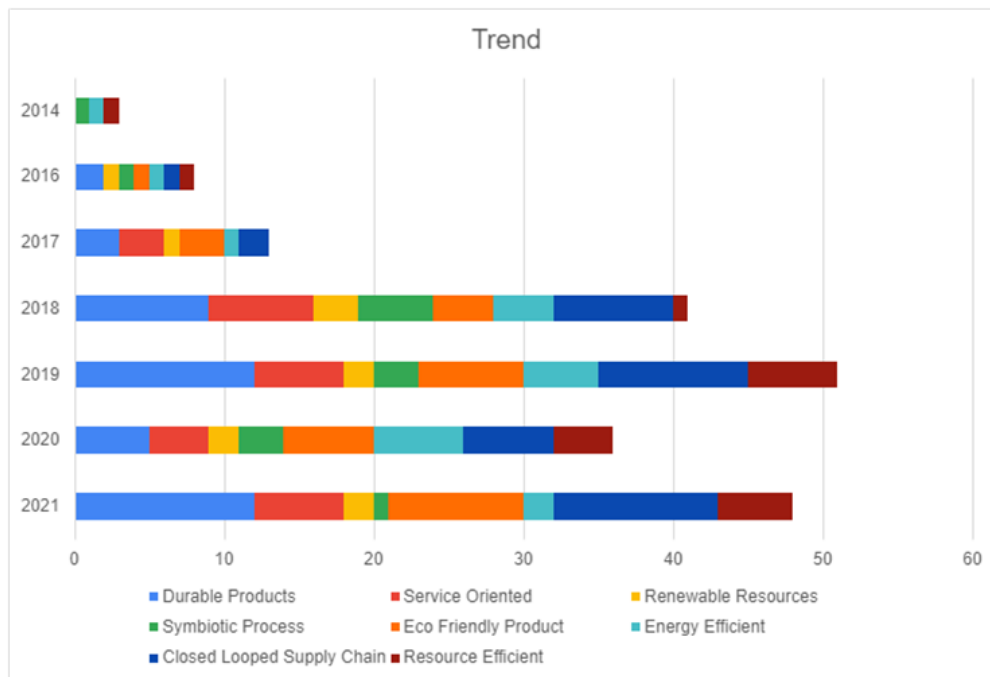
Furthermore, a close examination of the preceding table detailing the temporal progression of characteristics reveals that while the data indicates a general upward trend from 2014 to 2021, the frequency of occurrence for each characteristic fluctuates considerably. This phenomenon may be ascribed to the abundance of available guidelines, the majority of which fail to encompass the entirety of the Circular Business Model as previously expounded upon in this article. As a result, the objective of reading as many of these articles as possible throughout the year is to identify and classify all pertinent practices that contribute to the Circular Economy according to their respective attributes.

The results in figure above show that there are a total of eight characteristics which are durable products, service oriented, renewable resources, symbiotic process, eco-friendly product, energy efficient, closed loop supply chain and resource efficient.

The first attribute of a circular business model is to procure or produce durable products, which highlights the importance of a product having high performance or efficiency through the use of high-quality materials and the ability to repair or upgrade components to extend the product's life in the hands of the consumer. This will contribute to a reduction in market demand and, subsequently, in energy and material consumption associated with new manufacturing (Laubscher and Marinelli, 2014; Bocken et al., 2016; Ellen McArthur Foundation, 2016; Guldmann, 2016; Julia Nußholz, 2017).

"Service-oriented" refers to the practice of replacing the sale of physical products with the provision of products via service contract leasing for the use of the product. This allows the consumer to continue using the product as if it were their own while also allowing the seller to manage the product once it is no longer usable. This has the advantage of allowing sellers to recover valuable resources from their products and manage proper material disposal while still maintaining relationships with their customers (Mentink, 2014; Laubscher and Marinelli, 2014; Ellen McArthur Foundation, 2016; Julia Nußholz, 2017; Urbinati et al., 2017; Fraunhofer IZM, 2018; OECD (2018); Blomsma et al., 2019; M. Geissdoerfer et al., 2020).

The term "renewable resources" refers to the type of energy used in the manufacturing process, such as solar, wind, biogas, or hydro. These natural resources have the potential to reduce dependency on non-renewable energy sources while also decreasing environmental effects. This is accomplished in terms of material consumption by substituting bio-based, renewable, or recovered materials for traditional virgin resource inputs, hence lowering long-term need for virgin resource extraction (Schulte, Uwe G. 2013; Mentink, 2014; Bocken et al., 2016; Ellen McArthur Foundation, 2016; Lewandowski 2016; de Pádua Pieroni et al., 2018; Fraunhofer IZM, 2018; Blomsma et al., 2019).

A "symbiotic process" is one in which waste from one process is used as a feedstock for another process. Frequently, there are numerous by-products of a given chemical that are no longer usable in the current process but may be helpful in another business. For example, excess heat is frequently generated and can be transferred to other operations that require heat energy (Samuel, 2014; Roos, 2014; Bocken et al., 2016; Fraunhofer IZM, 2018).

"Eco-friendly" refers to the practice of manufacturing items, parts, and materials from recyclable resources and energy in order to eliminate and limit non-recyclable waste and pollution. By addressing the cycling of products, parts, or materials, items should be designed to be as recyclable as possible during the manufacturing process (Mentink, 2014; Laubscher and Marinelli,

2014; Bocken et al., 2016; Ellen McArthur Foundation, 2016; Guldmann, 2016; Julia Nußholz, 2017; Urbinati et al., 2017; Linder & Williander, 2017; OECD, 2018, M. Geissdoerfer et al., 2020). The term "energy efficient" refers to the process of developing products that consume less energy during their lifetime. Products are enhanced to consume less energy while performing their intended function.

The term "closed loop process" refers to the coordination of operations and information exchange between producers and users, as well as any intermediaries, in order to ensure that parts and products can be recirculated via recycling, cascading, and recovery, hence completing loops Mentink, 2014 (Laubscher & Marinelli, 2014) Laubscher and Marinelli, 2014; Guldmann, 2016; Julia Nußholz, 2017; Linder and Williander, 2017; Marina de Pádua Pieroni et al., 2018; Fraunhofer IZM, 2018; Blomsma et al., 2019).

Finally, being "resource efficient" in a circular business model implies consuming fewer resources during the manufacturing process, whether energy, material, or labour. Through technical and management advancements, production processes can be optimised to use less resources. Laubscher and Marinelli, 2014; Roos, 2014; Bocken et al., 2016; Lewandowski 2016 OECD; 2018; M. Geissdoerfer et al., 2018).

5.0 Practical Examples

The characteristic of durable products is the systematic development process that yields commodities with an extended life cycle and enhanced durability when handled by consumers. It emphasises primarily on the product's use phase, which is accomplished through engineering and design planning to maximise functionality or by improving material quality. Over time, product maintainability became an additional aspect of durability, allowing components to be remanufactured and repaired. One company that contributes to the development of more resilient products is HP Inc. This is achieved through the provision of maintenance, upgrades, and restorations for their products, thereby extending their useful lives. An additional illustration of a corporation extending the lifespan of its products is evident in Apple's operating system. Numerous operating systems, irrespective of whether they are implemented on computers or mobile devices, are releasing updates that are incompatible with significantly older devices, thereby rendering those devices obsolete. By placing emphasis on its software, Apple creates an operating system that is compatible with significantly older models, thereby extending the useful life of its products.

Being service oriented is highly promoted in a circular business model as compared to the linear business models. Instead of the traditional selling of physical products, it is the selling of products through service contract leasing for the use of the product. This allows for the consumer to still have the same use of the product as if it is owned by them but allows for the seller to manage the product after it is no longer unusable. Over the years, multiple terms such as "product-based services", "pay for performance", "access and performance" and one of the latest being "dematerialising" have been used to describe this process although carrying the same meaning. A recent development in this area presented the possibility of sharing of under-utilised products, allowing the seller to use one product for multiple users. There are many product-based companies that are starting to change their business models to adopt more service-oriented approaches such as Philips and Lyft. Philips Lighting has made a shift from selling light bulbs to offering lighting-as-a-service. By doing this, customers only pay for the light they use while Philips navigates the installation, replacement and disposal of the product. On the other hand, Lyft, a transportation service company, has implemented the ability to share rides to fully utilise the space within the vehicle whenever it makes a single journey.

Renewable resources refer to the utilisation of renewable sources of energy instead of the reliance on sources of energy that cause environmental damage. In addition to the use of renewable energy, resources also concern the sourcing of more sustainable material used in the production process. The transition to renewable energy and resources reduces the consumption of non-sustainable resources. There are already many big companies such as Google, Ikea and Starbucks which are using renewable energy (or making the transition from non-renewable sources) for their business to provide energy in their offices, warehouses, outlets, and facilities. Similarly, for vehicle manufacturer Volkswagen Group's, out of their total global energy consumption in its production operations, 46% of it was covered by renewable electricity in 2020. With ambitions to be 100% dependent on renewable energy by 2030, Volkswagen hopes to reduce the reliance on unsustainable resources. In addition, construction companies like Gamuda are using recycled steel and sustainable cement made from recycled waste products in their construction activities.

Symbiotic process is the process where waste developed in one process can be used as feedstock of another process. Oftentimes during the production process, there are various by-products that are no longer useful for that particular process however may be used elsewhere. The ability to reuse waste as much as possible reduces the need for a different process to source raw material or energy. One of the best examples of having symbiotic processes is the Kalundborg

Symbiosis, the world's first industrial symbiosis which can be found in Denmark. It is the partnership between twelve public and private companies where the residue from one company becomes a resource at another, benefiting both the environment and the economy. The local partnership allows for the sharing and reusing of resources, saving money and minimising waste creating a local growth while supporting green transition.

Eco-friendly product is the manufacturing of products which at its end of use phase can be fully recycled. Products should be designed as much as possible to be fully recyclable by considering cycling of products, parts or materials. By producing more parts or materials that are more recyclable, the consumers can properly recycle the waste once the product is no longer functionable. Creating eco-friendly products indirectly divert waste from the final disposal while reducing extraction and processing of virgin resources. There are many examples of companies that are making product packaging recyclable such as Brooks Sports. However, this is only a small part. Some companies are taking it even further by the recycling of their entire product. HP Inc is one of the companies that are developing solutions for paper de-inking to improve the recyclability of printed papers and forestry used. While it may be difficult for certain products, it is much easier for others like The Coca-Cola Company which after use of the product, is only left with the packaging which can be fully recycled.

Products that are energy efficient are products that reduce the consumption of energy during its use phase. Through constant research and development, there are new advancements and optimization in technologies which allow for products to consume less energy while still carrying out its intended function. Reducing energy leakages during a product's use phase can also contribute to the reduction in consumption of energy. Other than just focusing on their products, many companies are also focusing on their own operations making them more energy efficient. The Walt Disney Company leverages the use of smart design solutions for their buildings and infrastructure, including offices and theme parks globally, through the use of high efficiency lighting and HVAC equipment, geothermal technology, low flow fixtures and energy management controls. Similarly, companies like Home Depot are also reducing energy in operations while selling products that have eco options which will consume less energy.

Closed-loop supply chain systems are aimed at the coordination of information and activities between all parties of the supply chain to reduce environmental impacts throughout the whole supply chain. Closing loops in this sense requires collaboration between all stakeholders, building trusted partnerships. This allows for reverse logistics, a process that enables a return flow of the product back to the manufacturer to identify issues and reuse potential. The reverse logistics is

also a method for which the suppliers or consumers can share information and their feedback on the product. Companies like Philips are closing the loops with their current products to ensure useful material is not wasted through take-back, refurbishment, and recycling. Similarly, eBay through their e-commerce platform is encouraging customers to exchange or reuse items instead of throwing them away by their robust return policy and used item marketplace, allowing for users to send back used products or reselling usable products to keep them in the materials within the closed loop.

Being resource efficient focuses on improving resource consumption during the manufacturing process. In a circular business model, producers need to narrow down the source of material by using as few resources as possible while producing the same product. For example, Brooks Sports in their designing of sportswear, adopts the use of the Higg Index Design and Development Module (DDM) to assess the design of each part of the footwear uppers to maximize material efficiency to reduce waste. IKEA on the other hand is improving resource efficiency in just a simple way. By no longer producing their iconic product catalogues and other prints, they are able to reduce resources used. Additionally, IKEA, although known for its furniture and fittings, are even changing food ingredients to reduce resource use. Over the years, IKEA has been reducing the volume of beef and pork sold. They have also recently launched the HUVUDROLL plant ball, which only has 4% of the climate footprint compared to the ingredients of the iconic meatball.

6.0 Conclusion

Given the increasing prevalence of circular business models, this study was undertaken to provide a more comprehensive understanding of the circular business model concept and its defining attributes. Several significant contributions were made by this review, including the following: (1) an overview of the inception of the circular business model; (2) an analysis and compilation of definitions and attributes pertaining to circular business models; and (3) the development of a checklist enumerating the characteristics of circular business models. The inception of the circular business model and its innovations can be traced back to resource scarcity and technological advancements that prompted a shift in consumer behaviour. As a consequence, efforts were made to identify a model that could aid in mitigating the adverse environmental effects, thereby fostering sustainability and meeting societal demands. The results of a systematic literature review indicate that the attributes of a circular business model can be classified into six primary categories: expansion, dematerialization, cycling, bridging, intensification, and reduction. The discovery presented in this study offers crucial insights to organisations of all types by establishing

a criteria that enables them to assess the degree of circularity in their current business model and determine which steps need to be taken to increase the circularity of their operations.

