# BIMAR WEB APPLICATION FOR ISLAND RECLAMATION PROJECT

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**Abstract:** Industry 4.0 has lately become a popular term to describe the industrial world's trend toward digitalization and automation. The problem statement had been identified by using one set of pre-project questionnaires which involved 10 respondents. Based on the collected data, the analysis shows that the use of 2D drawing (which includes the limited information and less collaboration) and a lack of 3D modeling visualization causes misunderstanding and poor communication during the project presentation in the design phase. The scope of this study is an Island Reclamation Project located in the sea area near the south of Penang Island. The aim of this study is to develop a web-based application for project model viewers called the BIMAR Web application. The BIMAR Webapplication integrates Building Information Modelling with Augmented Reality. BIMAR Web application provides a better impact especially for a better understanding and visualization during project presentation. There is a total of 8 items that test the effectiveness of the BIMAR Web application that reported a mean score of more than 4.87 which gets a high interpretation. For the overall BIMAR Web application experience, the data analysis shows the standard deviation value of 0.000 which is categorized as the perfect agreement interpretation by using Cohen's Kappa interpretation table. BIMAR Web application is user-friendly and effective for project presentations.

***Keywords****: Project Presentation, Building Information Modeling, Augmented Reality, BIMAR Web Application, User Friendly*

## 1. Introduction

Technological developments and inventions have accelerated Industry 4.0, the fourth industrial revolution. The literature claims that Industry 4.0 fosters growth and development through its ability for efficiency. Growth in the construction sector has an influence on the engineering and construction sector since it is a subset of the overall set of gross domestic product value (Lat et al., 2021). Construction productivity and quality are probably going to increase as a result of Industry 4.0, which is anticipated to draw both domestic and foreign investors. Drones, building information modelling (BIM), augmented reality, and three-dimensional (3D) scanning are a few examples of tools that have reached maturity in the industry. A strategy must be created that asks for coordinated and dedicated efforts in a number of fields, including as operations, technology, personnel, regulation, and others, in order to fulfil this potential (Gao et al., 2019).

### 1.1 Building Information Modelling (BIM)

Building information modelling for the Island Reclamation project has a problem. The report highlights a variety of advantages of BIM in construction, such as a decrease in cost, time, carbon footprint, and capital costs. Additionally, BIM may help improve coordination and communication between stakeholders and increase overall effectiveness. On the other hand, BIM implementation is challenging and requires collaboration between the public and commercial sectors (Haron et al., 2017). Among the many benefits of using building information modelling in the construction industry is enhanced communication between architects, clients, contractors, and other project stakeholders (Alaloul et al., 2018). In addition, BIM provides precise cost estimates for the building phase before it begins. Additionally, BIM may save project waste since it can identify disputes. This cooperative synchronisation system may automate design and construction procedures while also enhancing the ability to manage huge amounts of heterogeneous data. Industry 4.0 is projected to boost construction quality and productivity and draw both domestic and foreign investors (Smith, 2014).

### 1.2 Augmented Reality (AR)

The general population oftentimes overlooks augmented reality since virtual reality is so commonly utilised. In terms of educational, architectural, and field engineering operations for both students and professionals, augmented reality has a lot of potential for the construction technology market. However, this can just be the outcome of a fundamental misunderstanding of the concept. Augmented reality is a live, virtual representation of the actual world with the ability to add additional features to the environment. Augmented reality was first used in the gaming industry as a kind of entertainment, but today architectural and engineering institutions all over the world are prioritising it for its educational value. Due to its ability to display a project as planned rather than as built to demonstrate progress, augmented reality may dramatically improve scheduling in the construction sector (Bottani et al., 2019). In a poll of architects and designers, the findings of a study project by building progress monitoring supported the engineers' claims. On a tablet PC, augmented reality may be enhanced with a Gantt chart or other 3D models. (Ahmed, 2019). Effective communication and information retrieval are two crucial elements of project success in the construction business (Lin et al.,2014). Access to project information on-site has been improved thanks to the advent of various augmented reality (AR) systems compared to more traditional information sources (Pejoska et al.,2016). Thanks to these AR technologies, project managers may immediately decide on corrective steps to decrease costs and delays caused by performance discrepancies. Several businesses are beginning to build lightweight mobile devices to help with on-site information retrieval. According on the user's location, these companies are developing technologies that can project building plans and relevant information (Yeh, K et al., 2012). Researchers are also working on techniques that make use of the camera on a mobile device to assist locate and identify a field using just a single snapshot of the site. The enhanced visual benefits of AR technology enable more effective discussion and idea exchange amongst participants while working on a specific project. When new technologies appear as a result of innovation and new technology, the construction process becomes increasingly simple. These innovations address issues including the lack of managerial talent and the cost-effectiveness of construction projects. These developments include virtual reality and augmented reality, for instance. Augmented reality, a brand-new and developing building technology, is thought to overcome the drawbacks of the present BIM on-site application. (Wang, X. et al., 2013).

