AUGMENTED REALITY ASSISTED MAINTENANCE AND MONITORING AT ON-PREMISE DATA CENTER

Muhamad Adib Bahari, Shah Runnizam Mohd Salleh and Muhammad Kamal Abdul Kiram

Information Technology & Analytics, TNB Research Sdn. Bhd., Selangor, Malaysia

ABSTRACT

Augmented Reality is a combination of a real-world and a computer-generated environment that can enhance the operation and maintenance experience. This paper aims to describe the implementation process of Augmented Reality in monitoring the health and condition of selected assets in Tenaga Nasional Berhad Research (TNBR) Data Center. This research focuses on asset maintenance and monitoring that requires frequent maintenance and close monitoring that rigorously requires human interventions. Integration with the off-the-shelf solution (Zabbix) and custom-made web-based applications, mobile app and AR viewer is established via Application Programming Interface (API) and respective Software Development Kit (SDK). Artificial Intelligence (AI) modules are embedded with the existing knowledge base to rank the best possible solution for each alert. As a result, the solution shortensdecision-making time and the troubleshooting process, especially with limited expertise.

KEYWORDS

Augmented Reality, Knowledge Base, Artificial Intelligence, Asset Maintenance, Monitoring System

1. INTRODUCTION

Augmented Reality (AR) is the augmentation of digital images on a real-world object using various AR apps [1]. AR includes graphic images then added to the real world which significantly enhance learn ability and the user experience. Image augmentation is done interactively in realtime when the AR system is combined with the real world.AR is an enabler for disruptive technologies listed under the fourth industrial revolution and slowly assimilates into industries. For instance, the utility industry takes advantage of AR technology by enhancing the employee experience, keeping employees safer, and also closing the knowledge gap [3].

Augmented Reality allows users to enhance their field of view with real-time superimposed digital information [4]. This allows users to gain information on an asset or step-by-step instructions on how to repair or maintain an asset. The end in mind of an AR system is to enhance the user's perception by supplementing the real-world environment with 3D virtual objects that appear similar to the same space or direction as the real world [6]. The 3D objects need to be developed using a 3D game engine such as Unity or Unreal that allows customizations in terms of sizing, camera distance, and 3D object placement.

David C. Wyld et al. (Eds): MLSC, ITCSS, ACSTY, SOFE, NATP, BDAB - 2023
pp. 49-58, 2023. CS & IT - CSCP 2023 DOI: 10.5121/csit.2023.130204

From a system development perspective, AR functionality is not a standalone module and utilized to visualize interactive data while allowing human-computer interaction. The foundation of AR requires a strong digitalization process to provide data, either from transactional processing, sensor outputs, databases and calculations. Although the interest in AR increases over time, publications regarding the implementation of the technology in the industry are still scarce. This has proven to be a strong motivation for researchers to further contribute in this area despite the mixed opinion on the practicality and safety aspects.

The objective of this research is to experiment with AR technologies in on-premise data center maintenance and operation workflow. In this research, a knowledge base with simple AI features is integrated into the system to assist in decision-making. The main component is a database that stores the historical events, possible root causes, possible solutions, and verification techniques. A simple calculation is applied to rank the best solution based on the frequency of similar cases that were previously solved. Finally, the solution will be displayed interactively on the AR viewer and the user will benefit in terms of efficiency of maintenance, incident data reliability, and data analytics for decision-making.

2. METHODOLOGY

To ensure the project objectives are achieved, project methodologies are planned carefully before the development process begins. A feasibility study has been conducted to select the critical data center equipment that requires frequent maintenance and close monitoring. The selection of equipment covers multiple types of servers, network equipment, and uninterruptible power supplies (UPS) to enhance variation in the knowledge base. Each equipment type consists of different attributes, for instance, servers store the attributes of CPU utilization, memory utilization and CPU temperature.