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Enhancing BQS Proficiency: Insights from Taylor's BQS Students on The Significance of Internship Learning Experiences for Knowledge, Skill, and Exposure

Wen Jie See, Azrina Md Yaakob, Myzatul Aishah Kamarazaly

Abstract

This study delves into the crucial realm of internship experiences, with a specific focus on Bachelor of Quantity Surveying (BQS) students at Taylor's University. The primary objective of this research is threefold: firstly, to assess the correlation between internship learning experiences and academic career outcomes among Taylor's University students; secondly, to ascertain the significance of these internship experiences for BQS students; and finally, to explore effective strategies for optimizing the educational value derived from internships. Employing a quantitative research methodology, this study collected data via a structured questionnaire. Key findings from the analysis not only reveal the positive link between internship learning and academic success but also emphasize the pivotal role of internships in augmenting knowledge, skill development, and exposure among BQS students. Furthermore, the study provides actionable insights for enhancing the overall quality of internship learning experiences, ultimately contributing to the holistic education of future Quantity Surveying professionals.

Keywords: Importance, Learning experience, Knowledge, Skill, Exposure, Internship, BQS student.

1.0 Introduction

Internships are recognized as pivotal in providing students with valuable experiential learning opportunities, a critical ingredient in preparing them for successful careers (Kolb & Kolb, 2017). Quantity Surveying (QS) students, in particular, benefit from immersing themselves in real-world scenarios, honing their knowledge, skills, and professional identities. These internships bridge the gap between classroom learning and the intricacies of real-world QS practice, an approach lauded by educational institutions aiming to equip graduates with industry-relevant skills. Employers increasingly seek graduates with both solid theoretical foundations and essential soft skills such as flexibility, problem-solving, communication, and punctuality (Jayaeam & Engmann, 2014). Notably, the QS profession demands not only theoretical knowledge but also personal skills and exposure, essential for interacting professionally with clients and others, further enhancing students' industry readiness.

However, in Malaysia, the academic side of Quantity Surveying faces constraints regarding knowledge transfer. While tools and facilities in local academic settings are adequate for building foundational knowledge, there is often a lack of emphasis on translating this theoretical knowledge into practical skills (Anjum, 2020). This disconnects between university learning and the practical demands of the profession can leave students ill-prepared for their internships, eroding their confidence and potentially deterring them from participating.

Taylor's University, for instance, offers a six-month QS internship aimed at fostering personal growth and career development. Yet, this transition from classroom to internship can be daunting, as fresh graduates often confront the realities of professional life without adequate preparation. Proficiency in mathematics, analytical thinking, communication, and problem-solving is crucial in the QS field. Unfortunately, many students fail to recognize the importance of applying their knowledge and skills precisely during internships, leading to uncertainty about their career prospects (Almoayad & Ledger, 2018).

Understanding the value of internship experiences, encompassing knowledge, skill development, and exposure, is critical for students before embarking on internships. Being mindful of these facets enables students to maximize their internship opportunities, engaging with industry experts, Investigating the precise contributions of internships to knowledge, skill, and exposure can illuminate their role in students' academic and professional progress. This understanding, as advocated by Anjum (2020), empowers students to prepare effectively for internships, harnessing their potential to translate classroom concepts into real-world practice confidently and robustly.

2.0 Problem Statement

Lecturers, despite having tools and support, may struggle to bridge the gap between theoretical and practical knowledge for students (Anjum, 2020). This lack of emphasis on connecting concepts with application hinders students' ability to effectively use their knowledge in practical settings, impacting fields like construction and quantity surveying (QS) (Kankanhalli, 2011). Research suggests that effective knowledge repurposing enhances organisational performance and innovation, benefiting employee performance (Kankanhalli, 2011). However, ineffective teaching methods contribute to students' difficulty applying conceptual knowledge in real-life problem-solving (Anjum, 2020). Internships play a crucial role in addressing this gap. Amin et al. (2020) emphasise that internships provide unique work experiences distinct from classrooms, essential for dealing with varied and complex professional tasks (Chue & SÄLJÖ, 2021). Katajavuori et al. (2006) highlight the interrelation of theoretical and practical knowledge in the industrial field. Yet, the connection between internship learning experiences and students' academic career outcomes remains underexplored. However, Burnett and Jayaram (2013) note that students often lack vital non-cognitive abilities crucial for bridging the gap between classroom and industrial learning.

Researchers Pitan & Adedeji (2012) attribute unemployment, even with accessible job vacancies, to academia's failure in producing graduates with the right skills (Kwarteng & Mensah, 2022). This indicates that fresh graduates lack the necessary skills for employment. In Quantity Survey, some students may not realise the importance of internships for gaining hands-on, out-of-classroom experience crucial for future employability. Mee et al. (2016) found that employers highly value interpersonal, teamwork, problem-solving, communication, analytical, and critical thinking skills. According to Halsey et al. (1997), academic credentials no longer adequately inform employers about potential hires. They emphasise that academic achievements primarily demonstrate test-taking abilities, not collaborative or interpersonal skills. Internship programs are seen as offering a valuable learning experience that goes beyond traditional classroom education, providing the diverse skills employers seek. Therefore, Quantity Survey students should recognize and prioritise the importance of internship learning experiences for their future careers.

Considering obstacles faced by students in internships, Vo et al. (2021) used SPSS to analyse data from 400 respondents, revealing challenges such as communication, working hours, problem-solving, self-confidence, supervision, and workplace environment, but not physical demands. Swaid et al. (2017) note that recent graduates often confront unanticipated challenges in their industries due to inadequate preparation during training. In this context, intern students' lack of proactive engagement with permanent employees hinders them from maximising their

internship learning experience. Emphasising the term 'value,' Thomas and Walden (1998) highlight that theoretical knowledge and soft skills are crucial for increased production. Work-based learning, as described by Andresen et al. (2000), encourages a participative, learner-centred approach, essential for constructing meaning. However, practical research on how students maximise the value of internship learning experiences is lacking. This is crucial as employers seek candidates with both soft skills and a strong theoretical foundation.

3.0 Objectives

- To identify the relationship between the internship learning experience and the students' academic learning outcomes in Taylor's University

- To identify the importance of internship learning experience for BQS students.

- To study the practical ways in maximising the value of learning experience in an internship.

4.0 Overview of internship learning experience

4.1 Theories Learning in classroom vs Practical Learning in internship.

Internships are vital for proactive learning, providing practical experience, teamwork skills, resume enhancement, networking, and income (Polytechnic, 2021). They develop generic or soft skills such as leadership, teamwork, critical thinking, and sustainability awareness. Unlike simulated exercises, internships involve hands-on experiences in real-world professional settings, fostering experiential learning (Kolb; 2015). Haupt and Kanzow (2023) highlight that theoretical knowledge assessment often relies on objective evaluations, emphasising knowledge acquisition without practical application. Academic internships serve as a bridge, connecting theory and practice through supervised engagement. This aligns with Anjum's (2020) findings that internships offer work-related experiences, contributing to students' learning progress. Nawi et al. (2020) emphasise that industrial training actively applies theory concepts in real-world settings, allowing Quantity Survey interns to employ their classroom knowledge but potentially uncovering more advanced practices. Work-related learning studies (Dsouza & T, 2022; Streumer & Kho, 2006; Adresen, Boud, & Cohen, 2000) use terms like work-based learning (WBL) and work-related learning. WBL values learners' work-related experiences, fostering intentional learning in real-life contexts. Lee et al.'s (2014) study on Taylor's University interns underscores the disparity between textbook learning and real-world operations. Incorporating internships into academic curricula, as seen in Kapareliotis et al.'s (2019) work, emphasises the need for integrating practical experiences alongside classroom pedagogies. Experiential learning principles

(Kapareliotis et al., 2019) call for deeper exploration of Quantity Survey internship experiences. Internships offer undergraduates the chance to apply theoretical knowledge in real-world settings (Hughes, 2006). Knowledge acquisition becomes reciprocal, with theoretical foundations complemented by experiential learning in internships (Little, 2006). Work-based learning (WBL) in internships allows for unique, individualised learning experiences, distinct from standardised classroom instruction (Agarwal & Gupta, 2008). Research suggests that students participating in internships perform better academically and professionally (Alhur, 2023; CHUE & SÄLJÖ, 2022; Gashaw, 2019).

4.2 Benefits and Implication of internship

4.2.1 Good Employability

In the evolving job market, academic excellence alone is insufficient; graduates must possess essential core competencies for workplace success (Okay & Sahin, 2010). Internships, defined by Zopiatis and Theocharous (2013) as brief practical work experiences, play a crucial role in imparting training and valuable job exposure. Okay & Sahin (2010) identify competencies associated with internships, such as enhancing graduate employability (Mason, Williams, & Cranmer, 2009). Simultaneously, internships contribute to managing career expectations and establishing a groundwork for future practical-oriented achievements (Zopiatis, Papadopoulos, & Theofanous, 2021). Engaging in internships is asserted to enhance academic understanding and employability prospects (Renganathan, Abdul Karim, & Li, 2012). Knouse and Fontenot (2008) outline advantages, including increased employment prospects, potential full-time job offers from internship employers, exposure to new career paths, and a realistic view of workforce demands. Studies, such as Cannon and Arnold (1998), show that students increasingly perceive internships as a pragmatic means to secure future employment opportunities. Zhao and Liden (2010) highlight a higher likelihood of young graduates receiving continued employment within companies that provided their internship experience.

4.2.2 Self-Development

Anjum's (2020) study proposed four hypotheses regarding the advantages of internships for personal development in business students: 1: Internship programs notably influence the professional advancement of business students. 2: Internship programs significantly impact the professional aptitude of business students. 3: Internship programs exert a substantial influence on the personal development of business students. 4: The personal capabilities of business students are influenced by internship programs. According to Callanan and Benzing (2004),

internship experiences significantly affect professional development. Gupta et al. (2010) emphasises internships as a bridge between academia and practical understanding, fostering a deeper comprehension of personal development, attitudes, and behaviours. Participation in training programs enhances students' soft skills and competence for entering the job market (Nawi et al., 2020). Systematic reviews, including critical thinking, self-awareness, and reflection, support this assertion (Sokhanvar, Salehi, & Sokhanvar, 2021). Internships offer a comprehensive range of interpersonal skills, gained through diverse interactions, problem-solving, leadership, and teamwork outside traditional academic settings. Internships contribute to positive personal attributes and work habits, fostering self-assurance (Gault, Leach, & Duey, 2010; Sapp & Zhang, 2009; Susan, 1988). They facilitate direct interaction between students and professionals, aiding in the establishment of a robust professional network for securing employment opportunities (Schambach & Dirks, 2022). In summary, the cultivation of these individual aptitudes through internships has the potential to enhance human capital and improve educational experiences for interns (Lee Hock Chong et al., 2014).

4.2.3 Networking

Establishing relationships between interns and professionals is crucial for their workplace integration, fostering a sense of belonging and facilitating knowledge exchange from seasoned professionals. Positive interpersonal connections aid interns in transitioning from an academic to an organisational context. Research, such as Robinson, Ruhanen, and Breakey (2015), highlights the significant impact of social connections formed during internships on students' perceptions and satisfaction levels. Work-based learning (WBL), as noted by Sudirman and Gemilang (2020), is effective in cultivating positive interpersonal relationships, dedication, knowledge and skill acquisition, and principles of social justice, equality, and empowerment. Chen, Shen, and Gosling's (2018) evaluation suggest that engaging in such relationships during internships enhances students' proficiency, self-assurance in collaboration, understanding of industry dynamics, adaptability to change, leadership skills, and competency in financial management.

4.3 Practical ways to maximise the learning experience in an internship.

4.3.1 Informal On-the-Job Experiences in Internships

Based on the study conducted by (Varghese, et al., 2012), the study found that students could not rely solely on their existing knowledge for successful performance in internships. Industry-specific heuristics, control, and learning strategies were crucial in bridging the gap between academic knowledge and practical work behaviour. Informal on-the-job experiences played a

significant role in acquiring these important lessons. Employers should prioritise informal contact with interns to pass down heuristic knowledge and entrepreneurial skills. Previous research conducted by (Roxas, Mae, Rowenna, De, & Jesus, 2008) suggests that acquiring entrepreneurial knowledge positively influences self-efficacy and the perceived desirability of entrepreneurship, which in turn influences entrepreneurial intent.

4.3.2 Enhancing Internship Programs Through Classroom Experiences, Support Structures, and Modelling Techniques

The internship program's classroom component afforded students a distinctive educational setting in which they obtained skills through the processes of observation, guided practice, and independent application of said skills. It is advisable for programme developers to incorporate efficacious approaches, such as immersive classroom experiences, to cultivate a nurturing community for interns (Varghese, et al., 2012). Additionally, it is beneficial to integrate a reflective element that encourages students to deliberately contemplate their personal development and articulate their experiences. Certain students encountered difficulties as a result of a perceived deficiency in support or guidance within their professional environment. This predicament is frequently observed in small and start-up companies that possess limited resources (Rohde, Klamma, & Wulf, 2005). Nevertheless, interns who were granted access to supplementary resources and established channels of communication reported a higher level of support and guidance from their employers. The implementation of explicit support structures and effective communication strategies can serve as a means of mitigating the constraints imposed by limited resources. The utilisation of modelling has been identified as a viable approach for informal instruction, demonstrating efficacy without necessitating substantial organisational resources. Employers can gradually diminish coaching systems, thereby enabling interns to independently explore and acquire knowledge, resulting in a heightened sense of achievement and enhanced self-efficacy. When selecting potential participants, internship programmer administrators should take into account the stability and resource capacity of companies (Varghese, et al., 2012).