## 1.3 Augmented Reality and Building Information Modeling Integration In The Construction Industry

Technology is a key component of the engineering industry, and recent advancements have raised the bar. It has provided a wide range of tools for engineering work and professions to aid in improving results and increasing industrial production. The construction sector has a reputation for being sluggish to adopt new technology, resistant to change, and open to novel ideas. Due to the industry's reputation for being data-driven, massive volumes of data, drawings, specifications, and bills of materials must be maintained and processed often (Kim et al., 2021). BIM encompasses much more than just 3D models and representations. Signaling promotes greater stakeholder participation and consistent coordination among many stakeholders during the design and construction phases. A part of intelligently mixed reality, augmented reality (AR) is referred to be "the most ambitious portrayal of ambient intelligence." Since AR mixes both actual and virtual data sources, it naturally blends human emotions. It was also discovered that AR ought to be extensively used and compatible with precise location technologies like laser signalling. The information and data that BIM offers are mainly static and pre-characterized. Tracking is another use for augmented reality, in addition to local growth and position recognition using vision-based AR.

## 1.4 BIM Software

- Autodesk Revit

The building information modelling (BIM) programme Revit, created by the company Autodesk, is extensively used in industry. The most frequent users are architects, structural engineers, mechanical, electrical, and plumbing (MEP) engineers, designers, and contractors. In-depth 3D model creation, modification, and inspection are all possible for Autodesk Revit users. It is common to compare AutoCAD to Revit, a CAD tool also utilised in the AEC industry. The majority of AEC professionals utilise both Revit and AutoCAD at the same time, although these two programmes are significantly different from one another. It's possible that AutoCAD is a design tool that enables users to produce 2D and 3D drawings on a computer. However, Revit is used to create an intelligent 3D model that incorporates real-world data. For instance, doors are only a drawing's surrounds in AutoCAD. However, the Revit designs would have a genuine door model in addition to information about the material, price, etc (Shick et al., 2019).

- Autodesk Naviswork

For AEC professionals and teams, Navisworks is a project evaluation and management application. It provides a comprehensive analysis of combined models and data that includes a wide range of stakeholders during the preconstruction stage. Navisworks increases completion certainty with better management and operational optimization. Autodesk's description of Navisworks as "3D design review software" is accurate; it aids users in reviewing 3D designs. Navisworks may thus be the finest software for BIM projects. Another reason for its widespread popularity is the ease with which it connects with other Autodesk BIM systems like Revit and Civil 3D. Revit and Civil 3D models may be rapidly imported by Navisworks users. (Shick et al., 2019).

- AutoCAD

The Autodesk company developed the computer-aided design application known as AutoCAD. It can create and modify digital 2D and 3D designs more quickly and easily than a

person. The data may also be retained and saved in the cloud, making them available whenever and wherever needed. Here are a few more benefits of using AutoCAD:

(a) Easy Edits: Before computers, a designer had to make manual changes to designs. The user would have to start anew or modify an already existing document, which may become confusing and complicated. With AutoCAD, editing and manipulating designs is straightforward.
(b) Faster Production: may create a library of reusable blocks to speed up production and repeat design portions. The design process may be completed more quickly than if it were done manually thanks to the ability to use and reuse saved files.
(c) Better Accuracy: Fractional design is possible using AutoCAD. As a result, the design is more precise in every dimension. The finished design may be loaded into a 3D printer or otherdevice to create a prototype. Alternately, the dimensions of the design can be utilised to produce parts of a constructible object, such a home or building.