The technical design follows which consists of the overall system architecture, data structure, network interconnectivity, desired mock-up user interface and user experience (UI/UX), and process flow for each module. The platform heavily relies on system development, hence, a proper design was produced by brainstorming, storyboarding and participatory design. Next, the system development phase started where each project deliverable was programmed using a suitable framework such as Unity, Vuforia, Laravel and Java. In parallel, the development of a database was initiated by extracting expert knowledge into key attributes such as historical events, possible root causes, possible solutions, and verification techniques.

After data has been collected, system integration takes place where network connections were established to enable data exchange between databases and backend monitoring API (Zabbix) that is crucial for AR viewer and mobile app. Once the development is readily deployed, an acceptance test was conducted to verify business logic, system stability and functionalities according to system requirements.

3. SCOPE OF WORK

The scope of work that has been carried out through the project is site and equipment selection that match the project criteria. Firstly, we need to identify the critical or working operational environment that requires frequent maintenance and monitoring. The inspection and maintenance of the environment must be carried out on-site.

Secondly, we need to identify the most suitable hardware and software for AR implementation. Online data collection mechanisms such as built-in sensors, add-on Internet of Things (IoT)

sensors, and data acquisition systems need to be integrated to ensure data interconnectivity. Multiple and different devices need to communicate with each other using different types of data exchange protocols. Therefore, the method and protocol used to transport data from online sensors to the central database are crucial to produce accurate result.

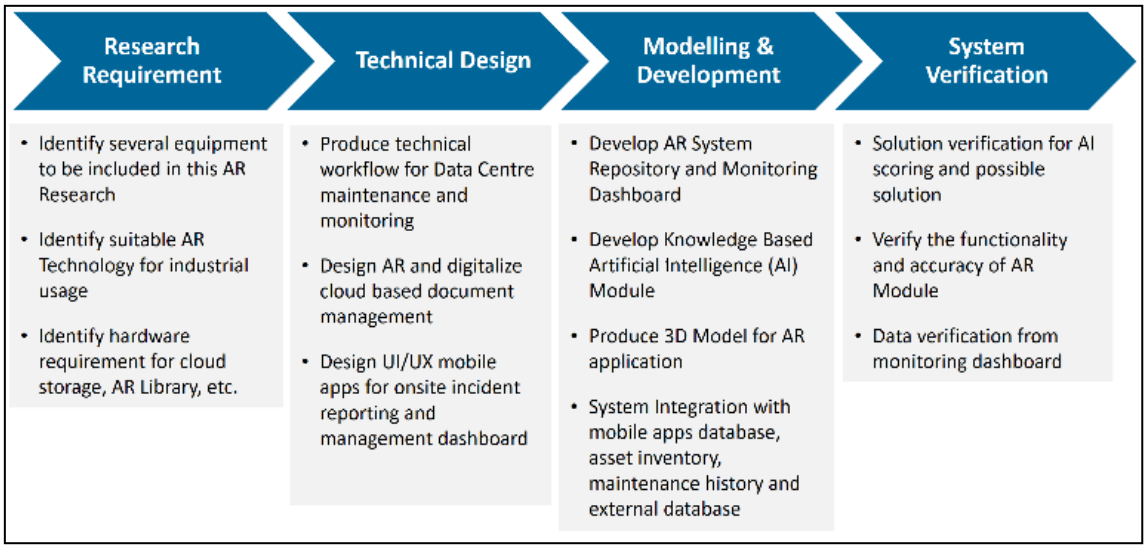

Figure 1. Overview of the Project Methodology

Thirdly, the development phase of modules is required for AR-assisted maintenance. A web-based application with API integration is developed to exchange data from the central database to the mobile application and the AR viewer. The mobile application complements the web-based functionality and acts as a companion tool to capture the data for inspection and maintenance on-site. A solution for each issue can be captured, thus developing the knowledge-based AI features for the root cause analysis.

Lastly, 3D models for markerless AR tracking are developed and embedded with live data from the database of the web-based application. Markerless tracking requires no marker e.g. QR, logo, or image, and solely responds to object recognition. This demonstrates both marker-based and markerless AR-assisted are capable to enhance inspection work on-site more conveniently and efficiently.