4.3.3   The Significance of Sequencing in Developing Entrepreneurial Competencies.

The process of sequencing is of utmost importance in facilitating students' development and assimilation of entrepreneurial competencies. Students who initially acquired a comprehensive comprehension of wider concepts prior to delving into specific tasks demonstrated the capacity to engage in critical thinking, comprehend intricate business operations, and effectively apply their skills in diverse settings. A comprehensive comprehension of entrepreneurship is crucial for

achieving success. Once students have successfully overcome the initial learning challenges, they can proceed to engage with progressively intricate tasks by leveraging their extensive repertoire of knowledge (Dutta, Li, & Merenda, 2011). It is recommended that employers engage in the monitoring of students' progress, gradually reducing the amount of guidance and support provided, while concurrently offering more demanding and varied assignments in order to enhance their educational attainment and comprehension (Varghese, et al., 2012).

5.0 Research Methodology

The research process is carried out by performing an initial exploration of relevant literature as necessary to ascertain the necessity of refining or expanding the selected subject of inquiry. The secondary data is obtained through quantitative methods in online questionnaires. The targeted population is BQS students in Taylor's University who are from Semester 5 (current interns), 6, 7 and recent graduates with a total sample size of 103, while 93 respondents are being collected. Therefore, nominal scale, ordinal scale in 5-point likert scale "Strongly Agree to Strongly Disagree" and interval scale is applied to capture students' profiles and perceptions. The analysis method used includes descriptive analysis, reliability test, correlation analysis and linear regression analysis.

6.0 Key Findings, discussions, and conclusion

This study focused on the significance of internship learning experience for Quantity Surveying (BQS) students at Taylor's University in Malaysia. It found that internships play a crucial role in bridging the gap between theory and practice, preparing students for their careers. Key findings included positive internship experiences and practical strategies for improving them.
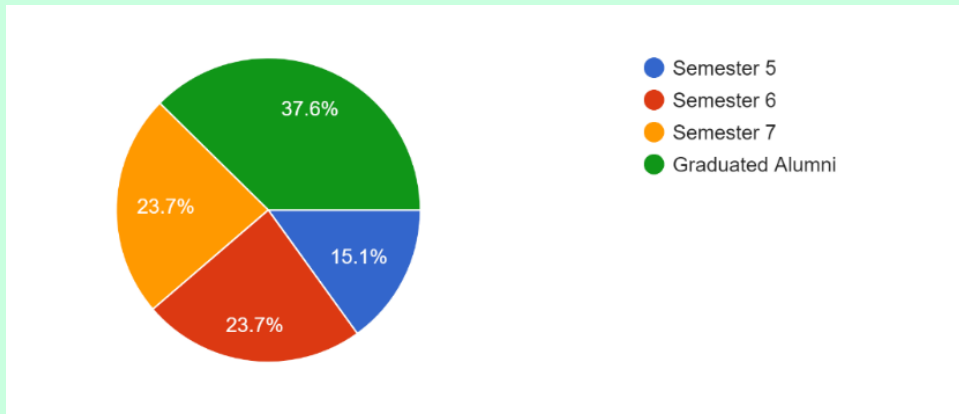
6.1. Demographic Information

Figure 6.1 Pie chart of number of respondents in each semester including recent graduates.

Table 6. 1 Statistical Results for Respondent's Academic Status

Semesters	Frequency	Percentage (%	Cumulative Frequency	Cumulative Percentage (%)
Semester 5	14	15.1	14	15.1
Semester 6	22	23.7	36	38.8
Semester 7	22	23.7	58	62.5
Recent Graduates	35	37.6	93	100.0

The findings of respondent in each semester as shown above in Figure 4.3 and Table 4.3 has indicated that 14 (15.1%) of respondent are in semester 5, 22 (23.7%) of respondent are in semester 6, 22 (23.7%) of respondent are in semester 7 and 35 (37.6%) of respondent are recent graduates where it shows that the recent graduate is the most active contributor in this study followed by semester 6 and 7 with a same frequency of response rate and lastly is the lowest number of respondents from semester 5.

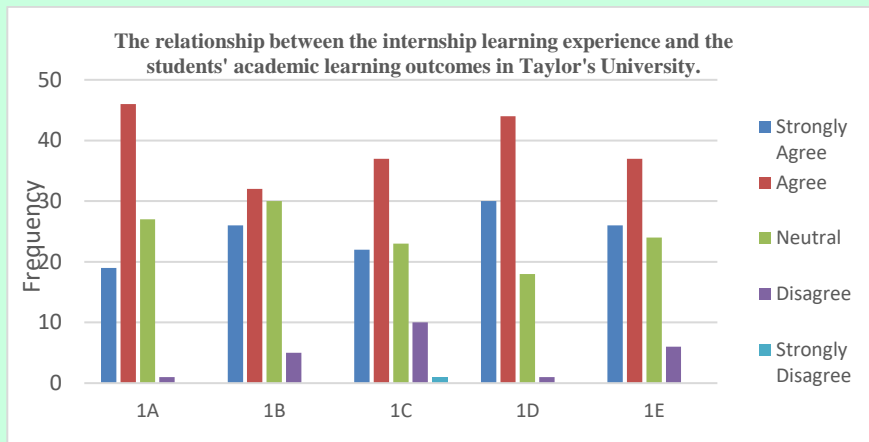**6.2 Key findings on the relationship between classroom learning and internship practical learning.**

Figure 6.2 Bar chart of the relationship between the internship learning experience and the students' academic learning outcomes in Taylor's University. (Classroom Learning Wise)
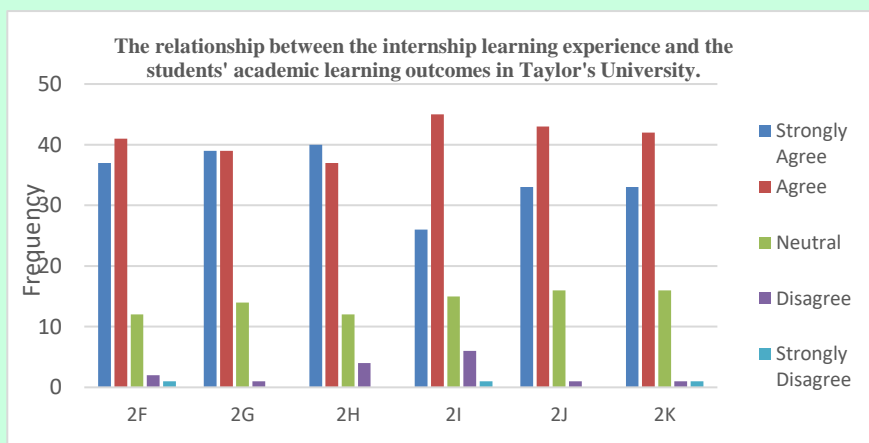

Figure 6.3 Bar chart of the relationship between the internship learning experience and the students' academic learning outcomes in Taylor's University. (Internship Practical Learning Wise)

Table 6. 2 Summary of the relationship between classroom learning and internship practical learning.

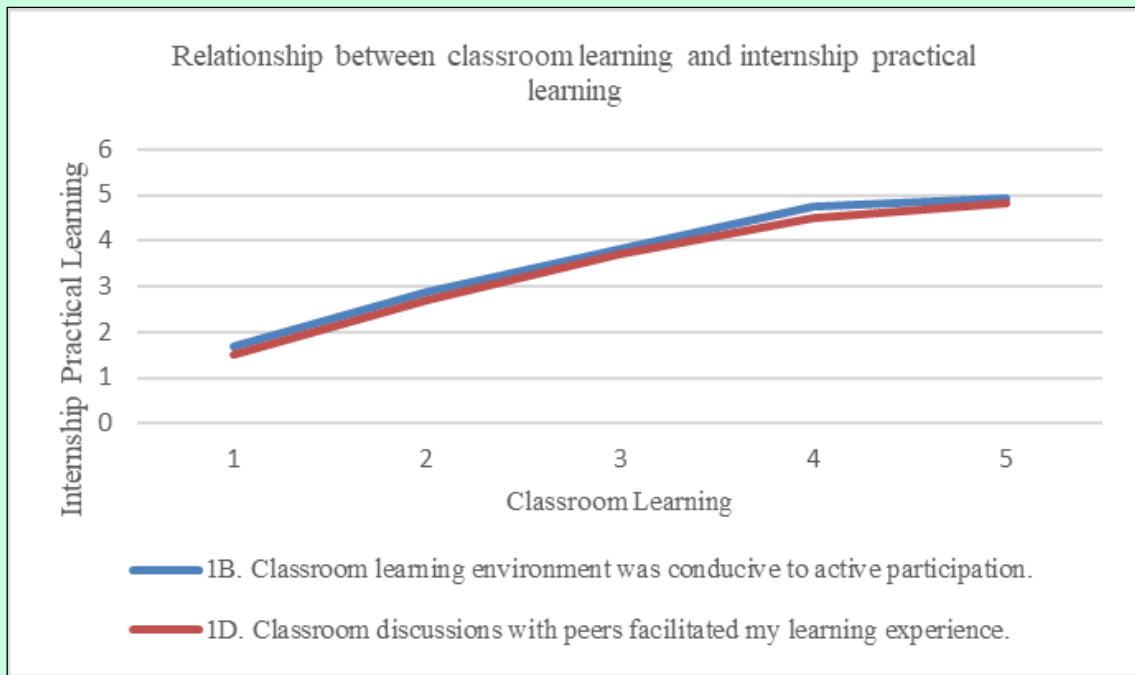|	Item	The relationship between the internship learning experience and the students' academic learning outcomes in Taylor's University.	Rank	Mean	Overall Mean
Classroom Learning	1A	assroom knowledge to practical applicatic	2	3.89	3.90
	1B	Classroom learning environment was conducive to active participation.	3	3.85	
	1C	Classroom assignments were relevant to real-world scenarios.	4	3.74	
	1D	Classroom discussions with peers facilita my learning experience.	1	4.11	
	1E	Classroom interactive teaching methods effectively catered to different learning styles.	2	3.89	
Internship Practical Learning	2F	Internship provided valuable practical skills.	3	4.19	4.08
	2G	Knowledge improved significantly during the internship.		4.25	
	2H	Sufficient guidance from supervisors during the internship.		4.22	
		Engaged in the tasks and projects assigned during the internship.		3.96	
		Internship discussions and interactions with peers facilitated my learning experience.		4.16	
	2K	Internship provided opportunities for networking and professional connections.		4.13	

Figure 6.4 Relationship between classroom learning and internship practical learning.

The relationship between internship learning experiences and academic outcomes at Taylor's University, establishes an interdependence influenced by students' ability to bridge the theoretical-practical gap. In examining knowledge, skill, and exposure gained during internships, diverse experiences emerge among students. While applying academic knowledge is common, technical skills and exposure to processes like tender interviews vary. The majority of surveyed BQS students' express satisfaction with classroom discussions, recognizing their facilitative role in learning. There's agreement that classroom instruction effectively translates theoretical concepts into practical applications, emphasising students' readiness for real-world Quantity Surveying roles. To support the findings, Hughes (2006) mentioned that the chance to gain experience in a real-world setting will provide interns the chance to apply the theoretical knowledge they have received in their earlier years of undergraduate study to relevant, real-world job sites. The conducive classroom environment for active participation is acknowledged. Practical application learning constructs a significant improvement in BQS interns' knowledge, attributed to valuable guidance from supervisors, showcasing the bridge between theory and practice. The findings underscore that classroom-acquired knowledge and skills are not solely theoretical but practically applicable. This study further justifies this interrelation by revealing that students successfully translate classroom learning into practical application, suggesting a proportional relationship between academic satisfaction and internship experience that aid them in their BQS future, where this finding also in line with research conducted by Kasradze & Gulua

(2021) that indicate internship is to facilitate the transfer of theoretical knowledge gained during the university program into real-world applications and foster the development and refinement of practical skills.

Table 6. 3 Accepted Hypothesis based on Table 6.4 in Objective 1

Hypothesis	Status
The higher the satisfaction level of active participation in classroom learning the greater the foster of internship practical learning experience.	Accepted
The higher the satisfaction level of peers' discussion in classroom learning the greater the foster of internship practical learning experience.	Accepted

Table 6. 4 Table of linear regression analysis of the relationship between practical learning and classroom learning

Coefficients						
Model		Unstandardized Coefficients		Standardised Coefficients		
		B	Std. Error	Beta		
1	(Constant)	2.524	.326		7.752	<.001
	Classroom Learning	.417	.083	.468	5.058	<.001
a. Dependent Variable: **Practical Learning**						

This study justifies the interrelation between practical and classroom learning for BQS students at Taylor's University. The statistical significance, with a p-value below 0.001, confirms this connection. The regression coefficient indicates a positive value of 0.417, suggesting that 41.7% of BQS students' practical learning is influenced by their classroom learning experience before the internship.