- Civil 3D

Civil engineers, designers, and other professionals may plan, build, and execute projects including transportation, water management, and land development with Autodesk's Civil 3D software. Civil 3D is a building information modelling (BIM) solution that is well-known in the civil engineering world as an industry-leading BIM solution. Civil 3D is used in infrastructure projects such as construction area development, road engineering, river development, dams, embankments, and many other types. People who are familiar with AutoCAD or who want to learn it can benefit much from using Civil 3D. Civil 3D changed from being an add-on for AutoCAD into a standalone solution based on the AutoCAD architecture as the software's ubiquity and demand grew. Civil 3D has a cosy design environment in addition to a wide range of AutoCAD-compatible shortcuts. Civil 3D supports real DWG (drawing) files, allowing you to store and share design data with other AutoCAD users. Pressure networks, corridor modelling, earthwork calculations, grading, pipelines, production drawings, geospatial analysis, and point clouds are just a few of the features and tools available for a project. (Mandal et al., 2019)

- QGIS Version 16 – Open Access

Users of the QGIS geographic information system (GIS) programme may produce, edit, and export graphical maps as well as analyse and change geographical data. QGIS supports both raster and vector layers, and vector data may be stored as either point, line, or polygon features. QGIS is essential for configuring and making sure that all drawings and models are in the correct coordinate reference system for 3D modelling. In addition, QGIS provides the appropriate aerial satellite image and Digital Elevation Model (DEM), a representation of the Earth's topography devoid of any vegetation, structures, or other surface characteristics, for the Island reclamation project (Correia et al., 2018).

## 2. Materials and Methods

The flowchart of the research design methodology in this study on the BIMAR Web application is displayed in Figure 1. The procedure begins with identifying the problem statement in the construction industry, data collection for the island reclamation model

design, development ofthe BIMAR Web application, and concludes by analyzing the data.