4. RESULTS AND DISCUSSIONS

The AR-assisted module has given a rounded solution that supports maintenance activities as well as asset monitoring. Information data on the asset could be displayed on both AR Web App (Figure 2) and AR Viewer (Figure 4).

AR Web App is a web-based application developed using Laravel PHP framework. This application was hosted at TNBR Data Center and accessible via the public network. The AR Web Server runs using Apache web server on Ubuntu 20.04 Long Term Support (LTS) operating system. API is utilized to simplify software development and innovation that enables applications to exchange data and functionality easily and securely through web services [2]. The API is hosted on the same server thus, increase data confidentiality. To gather real-time data from selected equipment, another API is configured using Zabbix to simulate data exchange to the AR Viewer.

Figure 2. Web App Process Flow

4.1. Asset Monitoring Dashboard

Asset Monitoring Dashboard allows the system administrator to monitor real-time data visualized through gauges and graphs. The dashboard summarizes critical information on existing assets such as server, network, and UPS health status. The dashboard displays feature for all assets as follows:

4.1.1. To display server health and condition status

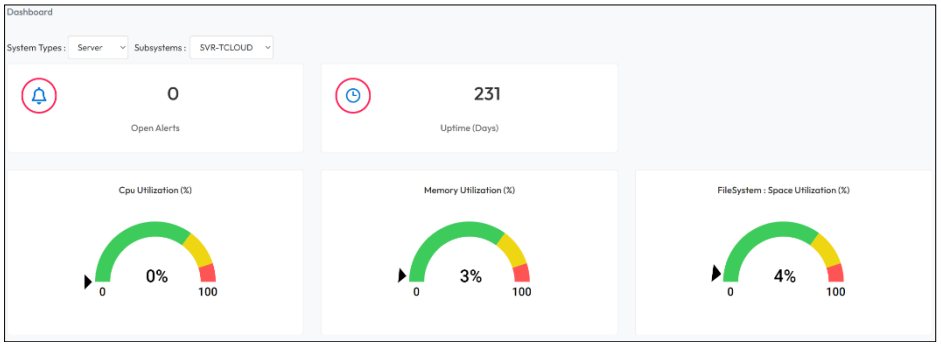

Figure 3. Server Health Status

4.1.2. To display network health and condition status

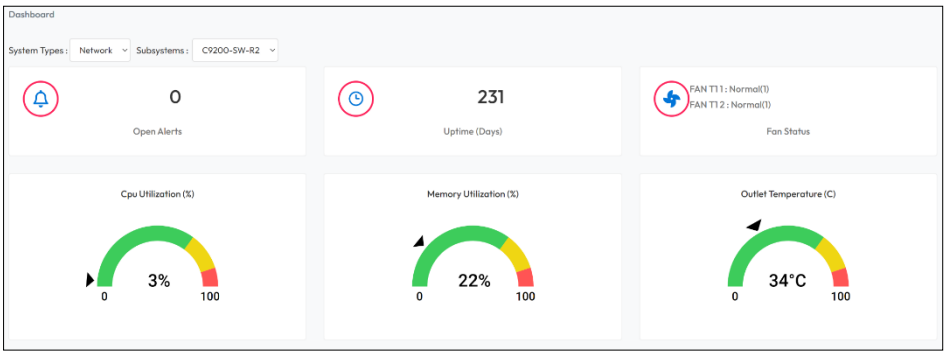

Figure 4. Network Health Status

4.1.3. To display UPS health and condition status

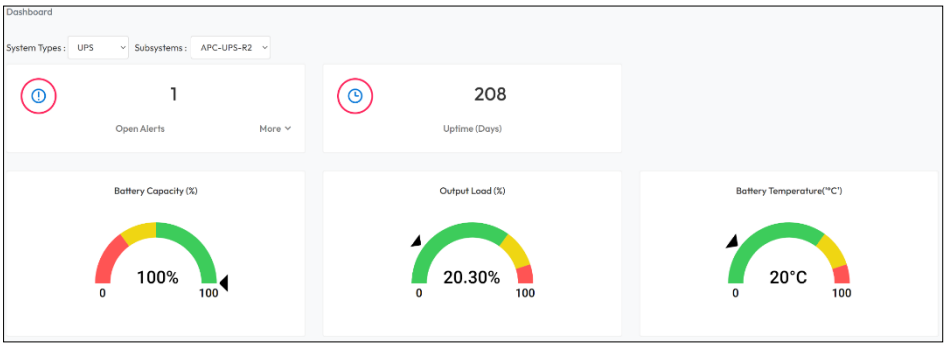

Figure 5. UPS Health Status

4.2. User Access Role