6.3 Key findings on the importance of learning experience in BQS internship.

Polytechnic (2021) mentioned before, only a good learning experience from internship can maximise the benefits from it. The findings indicate that BQS interns at Taylor's University indeed had a favourable experience during their industrial training, enabling them to maximise these benefits. The importance of learning experience is delineated through three key aspects:

Preparedness for Employability, Self-Development, and Professional Networking. These categories, acknowledged by the majority of respondents, are further substantiated through reliability and linear regression tests, as detailed below:
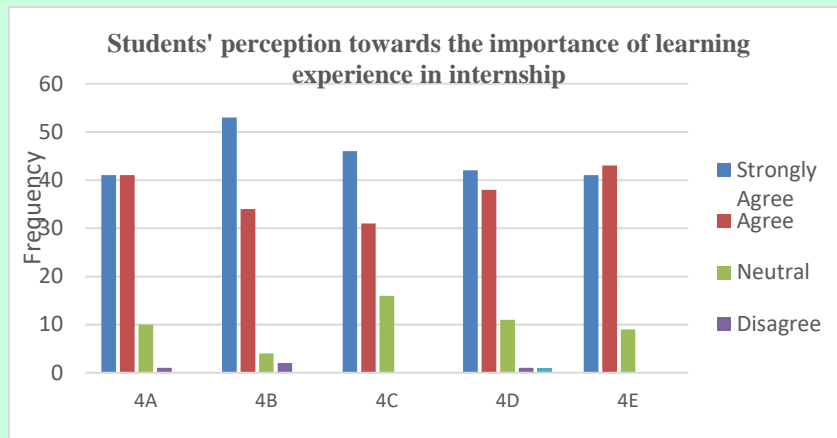

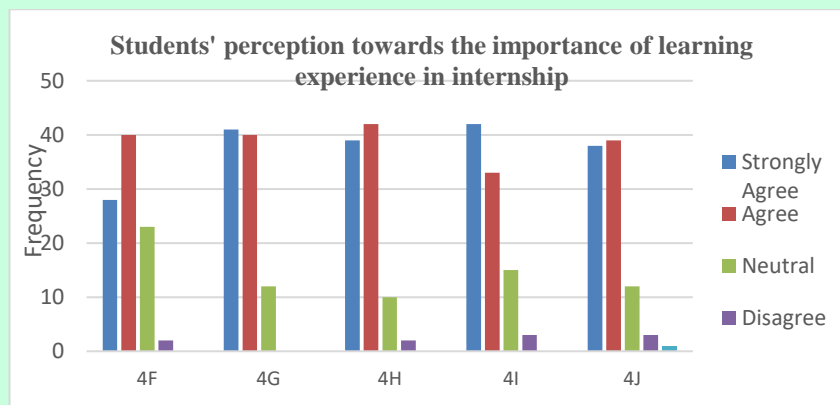Figure 6.5 Bar chart of students' perception towards the importance of learning experience in internship.

Figure 6.6 Bar chart of students' perception towards the importance of learning experience in internship (cont'd)

Table 6. 5 Summary of the importance of learning experience in internship, BQS context

	Item	The importance of learning experience in internship	Rank	Mean	Overall Mean	Overall Rank
Preparedness of Employability	4A	QS internship provided valuable practical knowledge.	3	4.31	4.35	1
	4B	Internship enhanced my understanding of real-world Quantity Surveying practices.	1	4.48		
	4C	Internship helped me strengthen my fundamental basics.	2	4.32		
	4D	Internship exposed me to different aspects of Quantity Surveying.	4	4.28		
Self-Developme	4E	The internship helped me develop capabilities required in my field.	1	4.34	4.23	2
	4F	Internship learning experience helps me in problem-solving abilities.	4	4.01		
	4G	Internship improved my QS decision-making abilities.	2	4.31		
	4H	Internship helped me develop essential soft skills.	3	4.27		
Networking	4I	Internship provided opportunities to interact with experienced professionals in the QS. I believe that building a professional network is important for career growth in Quantity Surveying.	1	4.23 | 8	4.21	3

According to this linear regression analysis also taken out to analyse the data based on their perception in rating form. The results show that BQS internship learning experience affects the

preparedness of employability by 62.1%, followed by self-development by 48.2% and lastly social networking by 80.90%.

Through this analysis, the learning experience in internship will affect BQS students' future employability, self-development, and social networking. In other words, after analysing the findings based on respondents' perception, the importance of learning experience in internship is it can foster the preparedness of employability, self-development, and social networking.

Table 6. 6 Prediction of learning experience influences BQS students' preparedness of employability, self-development, and networking.

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients		Sig.
		B	Std. Error	Beta		
1	(Constant)	1.777	.312		694	001
	LearningExperience	.621	.074	.658	333	001
a. Dependent Variable: **Preparedness_of_employability**						
2	(Constant)	2.236	.302		393	001
	LearningExperience	.482	.072	.574	679	001
a. Dependent Variable: **Self_Development**						
3	(Constant)	.851	.391		176	32
	LearningExperience	.809	.093	.673	669	001
a. Dependent Variable: **Networking**						

The study highlights the immense significance of internships in enhancing the learning experiences of BQS students at Taylor's University. The findings emphasise that these internships not only contribute to academic growth but also significantly boost employability. Interns gain practical competence, making them more appealing to employers and giving them a competitive advantage. Moreover, the experience fosters qualities like adaptability and effective communication, crucial not only in Quantity Surveying but also in broader professional contexts. Additionally, the networking opportunities provided by internships can lead to mentorships, industry insights, and potential job placements, further enriching students' educational journeys and preparing them for successful careers in Quantity Surveying.

6.4 Practical ways in maximising the value of learning experience.

The objective is to explore practical methods for maximising the value of internship learning experiences. According to Table 6.7, respondents agree that employers play a key role by gradually reducing guidance, offering challenging tasks, and varying assignments, allowing interns to apply theoretical knowledge to real-world scenarios where this had aligned to Dutta, Li, & Merenda (2011) research stating that, thorough reducing guidance and increase working load towards interns will makes them understanding of the field involved is crucial for attaining success. Additionally, informal interactions between employers and interns are crucial for imparting heuristic knowledge and practical insights not covered in formal training where this can be traced back to Varghese, et al. (2012) research mentioned that it was determined that students were unable to depend entirely on their pre-existing knowledge in order to achieve good performance during internships. The utilisation of industry-specific heuristic, control, and learning methodologies played a pivotal role in effectively connecting academic information with practical work behaviour. Lastly, program developers should incorporate immersive classroom experiences to simulate real-world scenarios, providing a safe space for interns to apply and refine their skills, fostering peer learning and collaboration. Based on BQS students' perceptions these approaches collectively can enhance the overall learning experience during internships. This context is in line with Rohde, Klamma, & Wulf (2005) mentioning the utilisation of explicit support structures and the execution of effective communication methods can function as a method of alleviating the limitations imposed by restricted resources. The application of modelling has been recognised as a feasible method for informal education, showcasing effectiveness without requiring significant organisational resources.
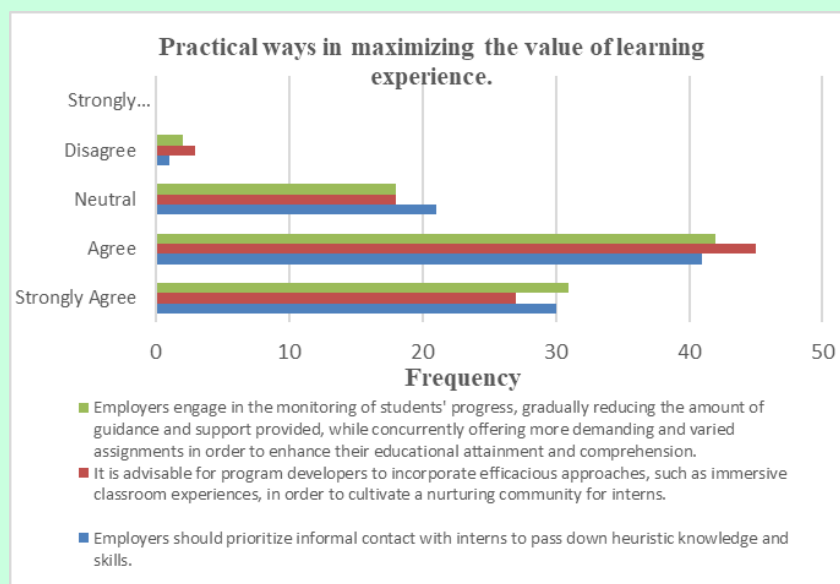

Figure 6.7 Bar chart of practical ways in maximising the value of learning experience.

Table 6. 7 Summary of practical ways in maximising the learning experience.

Item	The practical ways in maximising the value of learning experience.	Rank	Mean	Overall Mean
5A	Employers should prioritise informal contact with interns to pass down heuristic knowledge and skills.	2	4.08	
5B	It is advisable for program developers to incorporate efficacious approaches, such as immersive classroom experiences, in order to cultivate a nurturing community for interns.	3	4.03	4.07
5C	Employers engage in the monitoring of students' progress, gradually reducing the amount of guidance and support provided, while concurrently offering more demanding and varied assignments in order to enhance their educational attainment and comprehension.	1	4.10	

7.0 Research Limitations

This research is limited to Taylor's BQS students, potentially lacking generalizability to the broader population of Quantity Surveying students in Malaysia or internationally. The focus on a single institution, Taylor's University, may restrict diversity in experiences and perspectives, influenced by variations in internship programs, teaching styles, or resources across institutions. While quantitative data is valuable, it may lack the depth of qualitative insights. Relying solely on quantitative methods might overlook nuanced details of students' experiences. Additionally, it's important to recognize and address problems associated with internships when applying practical approaches.

8.0 Recommendations

Conduct longitudinal studies tracking the career paths of Quantity Surveying students over several years, starting from their internships, for a more comprehensive understanding of long-term impacts. Compare internship experiences and outcomes across Quantity Surveying students from various Malaysian institutions or different countries to identify variations and best practices. Integrate quantitative data with qualitative insights, using interviews or focus groups to reveal nuanced perspectives. Include surveys or interviews with Quantity Surveying employers to gather opinions on interns' preparedness and skills, providing a holistic view of the field.

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Integrating Virtual Reality and Building Information Modeling in Quantity Surveying Curriculum Courses

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Abstract

Innovative technology has been applied in many industries, including building. The construction sector has adopted several new technologies, enhancing productivity and safety. The construction business uses modern technology like BIM and VR. Digital BIM creates a 3D model of a building's systems and components. BIM can give precise cost estimates, construction timetables, and building performance simulations. Additionally, VR is a computer-simulated three-dimensional environment that may be interacted with. VR is used in construction to visualize and plan projects, as well as for training and teaching. VR-BIM lets stakeholders see a virtual building model before construction, identifying issues and disagreements early on. VR-BIM can assist construction students practice skills and processes. This study examines VR-BIM in construction education, specifically the Quantity Surveying (QS) Program. VR-BIM can assist QS students practice skills and processes and can create virtual construction sites to help students measure and calculate project materials and labor. VR simulations allow students to practice decision-making and problem-solving in a controlled environment. VR-BIM in QS education allows students to study and practice skills in a realistic and immersive environment, which may be more engaging and effective than lectures and textbooks. The research will use content analysis and qualitative interviews with lecturers to determine the curriculum courses VR-BIM implemented to meet course objectives. Thus, the research objectives of this study are (1) to review QS curriculum courses and identify any suitable subject for VR-BIM implementation; (2) to determine VR-BIM methods that should be applied to the identified subjects. This study seeks to explore how educators regard VR-BIM's application in the QS curriculum course chosen to help USM School of Housing, Building, and Planning (HBP) students learn QS.

Keywords: Virtual Reality, Building Information Modeling, Quantity Surveying, Curriculum Courses, Educators, Point of view.

1.0 Introduction

In the contemporary age, technology is rapidly advancing globally, and the construction industry is no exception, integrating cutting-edge technologies into its practices. The information and communication technology (ICT) revolution, as noted by Zaker and Coloma (2018), has significantly impacted various aspects of our lives, including the construction sector. Similarly, advancements in education have introduced several sophisticated technologies applicable across all levels, particularly in university education. In recent years, professionals in Architecture, Engineering, and Construction (AEC) have expressed a growing interest in incorporating Building Information Modeling (BIM) into academic programs (Abdirad, 2016). BIM, an evolution beyond 2D Computer-Aided Design (CAD), enhances collaboration, reduces errors, and streamlines project coordination (Wang et al., 2018).

Virtual Reality (VR), an integral component of BIM, has become instrumental in construction and has brought positive changes to construction education. The evolution of BIM from a mere 3D design tool to a comprehensive solution encompassing model analysis, clash detection, and project conceptualization has revolutionized the construction industry. Adoption of BIM yields benefits such as improved constructability, enhanced communication, and visualization, reduced cost estimation time, and smoother collaboration among stakeholders.

In education, VR has proven effective in providing immersive learning experiences, especially in scenarios where real-world experiences are challenging to replicate, such as construction site visits. VR models offer a practical alternative to traditional experiential learning activities, ensuring a clear understanding of complex concepts. Wang et al. (2018) suggest that VR applications can enhance Quantity Surveyors' (QS) understanding of architectural design by utilizing VR walkthroughs of virtual 3D building models. Integrating VR-BIM into QS programs offers hands-on experience with advanced construction technology, improving students' comprehension of building designs and fostering collaboration. Despite the potential benefits, obstacles hinder the full utilization of technology in education. Challenges include the lack of immersive systems integrating VR and BIM for QS practice, slow integration of BIM with VR, and limited familiarity or comfort with technology tools among educators.

The study by Abd Latif (2019) identifies difficulties faced by QS students in subjects like measurement, often due to a lack of vision and understanding of the content. Experiential learning activities, such as site visits, are challenging to implement due to safety concerns and the demanding project environment. Additionally, barriers like unfamiliarity with technology tools, lack of resources, and concerns about costs hinder the incorporation of VR and BIM into curricula. Only recently has technology advanced to a point where implementing VR-BIM is both feasible and beneficial. This study aims to explore the effectiveness of implementing VR-BIM in QS curriculum

courses compared to traditional methods. The research seeks to identify differences between VR-BIM and traditional learning and address concerns about resistance to new technology. By pinpointing strategies to enhance QS students' interest and evaluating the impact of VR-BIM on adaptability to future job changes, this research aims to contribute valuable insights into optimizing technology in education.

This study has derived research objectives from the previously outlined research problems. The objectives include conducting a review of Quantity Surveying (QS) curriculum courses to pinpoint those suitable for VR-BIM implementation; identifying appropriate VR-BIM methods for the selected courses; evaluating the impact of VR-BIM technology on enhancing curriculum course objectives; and obtaining feedback from educators to gauge their opinions on the selection and implementation of VR-BIM in Quantity Surveying curriculum courses.