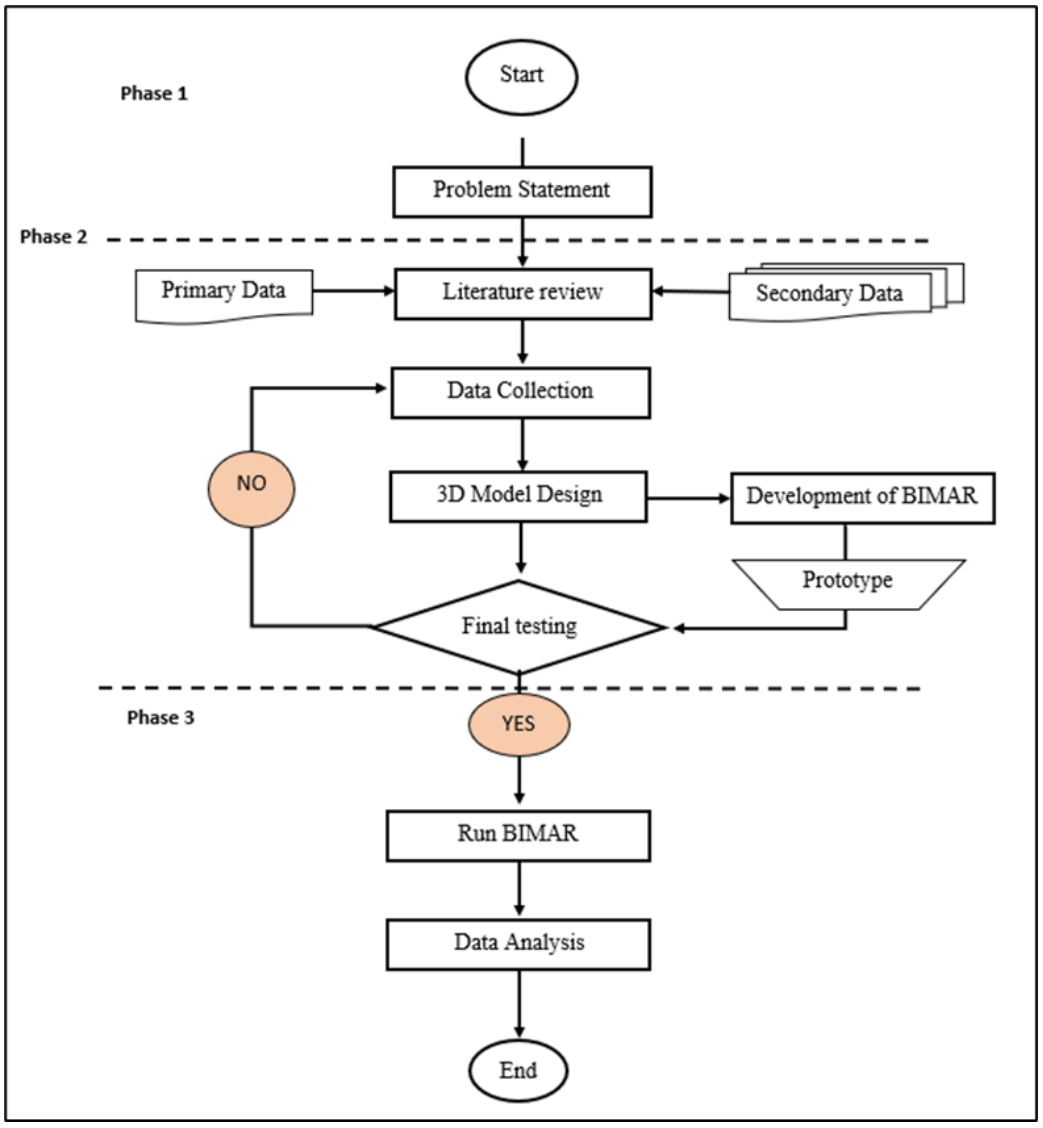



Figure 1. Research Design of the study

## 2.1 Questionnaire

There are two questionnaires which are Pre-Questionnaire and Post-Questionnaire in this study. The aim of the Pre-Questionnaire is to answer objective number 1 which is to collect the design components for the Island Reclamation project based on the Building Information ModellingLevel of Development 100 requirement. Besides, the post questionnaire being distributed andbeing analyzed to answer objective number 3, which is to evaluate the overall effectiveness ofthe BIMAR Web application. A number of 30 respondents from the construction industry give their feedback after experiencing the BIMAR Web Application.

## 2.2 Design Development

The innovation of the BIMAR Web application is to develop a web-based application for the Island Reclamation project which includes the 3D model, general project information, 4D simulation, and animation which can provide better visualization and understanding of the project. This application is being developed by using several software such as AutoCAD, Civil3D, Autodesk Infraworks, Navisworks, Google Earth Pro, and QGIS. All the BIM software is the student version and others are open sources hence the development of this project is free of charge. Table 1(a) and 1(b) below shows the process of developing the BIMAR Web application.