Multiple types of roles can be assigned to a designated user. Different types of roles will have different types of access limits such as personalized dashboards and permission control. The authentication is linked with Tenaga Nasional Berhad (TNB) Lightweight Directory Access Protocol (LDAP) to restrict access to only TNB users using their email authentication password. To enhance security measures, this Web App utilizes Secure Sockets Layer (SSL) which only enables the web browser to access the site via HTTPS. It is the standard technology for keeping an internet connection secure, thus safeguarding sensitive data.

4.3. Application Programming Interface (API)

API is a set of rules that computers or applications communicate with one another. APIs act as an intermediary layer that process data transfer between system. Data that is requested by a user or other application will be authorized and granted by API. Similar to this AR Web App, API integrates with both Mobile App and AR Viewer App to display selected data information securely. The AR system interprets the data and presented it on AR Dashboard in a structured manner.

4.4. Support Ticket

Businesses or organizations are increasingly dependent on ICT infrastructure and services to support business processes that lead to positive revenue growth. Therefore, the support ticket module platform is important for IT Department to monitor and optimize customer/user experience during the resolution process.

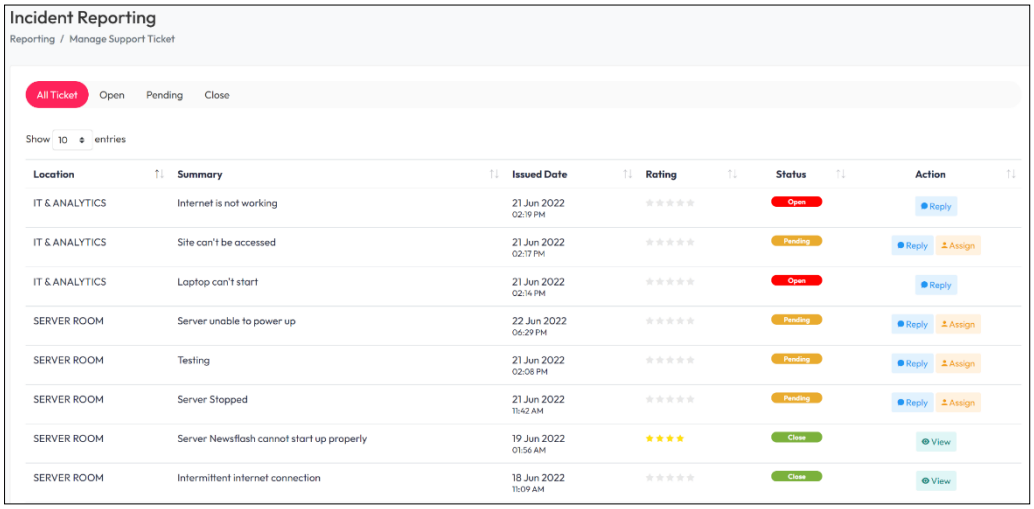

Figure 6. Incident Reporting

This is crucial for IT Department to comply with Service Level Agreement (SLA) that has been agreed upon. Chat box feature was included in AR Web as an additional module to capture the conversation between technician and staff.