2.0 Literature Review

2.1 Virtual Reality (VR) Technology

VR is a technology that allows users to completely immerse themselves in a computer-generated reality. Since the early 1990s, virtual reality has been present in the world of computer games. Ford began incorporating VR into its vehicle design and manufacturing processes in 1999 (Gaudiosi, 2016). Although virtual reality has yet to gain mainstream market acceptance, it is expected that it, like tablet computers and wearables, will become more widely accepted in the future. Construction, gaming, entertainment, marketing, education, product development, and corporate communication are just a few of the industries that could benefit from virtual reality. A review published in the journal Frontiers in Psychology (2018) claims that "VR is a simulated environment that can be interacted with in a way that appears real or physical. VR is achieved by combining hardware (e.g., head-mounted displays, haptic devices) and software (e.g., 3D graphics) to create a digital replica of the real or imagined environment. The user can then navigate through the environment and interact with virtual objects as if they were real." One of the most important aspects of virtual reality is its ability to create a sense of immersion, or the sensation of being completely immersed in the simulated world. This is accomplished through the use of specialized equipment such as head-mounted displays with a wide field of vision and high-resolution images, as well as haptic devices that allow users to touch and manipulate virtual objects. Furthermore, 3D audio is frequently used in VR systems to create a more realistic and immersive experience.

VR also necessitates interaction. Users can move and interact with virtual objects and characters using VR controllers or other input devices. This allows people to naturally navigate the virtual environment. VR headsets display 3D graphics and track the user's head and, in some cases,

hands (Gaudiosi, 2016). VR comes in a variety of forms, each with its own set of capabilities. Desktop VR systems are non-immersive and do not require any additional hardware. These systems can be used with a mouse, keyboard, or touchscreen on a computer or mobile device (Bailenson et al., 2016). Immersion or projection? VR provides a partial sensory experience and may necessitate the use of specialized equipment such as a headset or gloves. These technologies simulate and teach users by immersing them in a virtual world (Lee & Biocca, 2017). HMD VR systems, which require a headset with a screen or gloves with sensors, provide a full sensory experience. Users can interact with the virtual world as if it were real with these devices (Jiang et al., 2020).

3.0 Building Information Modeling (BIM)

BIM is a digital representation of the physical and functional properties of a building or infrastructure that can be used for design, construction, and operations. BIM is a groundbreaking innovation in the construction industry that allows for the virtual design and management of projects throughout the building's lifecycle (Ullah et al., 2019). It is a collaborative process that involves the creation and deployment of a digital model to manage and share project information from design to construction and operation. BIM "enables the creation of a digital prototype of the building, providing a common platform for communication and collaboration among various project stakeholders," according to a study published in the Journal of Computing in Civil Engineering (2018). BIM enables the integration of data, processes, and people to improve the design, construction, and maintenance of buildings and infrastructure. It can be used to visualize and simulate a design's performance, as well as to coordinate and communicate with various project stakeholders. BIM can be classified in a variety of ways, depending on the classification's focus. The Level of Development (LOD), which refers to the level of detail and accuracy of the virtual model, is one way to categorize BIM. LOD 100 represents the conceptual stage of design, where the model consists of basic geometric shapes. The model becomes more detailed as the design progresses, with LOD 200 representing the design development stage and LOD 300 representing the construction document stage. LOD 400 represents the construction stage, in which the model is used to coordinate and plan construction activities, and LOD 500 represents the operation and maintenance stage, in which the model is used to manage and optimize the building's performance.

Another way to classify BIM is based on the type of model created. 3D BIM is a digital representation of the building in 3D; 4D BIM adds a temporal element to the model to visualize the construction schedule; 5D BIM adds cost information to the model; and 6D BIM adds information about the building's operation and maintenance. Another study published in the International Journal of Project Management (2019) discovered that using BIM can result in cost savings, shorter project

duration, and higher construction quality. BIM can also help to improve the accuracy of cost estimates and facilitate value engineering, as well as support risk management and the early detection of potential issues. BIM can also be classified according to the model's scope, which can include the entire structure, a single discipline (such as structural or Mechanical, Electrical, and Plumbing (MEP)), or a specific system or component. Finally, BIM is classified according to the software used to create and manage the virtual model, such as Autodesk Revit, Trimble SketchUp, or Bentley Systems MicroStation.

4.0 VR-BIM in Construction Industry

Integration of VR and BIM in the construction industry has gained significant attention in recent years as a means of improving project management and decision-making. VR technology has the potential to transform the construction industry by enabling new levels of visualization and collaboration for construction projects. VR and BIM can be used together to allow construction professionals to walk through a building design and identify potential problems before construction begins. VR technology, according to Alashram et al. (2018) has the potential to revolutionize the construction industry by providing a new level of visualization and collaboration for building projects. When combined with BIM, VR can assist construction experts in detecting potential flaws in a building design before construction begins, lowering costs and increasing construction efficiency. VR is one of the IT achievements that has improved the capabilities of the BIM system in construction (Wang et al., 2018). There are numerous applications of virtual reality in the construction industry, including design review, construction planning, safety training, and quality control, and we will discuss the challenges and limitations of using virtual reality in construction. It also outlines future research directions in this area.

4.1 Implementation of VR in the Construction Industry

VR technology has the potential to transform the construction industry by enabling new levels of visualization and collaboration for construction projects. One of the primary benefits of virtual reality in construction is its ability to provide a new level of visualization and collaboration for construction projects. Construction professionals can use virtual reality to walk through a virtual model of a building and identify potential issues before construction begins (Zhu et al., 2019). This can help cut costs by identifying problems early and making corrections before they become more expensive to fix. VR can also help to improve overall construction efficiency by allowing professionals to identify and address potential bottlenecks before they occur (Alashram et al., 2018).

Overall, the use of virtual reality in construction has the potential to improve communication, coordination, and efficiency in construction projects (Alashram et al., 2018). All stakeholders in a building project can gather in a virtual space to view the project from various perspectives by using VR. This can aid communication and collaboration among team members, as well as provide stakeholders with a better understanding of the project who may not have a background in construction. VR can also be used to present a project to clients or investors in a more interactive and immersive manner, allowing them to fully understand and visualize it. Team members can access and collaborate on building projects from anywhere in the world using VR. This is especially useful for large construction projects with team members spread across multiple regions or countries.

4.2 Implementation of VR in QS Work

VR technology has the potential to transform the way quantity surveying work is done (Hilfert & König, 2016). Quantity surveyors can virtually visit construction sites and buildings, allowing them to take measurements more easily, visualize designs, and identify potential issues. This can save time and money by reducing the need for on-site visits and improve safety by allowing surveyors to assess sites remotely. This can save time and money by reducing the need for on-site visits (Yang et al., 2020). VR can be used to simulate various scenarios and estimate the costs associated with a construction project. This allows quantity surveyors to make more accurate cost estimates and budget projections because they can see firsthand how different design choices and materials affect the overall cost of the project. VR can be used to improve collaboration and communication among team members on a construction project. QS, for example, can use VR to meet with other team members and discuss project plans in a virtual setting. Allowing team members to communicate and make real-time decisions regardless of their physical location can improve the project's efficiency and effectiveness. Another way VR can be used is to track the progress of construction projects, allowing surveyors to more easily monitor the use of materials and labor and identify any potential delays or issues. VR can also be used to train new quantity surveyors by giving them hands-on experience in a virtual environment before working on real-world projects. Furthermore, VR can be used for quality control, allowing surveyors to assess the quality of construction work and identify any deviations from the design plans. Overall, virtual reality technology has the potential to greatly improve the efficiency and accuracy of quantity surveying work.

4.3 Implementation of BIM in Construction Industry

Using BIM in the construction industry, according to Krzysztof et al., (2020), can improve the construction process and speed up the building implementation process. Through analysis, it is possible to create a virtual building that can be used for design, coordination, construction, and management purposes. BIM is a multi-dimensional model and data integration technique that uses CAD to create a digital representation of a building. It increases work efficiency and quality by reducing errors throughout the construction process (Aliakbar Kamari et al., 2021). Furthermore, according to recent research by Kim et al. (2022), BIM is a digital representation of a building's physical and functional characteristics. It is the process of creating and using a digital model to design, build, and manage a building over its entire life cycle. BIM is the process of creating a virtual model of a building that includes all relevant information about the structure's design, construction, and operation. This model can be used to coordinate various construction disciplines like architecture, engineering, and construction. It can also be used to evaluate and improve building performance in areas such as energy efficiency, cost estimates, and schedule management. BIM enables easy and efficient collaboration among various professions by allowing them to share and access the same data sets and work on the same platform. Aside from that, it promotes greater collaboration among all parties involved in a construction project. It is used in the construction industry to increase efficiency, decrease errors and rework, and foster collaboration among project stakeholders.

4.4 Implementation of BIM in QS Work

According to Krzysztof et al., (2020), using BIM in the construction industry can improve the construction process and speed up the building implementation process. Analysis can be used to create a virtual building that can be used for design, coordination, construction, and management. BIM is a multi-dimensional model and data integration technique that creates a digital representation of a building using CAD. It improves construction efficiency and quality by reducing errors throughout the process (Aliakbar Kamari et al., 2021). In addition, recent research BIM is a digital representation of a building's physical and functional characteristics, according to Kim et al. (2022). It is the process of developing and employing a digital model to design, construct, and manage a building throughout its entire life cycle. BIM is the process of creating a virtual model of a building that contains all relevant information about the design, construction, and operation of the structure. This model can be used to coordinate various building disciplines such as architecture, engineering, and construction. It can also be used to assess and improve the performance of buildings in areas such as energy efficiency, cost estimates, and schedule management. BIM facilitates easy and efficient collaboration among different professions by allowing them to share

and access the same data sets and work on the same platform. It also encourages greater collaboration among all parties involved in a construction project. It's used in the construction industry to boost efficiency, reduce errors and rework, and encourage collaboration among project stakeholders.

4.5 The Relationship Between BIM and VR in the Construction Industry

The ability to visualize and interact with 3D models of buildings and structures is at the core of the relationship between VR and BIM. Construction professionals can gain a more immersive and interactive experience of the project by combining VR and BIM, improving the accuracy and efficiency of the planning process. BIM technology that has been combined with virtual reality and cost and sustainability LCA software. Integration of BIM with applications such as Quantity Take-Off (QTO), Scheduling tools, Life Cycle Assessment (LCA), and Virtual Reality (VR) may increase and expand BIM's flexibility and efficiency. BIM-created 3D models enable prototype visualization, whereas VR enables an immersive user experience of the final building. The immersive experience aids designers in course-correcting design modifications provided by user participants, as well as any unexpected changes or errors discovered during the early stages of design. The use of virtual reality and BIM in cost estimation and LCA analysis may aid in reducing disparities at the source (Aliakbar Kamari et al., 2021). This visualization can help to reduce design changes throughout the project's lifecycle. According to Sahar Y. Ghanem (2022), BIM improves the use of virtual reality as a tool in the construction industry by making it easier to incorporate virtual reality into the design process. VR-BIM, an interactive multimedia technology, enables users to interact with digital objects in a virtual environment, simulating physical presence in an enhanced virtual world. BIM and VR are critical technologies for the building industry's future, and they are used in a variety of critical aspects of construction projects. These technologies can be used to prepare for worker safety, defect management, quality management, project scheduling, knowledge collection, safety management, logistics management, and project progress evaluation (Ahmed, et al., 2017). According to Alizadehsalehi et al. (2019) and Balali et al. (2020), VR combined with BIM allows professionals to interact in real time with detailed information in a BIM model, thereby improving communication and understanding among stakeholders.

5.0 VR-BIM in Construction Education

VR has the potential to transform the way construction education is delivered. Students can fully immerse themselves in a virtual construction site using VR for BIM, allowing them to explore and understand the various components and systems of a building in a highly interactive and realistic manner. According to Zaker and Coloma (2018), while VR technology is rapidly gaining popularity, it has limitations in terms of the additional effort required to display BIM models. BIM and ICT, is a popular platform for delivering courses and is an essential component of AEC education. BIM has the potential to improve collaboration and communication among current students who will become architects, engineers, and construction managers, including quantity surveyors, in the future (Arashpour et al., 2017). Beyond simply reading technical drawings, the use of BIM and VR together provides a new way of learning (Hassan Anifowose et al., 2022). Integration of BIM- VR, according to Sahar Y. Ghanem (2022), allows users to place a building design in a 3D virtual environment with all relevant building information, allowing them to experience the BIM model in a virtual environment. One of the primary advantages of using VR for BIM in construction education is the ability to more intuitively visualize and manipulate complex 3D models. Students can use VR to fully immerse themselves in 3D models of construction projects, allowing them to visualize and comprehend the relationships between various building components and systems (Bui et al., 2017). Furthermore, VR can be used to simulate real-world construction scenarios, giving students the opportunity to practice and apply their knowledge in a safe and controlled environment. VR-BIM can also improve student collaboration and teamwork by allowing them to collaborate on virtual construction projects and share ideas and insights (Rahman et al., 2016). Furthermore, VR-BIM enables students to interact with virtual construction projects in a highly immersive and interactive manner, which can engage and motivate them to learn (Bui et al., 2020). Finally, VR-BIM can be used to assess and evaluate student learning, allowing educators to track progress and identify areas where more assistance may be required (Dong et al., 2019). Overall, VR-BIM has the potential to significantly improve construction education effectiveness by providing students with a more immersive and interactive learning experience.