Table 1(a). BIMAR Web Design and Development

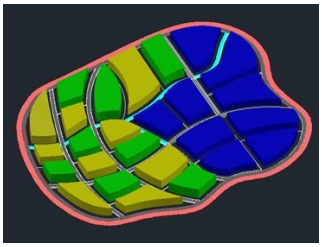
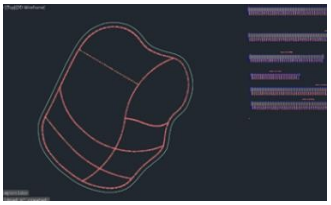
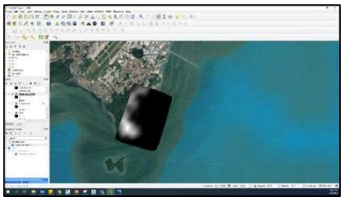
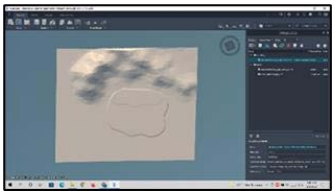
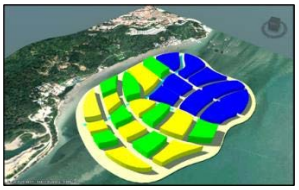
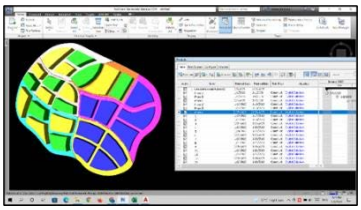
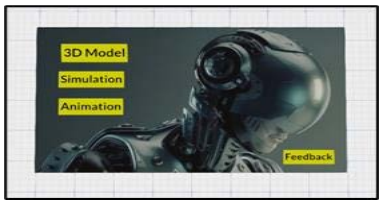
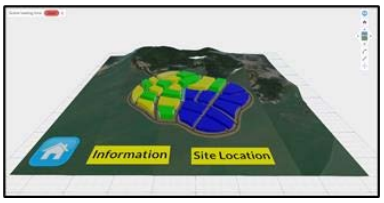
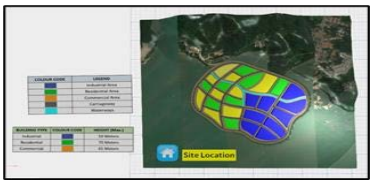
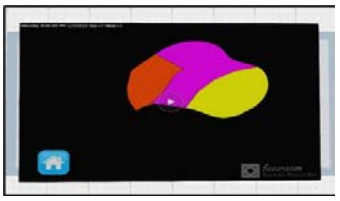
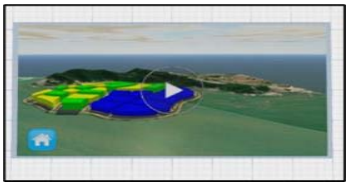
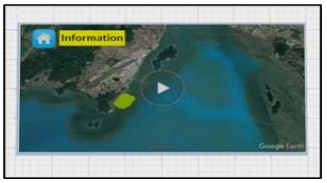
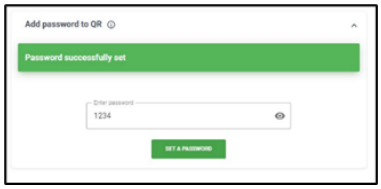
| | |
|---|---|
| 1. TIN Surface for the Model Platform  | 2. Extrude the Building envelope  |
| 3. Roadways designed using Civil3D  | 4. DEM for the study area using QGIS  |
| 5. Import DEM and Island Platform  | 6. Import all models in Infraworks  |