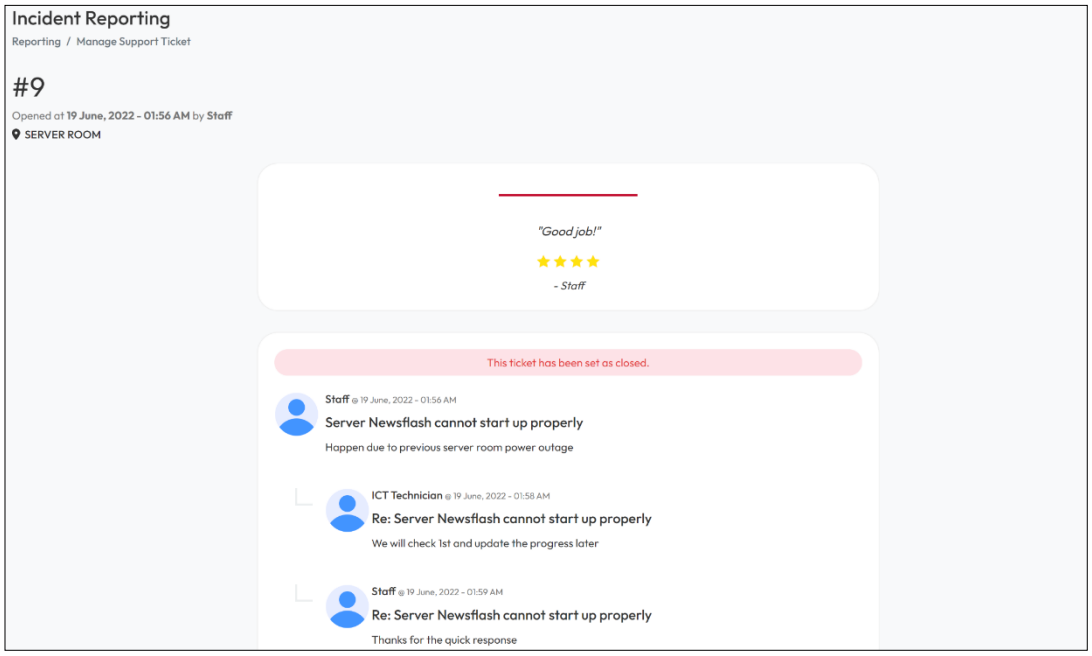

Figure 7. Star Rating Feedback

Star ratings are included inside the module allowing the staff to rate the technician service or share their feedback. This is important to evaluate their services and competencies, as well as to monitor Key Performance Index (KPI). This provides valuable information and room for improvement by the SLAs or customer charters.

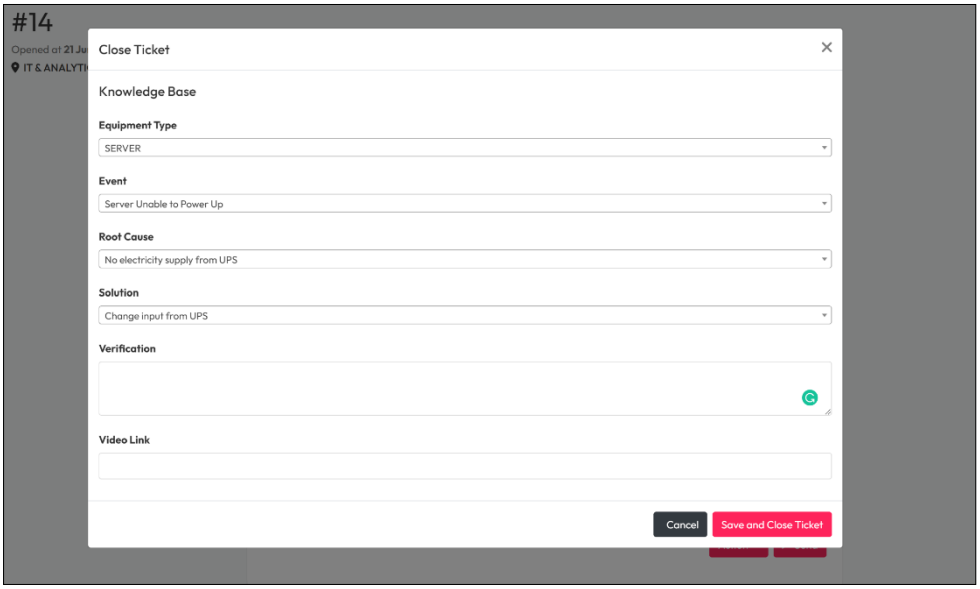

Figure 8. Knowledge Base Data Entry

Upon closing the ticket, the technician is required to key in the knowledge base. All information such as events, root causes, and solutions is already predefined. With this, the data can be collected and stored inside the database accurately and in a standardized manner.