5.1 Implementation of Integrated VR-BIM in QS Education

VR and BIM are increasingly being used in quantity surveying education to provide immersive, interactive learning experiences for students (Bourdakis, 2017). Through the use of VR walkthroughs to navigate virtual 3D building models, QS practitioners and students can improve their understanding of architectural designs, leading to more efficient decision making and more precise quantity surveying work (Wang et al., 2017). This can assist them in visualizing and comprehending complex building plans, as well as identifying potential issues or challenges that

may arise during the construction process (Azhar et al., 2018). One possible application of virtual reality in quantity surveying education is to create virtual construction sites for students to explore and analyze. Students, for example, could use virtual reality to walk through a virtual building and practice measuring quantities of materials and labor. This can help students improve their cost estimation and project management skills. Another way to incorporate virtual reality into QS education is to provide students with virtual simulations of real-world construction projects. Students could, for example, use VR to practice analyzing and optimizing construction schedules, identifying potential risks and hazards, and budget management. This type of immersive learning experience can assist students in developing the skills and knowledge required for success as quantity surveyors. BIM is a digital representation of a construction project's physical and functional characteristics. It is capable of producing detailed 3D models of buildings and structures, which can then be accessed and analyzed using VR technology. This can assist students in better understanding the relationships between various components of a construction project as well as the construction process.

Wang et al. (2018) aim to develop a VR-enabled BIM immersive system for use in both quantity surveying practices and education in their study. The system is divided into two parts: an immersive system (such as a head-mounted display or a 360-degree display) and a non-immersive system (such as a desktop VR setup). The immersive system is intended for use on a desktop or other non-immersive platform to provide a fully immersive VR experience, whereas the non-immersive system is intended for use on a desktop or other non-immersive platform. The system's goal is to provide quantity surveying students and practitioners with a more interactive and hands-on learning experience, allowing them to better understand the concepts and processes involved in construction projects.

VR and BIM can be used in quantity surveying education in a variety of ways, including VR simulation. Students can explore and interact with virtual simulations of construction projects created with VR. This can assist them in better understanding the relationships between various components of a construction project, as well as the overall construction process (Azhar et al., 2018). Furthermore, BIM software can be used by students to create detailed 3D models of buildings and structures (Lee et al., 2016). These models can be accessed and analyzed using VR technology (Azhar et al., 2018), allowing students to better understand the relationships between various construction project components (Bourdakis, 2017). Next, collaborative learning with VR and BIM can be used to facilitate student collaboration (Lee et al., 2016). Students, for example, can collaborate on a virtual construction project using VR and BIM, allowing them to share ideas and insights while also learning from one another. Furthermore, problem-based learning techniques such as VR and BIM can be used to create problem-based learning scenarios that challenge students to identify and solve issues that may arise during the construction process. This can assist

students in developing problem-solving skills and critical thinking about construction projects.VR and BIM can be used in quantity surveying education in a variety of ways, such as VR simulation. VR can be used to create virtual simulations of construction projects that students can explore and interact with. This can help them better understand the relationships between various components of a construction project, as well as the construction process as a whole (Azhar et al., 2018). Furthermore, students can use BIM software to create detailed 3D models of buildings and structures (Lee et al., 2016). These models can be accessed and analyzed using VR technology (Azhar et al., 2018), allowing students to better understand the relationships between various components of a construction project (Bourdakis, 2017). Next, collaborative learning with VR and BIM can be used to facilitate collaborative learning among students (Lee et al., 2016). Students, for example, can collaborate on a virtual construction project using VR and BIM, allowing them to share ideas and insights and learn from one another. Furthermore, problem-based learning tools such as VR and BIM can be used to create problem-based learning scenarios that challenge students to identify and solve issues that may arise during the construction process. This can help students improve their problem-solving abilities and think critically about construction projects.

5.2 The importance of VR-BIM in Quantity Surveying (QS) curriculum for QS profession

As the construction industry becomes more digital, future young quantity surveyors must become familiar with and proficient in the use of VR and BIM technologies. Incorporating VR-BIM into quantity surveying curriculum courses can provide several significant advantages to future young quantity surveyors. For starters, VR-BIM can help students gain a better understanding of the design and construction processes, improving their overall knowledge and skills as future quantity surveyors. For example, Gao et al. (2016) discovered that students who use VR in a quantity surveying course improved their understanding of the construction process significantly. Furthermore, incorporating VR-BIM into the curriculum can help students better understand and visualize the design and construction processes. This can improve student engagement and understanding of the material. According to Al-Dhafiri et al. (2019), using VR in a quantity surveying course improved student engagement and learning outcomes. Another significant advantage of incorporating VR-BIM into the curriculum is that it can prepare students to use these technologies in the workplace. As the construction industry becomes more digital, students must be able to use VR and BIM software. This can make students more marketable and better prepared to perform their duties as quantity surveyors once they graduate.

Furthermore, VR-BIM can help to improve the efficiency and accuracy of construction project cost estimating and budgeting. Quantity surveyors, for example, can more easily access and analyze data on the materials, labor, and other costs associated with a project by using BIM, which can help

to improve the accuracy of cost estimates. Furthermore, by using VR, quantity surveyors can more easily identify and address potential issues that may impact project costs. As a result, VR and BIM are widely used in quantity surveying programmes because they enable better communication and collaboration among stakeholders, improve overall quality and safety of construction projects, and increase the efficiency and accuracy of cost estimating and budgeting for construction projects. This has been reported in various studies, such as Wang et al. (2019), who discovered that using VR in BIM-based design reviews resulted in a 40% reduction in design errors.

6.0 Methodology

The research methodology employed in this study comprises three main components: literature review, content analysis, and interviews. Firstly, a comprehensive literature review was conducted to explore Quantity Surveying (QS) curriculum courses and identify subjects suitable for the implementation of VR-BIM. This involved a thorough examination of existing academic literature and relevant sources to inform the selection process. Subsequently, content analysis was employed to identify specific VR-BIM methods suitable for integration into the chosen curriculum courses. This analysis involved a systematic examination of the content related to VR-BIM, focusing on methods that align with the objectives of the QS curriculum. Finally, interviews were conducted to gather insights and feedback from educators, aiming to gain a deeper understanding of their opinions on the selection and implementation of VR-BIM in QS curriculum courses. Together, these methodological approaches form a comprehensive strategy to address the research objectives and contribute valuable insights to the study.

7.0 Findings

7.1 Identification of Suitable QS Subjects for VR-BIM Integration

The study involved an in-depth examination of all courses and their respective objectives. A selection of eight (8) existing courses has been made for the implementation of VR-BIM. This content analysis serves as a preparatory step for the subsequent method, which involves interviews. The gathered data and analyzed content facilitate a focused investigation into the suitability of VR-BIM implementation within specific curriculum courses. The findings indicate the presence of several subjects conducive to the integration of VR-BIM, offering potential enhancements to the comprehension of various aspects in a Quantity Surveying curriculum. The subjects including;

i. Building Construction: VR can be used to visualize and explore different construction methods and materials, and to get a better understanding of how buildings are put together

ii. Measurement: VR can be used to practice taking measurements and to better understand how different elements of a building relate to each other. BIM can be used to create accurate measurement models of building projects, which can be used to practice taking measurements and to better understand the spatial relationships between different elements of a building

iii. Cost Management: BIM can be used to create accurate cost estimates for different construction projects and to better understand the costs associated with different materials and methods.

iv. Health, Safety and Environmental Management: VR can be used to simulate different safety scenarios and to practice emergency response procedures.

v. Building Services: VR can be used to visualize and explore different types of building systems, such as electrical, plumbing, and heating, ventilation, and air conditioning (HVAC), and to better understand how they work.

vi. Infrastructure Technology: VR can be used to visualize and explore different types of infrastructure projects, such as roads, bridges, and tunnels, and to better understand how they are constructed.

vii. Construction Materials: VR-BIM can be used to generate the material to construct the construction and visualize materials, and to get a better understanding of how buildings are put together.

viii. Methods of Construction: VR can be used to visualize and explore different construction methods and materials, and to better understand how different methods and materials can be used in different construction projects.

7.2 Determination of VR-BIM Methods for Identified Subjects

This section provides a detailed overview of the integration of VR-BIM methods across various courses within the Quantity Surveying curriculum. Table 2.1 presented courses encompass a range of objectives aimed at equipping students with essential skills and knowledge in the field. The incorporation of VR-BIM technologies is strategically aligned with each course's objectives to enhance the learning experience and practical application of Quantity Surveying principles. Through a comprehensive analysis of each course, this section delves into the specific VR-BIM usages employed, such as material quantity take-off and schedule, construction sequence visualization, and interactive modules. The methodologies outlined showcase the tailored approaches used to leverage VR-BIM in diverse learning contexts, offering students immersive and interactive experiences that align with the demands of the construction industry.

Table 2.1: VR-BIM usage and methods for identified subjects

CODE & COURSE NAME	OBJECTIVES	VR-BIM USAGE	METHOD
RQG236 Measurement 1	Perform quantity take-off	• Find the quantities • Observe how various building components	Material Quantity take-off and schedule
RQG237 Measurement 2	• Perform quantity take-off • Can evaluate drawing • Understand the materials in construction	• Find the quantities • Observe how various building components	Material Quantity take-off and schedule
RQB261 E-Measurement	Perform take-off all materials' quantities through software	• Find quantities and pri real project using BIM • Build a 3D interactive model. • Clash detection • Construction sequenc	• Material Quantity take-off and schedule • Use 3D modeling software
RAG161 Building Constructio 1	• Learn the basic building components. • Recognize construction drawings	• Construction sequenc • Visualization	Interactive Module
RAG265 Building Construction 2	Help students understand the complex relationships between different components of a building and the overall construction process. • Learn the basic building components.	• Construction sequence • Visualization • Site trip	• Interactive Modules • Project-based learning
REG361 Methods of Construction	Learn the knowledge of several methods in the construction.	• Construction sequenc • Visualization	Interactive Modules

RMK156 Health, Safety and Environmental Management	• Understand the principles of health, safety, and environmental management. • Identify and assess health, safety, and environmental hazards in various contexts. • Develop the skills to communicate effectively about health, safety, and environmental issues. • Apply appropriate risk assessment and hazard management strategies.	• Visualization • Scheduling • Create virtual simulations of hazardous work environments	Interactive Modules
REG265 Infrastructure Technology	• Understand the concept of infrastructure and its role in society. • Identify and describe the components and functions of various types of infrastructure. • Apply engineering principles a tools to design infrastructure systems. • Understand the importance of sustainability in infrastructure development and managemer	• Construction sequenc • Visualization	Interactive Modules

8.0 Conclusion

The findings of this study reveal a strategic and comprehensive approach to the integration of VR-BIM into QS education. Through a meticulous examination of existing courses and their objectives, eight subjects were identified as conducive to the implementation of VR-BIM, showcasing the potential to enhance students' comprehension of various aspects within the QS curriculum. The determined subjects, ranging from Building Construction to Health, Safety, and Environmental Management, demonstrate the versatility of VR-BIM applications across diverse QS domains. The study emphasizes the potential benefits of VR-BIM in visualizing construction processes, understanding materials, practicing measurements, and simulating safety scenarios, aligning with the industry's demands for immersive and practical learning experiences. By aligning the incorporation of VR-BIM technologies with the specific objectives of each course, the study aims to

equip QS students with essential skills and knowledge, fostering a deeper understanding and practical application of Quantity Surveying principles. The tailored approaches, such as material quantity take-off, construction sequence visualization, and interactive modules, underscore the study's commitment to providing students with immersive and interactive learning experiences. In conclusion, the integration of VR-BIM into the QS curriculum holds the promise of preparing students for the dynamic challenges of the construction industry. By leveraging advanced technologies in education, this approach not only enhances theoretical understanding but also cultivates practical skills, ensuring that QS graduates are well-equipped to contribute effectively to the evolving landscape of construction management.

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The Precision Volume Estimation of Water Tanks Through UAV-based 3D Structural Modeling

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Abstract

Unmanned Aerial Vehicle (UAV) technology has made significant progress. The use of UAVs for measurement was also possible for challenging objects, such as the high elevation of water tank structures. The water tank material was made of metal. Thermal expansion was the phenomenon in which metals experience a slight increase in their dimensions, such as length, width, total area, and volume, as a result of an increase in temperature.The purpose of this paper was to conduct observations during different periods of time to determine the changes in volume of the water tank structure by using a UAV. The results were compared with the actual volume of the water tank structure to validate the measurement. In this study, the image acquisition was done using Phantom 4 Professional, and the 3D model was produced using Agisoft Metashape software. The 3D water tank model that was created was also high-quality and accurate. This shows that Agisoft Metashape software does an excellent job of processing the 3D model. The findings demonstrate that there was a volume reduction between the actual measurement and the structure volume measured by the UAV for the water tank structure. The results show that the measurement error was low, between -0.8% and -1.4% of the actual volume. This suggests that the water tank was relatively stable in terms of its volume and that the measurement error was relatively low. Overall, the results of the measurements show that the volume of the water tank structure remains relatively constant throughout the day, with only small changes. The afternoon observation result was the most accurate when compared to the actual volume and environment temperature reading of 32°C. The point cloud generated using CloudCompare software has denser compared to the morning and evening. Hence, it means that environmental temperature was a factor affecting the volume of the water tank structure, as changes in temperature can cause the metal structure to expand or contract.