Table 1(b). BIMAR Web Design and Development

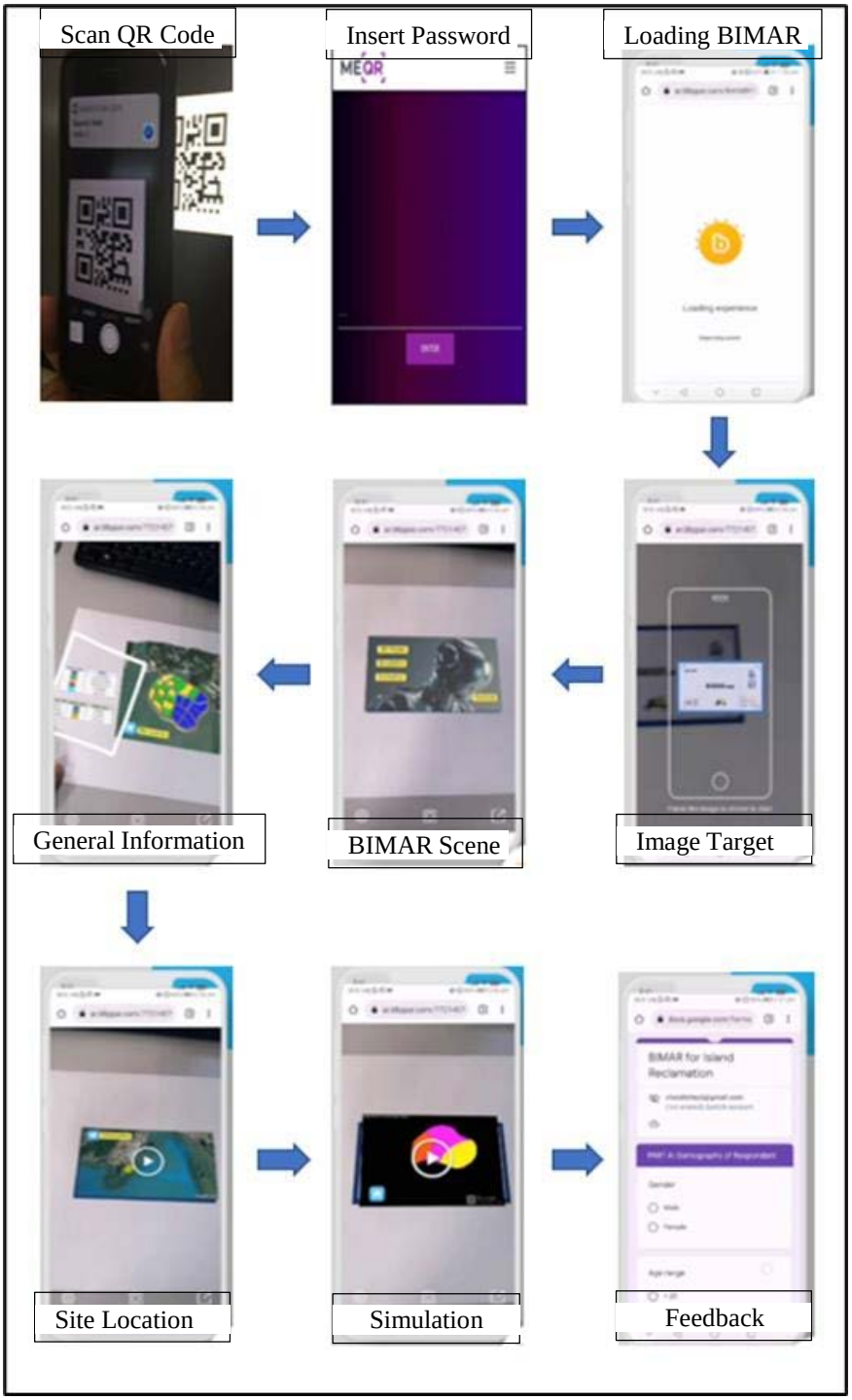
| | |
|---|---|
| 7. 4D Simulation using Navisworks  | 8. Insert Image target in Blippar   |
| 9. Design scene on top of the image target   | 10. Import Island Model into Blippar   |
| 11. Insert model information into the scene   | 12. Import 4D Simulation video  |
| 13. Import Island Animation video  | 14. Import Site Location zoom in video   |
| 15. Set Password-Protected QR Code   | 16. Generate and download QR Code   |

## 3. Results

### BIMAR Web Application Prototype

Table 2 below shows the procedures to experience the BIMAR Web prototype which consists of 9 simple steps for the complete BIMAR Web application experience.

Table 2. BIMAR Web application prototype



The password-protected QR Code is designed to protect the privacy and confidentiality of company project data. Users have to key in the password before accessing the model. There are 3 main components in this application such as Island 3D model, site location zoom-in video, project general information, 4D simulation for island reclamation development progress, and the flythrough animation for the model. Users do not have to install any application because this is a web-based application that can access by both IOS and Android devices. The paperless concept was designed to save our environment and become more sustainable. A valid perception regarding the effectiveness of the product by the architect, site engineer, project manager, and planner. A set of questionnaires is being distributed to test the effectiveness and get feedback regards the BIMAR Web application for future improvement. Table 3 shows the result obtained by the developer regarding the effectiveness of the BIMAR Web Application based on mean score interpretation table.