To lodge an incident report, support tracking and asset monitoring can be accessed through AR Mobile App (Fig. 2). The mobile app complements the functionality of the web application in terms of flexibility and practicality. The functionality is trimmed from the web version and personalized to the different types of roles such as system administrator, technician, and user. The app consists of a personalized dashboard, asset management, and incident reporting. Intuitively designed, the app interface and user experience are engaging thus reducing the learning curve. The app is ready on both the Android and iOS platforms.

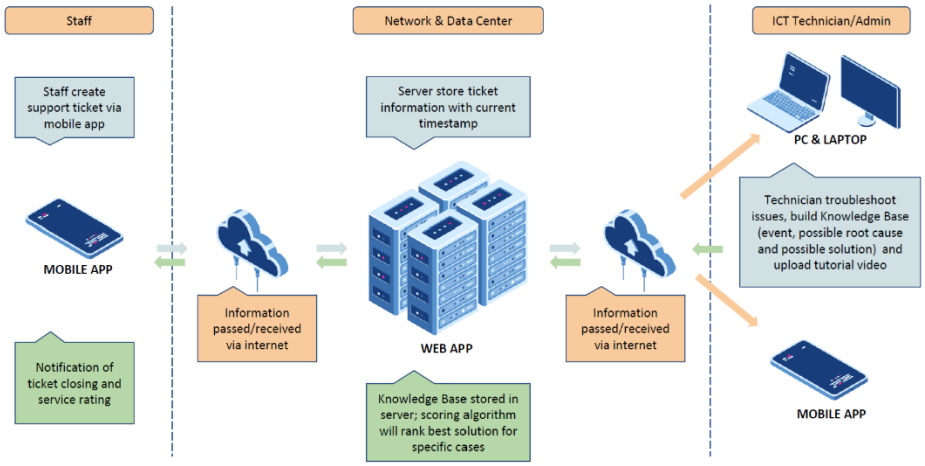

Figure 9. Mobile App Process Flow

AR Viewer has been designed to support on-site inspection, regular maintenance, and troubleshooting. With AR, machine maintenance can be performed faster and with fewer errors. That reduces mean time to repair, improves equipment availability, and reduces unplanned downtime.