Keywords: *UAV; Water Tank; volume of structure; 3D modelling; different period of time*

1.0 Introduction

Significant advancement in UAV development has been seen across numerous industries, fields, and uses (Rhodes, 2017). In surveying, UAVs can also perform volume measurements. Volume calculations were important and can be used to estimate the amount of material used in many industries, such as mining, mining in open pits, and other engineering fields where work needs to be done quickly and correctly. Utilising UAV allows for the measurement of difficult objects such as water tanks structure. Furthermore, with processing, UAV technology can produce point clouds using software such as Agisoft Metashape. This has generated the 3D modelling for an object such as a water tank. The water tank material was made of metal. The process by which metals suffer a slight increase in their length, width, total area, and volume of structure in response to an increase in temperature was referred to as thermal expansion. When the temperature changes, matters tend to change in size, shape, and area (Bajpai, 2018). This was called thermal expansion. The increase in atomic vibrations that causes thermal expansion was the root cause of this phenomenon; the particular metal determines the degree to which the expansion occurs. In addition, due to the high elevation of the water tank, it was difficult for humans to perform exact measurements. UAV monitoring has the advantage of being able to survey areas that are hard to gain access to on foot, capturing spatial variation, adjusting the timing of data collection to meet the needs of research, and collecting a large amount of accurate data quickly at a relatively low cost (Haskins et al., 2021). It can be stated that the low-cost UAV has the ability to be used to measure the volume of water and its dimensions (Ab Rahman et al., 2017).

The aim of this study was to conduct observations during different periods of time to determine the changes in volume of the water tank structure. The objectives for this study were to produce a 3D structure model of water tank in different periods of time morning, afternoon and evening and to analyse the volume of water tank structure in contrast to the actual.

2. Literature Review

Volume is the amount that fills a container to capacity. Three-dimensional, boundary-bound space is called "volume". For instance, the volume of a solid, liquid, gas, plasma, or create in a given environment. On the other side, the capacity of a container is typically thought of as the same thing as the volume of the container (Ab Rahman et al., 2017). In accordance with the principles of sustainable development, UAV photogrammetry can be used to figure out volume and map large areas. Using a UAV, users can also map areas that are dangerous or hard to

get to, whereas users would have to use some kind of special equipment to do that otherwise. Using a UAV is also contactless, making it possible to map dangerous areas without having to drive or walk on them (Kokamagi et al., 2020).

When doing calculations involving volume, getting the best possible representation is directly linked to achieving a high level of accuracy. Analysis of accuracy in Table 1 shows that the volume calculation produced using the UAV and photogrammetric methods agreed to 99.33% with the volume calculation made using the conventional method, and it was observed that sufficient accuracy was provided. Errors in measurement are frequently unavoidable for a variety of reasons, including a lack of experience on the part of the person performing the measurement, the limitations of the measuring tools themselves, or other external factors. The formula for the percentage of error will tell us how significantly these naturally occurring mistakes have impacted our findings (Physicscatalyst, 2022).

Table 1: Result of accuracy research of the volume measurement, made of UAV by using photogrammetric techniques (Ulvi.2018)

PARAMETERS	CLASSIC (m^3)	UAV PHOTOGRAMMETRY (m^3)	DIFFERENCES (m^3)	ACCURACY RATE %
SOLID VOLUME (m^3)	286	287.94	-1.94	99.33
REFERENCE CODE (m)	1203	1203	0	----------

3.0 Methodology

This chapter covers the methodology flow that is used during the study. It is divided into several phases that will review the workflow involved. This will help in basically giving an idea how this study will be carried out to solve all the aims and objectives of this project dissertation. Next section of this chapter will explain a detailed workflow of this study. Figure 1 shows the workflow of methodology. Phase 1 was preparation. It first determines which software was suited for the objectives, and then it determines the problem statement to use. Phase 2 was the stage of planning everything out. The tasks that were included in this project include reconnaissance of the study area, determining an appropriate place for GCP, preparing the flight planning, and using the method point of interest (POI). Phase 3, the data collection process, was discussed in detail. It was an essential phase in the process. During this phase, it was important to establish Ground Control Points and record digital aerial images of the area. With the use of photogrammetry technology, it can produce a 3D model of the water tank by utilising Agisoft

Metashape software. Phase 4 was the processing of the data, which will form the following phase. Agisoft Metashape was used as the software application of choice. Phase 5, the analysis of the data, was the final step. In this chapter of the research project, the water tank was compared to both the actual measurement data and measured values in this phase of the study.
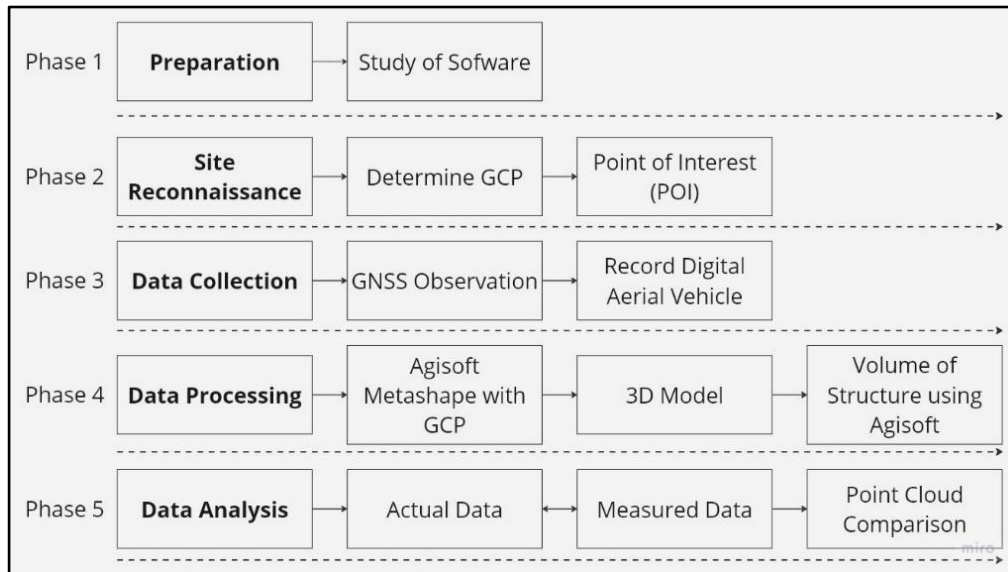

Figure 1: The workflow of methodology

4.0 Study Area

The study will take place in Selangor, at Vocational Special Education Secondary School Shah Alam (SMPKV). This research will focus on the water storage tank in the SMPKV Shah Alam, Seksyen 17. Figure 2 shows the study area of water tank in Shah Alam.
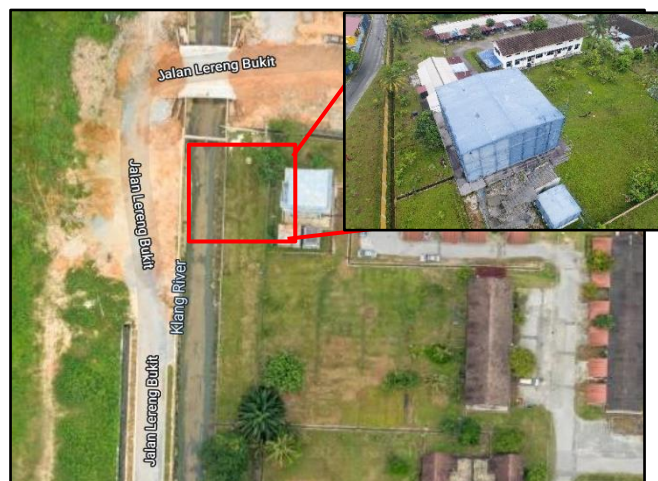
Figure 2: Study Area of water tank at SMPK Vokasional Shah Alam, Seksyen 17
(Google Earth)

5.0 Software and Application

The software used to achieve the objective was Agisoft Metashape. Agisoft Metashape will produce a point cloud and 3D model of a water tank with different periods of time. To make a comparison for further analysis, actual measurement data of the water tank will be used for comparison. In addition, DJI Go 4 and LandStar 7 have been chosen for data collection software. The objective of this study can be reached with the help of each piece of software as shown in Table 2.

Table 2: Type of Software

Phase	Software	Task
Site Reconnaissance	DJI Assistant 2 for Phantom	Camera and vision sensor calibration
Data Collection	DJI Go 4	Point of Interest (POI)
Data Collection	LandStar 7	GCP coordinate observation
Data Processing	Agisoft Metashape	Volume measurement and 3D modelling
Data Analysis	Cloud Compare	Comparing the point cloud obtained from the image process for the water tank on Agisoft Metashape

6.0 Point of Interest (POI)

In this particular research project, the site area consists of a water tank, and the path that is taken to capture images is all the way around the water tank. Using an unmanned aerial vehicle (UAV) drone, photographs were obtained at the location, which was situated at SMPKV, Shah

Alam. When doing work with photogrammetry, one of the most crucial things was to take photographs of a high quality.

Point of Interest (POI) method will be used for this study through the DJI Go 4 application. There was a smart flying mode on several DJI drones called Point of Interest (POI). The settings for the Point of Interest (POI) were 40 metres in altitude, 18 metres in radius, 3.2 km/h speed, 2 second timed shot, and clockwise around the water tank, as determined by using the DJI Go 4 application. Figure 3 shows the setup of POI for this study.

Figure 3: The Parameters of Setup Point of Interest (POI)

7.0 Ground Control Points and Verification Points

GCP observation was essential for this research. For instance, the accusation will gather data via GNSS, and the ground control point will be used to coordinate the location for the aerial image. Field reconnaissance was carried out in order to identify safe areas for the purpose of ensuring that the current conditions are safe. 2 Control Point will set up in the location and observe by MyRTKnet method.

In addition, for transferring coordinates from the ground, Total Station has been used. Before beginning the process of image acquisition, there must first be a total of 17 GCPs established at the water tank structure using reflector stickers. After that, transfer coordinates x, y, and z by using the prismless Total Station. The Z value will be used in the elevation formula as below. To figure out the horizontal distance, all total stations measure the slope distance and zenith (vertical) angle recorded by the theodolite along the line of sight.

After observing two control points using the MyRTKnet method, these two control points that were established were used as the datum for starting work At least two new CRM signs that are not less than 30 metres apart are observed with the MyRTKnet method for both signs in one initialization. The same process needs to be repeated for the second initialization (DSMM, 2009). In addition, CP 3 and CP 4 were established using Total Station for X,Y coordinates, and Z coordinates were used as the fly levelling method from CP 2.

Figure 2.4 shows a TOPCON total station used to conduct a support survey, which was used to determine the scaling method for the 3D model. This choice was based on two major factors: the fact that we were unable to employ a GNSS receiver to transfer the coordinates to the water tank structure due to the fact that the structure was higher and could only be tracked with a prismless total station, as well as the fact that we needed to create scale bars using Agisoft Metashape for better accuracy. Therefore, four points were placed on the ground to make an open polygon, as shown in Figure 2.5. A detailed survey was then done to measure several support points, from which 17 were selected to model scaling: 5 of these were chosen and observed from CP 1; 5 points were observed from CP 2, 3 points were observed from CP 3, and 4 points were observed from CP 4. Figures 4 - 9 show that the water tank structure has a total of 17 GCPs and 30 VPs. All of the points were measured using the old Cassini-Soldner (old) Selangor system and then converted to WGS 84 for the processing phase.

Figure 4: Transferring Coordinates to water tank structure

Figure 5: The location of the Control Points area (Google Earth)
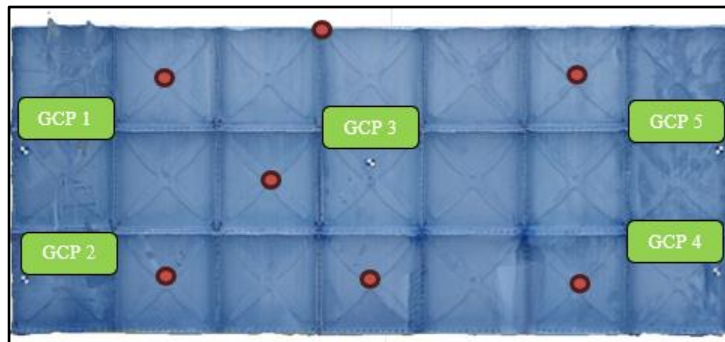
Figure 6: View of the CP 1 observations. GCPs were represented
in green while VPs were represented in red
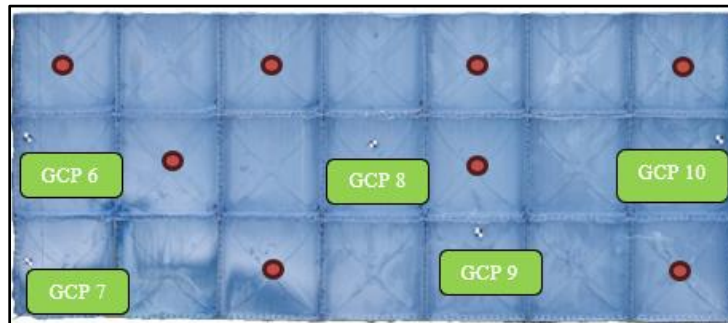
Figure 7: View of the CP 2 observations. GCPs were represented
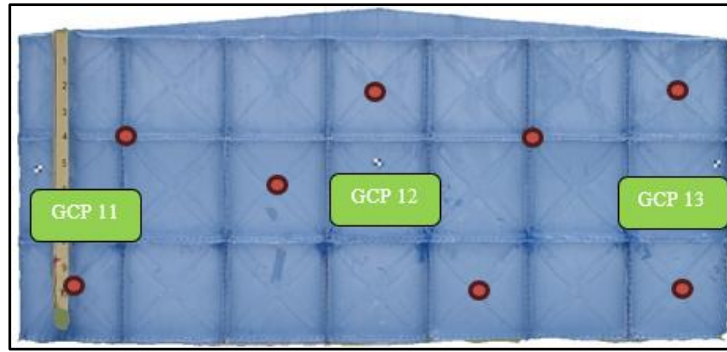in green while VPs were represented in red

Figure 8: View of the CP 3 observations. GCPs were represented in green while VPs were represented in red
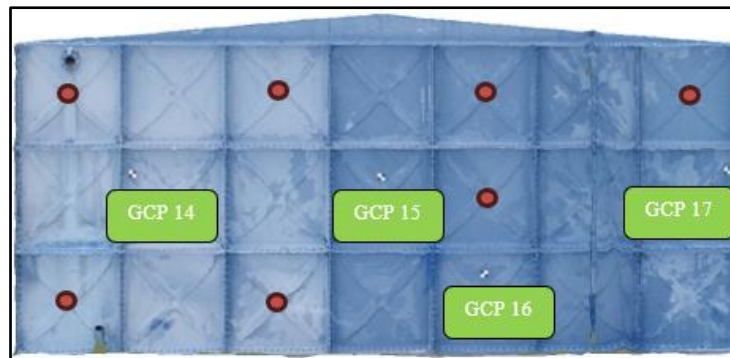

Figure 9: View of the CP 4 observations. GCPs were represented in green while VPs were represented in red

8.0 Result and Discussion

This chapter presents the result that was obtained from the raw data that was processed using the Agisoft Metashape software. Particularly, the chapter focuses on the results of the processing. WGS 84 (EPSG :4326) was chosen to be the coordinate system. The total method was applied to the total of 105 images for each period of time taken in the morning, afternoon, and evening.