Table 3. Mean score and standard deviation

| BIL. | ITEM | RESPONDENT (N=30) | | |
|---|---|---|---|---|
| | | MEAN | SD | INTERPRETATION |
| 1 | Loading time for BIMAR Web | 4.87 | 0.346 | HIGH |
| 2 | IOS and Android friendly | 4.97 | 0.183 | HIGH |
| 3 | Private and confidential protection | 5.00 | 0.000 | HIGH |
| 4 | Provide better visualization for 3D Modelling through scanning | 4.97 | 0.183 | HIGH |
| 5 | Can get the project general information easily through scanning | 4.93 | 0.254 | HIGH |
| 6 | Improve communication between team members from a different department | 4.87 | 0.346 | HIGH |
| 7 | Reduce the paper used during the design phase | 4.90 | 0.305 | HIGH |
| 8 | Provide a better understanding forproject progress through 4D simulation | 4.90 | 0.305 | HIGH |

Table 3 above shows the evaluation of the BIMAR Web Application's effectiveness in the project, there are a total of 8 items that have been tested by the respondents. The study recorded strongly agrees that the loading time for experiencing the BIMAR web is very short so this will save time during the model viewer (Mean=4.87). Besides, the BIMAR Web application can be accessed by both IOS and Android devices which were recorded strongly agreed by the respondents (Mean=4.97). This study also recorded the strongly agree of the respondent about the password-protected QR code which can provide private and confidential protection for company data (Mean= 5). In addition, the respondents also strongly agree by using the BIMAR Web application can provide better visualization for 3D modeling through scanning (Mean= 4.97). Because this application can get the project general information easily through scanning, the respondents after experience strongly agree about this function (Mean=4.93). Hence, the respondents also strongly agree about the BIMAR Web application can improve communication between team members from different departments (Mean=4.87). The study also recorded that using the BIMAR Web application was able to improve communication between team members from different departments (Mean=4.87). The study also recorded thatthe BIMAR Web Application provides a better understanding of project progress through 4D simulation (Mean=4.90). Furthermore, the respondents strongly agree with the paperless concept which can reduce the paper used during the design phase and can save our environment (Mean= 4.9). This study also recorded that the respondents strongly agree that by using the BIMAR Web application can provide a better understanding of project progress through 4D simulation (Mean=4.90).

## 4. Discussion

Based on the collected data, stated that the issues that occur in construction industry especially for the island reclamation project. The top 3 problems are the used of 2D drawing which included limited information, lack of 3D visualization which bring misunderstanding, and thepoor communication between different department during the project design phase presentation. Based on the problem that raised in the construction industry, the data collectionfor the island reclamation modeling based on Building information modelling level of development 100 requirement has been collected. All the modeling were modeled and createdby using BIM software such as AutoCAD, Civil3D, Infraworks, Navisworks, and QGIS opensource. The BIMAR web application is the web-based software where no application installation needed and can be access by both IOS and Android devices. The password- protected QR Code was developed to provide private and confidential protection. By using the BIMAR web application, users can access the BIMAR experience easily and can just simply scan to get the project general information which included the building envelope type, building maximum height, site location. Simulation, and animation for the island reclamation project. Besides, the google form was provided to collect the feedback and recommendation from userfor the BIMAR Web application future improvement. Overall, for the evaluation of the BIMAR Web application are very satisfied and all the respondents give a very positive feedback after experience the BIMAR Web application. The BIMAR web application will be upgrade to VRin the future for better visualization about the project.

## 5. Conclusion

In conclusion, the results of questionnaires and data collection completed can be identified asthe main problems in the construction industry, especially for the project design phase presentation such as the 2D drawing includes limited information or data (only portrayed in two dimensions), 2D drawing provide less collaboration with different disciplines which involve in the same project and lack of 3D visualization which causes misunderstanding and poor communication that affect project success. However, an innovative product which is an application that integrates Building Information Modelling with Augmented reality has been successfully developed to be used in the island reclamation project presentation. BIMAR Webapplication has been tested by using both IOS and also android devices where there is no application installation needed and can experience it through scanning the QR code. In addition, the data findings from the expected validity survey concluded that most respondentshad a positive perception (100%, 30 respondents) of the BIMAR Web application. Besides, the BIMAR Web application was very easy to access with a single scan on a password-protected QR code which secure the privacy and confidential protection of the model. Most important was no application installation was needed to experience the BIMAR model and users do nothave to worry about the phone storage. In addition, the details about the island reclamation project had been designed and developed which is required by the respondents. BIMAR Web application in the construction design phase would improve communication and give better understanding of the project.

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