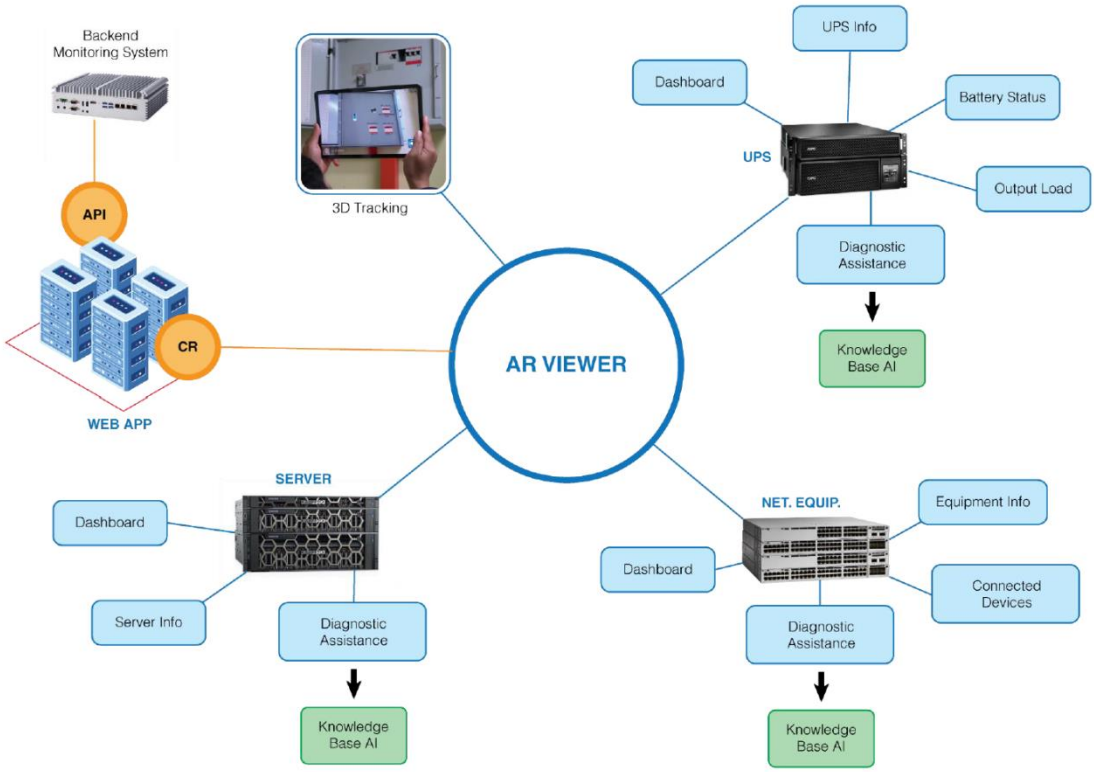

Figure 10. AR Viewer Process Flow

With all modules ready, the technical person in charge can easily identify the problem that arises and respond to the issue with the solution given by AR Viewer. This will shorten the time of troubleshooting and increase work productivity.

5. LIMITATIONS

The limitation of the research can be divided into three aspects, which areknowledge base maturity, practicality and safety, and organizational change management. To produce the best user experience, the knowledge base should be mature in terms of historical data and contain an adequate amount of use cases. This requires a lot of effort to extract expertise from domain experts and experienced users, especially in a niche area. The collected data must be cleansed for further analysis.

In terms of practicality and safety, the AR viewer can be designed as glasses, head mount units, wearables and mobile apps. Each of the design must be suited to the working environment to ensure usability and complies with safety policy. Lastly, a new approach introduced to organizations may result in lack of user support and engagement. Change management plans should be taken into consideration in the early development stage to ensure a successful outcome.

6. FUTURE WORK

This paper suggests further studies with larger knowledge base datasets to enhance the accuracy of the diagnostic analysis. Machine learning can be incorporated into the existing approach to mimic the human decision-making process. Wearables and head mount devices in the market should be studied in practicality and safety aspects to fully appreciate what AR technology has to offer from time to time.

7. CONCLUSIONS

In summary, the project has successfully executed and produced a functional system that enhances user and customer experience, as theoretically, AR increases user engagement and interaction. This proves that AR technology is capable to retain maintenance expertise by digitalizing knowledge [5]. This AR-assisted project can be applied not only to TNBR Data Center but also to other equipment such as system at Hydro Power Plant or other industry that requires frequent maintenance.

REFERENCES

[1] A.Riya and S.Abhishek, “Augmented Reality and its effect on our life” – IEEE, 2019 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence)
[2] What is an Application Programming Interface (API) - https://www.ibm.com/cloud/learn/api
[3] How AR fits into Industry 4.0 - https://electronics360.globalspec.com/article/18215/how-ar-fits-into-industry-4-0
[4] What Is Augmented Reality (AR)? A Practical Overview - https://www.threekit.com/blog/what-is-augmented-reality
[5] Augmented reality tools: A digital bridge for the skill gap - https://www.controleng.com/articles/augmented-reality-tools-a-digital-bridge-for-the-skill-gap
[6] R. Azuma, Y. Bailot, R. Behringer, S. Feiner, S. Julier and B. MacIntyre, “Recent Advance in Augmented Reality” – Computers & Graphics, November 2001

AUTHOR

Muhamad Adib is an IT Executive in one of the subsidiaries company for Tenaga Nasional Berhad (TNB) in Malaysia. He was born in Kuala Lumpur. He holds a degree in Business Computing and further his Master in Economics. Passionate about implementing technology, especially in IT that could help people make life easier.