9.0 GCP and VP Accuracy

Figure 10 shows the root mean square error (RMSE) values for the X, Y, and Z coordinates of ground control points (GCPs) and verification points (VPs) taken in the morning, afternoon, and evening.
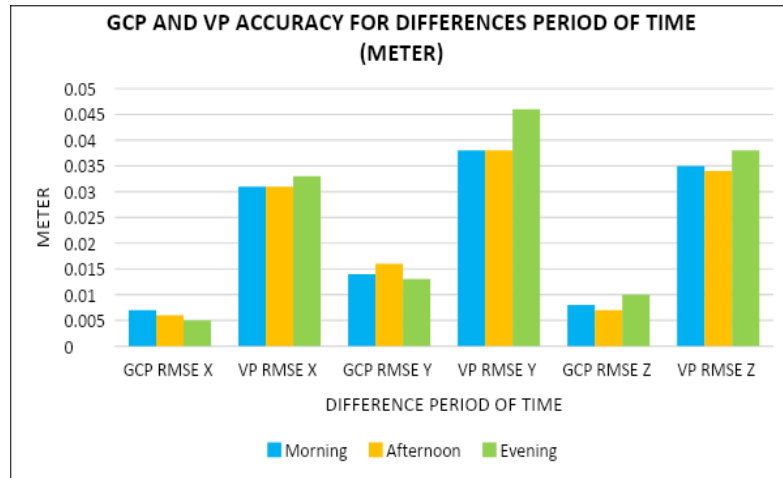
Figure 10: GCP and VP RMSE for differences period of time (metre)

Based on the graph figure 4.1, we were able to observe that the RMSE values for all time periods were relatively small, which means that the GCPs correspond with good accuracy and precision. The RMSE values show that the 3D modelling performed with Agisoft Metashape was accurate enough for mapping and surveying applications, with errors of a few centimetres or less. In summary, the RMSE values for all three times of day were relatively low. This means that the 3D modelling software was accurate, and that accurate measurements and research studies might be made using the model.

10.0 3D Structure Model of Water Tank in Different Period of Time

Table 3 shows the 3D model result. The objective of this study was to turn pictures into a 3D model of the water tank structure for different periods of time that can be used for volume measurement. The ability of the Agisoft Metashape software to generate a 3D model means that the first objective of being able to create a 3D model was accomplished. To make analysis easier, the 3D model appears in a table.

Table 3: 3D Model Result

Period of Time	3D Model of Water Tank Structure
Morning	 Number of Points Clouds: 609,663
Afternoon	 Number of Points Clouds: 1,397,159
Evening	 Number of Points Clouds: 1,260,298

Based on Table 3, Agisoft Metashape software was capable of taking the point cloud and turning it into a 3D model. The number of images was enough to cover the whole water tank structure with good overlap and side lap; therefore, the 3D model did not contain any gaps in it. The structure of the water tank was also the same colour as it was at the location. This shows that the 3D models made with Agisoft Metashape software were very good. A UAV point cloud was capable of creating a very accurate 3D model (Sani et al., 2022).

11.0 Volume of Structure of Water Tank Result

The volume result that was obtained from each processing done with the Agisoft Metashape software could be found in figure 11.
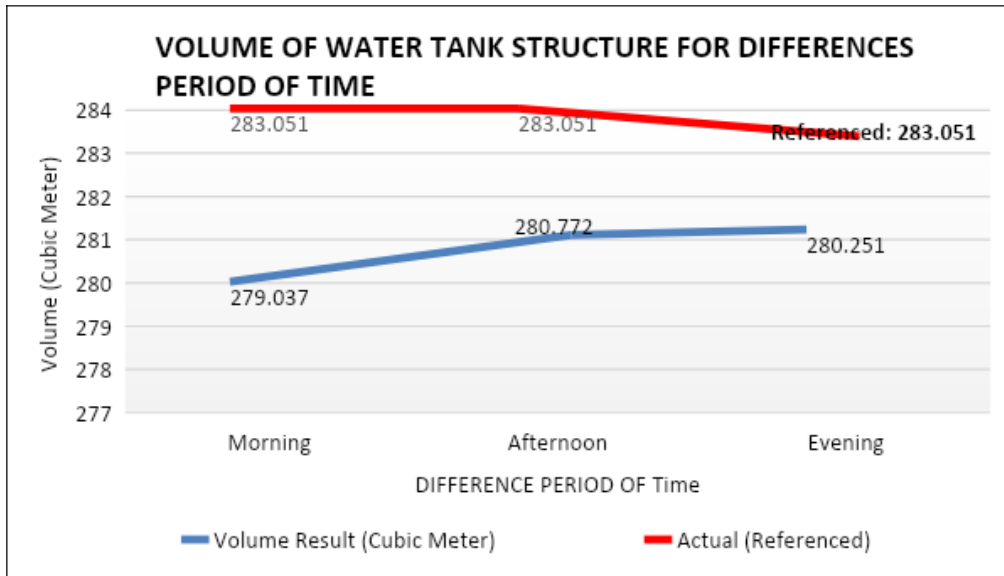
Figure 11: Volume of structure of water tank for differences period of time

The marking of the scale bars was based on the GCPs that has been marked on the water tank structure and can be identified on the 3D model. The marking was done in order to ensure that the markings were accurate. The findings demonstrate that there was a volume reduction between the actual measurement and the structure volume measured by the UAV for the water tank structure. The volume of a water tank structure appears in the figure with the measured environment temperature at different periods of the day. The actual tank volume is 283.051 m^3, therefore that number will be used as the actual referenced. Morning saw the lowest amount at 279.037 m^3, with the afternoon and evening showing slight rises to 280.772 m^3 and 280.251 m^3, respectively. Each measured environment temperature was different, with the morning reading was 28°C, the afternoon reading was 32°C, and the evening reading was 30°C. This means that environmental temperature was a factor affecting the volume of the water tank structure, as changes in temperature can cause the metal structure to expand or contract. In general, the results of the measurements show that the volume of the water tank structure remains relatively constant throughout the day, with only small changes.

12.0 Differences Percentage of Volume Between Actual and UAV

Table 4 shows the change in the volume of the water tank structure over various periods of time and also the error percentage for each time period.
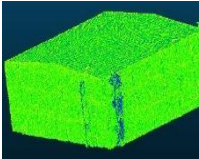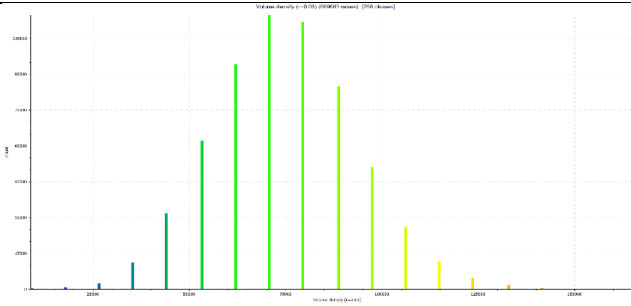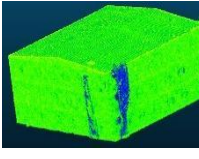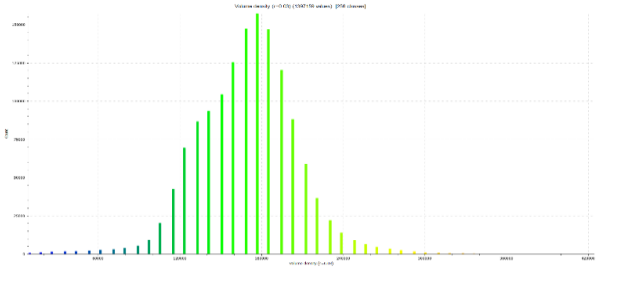
Table 4: Error percentage comparison
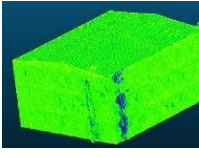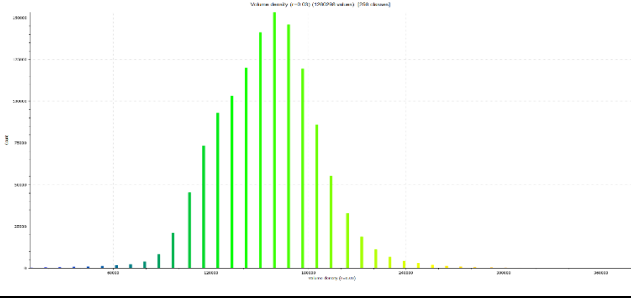
Difference Period of Time	Volume Difference (m^3)	Error (%)
Morning	-4.014	-1.418
Afternoon	-2.279	-0.805
Evening	-2.800	-0.989

From table 4, it was clear that the error values were relatively low, ranging from -0.805% to -1.418%. It demonstrates that the measurements were relatively precise and that the water tank structure volume did not shift much throughout the day. As the day continues, the error percentages decrease. The largest error percentage was -1.418% in the morning, and the lowest error percentage was -0.805% in the afternoon. A volume tolerance ranging from 2 to 4% was usually accepted in topographic surveys and general land surveys. This indicates that the volume estimated for a surveyed region should not be more than ±2-4% off from the actual or predicted volume. An error of 3% to 4% can be expected from the comparison. The law in certain countries requires volume calculations to be accurate within 3% of the whole material (Raeva et al., 2016). When comparing the results, it was determined that the volume estimated using total station data was out by 2.88%, while the volume estimated using UAV data was out by only 0.67%, suggesting that the UAV-based volume estimate was more accurate (Arango C & Morales C, 2015). The results of the measurements, taken as a whole, indicate that the water tank structure was generally stable in terms of its volume, and that the measurement error was relatively low.

13.0 Volume Density for Agisoft Metashape Software

In order to use the CloudCompare software, the point cloud has been analysed at different times of day, including in the morning, afternoon, and evening. The CloudCompare software was used to make a volume density histogram for a chosen point cloud in order to study the pattern on the histogram. The volume density has been defined as the number of neighbours divided by the volume of the neighbourhood (Daniel, 2017). Based on table5, CloudCompare software was used to examine the data collected from the morning, afternoon, and evening to determine volume density.

Table 5: Volume density comparison between different periods of time

Time	Point Cloud Data	Volume Density Histogram
Morning		
Afternoon		
Evening		

According to table 5, the afternoon and evening volume density point clouds were denser than the morning volume density point clouds. Once applied to the histogram, the values showed the

number of point clouds generated. Therefore, the number point cloud for the afternoon histogram was 1,397,159, and the number point cloud for the evening was 1,260,298. Additionally, the volume density bar graph had bars that were close to one another, creating a dense pattern. The following was different from the morning histogram, which has bars that are further apart and have bigger spaces between them because the number of point clouds generated was 609,663. Overall, we were able to conclude that the afternoon observation delivered the most accurate results in Agisoft Metashape software when comparing the measured volume to the actual volume. Has an excessive point cloud number and a high-volume density, both of which contribute to a significantly small volume calculation error (Eizat,2022).

14.0 Conclusion

This study demonstrates the application of UAV 3D modelling in the process of acquiring images of a water tank located at a high elevation. The volume of the water tank structure has been determined for different periods of time using the Agisoft Software. There were two objectives for this study. The first was to create a 3D structure model of a water tank at three different periods of time: morning, afternoon, and evening. Agisoft Metashape was capable of transforming every UAV image into a 3D model. The georeferenced image was processed by Agisoft Metashape to create a high-quality and accurate 3D model of the water tank structure's volume. Agisoft Metashape calculated the GCP's RMSE. The 3D water tank model was also precise. The second and last objective was to measure the water tank's structural volume. The result shows morning, afternoon, and evening water tank structure volumes. The measurement error for the water tank structure was between -0.8% and -1.4%. This shows the water tank's volume was stable and the measurement error was modest. Eliminate all secondary faces to calculate the area, which determines volume. Remove it precisely. In summary, we were able to figure out that the volume of the water tank structure changed over time. The afternoon observation was closest to the volume. In addition, UAV technology was a suitable method for making observations of high-elevation water tank structures.

In conclusion, both of the objectives that were set for this study have been accomplished, and the findings of this study have demonstrated that a water tank made from metal has thermal expansion, which changes the volume of the water tank structure for different periods of time. This means that environmental temperature was a factor affecting the volume of the water tank structure, as changes in temperature can cause the metal structure to expand or contract. In general, the results of the measurements show that the volume of the water tank structure remains relatively constant throughout the day, with only small changes. The Agisoft Metashape

software created 3D models and calculated volumes accurately. From this study, it has been shown that UAV 3D modelling has the potential to calculate the changes in volume of a water tank structure for different periods of time, and the most important thing is that humans are hard to reach at high-elevation water tanks.

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